



**Preparatory action — User-friendly
information tool on urban and regional
vehicle access regulation schemes 2
UVAR Exchange**

**Task 1.1 and 1.2
Practical aspects of UVAR information
provision through signage**

Final report

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Abbreviations and acronyms

CCZ	Congestion Charging zone
LEZ	Low Emissions Zones
LTZ	Limited Traffic Zones
NAP	National Access Point
PED	Pedestrian Zones/Areas
PEDP	Pedestrian Priority Zones
UNECE	United Nations Economic Commission for Europe
UVARs	Urban and regional Vehicle Access Regulation
ULEZ	Ultra-Low Emission Zones
VMS	Variable Message Signs
ZEZ	Zero Emission Zones

1. Introduction

This report was prepared within the framework of the **European Parliament Preparatory action — User-friendly information tool on urban and regional vehicle access regulation schemes 2**, based on contract No MOVE/B3/SER/2020-716/SI2.852092 implementing the No MOVE/2020/OP/0012, signed on 15 July 2021.

The report is submitted to the European Commission – Directorate General for Transport and Mobility (DG MOVE) by the Consortium led by Panteia in association with ARMIS, AustriaTech, CORTE, MAPtm, TRT Trasporti e Territorio, and Sadler Consultants.

It is the result of both desk research activities and the collaborative work carried out within Task 1.1 and 1.2 with a group of stakeholders and local authorities aimed at understanding how to provide proper information through signage to road users approaching, in the vicinity and inside urban vehicle access regulation schemes (UVARs).

It describes and presents:

- how UVARs' on-road information is provided in different EU countries, highlighting peculiarities of different UVAR typologies and current practices in road signs (Chapter 2);
- the recommendations and a set of proposals for harmonised, easily understandable and complete UVAR signage in the European Union (Chapter 3);
- the elements that affect the complexity and understanding of UVAR schemes with impacts on signage (Chapter 4);
- the recommendations on the use of C-ITS for UVARs (Chapter 5);
- conclusions and next steps (Chapter 6).

A collection of existing UVAR signs and proposals of hamonised signs as a result of subtask. 1.4.1 demo activities is provided in Annex 1.

Annex 2 includes the results of a visual survey conducted among EU drivers on UVAR signage comprehension and understanding between November and December 2022.

This report is also complemented by the results of subtask 1.3, condensed in the document “Guidelines of UVAR VMS”.

2. UVAR typologies and current practices in signage

According to different national legislations, a competent authority may restrict, either permanently or temporarily, the access to an area, road, or a portion of the road to all motor vehicle traffic or to specific categories. This is commonly justified by safety, health, environmental or mobility/public order reasons.

When such restrictions are implemented in urban and metropolitan areas, they are referred to in general terms as **Urban Vehicle Access Regulations or UVARs**.

This report focuses on the following 5 main UVAR typologies:

- **Pedestrian Zone**
- **Limited Traffic Zone**
- **Low Emission Zone**
- **Congestion Charge Zone**
- **Pedestrian Priority Zone**

These are hereafter briefly introduced in order to present their overall scope, main characteristics and a first set of signs and symbols used for their identification highlighting the elements affecting clarity and comprehension.

A fundamental reference is the 1968 UN Convention on Road Signs and Signals (and the European Agreement supplementing the Convention)¹, which focuses on uniformity and harmonisation to facilitate international road traffic and improve road safety.

The report refers to zonal UVAR applications²: these are areas that include several streets or an entire neighbourhood/portion of the city, bordered by UVAR signage (zonal signs and sometimes also road markings) at entry and exit gates, with rules that are valid for all roads in the zone and thus avoiding the repetition of the regulatory sign at every road junction. A **sign having a zonal validity** is displayed on a rectangular main panel with a white/light-coloured ground and the word “ZONE” displayed above or below the sign on the panel as described in Annex 1, section E (special regulation signs), subsection II, paragraph 8 (a) to the Vienna Convention. Additional panels can be installed below the main one in case of more information to be communicated to drivers.

The “NO ENTRY” sign shaping a red roundel (C,2 as in the Convention) and its variants, is the basic sign used for the entry zonal sign of different UVARs as further described in the next sections.

UVAR zonal signs are also complemented by **advance warning signs** at different approaching distances from the entry sign (including static or variable message signs on motorways for larger schemes). These enable drivers to be informed in time on the UVAR and in case to divert before reaching the gate. UVAR signs can be also installed inside the zone usually to inform about upcoming restrictions or of the need to register or pay a charge within a certain time after entering.

¹ https://unece.org/DAM/trans/conventn/Conv_road_signs_2006v_EN.pdf - The Convention has been ratified by most European countries with the exception of Spain, Ireland and Malta (plus the United Kingdom outside the EU).

² UVARs may also be applied punctually and so we can have single roads with no access to motor vehicles of a specified maximum length/height/weight, temporary restrictions for weekly street markets but also other UVAR sub-types such as School streets, Play streets or Living streets. In such UVARs the respective sign is generally displayed without the rectangular panel with no zonal reference.

2.1 Pedestrian Zone

The first UVAR typology is the **Pedestrian Area** or **Pedestrian Zone**, typically a square or a group of contiguous roads where no motorised vehicles are allowed and the whole space is reserved only to pedestrians, sometimes also allowing bicycles as equal or ‘tolerated’ status.

Pedestrian areas might admit just very few vehicle/user categories such as emergency/police vehicles, people with reduced mobility, residents who needs to reach their garage, delivery vehicles (usually in one short and off-peak time window) or micro/autonomous/cycle-based collective passenger vehicles. Parking is not allowed and admitted vehicles should proceed at walking speed. The access details are given, if appropriate and as for other zonal UVARs, below the sign on the rectangular panel or on additional panels below the main one.

The overall objective is to make these areas more liveable and safer by prioritising walking, social interaction and to protect visually and physically sensitive sites such as monuments and landscapes. Quite often such zones cover small city portions even if cities are increasingly implementing pedestrian zones over large parts of the city centre, to ensure that it is attractive to visitors.

From a driver perspective, recognising pedestrian zones is relatively easy: the intimate characteristic of the area (e.g. the presence of monuments in squares), street furniture, cobblestones in historical cores or other physical interventions transforming roads into public spaces often reinforce the message that no motor traffic is allowed thus complementing the information provided by the signs.

In the majority of countries signs are based on a blue symbol representing one or two human figures, thus assuming more an informative character other than a restriction communicated to car drivers. In other countries such as Portugal, Spain and the UK the red prohibitive sign (C,2 roundel) is used. Additional information is displayed when the pedestrianisation is not permanent (time validity) or to indicate allowed vehicles (e.g., bicycles) or time windows for delivery operations.

Figure 1: Examples of Pedestrian Zone signs



2.2 Limited Traffic Zone

In line with the objectives of pedestrianisation (liveability, road safety, cultural and natural heritage protection, climate change) and in order to reduce congestion, **Limited Traffic Zones (LTZ)** restrict access to only those motorised trips that are considered necessary for the functioning and daily life of the area. Residents, garage owners/tenants, caregivers, people with reduced mobility (PRM), freight carriers, shop tenants, maintenance and servicing companies are commonly authorised and pre-registered with permission to enter, plus some categories of automatically exempted vehicles such as public transport, taxis, emergency/police.

Usually covering wider areas such as historical centres or marinas, LTZs always work with **Permits**. These authorisations must be requested in advance through a tailored website or in person at city offices. Some permits have a longer validity (e.g., 1 to 5 years for the categories indicated above) others may allow occasional access from other user types such as residents visitors or hotel guests³. LTZ might also restrict access (in addition or exclusively) to specific vehicle categories (quite common are the restrictions for lorries and coaches) or vehicle characteristics such as type, weight, size or pollution levels (noise, air quality). Parking is also allowed, and time windows are largely used to regulate freight vehicles' access and loading/unloading operations. LTZ regulations may request to display the permit on the windscreen as stickers.

The overall principle is to reduce motor traffic to the very essential and minimum level, or at least to significantly reduce it (particularly through traffic), depending on the number of categories and requirements granted by the permit system. The policy objective is to prioritise walking, cycling and public transport.

Limited Traffic Zones are widespread in Italy⁴ but this UVAR typology is present in many other EU Member States with different names and acronyms as indicated in the following table.

Table 1: LTZ name and description in 6 EU countries

Country	Definition and acronym	Notes
Italy	Zona a Traffico Limitato (ZTL) – <i>limited traffic zone</i>	The English definition and acronym (LTZ) is already mandatory on Variable Message Signs (VMS) at every camera-enforced entry gate.
Belgium	Zone à Accès Limité (ZAL) – <i>limited access zone</i> Beperkt Toegankelijke Zones (BTZ) – <i>restricted traffic zone</i>	Different use of terms (access vs. traffic; restricted vs. limited) in the two languages. Examples are the “car free” (autovrije) zones of the city of Ghent and the schemes implemented in Brussels (Ixelles) and Antwerp.
France	Zone à Trafic Limité (ZTL) - <i>limited traffic zone</i>	Nantes introduced a LTZ in 2012 followed by Grenoble in 2015. Paris launched a consultation for a permanent scheme in Paris Centre Saint-Germain promoting it as “quiet zone” (zone apaisée).
Spain	Área de Prioridad Residencial (APR - Valencia) – <i>residential priority area</i> Àrees de Circulació Restringida (ACIRE- Palma) – <i>restricted traffic area</i>	Different definitions and acronyms are used across the country. Spain has not ratified the 1968 UN Convention on Road Traffic, and this is reflected in a lack of harmonisation of signage.

³ The ReVeAL Guidance gives more details on this in section 5.3: <https://civitas-reveal.eu/resources-overview/publications/guidance/>

⁴ The very first European traffic ordinance was introduced in Siena in 1965 and nowadays there are more than 350 ANPR-enforced LTZs across the country.

	Zona de Acceso Controlado (Pamplona) – <i>controlled access zone</i>	The former APR in Madrid was renamed Madrid Central and now Madrid Distrito Centro.
Poland	Strefa Ograniczonego Ruchu (SOR - Krakow) – <i>restricted traffic zone</i> Strefa Ograniczonej Dostępności (SOD – Gdańsk) - <i>restricted access zone</i>	Different definitions and acronyms are used in the two Polish cities where such UVAR typology is active.
Portugal	Zona de Acesso Automóvel Condicionado (ZAAC) – <i>conditional motor access zone</i>	These are in place in many cities including Lisbon, Porto, Coimbra, Santa Maria da Feira, Chaves and Guimarães.

The absence of a common definition and understanding of its purpose and functioning led some typical LTZ schemes to be indicated as Pedestrian Zones (e.g., in Spain).

