Final Report

Study on
Urban Vehicle Access Regulations

Authors:

A. Ricci, S.Gaggi, R.Enei, M.Tomassini, M.Fioretto (ISINNOVA)
F. Gargani, A.Di Stefano, E. Gaspari (PwC)
with contributions from experts:
G. Archer, S. Kearns, M. McDonald, F. Nussio, A. Trapuzzano, T. Tretvik

April – 2017

EUROPEAN COMMISSION
Directorate-General for Mobility and Transport
Directorate B - Investment, Innovative & Sustainable Transport
Unit B4 – Sustainable & Intelligent Transport

E-mail: MOVE-B4-SECRETARIAT@ec.europa.eu

European Commission
B-1049 Brussels

Study on
Urban Vehicle Access Regulations

Europe Direct is a service to help you find answers to your questions about the European Union.
Freephone number (*)**:**
00 800 6 7 8 9 10 11

(*) The information given is free, as are most calls (though some operators, phone boxes or hotels may charge you).

ISBN: 978-92-79-57535-8
doi:10.2832/64096

Table of Contents

Index of figures

Executive summary

This report is the Final Report of the DG MOVE study on 'Urban Mobility - Preparation of EU Guidelines on Urban Vehicle Access Regulations (UVARs)', as specified under the contract MOVE/C1/SER/119-2014-371.

The study purpose is to assist the European Commission in preparing six high quality non-binding guidance documents (NBGDs) on different aspects of access regulations.

The aim of this report is to summarise the key results of the study. Accordingly, the document is structured as follows:

- Chapter 1 introduces the overall UVARs theme, providing an overview of the EU policy and objectives underlying the implementation of UVARs schemes and the rationale behind the study.
- Chapter 2 describes the methodological approach underpinning the preparation of non-binding guidelines documents (NBGDs), data sources used and the logic behind stakeholders' involvement.
- Chapter 3 provides a summary account of the individual NBGDs, describing the topics examined.
- Chapter 4 summarises the recommendations emerging from the individual NBGDs. Overlapping recommendations across the NBGDs have not been repeated in order to provide a consistent picture of the overall indications.
- This Final Report is complemented by a separate set of six Annexes, each corresponding to the one individual NBGD: 1. Information and communication (Annex 1), 2. Enforcement (including cross-border), vehicle types, their identification and exemptions (Annex 2), 3. Planning, consultation and design (including definitions and typologies) (Annex 3), 4. National legal frameworks (Annex 4), 5. Evaluation and assessment (Annex 5) and 6. Technology options and interoperability (Annex 6).

The study has been carried out by a consortium consisting of two experienced organisations in research and consultancy, ISINNOVA and PriceWaterhouse&Cooper (PwC), under the lead of ISINNOVA.

The policy relevance of the UVARs design and implementation stems from the consideration that behind the adoption of the UVARs different schemes, generally three motivations stand out, in isolation or in combination:

1. *Environmental aims*, such as in the Low emission zones (LEZ) regulative frameworks, in which many cities regulate vehicle access in order to foster the use of cleaner and more energy-efficient vehicles towards enabling the city's compliance with the EU air quality limit values for particulate matter and nitrogen dioxide.
2. *Raising revenues*, as in the Norwegian urban road tolling systems, for which funding road construction from toll revenue has been in practice for over 70 years, and also more recently also operate around cities.
3. *Reducing congestion*, as in the Milan, London or Stockholm cases, in which the key targets are to improve congestion, air quality, urban accessibility, and/or to foster the

development of alternative transport modes and the use of cleaner and more energy-efficient vehicles.

The European Union addresses the issue of UVARs schemes in the light of the subsidiarity principle, according to which urban mobility essentially falls under the local responsibility. In such a context, the European Commission provides indications and guidelines to deal more effectively with the design and implementation of UVARs schemes, in partnership with Member States and other relevant stakeholders, in order to avoid fragmentation and ensure a seamless transport system.

The 2013 EC Communication "Together towards competitive and resource-efficient urban mobility", pointed out that smarter urban vehicle access regulations (UVARs) and road user charging required "non-binding guidelines" that "would allow cities and Member States to benefit from the experiences elsewhere, and, where appropriate, foster a more common approach to issues such as vehicle categories, road signs, information provision, enforcement, exemptions, and pricing. This would make it easier for users to understand and comply with schemes, while leaving cities flexibility to adapt to their local circumstances".