LTZs signage uses the zonal rectangular panel with the red “C,2” roundel sign at the centre. Applications mainly differ in terms of usage of the main panel vs. supplementary panels to display the key information on permitted user categories and/or time validity. A CCTV symbol or text is added for camera-enforced schemes.

Due to the large number of implemented schemes, the Italian Ministry of Transport issued in 2019 its "Guidelines on the regulation of road traffic and signs in limited traffic zones"⁵ addressed to all city authorities. The guidelines, the first of this type in Europe addressing specifically on-road information provision, are aimed at “creating homogeneous, coherent and more easily recognisable sign systems for road users” and also at “facilitating authorisation procedures for the installation of Automatic Number Plate Recognition (ANPR) systems” as from the introduction to the document.

Here below, a selection of four LTZ entry signs from Italy, Belgium, Portugal and Poland is presented to highlight peculiarities and some missing or less comprehensible elements.

Figure 2: Examples of LTZ entry sign in EU



⁵ https://www.mit.gov.it/sites/default/files/media/notizia/2019-07/Linee_Guida_ZTL_5050_28_giugno_2019.pdf

- The mandatory Italian sign uses the extensive definition in lowercase letters on the main zonal panel and, on the additional panel, a small text indicating “no entry to unauthorised motor vehicles” (and motorcycles if applicable), the word “except” followed by a symbol of PRM and text specifying they should be preliminarily authorised, the exempted categories such as police/emergency and allowed delivery times (but not indicating the need of prior authorisation for such vehicles). In case of ANPR-enforced schemes, further additional panels are used to display the information on enforcement (symbol plus text), phone number and website for information and registration and a small VMS panel.
- The Belgian sign in Ghent indicates on the main panel (with small symbols) the exclusion of bicycles and motorcycles from the prohibition and includes the text “excluding permit holders”; it also includes a pedestrian priority sign as secondary panel.
- The sign in Guimarães (PT) indicates “except authorised (vehicles)” (also in English), a small text with temporal validity of the scheme and a CCTV symbol; a secondary panel uses pictograms for indicating speed, size and vehicle type restrictions.
- The sign in Krakow (PL) does not use the zonal rectangular panel (despite the restriction is applied to an area) and largely use text in national language on a secondary panel to indicate exceptions.

In all the examples above the use of symbols is not prominent nor harmonised and some key information are displayed through small texts not legible by the drivers and/or by vehicular cameras.

2.3 Low Emission Zone

The focus on pollution levels and the difficulty of meeting the EU air quality standards has led in recent years to the introduction of **Low Emission Zones (LEZ)**, also called “Environmental Zones” in some countries (i.e., Germany, the Netherlands, Sweden, Denmark).

LEZs restrict vehicular access to only those vehicle categories that meet set minimum air quality standards. The European vehicle emission standards for exhaust emission and the respective “Euro” stages, from 1 to 6 (or I to VI depending on vehicle type), are used to regulate LEZ restrictions.

Different from LTZs, the primary objective of Low Emission Zones is to reduce air pollution from motor traffic. Generally, pure LEZs rarely reduce traffic levels⁶: their effect is to accelerate the renewal of the fleet. The founding principle is to discriminate by air pollution contribution and not by the ‘societal need to enter’ as with LTZs, often with differing standards by fuel and sometimes vehicle type. This should be reflected in the communication to drivers: compliant, less polluting vehicles are allowed to access the zone, and no other additional conditions are applied (apart for exceptions) as opposed to LTZs that add environmental restrictions to the user categories eligible for obtaining a permit as in the regulation (this is the case of the so called “Environmental LTZ” of Bologna in Italy).

LEZs are usually phased in, with increasingly strict standards over time. Occasionally stricter rules applied in different and usually concentric areas may lead, for the sake of communication and comprehension by road users, to different sub-type names such as Ultra Low Emission Zone (ULEZ) in London or Zonas de Bajas Emisiones de Especial Protección (ZBEEP) - *special protection LEZ* in Madrid. When only zero emission vehicles are allowed, the LEZ becomes a Zero Emission Zone (ZEZ).

The geographical scope for LEZs normally includes a large portion of the urban territory (sometimes entire metropolitan areas) and is therefore wider than a typical LTZ. The guidelines issued by the

⁶ See <https://www.umweltbundesamt.de/themen/luft/luftschadstoffe/feinstaub/umweltzonen-in-deutschland#1-wie-ist-der-aktuelle-stand-der-umweltzonen> (in German). The exception being the London ULEZ with a Euro 6 diesel standard in 2019, using as a legal basis a charging scheme where compliant vehicles are free.















Spanish Ministry of Transport (MITMA) recommend defining a LEZ size that is “*significant and sufficient for the fulfilment of its objectives*” and “*includes a significant part of the population, of the surface area of the municipality or of the motor vehicle traffic*”. Another more recent and complete LEZ guidelines document⁷ published by another Spanish Ministry (MITECO) confirmed such indication but also introduced the possibility to implement LEZ in smaller areas and also punctually (e.g., at big car traffic attractors such as hospitals, universities, etc.).


















Since different standards are applied to different vehicle types and fuels, some EU countries, namely Germany, Austria, Spain, France and Denmark⁸ adopt a simplified (but unfortunately not harmonised) national classification system making use of stickers/vignette, also called environmental certificates or labels, based on a set of coloured numbers (or letters) as in the following figure.















⁷https://www.miteco.gob.es/es/calidad-y-evaluacion-ambiental/participacion-publica/borrador-directrices-paralacreacion-de-zonas-de-bajas-emisiones_tcm30-530517.pdf


















⁸ In Denmark a simplified system based on only 2 stickers (green and a red) is in use

Table 2: Equivalence of emission stickers in EU countries

PETROL Passenger cars and light vans								
Emissions regulations	EURO 6	EURO 5	EURO 4	EURO 3	EURO 2	EURO 1	Previous	Special Authorization
Spain							--	
Germany								--
Austria								--
France								--
Denmark							--	

DIESEL Passenger cars and light vans									
Emissions regulations	EURO 6	EURO 5	EURO 4	EURO 3	EURO 3	EURO 2	EURO 1	Previous	Special Authorization
Spain								--	
Germany								--	
Austria								--	
France								--	
Denmark							--		

PETROL Heavy duty vehicles, buses and coaches								
Emissions regulations	EURO 6	EURO 5	EURO 4	EURO 3	EURO 2	EURO 1	Previous	Special Authorization
Spain							--	
Germany								--
Austria								--
France								--
Denmark							--	

DIESEL Heavy duty vehicles, buses and coaches									
Emissions regulations	EURO 6	EURO 5	EURO 4	EURO 3	EURO 3	EURO 2	EURO 1	Previous	Special Authorization
Spain								--	
Germany								--	
Austria								--	
France								--	
Denmark							--		

Alternative energy vehicles							
Emissions regulations	BEV	EREV	PHEV	VEGF	PHEV	HEV	CNG LNG LPG
Spain							
Germany							
Austria						--	
France						--	
Denmark							

2 wheeled vehicles														
Emissions regulations	BEV EREV	VEGF	PHEV	PHEV	HEV	CNG LNG LPG	EURO 5+	EURO 5	EURO 4	EURO 3	EURO 2	EURO 1	EURO 1	Special Authorization
Spain														--
France					--								--	--
Denmark												--		

Source: Spanish Ministry of the Interior; <https://sede.dgt.gob.es/es/vehiculos/distintivo-ambiental/equivalencia-distintivo-ambiental-ue.shtml>

Note: some countries also allow retrofitting of diesel particulate filters and/or NOx aftertreatment, which is not included in this diagram.

The distinctive visual elements for some countries are a polluting vehicle inside the red prohibitive roundel (Belgium, Spain and Sweden) that becomes a text (e.g., *milieu, umwelt, emise*) complementing the “zone” word for some other countries.

This characterisation is not adopted in Italy or France where the simple “no entry” C,2 sign is used (as for LTZ) and supplementary panels indicate (via a text or symbol) the reference to admitted vehicle categories and Euro standards.

Portugal has introduced in 2020 a new zonal sign indicating the acronym ZER (*Zona de Emissões Reduzidas*) below the red roundel (and thus differentiating the LTZ from the LEZ sign). This has been adopted also in Barcelona by adding the acronym ZBE or its extensive name (but which is not requested by the national guidelines that prescribe the symbol of the polluting vehicle, also without the zonal indication).

In France, The Ministry of the Ecological Transition published in 2020 the “*Guidelines for the implementation of Low Emission Zones*” (called Zones à Faibles Émissions mobilité - ZFE-m)⁹. The document provides indications on LEZ signage even if tailored guidelines are announced and under preparation by Cerema.

The use of stickers has the advantage of limiting the number of information to be shown on LEZ signage (these can be displayed on the main zonal or on an additional panel). Countries not using stickers should in fact specify allowed Euro standards per vehicle type and fuel type on additional panels. This is done in The Netherlands¹⁰ where emission standards are displayed in a coloured roundel (but not being a sticker).

In Belgium and in Italy (and also in the UK) information on allowed emission standards are not displayed on main entry panels (apart for some advance warning signs) thus making it impossible to understand and comply to LEZ rules while driving.

Stickers-based LEZs always need the vehicle to be registered to the system (as for permits in LTZs), particularly for foreign vehicles. In non-sticker systems enforcing the scheme with ANPR, compliance is automatically checked through a direct link with the national vehicles' registry.

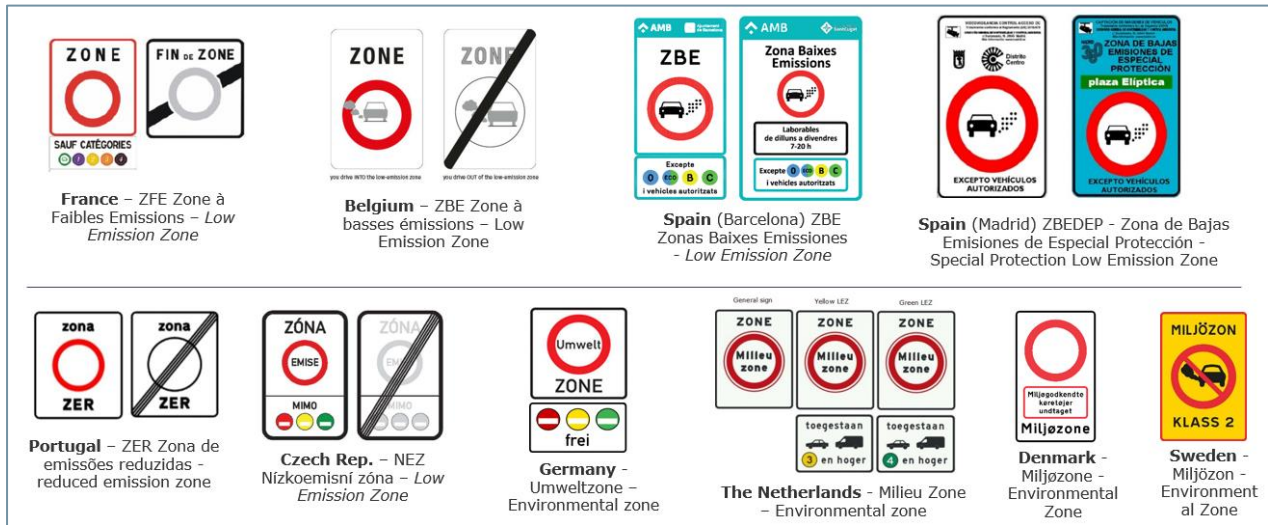
LEZ also works with exemptions for non-compliant vehicles associated to certain user or vehicle category as specified in each local regulation. These are special authorisations (as for LTZ permits) that particularly in ANPR-enforced schemes have to be requested and obtained in advance from the local authority or the mobility agency/operator (irrespective of the sticker/non sticker system adopted).

The use of additional panels for time validity, exceptions to the rule and the indication of the CCTV symbol is similar to LTZs and Pedestrian Zones.

⁹ https://www.ecologie.gouv.fr/sites/default/files/Guide_accompagnement_mise_en_place_ZFEM.pdf

¹⁰ <https://www.milieuzones.nl/english>

Figure 3: Collection of Low Emission Zone road signs



Source: national road codes and guidelines

Figure 4: Examples of Low Emission Zones signs



Source: TRT, French ZFE-m Guidelines, City of Utrecht

2.4 Congestion Charge Zone

Vehicular motor traffic might not be restricted according to certain vehicle/user category or emission standard but require payment to enter.

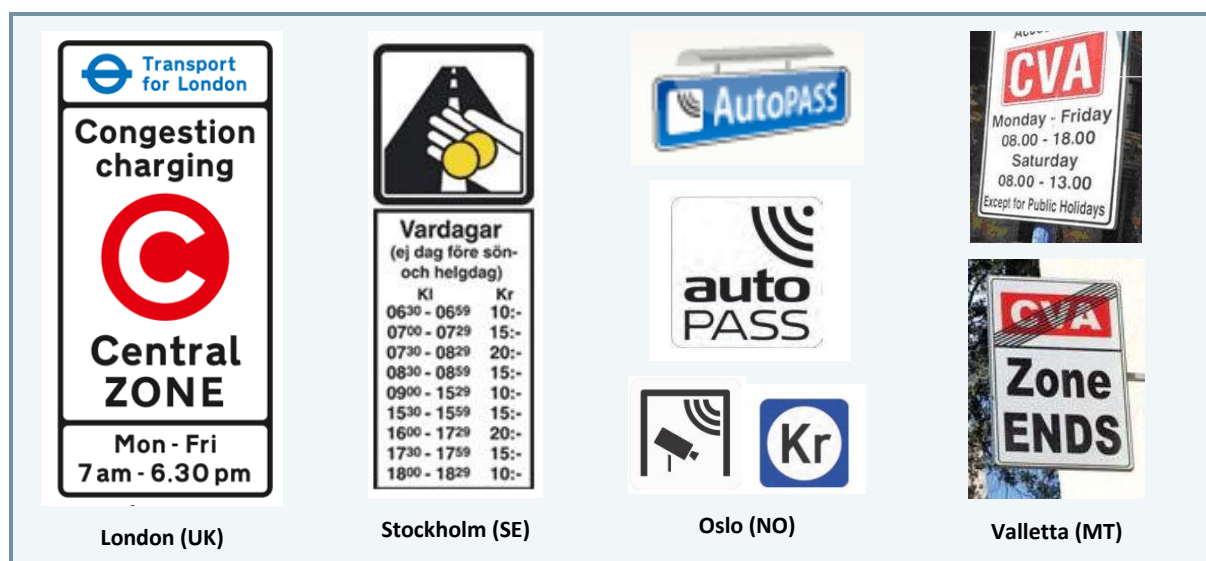
Again, a combination is possible between the two scopes of pollution and congestion reduction (as in the LEZ and LTZ distinction): a Pollution Charge Zone is an UVAR scheme where only vehicles not meeting a set emissions standard have to pay, whereas in a Congestion Charge Zone all motor vehicles are charged irrespective of their emission standard. Differential charges might be applied for different vehicle type and user categories, for example higher charges for lorries than cars, polluting vs less polluting (e.g., Oslo¹¹). Pollution charge zones can be also communicated as LEZs; the charge for non-compliant vehicles to enter being equivalent to a penalty fee, but the legal basis of the scheme being different, and daily exemptions are not issued – drivers simply pay the entry fee.

In 2008, Milan implemented the Ecopass pollution charging scheme, which accelerated fleet renewal at the start, but as the standard was not tightened, it progressively lost its congestion reduction effect as more and more vehicles could access the zone. It was therefore converted into a Congestion Charge, “Area C”, in 2011 where pre-Euro 4 vehicles are not permitted to access and all vehicles entering pay a fee (so it has an LEZ incorporated into the charging scheme).

Charging systems and regulations, also known as urban road tolls, usually work with ANPR or transponders (to check payments) and exemptions for some vehicle categories. Such scheme can cover both small and wider areas.

The official sign applied in London (but part of the national Traffic Signs Manual) is a white “C” (meaning “charge”) into a full red circle that tend to create an assonance with the red prohibitive roundel but not exactly communicating an access restriction as such. In Stockholm (Sweden), a tailored pictogram with coins is used. Norway uses the AutoPASS logo (that is the national automated system for collection of road and ferry tolls) but also other symbols in various formats. In Valletta (Malta) the CVA acronym is used on signs.

Figure 5: Examples of Congestion Charge and urban tolls signs



Source: TfL and CLARS / official websites of the schemes

¹¹ <https://urbanaccessregulations.eu/countries-mainmenu-147/norway-mainmenu-197/oslo-charging-scheme>

2.5 Residential Area, Encounter Zone, Superblock

In all previously mentioned UVARs, vehicle access restrictions or charges are applied: access is regulated through legal regulations. However, there are also other UVAR typologies where motor traffic is regulated through a required change in driving behaviour or by changes in the spatial road layout.

Two typical examples are **Residential Areas/Home Zones** and **Encounter Zones/Superblocks**. Users must adapt their driving/walking style while going in/out, moving and use such areas.

Box 1: Residential Areas definition in Vienna Convention

The art. 27 bis of the 1968 UN Convention on Road Traffic (European Appendix) clearly states which behaviours and uses are allowed in **Residential Areas** signposted as such:

- (a) Pedestrians may make use of the road over its entire width. Games are allowed.
- (b) Drivers shall proceed at very low speed, as specified by national legislation and which in no case should exceed 20 km (12 miles) per hour.
- (c) Drivers shall not put pedestrians at risks nor behave in an obstructive manner. If necessary, they shall stop.
- (d) Pedestrian shall not impede vehicular traffic unnecessarily.
- (e) Parking is forbidden except where allowed by parking signs.
- (f) At intersection, road users emerging from a residential area shall give way to other road users, except when otherwise provided in domestic legislation.

Source: United Nations

The shared character of the road is the most relevant element, but typically the physical configuration of the area also reinforces and enables such coexistence. Traffic calming interventions and opposing one-way streets/modal filters are widely used to avoid through traffic. The success of the **Woonerf** concept developed in the Netherlands (“woon” literally translates as residential and “erf” as yard) is due to a strict combination of law and road design elements.

The concept has been extended to other parts of the city: the “erf” can have other primary uses like crafts, trade, tourism, education and recreation. In France, Switzerland, Austria and Belgium these are named **Encounter Zones** (*Zone de rencontre, Begegnungszone*) and so are the Spanish **‘Superblocks’** (*Superillas/Supermanzanas*) that use traffic filters to remove traffic rather than banning it. Portugal has extended the definition to **“Residential and coexistence areas”**. A 30 km/h limit is usual in such zones, and similarly, but with less emphasis on road use and design, **30 km/h Zones** can be another way of defining Encounter Zones or Superblocks especially in countries where the legislation does not allow other UVAR types. Of course, traffic calming elements remains fundamental and should be present in addition to the prescribed speed limit for drivers.

These areas can be referred as “Pedestrian Priority Zones” even if the original definitions are more appropriate to distinguish the context and the characteristics of each scheme. It should be noted that these types of UVARs are not always defined as UVARs and can be implemented on a smaller scale than many ‘traditional’ regulatory UVARs.

Apart from Italy, all remaining signs use a similar and homogeneous combination of white pictograms into a blue panel: a pedestrian, a playing child, a home, and a car have different dimensions according to the relative importance of each road user. The French sign for “zone de rencontre” does not include the child but a 20 km/h speed limit in the panel.

Figure 6: Pedestrian Priority road sign collection



Source: https://en.wikipedia.org/wiki/Comparison_of_European_road_signs

As from the Belgian example in Figure 2, this sign can be associated to a LTZ zonal panel in absence of sidewalks or protected pathways, particularly in historical cores.

2.6 Advance warning signs and road markings

In addition to entry/exit zonal signs, different **advance warning signs** are also used. Some countries (e.g., Italy, France, Spain) provide clear instructions and prescribes minimum mandatory distances from the entry sign: the absence of advance warning signs can in fact invalidate fines issued via ANPR systems. The approach to an UVAR must be specifically signposted to provide users with information leading them, where appropriate, to choose an alternative route or to favour other transport modes via indications to a multimodal interchange or simply a parking area.

Advance warning signs can be present on main access roads and motorways several km before the zonal boundary but also in their proximity at distances ranging from 90 m to 500 m, particularly at the last junction that allows a detour in order to avoid the entry into the zone.

Figure 7: Examples of advance warning signs





Source: Italian LTZ guidelines, AMB Barcelona, Sadler Consultants and TRT

Some cities also implemented **complementary road markings** to emphasize the presence of an UVAR entry/exit gate and boundaries. This practice should be encouraged at EU level either by using linear markings or pictograms on the road surface.

Figure 8: Examples of road markings



Source: University of Ghent

Other signs are present inside the zone either to remind drivers that the scheme is enforced by cameras or to promote the upcoming introduction of new restrictions.

3. Recommendations on UVAR signage

This chapter presents a set of recommendations on how to properly organise and display information on UVAR signage together with some proposals for harmonised signs and signals¹².