Against the risk that the growing diversity of different access regulations schemes being implemented in different ways may hamper the achievement of economies of scale and contribute to the fragmentation of the single market, the rationale of this study is to deliver non-binding guidance documents (NBGDs), in accordance and with the involvement of relevant stakeholders, that may assist policymakers in the smooth and successful UVARs implementation. To this end, the guidelines, also include the illustration of best practices to serve as inspiring examples.

Therefore, the key factors behind the successful implementation of the practices showcased in the NBGDs, as well as the potential impact of a European rapprochement, have been analysed with the help of external experts and a selected group of stakeholders. The overall analysis has allowed for the identification of a set of recommendations specifically directed to cities that consider the introduction of a UVAR scheme.

The NBGDs publications are aligned with the view of the European Commission whereby a gradual rapprochement of basic principles of communication and information strategies at the European level would be beneficial.

In drafting the NBGDs, indeed, the acknowledgment of the complexity of the urban landscape and the application of the principle of subsidiarity have led to the conclusion that there is no one-size-fits-all approach.

This notwithstanding, it appears that commonly applicable solutions to shared challenges and concerns - as outlined in the NBGDs - can be identified and proposed for all of the relevant topics on the basis of a European rapprochement of practices for the benefit of cities, citizens and stakeholders across Europe, including business and industry.

The rapprochement can also clarify roles and competences at urban, regional, and national scale in the context of the subsidiarity principle. For example, the European harmonization of license plates standards and type of data stored could favour the automatic collection of penalties from foreign vehicles at urban level, in addition to making the interoperability of ANPR technologies easier, without challenging the autonomy of local decisions on the features of UVARs scheme.

Ultimately, the application of shared basic principles in the implementation of UVARs schemes across the urban areas would contribute to reduce fragmentation and improve efficiency and effectiveness.

A summary of the recommendations drawn by each NBGD, listed by main relevant topic, is provided in the chapter 4.

Taken together, the NBGDs provide a set of guidelines and a number of recommendations that can support local administrators in addressing important aspects concerning both the UVARs preparation and implementation steps.

The issues addressed by the NBGDs provide guidance on how to ensure smooth and comprehensive information and communication flows across stakeholders, the advisable types and number of exemptions to be applied, the steps to be undertaken in the design and pre-implementation stages, the consideration of national legislation and administrative frameworks, the choice of the most appropriate evaluation techniques, and the technological options for implementation. Barriers and enablers are also discussed for each topic, to serve as a toolkit for policymakers in the ex-ante evaluation of potential implications of UVARs schemes design and implementation.

1. Introduction to the overall UVARs theme, policy relevance and rationale behind the study

The Urban Vehicle Access Regulations schemes (UVARs) theme is highly relevant in the every-day life of hundreds of European cities.

UVAR can be broadly defined as: 'measures to regulate vehicular access to urban infrastructure[1]. As such, several techniques and typologies have been adopted across urban areas to regulate the vehicles access to urban infrastructure.

The following list shows the main typologies of UVARs.

1. Cordon-based: vehicles are not allowed to cross a cordon[2], 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.
2. Area license-based pricing: a fee is charged for driving within an area during specific hours. The rules may vary by time of day and vehicle type.
3. Toll rings are the application of highway tolling schemes, similar to the 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.
4. Point-based (e.g. vehicles are not permitted to cross a bridge or enter a specific section of the city).
5. Distance or time-based: this is essentially a pricing scheme based on the distance or time a vehicle travels along a congested route or in a specified area, and may vary with time, vehicle type and location.

Behind the adoption of one or the other UVARs typology, three motivations generally stand out, in isolation or in combination:

1. Environmental aims, such as in the Low emission zones (LEZ) regulative framework, in which many cities regulate vehicle access in order to tackle the vehicles non-compliance with EU air quality limit values for particulate matter and nitrogen dioxide.
2. Reducing congestion, as in the Milan, London or Stockholm cases, in which the key target is to reduce congestion, improve air quality and urban accessibility and/or to foster the development of alternative transport modes and the use of cleaner and more energy-efficient vehicles.
3. Raising revenues, as in the Norwegian urban road tolling system, for which funding road construction from toll revenue has been in practice for over 70 years.

The policy relevance of UVARs schemes implementation is therefore high and has accordingly been addressed several times by EU initiatives, with particular reference to the subsidiarity principle, according to which urban mobility essentially falls under the local responsibility.

In such a context, the European Commission provides indications and guidelines to deal more effectively with the design and implementation of UVARs schemes, in partnership with member States and other relevant stakeholders, in order to avoid fragmentation and ensure a seamless transport system.