The methodology has been developed within task 1.2 and validated in a round of three stakeholder workshops mainly focused on Low Emission Zones signs. Recommendations strictly follows the rules and flexibility offered by the 1968 UN Vienna Convention on Road Signs and Signals (and the European Agreement supplementing the Convention) and incorporated the results of demo activities and the driver survey included in annex.

3.1 MAIN PANEL

General characteristics

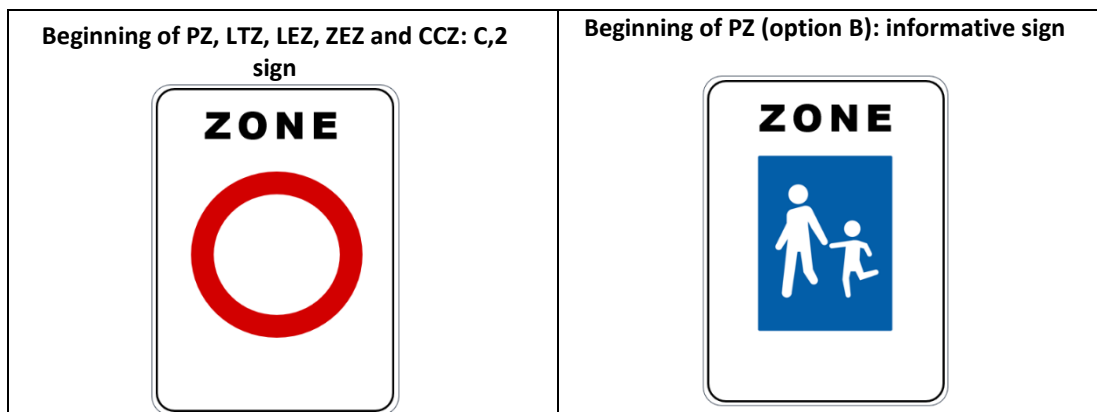
- Pedestrian Zones (PZ), Limited Traffic Zones (LTZ), Low/Zero Emission Zones (LEZ, ZEZ) and Congestion Charge Zones (CCZ) should use signs having a **zonal validity** indicating the entry to/exit from the zone with the sign displayed on a **rectangular panel with a light-coloured ground**¹³ as described in Annex 1, section E (special regulation signs), subsection II, paragraph 8 (a) to the Vienna Convention on Road Signs and Signals.¹⁴ This means that the sign applies to all roads in a zone and thus avoiding the repetition of the regulatory sign (alone and with no rectangular zonal panel) at every road junction.
- On zonal signs indicating the beginning of the UVAR, **the word “ZONE” or its equivalent in the national language** may be displayed above or below the sign on the panel.
- Since the Convention allows to include specific details of the restrictions/prohibitions below the sign on the main panel (e.g., time validity), there's a **preference for placing the word “ZONE” above the sign**.
- The **layout line** on the main panel should **be black and slightly recessed**.
- For PZ, LTZ, LEZ, ZEZ and CCZ, the sign displayed on the rectangular panel should be based on the prohibitory/restrictive signs as in Annex 1, section C of the Vienna Convention, featuring a **red roundel with a white or yellow background**.
- For Pedestrian Zones, the sign displayed on the rectangular panel should be preferably based on special regulation signs, featuring a **white human symbol inside a blue rectangle**.

¹² Examples in this chapters mostly uses Tern symbols (credit: Mr Stefan Egger. <https://iidre.weebly.com/symbols.html#/>)

¹³ This is mainly white, but may also be yellow in some countries for greater recognisability when there is frequent snow on the roads

¹⁴ https://unece.org/DAM/trans/conventn/Conv_road_signs_2006v_EN.pdf

Figure 9: Preferred characteristics of the main panel

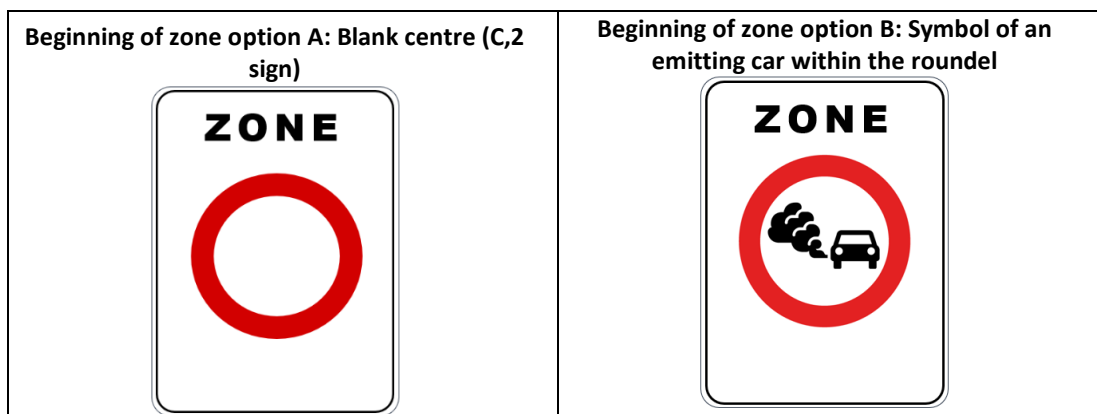


- As a general recommendation, the organization of elements and information on **zonal panels should be as simple as possible**; the use of symbols should be favoured instead of words.
- In order to further increase the clarity and recognition of the main zonal panel, additional information should be preferably placed on additional separate panels below the main one.
- No other pictograms and symbols such as the CCTV or the Municipality logo should be displayed on the main panel.
- Both symbols and text should be enough large in size to be seen and understood by the drivers (very small elements should be avoided).

Characteristics of the sign and use of symbols

- There are **two recommended possibilities** regarding the red roundel that could be adopted for (new) LEZs as in the following options for entry zonal signs.

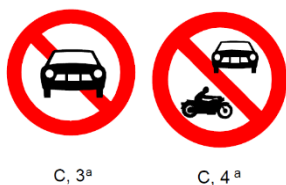
Figure 10: Recommended LEZ sign



- The main panel for ZEZs should be the same as for LEZs with specific information for ZEZs to be displayed on additional panels (see below).
- Based on workshops discussions and the results of drivers’ survey, **the specific symbol in option B helps in conveying the message of the LEZ**. Therefore, the recommendation is to develop and use a common symbol of an emitting car/vehicle at international/EU level in order to make the message of the sign easier to understand and also to differentiate LEZ signs from other UVAR typologies, e.g., Limited Traffic Zone or Pedestrian Zone (for countries using the prohibitory red roundel).
- If the LEZ sign is to contain the proposed symbol of an emitting car, the silhouette of **vehicle should be preferably depicted from the front view**, taking into account the following considerations and limitations:

- A/ The Convention car symbol in section C (section covering the road signs for prohibition) is seen from the front view (and also applies to the back view per Convention symbol design). **The (C,3^a) sign prohibits all motor vehicles, including motorcycles with side cars, but does not prohibit 2-wheeled motorcycles and mopeds.** Some countries include symbols for cars and motorcycles when they wish to prohibit both vehicle types or all motorvehicles (C,4^a sign).

Figure 11: Prohibition of access (motor vehicles and 2-wheeled motorcycles)



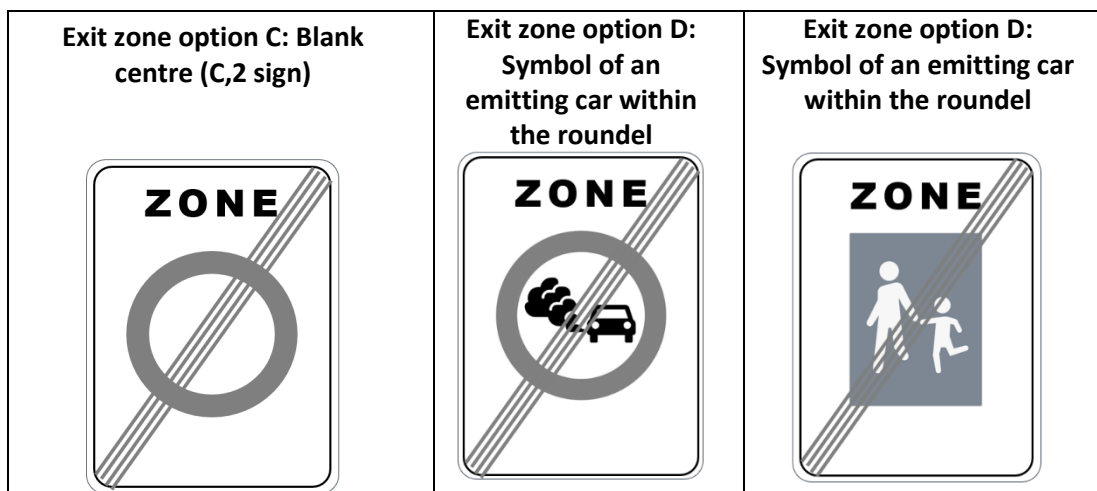
- B/ On the other hand, the car's **side view** stands for and is used by Convention Contracting Parties to mean passenger car specifically (except for Convention warning signs) so to specify rules applicable to that vehicle type only. The side view of a polluting vehicle could be used, for example, for schemes applying to certain vehicle types only as in the Netherlands for LEZ restricting access only to lorries (see Convention C,3^e sign).

Figure 12: Prohibition of access (lorries)



- To indicate the exit from the UVAR, the same sign displayed on a rectangular panel shall be set up as that placed at the entry to the zone but it shall be **grey on a rectangular panel with a light coloured ground**. A black or dark grey diagonal band (or parallel grey or black lines forming such a band) shall slope downwards across the sign **from right to left**.
- According to the Vienna Convention amendments, the preferred way to end zone is with **four thin parallel lines** rather than with the bar because with some images it makes it easier to see what is beneath the prohibition symbol. For the same reasons, the smog emitting from the vehicle should be depicted on the left sign within the roundel, in order for it to be visible under the parallel lines sloping downwards.

Figure 13: Preferred "end-zone" signs



- No other elements should appear on the panel (such as text ‘end of zone’).

Information about the LEZ scheme

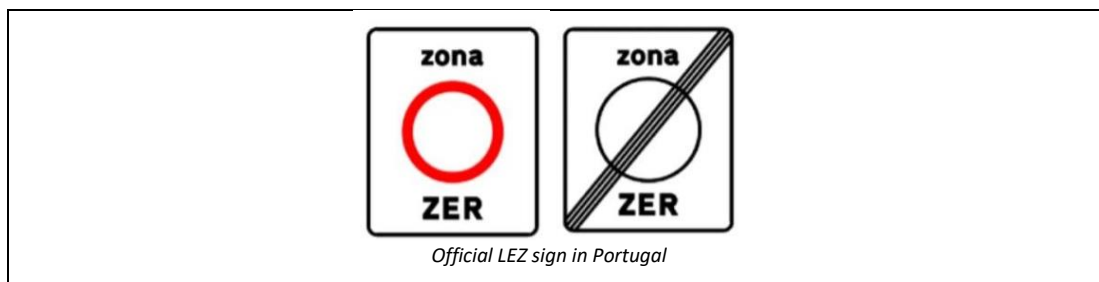
- **No inscription (text) related to the LEZ** should appear **within the red roundel** (e.g., as in use in Germany, the Netherlands and Czech Republic). According to the logic of the signs system, these mean that the text in the roundel is banned.

Figure 14: Examples of LEZ signs



- **Use of abbreviations** (such as “LEZ”, “LTZ” or national equivalent of the scheme as in the following example) **should be avoided** for reasons of readability and comprehension by drivers.

Figure 15: Example of LEZ sign



- Depending on national legislation / practice, the **extended name of the scheme may be spelled out in national language on the main panel**. Also, it **may appear in multiple languages** (for example in multilingual regions/countries or in areas with a lot of foreign drivers). In such cases and particularly in absence of a specific symbol (i.e., polluting car for the LEZ sign), the **word “ZONE” should be displayed alone above or below the red roundel, followed or preceded by the text “Low emission” or “Limited Traffic” or similar**.
- For LEZ and ZEZ, the word “emission” allows for similar meaning and spelling in many EU national languages (although not for every EU language) and should be preferred to the scheme name “Environmental zone” used in some countries (e.g., NL, DE, DK, SE).
- In the following, **proposals** for some harmonised LEZ entry zonal signs (applicable according to current national norms) are presented; the option of a sign using a polluting car symbol remains the ideal solution.


Table 3: Proposals for LEZ signs

<p>The Netherlands</p>	<p>Germany</p>	<p>Czech Republic</p>
<p>Denmark</p>	<p>France</p>	<p>Poland</p>
<p>Italy</p>	<p>Portugal</p>	
<p>Pros:</p>		
<ul style="list-style-type: none"> ✓ This allows for a distinction between LEZs and other types of UVARs, such as 'Limited Traffic Zones' (LTZ) as it is the case of zonal signs in Italy, Portugal, France, Belgium and other countries. ✓ Providing the information to drivers to understand the rationale for the prohibition may increase compliance by drivers.¹⁵ 		


¹⁵ Several studies support this in relation to variable-message signs (VMS), notably: Steinhoff, Christiane, Keller, Hartmut, Kates, Ronald, Färber, Brigitte & Färber, Berthold (2000). Driver Perceptions and the Effectiveness of Preventative Traffic Management Strategies. Proceedings of the 7th World Congress on Intelligent Systems, Turin, Italy, 6–9 November, 2000. de Craen, S. & de Niet, M. (2002). Extra information on Dynamic Message Signs: possibilities and effects. (Extra informatie op matrixborden: mogelijkheden en effecten.) Stichting wetenschappelijk onderzoek verkeersveiligheid SWOV, R-2002-13, p. 37. Netherlands.

Cons:


- ✓ It adds more information that needs to be processed by the driver in a short amount of time as opposite to the use of a specific symbol within the roundel as in the following proposals.



The Netherlands



Germany



Czech Republic

3.2 SUPPLEMENTARY PANELS

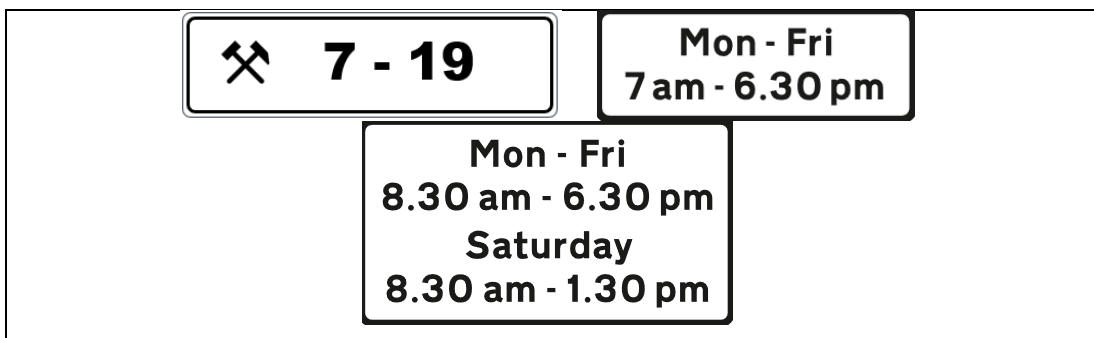
The layout and organisation of information on additional panels is similar for all UVARs. We recommend the following guidelines for organising the elements in such panels in order to promote a more uniform approach.

- All additional information should be organised in one or more supplementary panels, including:
 - o **Time validity** of the scheme, if applicable (i.e., in case of not “permanent” UVAR H24/365).
 - o The vehicles that are **permitted to enter** through the general UVAR rule, i.e. Euro standards / vehicle categories to which the prohibition **would not apply**.
- Whenever the use of symbols is not possible, **information** on additional panels should be **clear** and provided in a **short text**. Where possible using words that are simple, and similar to other European languages.

Time validity

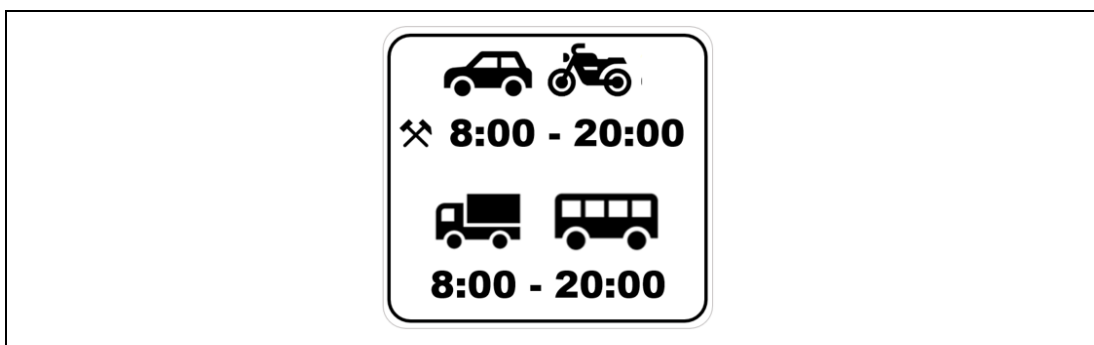
- It is recommended to first list the **time validity of the prohibition right under the main panel**. Some countries such as Italy have already adopted corresponding symbols to differentiate between working weekdays (a crossed hammer, alone indicating working days Monday to Saturday) and Sunday and festive days (cross). It’s worth noting that such symbols are not widely recognised by the drivers and therefore textual information might be displayed in any case.

Figure 16: Time validity signs



- In case of different time validity applying to different vehicle types, the vehicle type symbols (using the side view) should come first.

Figure 17: Time validity signs for specific vehicles





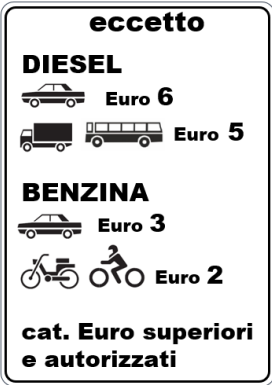
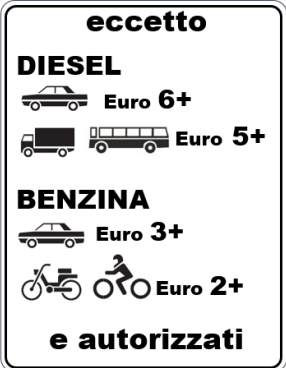



Exceptions to the rule

- To list the exceptions to which prohibition does not apply, the word ‘**Except**’ in a national language/s should appear on top of the supplementary panel listing these exceptions. The use of other words to refer to exceptions (such as the word ‘allowed’ as is currently the case in the Netherlands) is not recommended, as it is less easily understood in other languages.
- **Vehicle-specific exceptions to the ban**, i.e., vehicle types that may enter the UVAR according to different rules, if applicable, **should use symbols of corresponding vehicles** (for example van, bus, etc.) depicted from **side view** (as opposed to the front/back view). If **fuel type** needs to be specified, it should appear **in text**.
- Harmonisation of sticker/vignette system at EU level would be extremely difficult given the number of current schemes, and cause confusion in changing currently understood schemes. However, it is strongly recommended that **countries where such system is not yet introduced (particularly in neighbouring ones) should try to align with a currently used scheme**.
- **There is a need to differentiate between symbols for stickers and Euro standards**, as there are Member States where camera enforcement is used instead of stickers and there is no intent by the EC to harmonise these rules at EU level due to the difficulties mentioned above.
- **Euro emission standards or stickers of vehicles that are allowed to enter the LEZ** should be always indicated on a supplementary panel.
- The **text “Euro”** should be added side to the number to allow a differentiation compared to stickers.
- The text **“and higher categories”** or a **“+”** can be added after the first admitted Euro standard to indicate that all higher standards are also allowed (particularly when the list would be too long to be displayed on the panel).
- The wording **“and authorised”** in national language/s should appear right after the symbols

of exceptions and on the same supplementary panel to refer to all other types of exceptions to the rule that may exist in the UVAR scheme; this avoids indicating on the panel a significant amount of information.

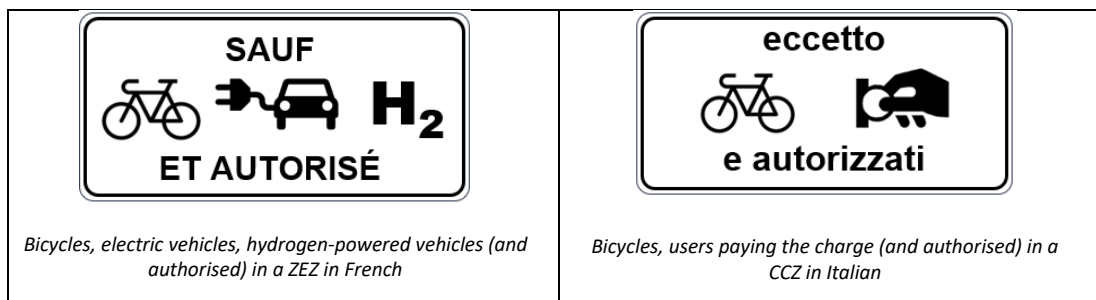
- In the following, **proposals** for some harmonised supplementary panels are presented.