International organisations (UNECE) have also contributed to setting the framework towards a common approach, for instance through the Convention on Road Signs and Signals (1968[3]), which set out rules ensuring uniformity of road signs, signals and symbols, necessary in order to facilitate international road traffic and improving safety.

As far as the European Commission is concerned it announced its intention in the 2011 Transport White Paper to tackle these issues by providing an EU-level 'framework for urban road user charging and Access Regulations Schemes and their applications, including a legal and validated operational and technical framework covering vehicle and infrastructure applications'. This framework would seek to address the modalities for the development of Access Regulations Schemes. Authorities at the local level would retain their authority to decide on the appropriateness of an Access Regulation Scheme and to delimit the area under the scheme, to fix the amount of fees levied where a charging scheme is used, etc.[4]

An online public consultation was conducted on "The urban dimension of EU transport policy[5]" from 17 September to 17 December 2012. A vast majority of respondents (71%) thought that EU support would contribute to more harmonious development of access regulations and urban pricing schemes at the local level. The most sought-after EU-support in relation to access regulations schemes was the development and exchange of information and best practices, development of voluntary guidelines and recommendations, mandatory criteria and interoperability standards for equipment[6].

On 22 September 2014, following the inter-institutional negotiations, the European Parliament and the Council adopted the Directive on the deployment of alternative fuels infrastructure (Directive 2014/94/EU). The cornerstones of the Directive are the following:

- requiring Member States to develop national policy frameworks for the market development of alternative fuels and their infrastructure;
- foreseeing the use of common technical specifications for recharging and refuelling stations;
- paving the way for setting up appropriate consumer information on alternative fuels, including a clear and sound price comparison methodology.

Of particular interest for setting the policy background of this study is the proposition advanced in the 2013 EC Communication "Together towards competitive and resource-efficient urban mobility[7]", which stated that smarter urban access regulations and road user charging required "non-binding guidelines" that "would allow cities and Member States to benefit from the experiences elsewhere, and, where appropriate, foster a more common approach to issues such as vehicle categories, road signs, information provision, enforcement, exemptions, and pricing. This would make it easier for users to understand and comply with schemes, while leaving cities flexibility to adapt to their local circumstances"[8].

Finally, the 2013 Commission Staff Working Document "A call for smarter urban vehicle access regulations" pointed out that "the Expert Group on Urban Mobility should consider access regulations developments and assist with, for example, the elaboration of suitable best practice guides and non-binding guidance to help cities implement access regulations schemes effectively"[9].

The following table summarises the main steps undertaken at EU/international level, in shaping the policy relevance and the policy framework concerning access regulations strategies and traffic regulation.

UNECE Convention on Road Signs and Signals[10]

The Convention set out in Vienna in 1968, established common rules ensuring uniformity of road signs, signals and symbols, necessary in order to facilitate international road traffic and improving safety. Following the opening for signature of the Vienna Convention on Road Signs and Signals, the Inland Transport Committee (ITC) of the Economic Commission for Europe, considering that it was necessary to achieve greater uniformity in the rules governing road signs and signals in Europe, asked the UNECE Group of Experts on Road Traffic Safety to prepare a draft Agreement supplementing the Vienna Convention. The final text of that Agreement was approved by the Inland Transport Committee on 1 May 1971 (see document E/ECE/812-E/ECE/TRANS/566) and was opened for signature the same day. The Agreement entered into force on 3 August 1979 and on 1 July 2007 it had twenty-nine Contracting Parties. This Agreement was supplemented on 1 March 1973 by a Protocol on Road Markings, which entered into force on 25 April 1985. This Protocol has twenty-four Contracting Parties, at the date of 1 July 2007.

Urban Mobility Package[11]

The section on smarter urban access regulations and road user charging within the Urban Mobility Package describes the role of urban vehicle access regulations in helping optimize urban access, air quality and to contribute to the goal of phasing out conventionally fuelled vehicles in cities by 2050.

In such a context, the European Commission has envisaged the need to exchange information among Member States and experts on urban access regulations across the Union, including practical implementation, conceptual foundations, effectiveness and impacts. This will lead to non-binding guidance to help cities implement access regulations schemes effectively.

Transport White Paper[12]

The 2011 Roadmap to a Single European Transport Area – Towards a competitive and resource efficient transport system commits in its action 32 – an EU framework for urban road user charging to develop a validated framework for urban road user charging and access regulations schemes and their applications, including a legal and validated operational and technical framework covering vehicle and infrastructure applications.