Table 4: Proposals for supplementary panels

 <p>PZ, LTZ additional panel in Spanish</p>		
 <p>Euro standard, fuel and vehicle type exceptions in Dutch</p>	 <p>Euro standard and fuel exceptions in Italian</p>	 <p>Euro standard and fuel exceptions in Italian</p>
 <p>Sticker system in Spanish</p>	 <p>Sticker system in French</p>	 <p>Sticker system in German (the word "free" instead of except is used to allow for prompt application)</p>

- The supplementary panel referring to ZEZ and CCZ should use symbols as in the following examples (symbols are taken from the Tern collection and are own elaborations)

Figure 18: Symbols for ZEZ and CCZ supplementary panels



- For CCZs, the adoption of a common symbol referring to the need of advance payment should be encouraged at EU level; the use of a common text "CHARGES APPLY" or "ACCES SUBJECT TO CHARGES" should be also evaluated and discussed with national and local entities.
- Similarly, to the already discussed adoption of a common symbol for electric vehicles, also a common **Permit symbol** should be discussed and evaluated at UNECE level.

Enforcement and further information

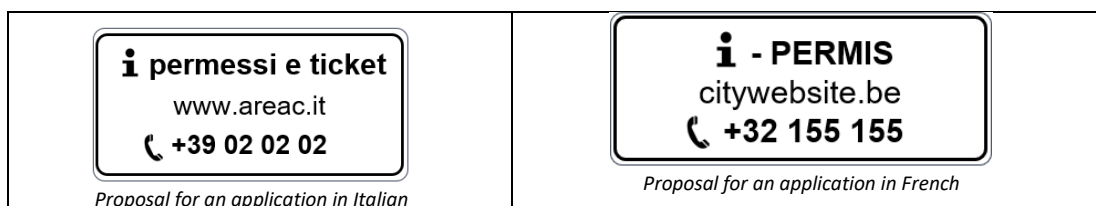
- A **symbol of a (surveillance) camera** should be displayed on a supplementary panel and not on the main one where the UVAR is enforced using automatic number plate recognition (ANPR). The use of additional text (such as “camera” or “electronic control”) is not recommended even if a further specification might be requested in some countries.

Figure 19: Surveillance symbol for supplementary signs



- A further additional panel should provide a **website and/or a phone number** (as applicable in some countries, for example Italy) that can be consulted by drivers for **more information and registration**.

Figure 20: Additional information to be displayed in supplementary signs



3.3 ADVANCE WARNING SIGNS AND VMS

- In case of a **sticker system**, information to drivers that they must obtain stickers in advance should appear on **advance warning signs and/or VMS panels before entering the zone and also in English language**.






































- The replication of the zonal UVAR sign embedded in advance warning signage should be made without any further textual element and limiting the number of additional pictograms referring to restrictions.
- Variable Message Signs (VMS) allow for additional panels or signals and can combine text and graphic signs or symbols (the same that are used on metal road signs). These could be used as advance warning signs or at the entry of an UVAR to reinforce the attention to the prohibition (particularly when the scheme is not permanent but linked to certain time validity or conditions – i.e. emergency schemes) and to allow also information to be displayed in English.
- Information on camera enforcement and fines could appear on VMS placed well in advance or prior to the entry, to reduce the amount of information on the UVAR main / supplementary panels and warn the drivers to obtain stickers, permits or pay.
- Information on where to gain, for example, stickers or permits could be given either on the VMS or on separate informative signals.
- The following example is of a small VMS panel prescribed by the Italian guidelines on LTZs. It can be placed on top the main zonal sign or as separate element in the proximity of the zone.

Figure 21: Example of VMS panel



PROPOSALS OF HARMONISED UVAR SIGNS from DEMO ACTIVITIES

Figure 22: Proposals for harmonised UVAR signs

<p>Zona</p>  <p>EXCEPTO   TAXI Y AUTORIZADOS</p> <p>  8 - 13 16 - 18</p>      <p>i Y PERMISOS cityname.uvar  945 16 11 00</p> <p><i>Limited Traffic Zone Spain</i></p>	<p>Zona</p>  <p>eccetto   e autorizzati</p>  <p>i permessi e ticket www.areac.it  +39 02 02 02</p> <p><i>Congestion Charge Zone Italy</i></p>	<p>ZONE</p>  <p>uitgezonderd   Euro 4   Euro 6 hoger Euro en toegestaan</p>  <p><i>Low Emission Zone The Netherlands</i></p>	<p>ZONE</p>  <p>SAUF   H₂ ET AUTORISÉ</p>  <p>i - PERMIS citywebsite.be  +32 155 155</p> <p><i>Zero Emission Zone Belgium</i></p>
<p>ZONE</p>  <p>   Lun - Ven 7 - 19</p> <p>  8 - 20</p> <p>SAUF     ET AUTORISÉ</p> <p><i>Low Emission Zone France</i></p>			

4. Elements influencing road UVAR information provision

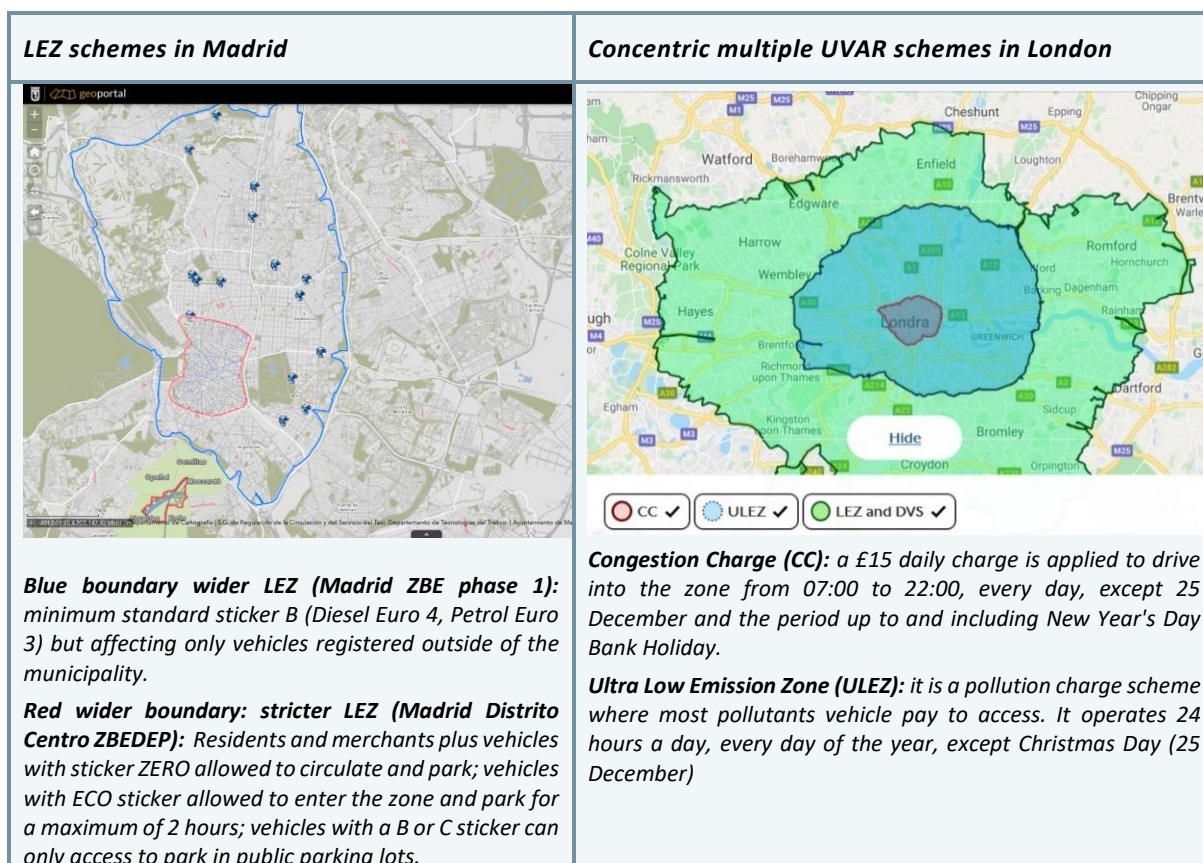
4.1 Presence of different UVAR schemes, boundaries and temporal validity

In many EU cities, different UVAR typologies are in place: perhaps an ideal “concentric” situation with a city-wide LEZ, a central LTZ (and/or a Congestion Charge or a stricter LEZ) plus a pedestrianised core (e.g., historical squares or commercial areas) complemented by other pedestrian priority zones or streets.

It is important to exactly define each typology and its boundaries to enable clear signage - particularly for the main zonal panel. As indicated in the previous chapter, the difference between vehicle user and emissions-related restrictions might lead to the distinction between a LTZ and a LEZ and this applies also for charging schemes with different signs and pictograms helping to communicate clearly. Also, concentric UVARs with boundaries along clearly recognised roads, such as the main ring roads can be easily understood by drivers with signs installed both while approaching, before the last diversion possibility, and at each entry/exit gate: the overall communicated principle is that stricter rules apply while driving to the centre.

The Spanish LEZ guidelines (MITECO) prescribe “clearly communicable, perceptible and memorable boundaries” and suggest also to use “administrative boundaries known to the public, such as district and neighbourhood boundaries, important roads such as ring roads or avenues, prominent features such as large green areas, rivers or coastlines, railway lines, etc.”

Figure 23: Concentric UVAR schemes



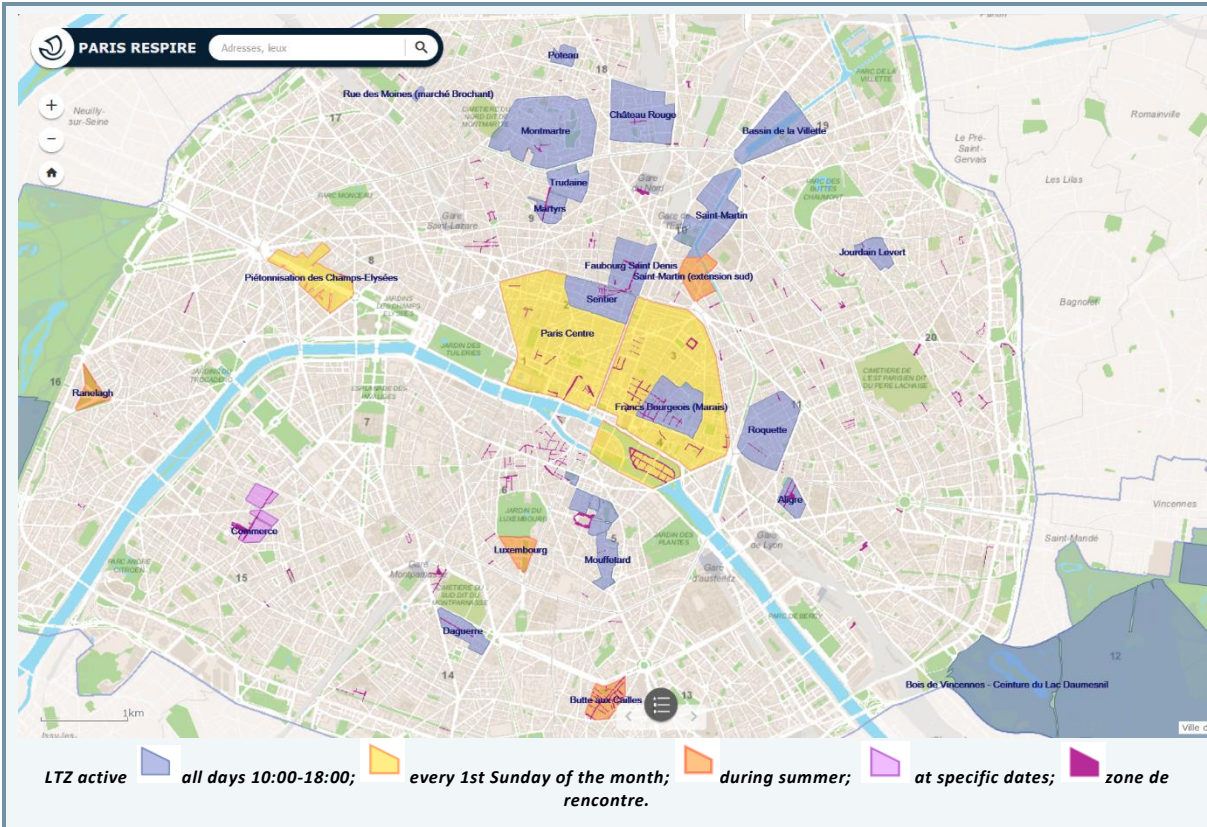
<p>Southern red boundary: LEZ (Madrid Plaza Eliptica ZBEDEP): minimum standard sticker B (Diesel Euro 4, Petrol Euro 3)</p>	<p>Low Emission Zone (LEZ): it is pollution charge scheme but applying very high tariffs comparable with fines for violations. It operates 24 hours a day, every day of the year.</p> <p>Direct Vision Standard (DVS) and HGV Safety Permit: it operates at all times for lorries over 12 tonnes gross vehicle weight</p>
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Source: Madrid Municipality and TfL

Other UVAR schemes are distributed within the city in a more scattered way: as in the “Paris Breathe” scheme (a system of LTZs and Encounter Areas), the “Superillas” in Barcelona or the “Low Traffic Neighbourhoods” (LTNs) in the UK (a combination of pedestrian priority schemes and street closures). Such schemes are often ‘Spatial Intervention’ schemes, UVAR policies to avoid through traffic and create more liveable neighbourhoods that are implemented in smaller residential, historical, or touristic areas bordered by main roads where the traffic is not restricted nor calmed.

Proper signage is needed at each entry/exit junction and before the last diversionary possibility and other physical interventions such as kerb extension, speed cushions and lane narrowing increase the communication to drivers to support the signs, road markings and the rules/restrictions indicated on panels (e.g. speed or size limits). Usually, one-way streets as well as movable or permanent barriers/bollards are implemented in order to reduce the number of entry points and therefore the complexity of installed UVAR signage as well as to reduce unintentional violations from the drivers.

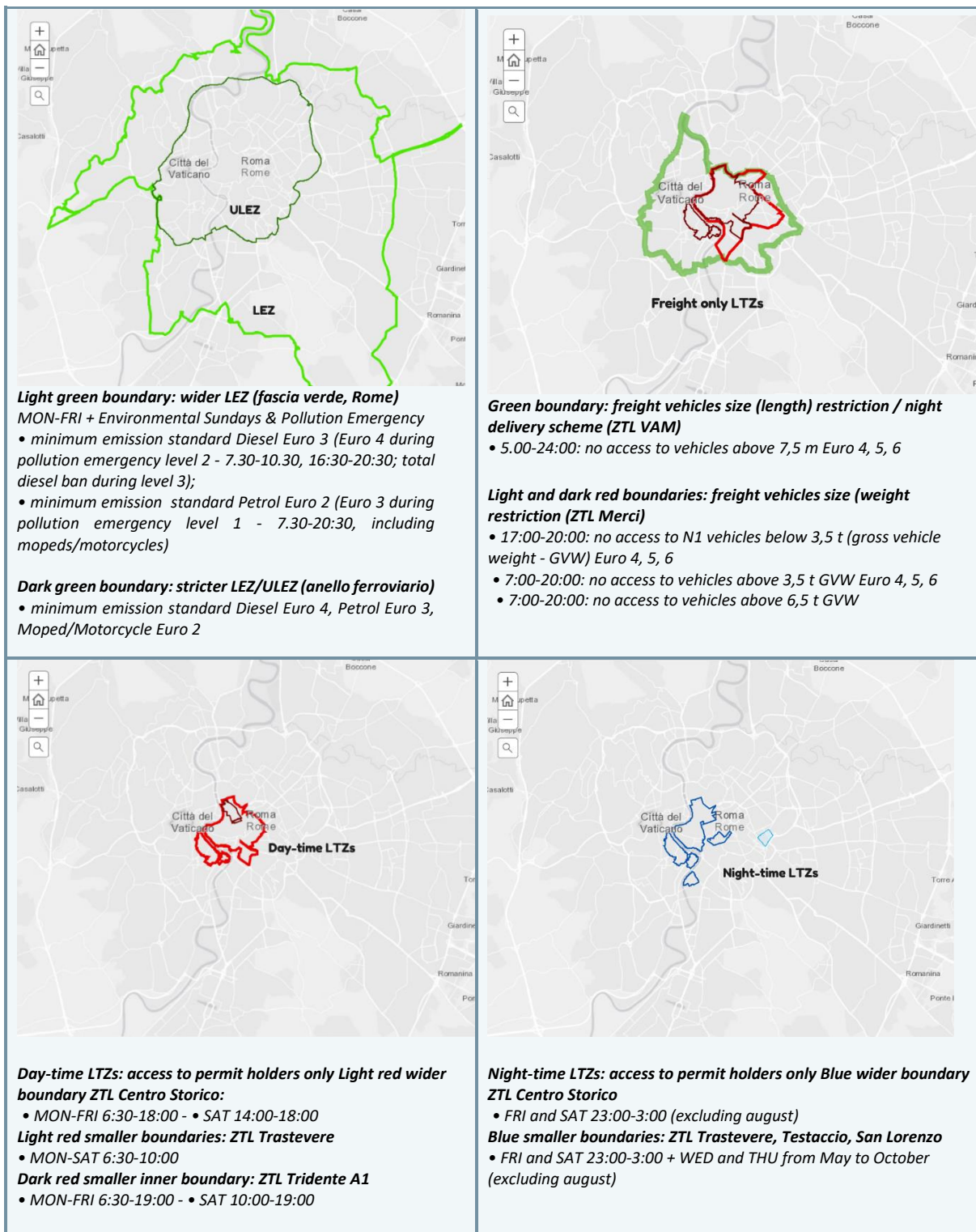
Figure 24: System of LTZs and Encounter Zones in Paris



Source <https://capgeo.maps.arcgis.com/apps/webappviewer/index.html?id=86256d58cf7040a3bf30e79e30e8f2c9>

Multiple “nested” schemes with different boundaries, or the presence of sub-zones or streets within a single UVAR with non-homogeneous rules, can have big impacts in terms of on-road information provision and on the level of comprehension and reaction to signage by the drivers as demonstrated by the results of our survey (see Annex 2). A proper UVAR policy should carefully take into consideration these aspects and look for a right balance between effectiveness, user needs and clarity.

Figure 25: Multiple UVAR schemes, boundaries and regulations in Rome



Source: <https://romamobilita.it/it/servizi/ztl>

As shown in the previous example from Rome, temporal variability also adds complexity to providing information on road signs. UVAR validity can be **permanent** (i.e., valid all days 24h) or **variable** when the restrictions relate to specified: time slots within 24 hours, weekdays and holidays within the week, specific days of the week, months or periods within the calendar year.

The implementation of temporally variable UVARs should be carefully evaluated. Italian national guidelines prescribe that *“LTZs with overlapping and combined criteria of variability (times, days and periods) or different periods of validity for different categories of vehicles should be avoided, in order to not create confusion and induce users into unintended and improper behaviour”*. The guidelines themselves were published due to the complexity and lack of homogeneity of many LTZs.

Italy has also introduced mandatory Variable Message Signs (VMS) at each camera controlled LTZ entry point with short messages displayed both in Italian and English. The text *“LTZ activated/not activated”* (and LTZ ON/OFF) substituted the previous *“Gate activated/not activated”* that got to misleading information and opposite interpretations from many drivers. VMS are also recommended in the LEZ guidelines published by the mobility agency of the Barcelona area AMB for communes within Barcelona. France uses VMS to inform about the 'pollution emergency' schemes on the motorways whereas Stockholm uses it in conjunction with their congestion charging scheme.

Movable signage and barriers can also be used for seasonal and occasional UVARs but also for testing new schemes instead or before of installing fixed permanent signage.

There are also “pollution emergency schemes” activating traffic restrictions in case of air quality emissions exceeding warning limits. Such schemes often use VMS messages on motorways and main access roads – particularly for schemes relating to the motorway speed limits –and do not rely on stationary signs.

4.2 Role of enforcement system and pre-registration

The use of cameras with ANPR systems is used in many countries for checking vehicle’s compliance with access regulations and therefore ensuring their effectiveness.

As indicated above, Italy has the largest number of camera-enforced LTZs and Milan has recently enforced with 186 ANPR cameras its city-wide LEZ (called Area B, active Mon-Fri 7:30-19:30). All camera systems need a preliminary certification and validation by national authorities whereas the instalment and exact positioning of cameras and road signs for each UVAR is currently being liberalised and will no longer be subject to prior approval from the Ministry of Transport.

In Spain, ANPRs are already present in many LTZs and are considered a fundamental element for the implementation of LEZs: Spanish national guidelines recommend implementing a system capable of checking compliance of at least 90% of the vehicular traffic.

In Germany current legislation does not allow such type of enforcement (and so only manual enforcement is possible) whereas in France ANPR systems can be used for LEZs (as recently introduced by the art. 86 of the Mobility Orientation Law – LOM) but the control may only concern a maximum of 15% of the vehicles circulating in the zone. Also, there can be a maximum of one enforcement device every 40 km of road.

The presence of cameras at entry and sometimes also exit gates (to check time windows and allowed maximum access times) add a further physical element to the main UVAR panels, thus increasing the driver’s level of attention to signs and their information/prohibition messages. In order to limit the number of cameras (and therefore the investment for the enforcement system), check points and mobile cameras might be installed inside the zone and not (or not only) at boundary gates (see the Madrid LEZ/ZBE example above).

Some countries require additional mandatory panels or signs showing a text and/or a CCTV symbol due to privacy issues, are also associated to this type of enforcement and complement the overall gateway signage.

ANPR systems work with “whitelists” of authorised or exempted vehicles. This implies the functional link with another fundamental UVAR management system that associate number plates to permits, exemptions or emissions stickers/certificates. If a vehicle is not included in the whitelist, a fine is issued and sent to the UVAR offender.

When restrictions refer to specific vehicle’s characteristics such as size, weight, type or emission standards, drivers might be led to think they have to check the compliance of their vehicle themselves – as usually happens for manually enforced UVARs. Camera-enforced schemes should always clarify the need of pre-registration when the automatic verification of vehicles’ characteristics via the National Registry is technically not possible or not implemented by the local authority.

5. Recommendation on UVARs and C-ITS

C-ITS service provision is seen as a possibility to interact about active UVARs directly with single vehicles based on information provided directly from the regulating authority. Hereby the relevant UVAR information and its restrictions can be transmitted directly into the vehicle.

To test whether the use of C-ITS in the context of UVAR is possible and reasonable, two full demos took place. The aim of the tests was to check whether the correct message is sent when entering or leaving the Zero Emission Zone in Vienna (Austria) and Trento (Italy).

The availability of C-ITS infrastructure in the pilot test sites (cities) is necessary for the complete demonstration of UVAR related C-ITS message and in addition the possibility to send IVI messages. What the in-depth discussion with the cities showed is that the implementation of C-ITS infrastructure in the European cities is currently still a development task. Within the project UVAR Exchange, an intensive exchange with numerous cities took place. With the result that many cities were challenged to set up a practical test within the time frame due to the given framework conditions on urban level. So, a majority is missing the necessary basic C-ITS infrastructure to enable such a pilot demonstration and are therefore not relevant for a full demonstration. And most of those cities contacted that are already active in the area of C-ITS have not implemented IVI messages in general yet (as the focus is on SPAT-MAP for the traffic light information currently).

Major learnings from the C-ITS demonstrations within the UVAR Exchange project is that C-ITS in the urban area is still a major innovation task.

The topic of C-ITS has been driven mainly by motorway operators so far. For a few years cities start to raise interest in the usage of C-ITS for urban traffic management. However, the deployment of C-ITS related infrastructure in urban areas, is currently a work in progress. UVAR Exchange project also showed even more that many cities are not aware of the topic of C-ITS at all, and specifically not related to UVAR.

Looking towards the future of C-ITS for UVAR a bundle of measures needs to be implemented, considering the triangle of **cities**, **vehicles**, (legal) **framework** and **standardisation**.

On the level of the cities there is the need to raise awareness for C-ITS as a tool for innovative, demand-based traffic management in the urban areas that enables the implementation of policy measures including e.g., the reduction of the environmental impact. The major learnings show that specific awareness raising measure on the possibilities of C-ITS (connected with urban use cases like UVAR) are necessary to make the first steps towards the C-ITS implementation in cities. C-ITS enables more demand-based and dynamic urban traffic management, e.g., adaptations based on environmental criteria, including a proper and timely information to the travellers. C-ITS shows significant support to achieve lower emission drive systems by increased traffic efficiency. Evaluations already show the positive impact regarding emission savings through improved traffic flow, leading also to reduced air pollution. Having in mind the current challenges cities are facing in this regard the use of C-ITS should be one part of the bundle.

For those cities that are already active in the C-ITS domain the topic of UVAR and C-ITS (and the potential implementation) is still new. The results of the UVAR Exchange project can be used as a starting point for more dissemination and awareness raising for the UVAR use case in those cities that are already active in this area. The demonstration of the two different C-ITS use cases (free text vs. traffic sign) also allows the consortium to come up with first insights on the potential implementation and the estimated effort for the implementation (depending on the actual status of C-ITS deployment).

On the side of the automotive industry there is the need for a stronger commitment towards the use of C-ITS as part of their user service, as this is part of the full picture for making urban C-ITS services, as for (dynamic) UVARs reality. As the automotive actors are the ones who will contribute to the wide uptake of C-ITS services by the adoption of the necessary equipment in the cars and hence contributing to the uptake of the respective services, it is important to tackle them as well in the future activities.

In addition, the third important column on (legal) framework and standardisation aspects is of equal importance.

The C-ITS message types currently available are in principle appropriate for the UVAR message but need high effort for the implementation of urban areas, **as it is not appropriate for the implementation within “zones” or “districts”**. So, this is not the final solution for long-term deployment on the urban level. Therefore, it is recommended that the relevance of urban C-ITS is emphasized within the major C-ITS platforms like the C-Roads platform WG 4 on urban C-ITS harmonisation to develop and standardize C-ITS message types appropriate for the cities' needs (e.g., for UVAR specific cases). The results of UVAR Exchange can be used as a first input to the discussion. But there is a need for further developments in these areas to make a wide-spread deployment of urban C-ITS services and C-ITS for UVAR possible.

Last but not least it is recommended to start with the topic of UVAR immediately so local authorities will also learn by the already existing pilots. Therefore, it is recommended to start with those areas which need less adaption to make C-ITS for UVAR already reality: It is recommended to start implementing UVAR via C-ITS on the interfaces between the motorway and the urban areas. As the C-ITS deployment on the motorways is already quite advanced this can be easily implemented. The early information of the driver can also be expected to have a positive impact on the traffic management. In this regard it is recommended to identify those areas with high potential for this implementation and start with trials and first long-term demonstrations. This could also foster the deployment of UVAR via C-ITS in the future, direct in the city area.

6. Conclusions and next steps

This brief report highlights the peculiarities of five main UVAR typologies and the road signs used across Europe for advance warning, beginning of a zone and exit from a zone.

Despite some differences, main zonal panels are more or less similar whereas additional panels differ a lot, both in the way information is displayed (order of information, use of text and symbols or predominance of text) and in terms of completeness and clarity of signage.

In some countries, UVAR entry signals are too minimalistic with some key information totally missing (e.g. in Belgium and the UK LEZ signs do not inform drivers on admitted emission standards). On the other hand, displaying all information can be ineffective in terms of comprehension when too many elements varies in the UVAR scheme such as overall time validity, vehicle type, fuel type, dimensions, time windows for delivery operations. Similarly, different boundaries or the presence of many concentric UVARs largely influence on road information provision in terms of number and position of signals.

It's important to underline that the amount of information that can be conveyed by road signs and understood by drivers is limited. Therefore, simple UVAR schemes with clear, harmonised main zonal and additional panels are recommended.

The use of a polluting car symbol inside the prohibitory red roundel C,2 sign, largely improve the proper identification of Low Emission Zones as opposite to other traffic limitations as demonstrated by the results of our survey among EU drivers and the consultation with several stakeholders.

The use of different emission sticker systems for Low Emission Zones forces foreign vehicles to preliminarily register to the national scheme. Additional informative signage, VMS and C-ITS messages in English are therefore fundamental. Moreover, also in countries not using a sticker system and enforcing LEZs with cameras the need to pre-register (as for all ANPR-controlled Limited Traffic Zones) for foreign vehicles is equally important when the emission standard is not automatically detected.

Harmonisation is possible particularly in terms of UVAR signage as suggested by this report and the Annexes. This can be done by avoiding redundant and/or not essential information, improving the use of symbols instead of or in association with text and properly organising the information on the panels and on different signals.

C-ITS will be an important future component for UVAR in specific and efficient urban traffic management in general. There is a strong need to set specific measures that will create the relevant framework conditions and raise the awareness and commitment for the topic. Meanwhile it is important to start with the first demonstrations with pilot sites that have the appropriate framework conditions to “keep rolling”. UVAR Exchange already delivered a valuable basis for these first pilots.

As a result of our activities, the following next steps are envisaged:

- Disseminate and orient learning opportunities, via the CIVITAS Initiative, the ELTIS platform, the C-Roads platform or other demonstrative projects, on the comprehension of differences and functioning of each of the five UVAR typologies target by this report, namely Pedestrian Zones, Limited Traffic Zones, Low Emission Zones, Congestion Charge Zone and Pedestrian Priority Zones. Knowledge materials, webinars, workshops and training sessions should include elements such as road signs, road marking and adaptations of the road layout as well as other practical aspects of UVARs' information provision and access (info on the web, C-ITS,

registration procedures, etc.) In this vein, the suggestion is to pursue and work more on UVAR design following a user-centric approach and thus covering all aspects (e.g., coexistence of different schemes, boundaries, time validities, affected categories and enforcement systems) that can influence their implementation.

- Support the adoption at national level of the polluting car symbol inside the C,2 prohibitory red roundel for Low Emission Zones, thus facilitating the recognition of the scheme and its differentiation from other UVARs namely Limited Traffic Zones.
- Continue to contribute to the work of the UNECE Group of Experts on Road Signs and Signals which had been mandated to assess the new signs for a possible inclusion in the 1968 Vienna Convention in a number of priority areas, including the polluting car symbol for LEZs or the symbol depicting zero emission vehicles. Other symbols might be suggested for discussion as for the ones depicting permits and charges.
- Invite the EU national members of the UNECE Group of Expert on Road Signs and Signals and other key representatives from the Ministries to work more (e.g., within the Expert Group on Urban Mobility) on UVAR signage harmonisation, particularly on the use of a common layout and rules for organising text and symbols on the panels: this may led to immediate adaptations in line with the current legislation (e.g., transferred in official guidelines so that cities can properly adapt their signage) or prepare the ground for future changes of national norms such as the introduction of new signs, symbols, inscriptions or road marking.
- Support the adoption of common UVAR messages for the different UVAR typologies to be displayed on informative metal signage, VMS and via C-ITS in both local and English language.
- Test recommendations and guidelines in real-world scenarios and evaluate solutions are effective in communicating the intended message to drivers. This could involve monitoring driver behaviour before and after the installation of the new/improved signs and VMS panels or conducting surveys to gather feedback from drivers.
- Organise dedicated workshops and sessions in C-ITS related networks raising the awareness for the topic of UVAR, to start of the discussion based on the learnings, also in regard to the legal framework concerning impact, large-scale feasibility and implementation - including standardisation, C-ITS service specifications and development needs.

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