Greening Transport Package

The EU has made internalisation of external costs of transport one of its main principles in transport policy. In 2008, the EC Greening Transport Package (COM/2008/0433), included a strategy for the internalisation of external costs (COM/2008/0435). With regards to urban pricing schemes, the latter document refers directly the Action Plan on Urban Mobility (COM/2009/490).

Action Plan on Urban Mobility[13]

The Action Plan on Urban Mobility's (APUM). Action 7- access to Green Zones; Action 12- Study on urban aspects of the internalisation of external costs and Action 13 — Information exchange on urban pricing schemes – relate directly to this measure.

The rationale of the present study stems logically from the recognition of the European policy relevance of the UVARs schemes and the acknowledged objective to assist municipalities and local policymakers in their implementation in the context of the subsidiarity principle.

As widely documented in previous studies, e.g. in the ARS study[14], while the nature and functioning of the existing UVARs schemes are in general well documented, major efforts are needed to ensure that more and better evidence on UVARs evaluation is produced, in order to document their potential benefits and the risks to be addressed.

Furthermore, there is a general lack of understanding of access regulations, their implementation and their effectiveness. As stressed in the European Commission Staff Working Document "A call for smarter urban vehicle access regulations"[15] "of the thousands of regulations implemented in Europe very few have been comprehensively and independently evaluated. There is a lack of understanding of what works best and which access regulations are the most effective. To improve urban accessibility and make cost effective use of urban transport infrastructure there needs to be a better understanding and evaluation of the broad range of impacts of access regulations, improvement of air quality and overall performance of the urban transport systems".

Against the risk that the growing diversity of different access regulations schemes being implemented in different ways may hamper the achievement of economies of scale and generate risks of market fragmentation, the rationale of this study is to deliver non-binding guidance documents (NBGDs), in accordance and with the involvement of relevant stakeholders, that may assist policymakers in the smooth and successful UVARs implementation.

Six strongly interrelated key topics are presented in as many NBGDs publications (one NBGD for each topic), that should be seen in their global and dynamic interdependence, as shown in the following figure.

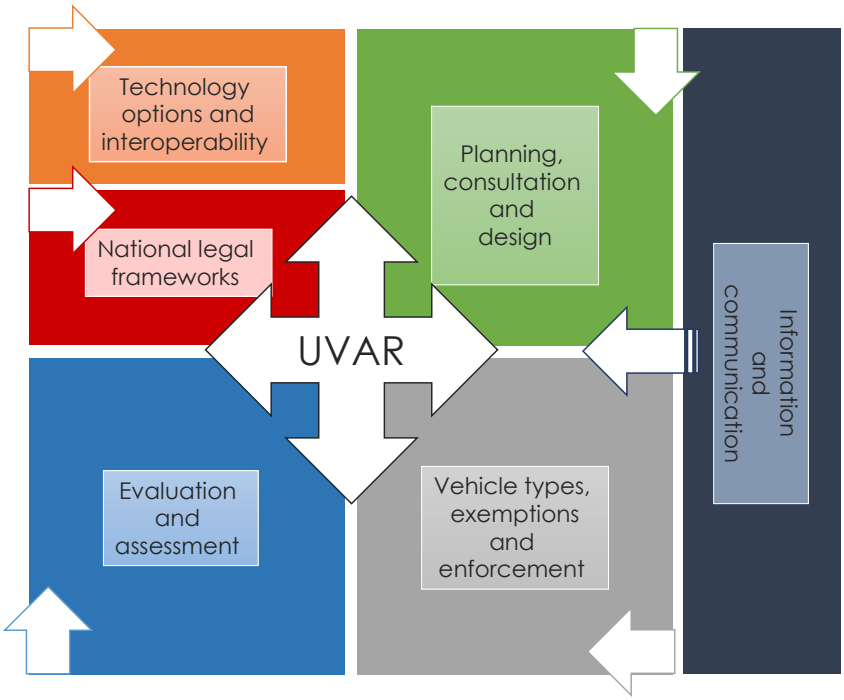


Figure I: The UVARs scheme

While in drafting the NBGDs there is obviously no one-size-fits-all approach, commonly applicable solutions to shared challenges and concerns can be found for all of the relevant topics, which can lead to a European rapprochement of practices for the benefit of cities, citizens and stakeholders across Europe, including business and industry.

Topics selected

Six relevant topics on different aspects of access regulations have been selected at the outset. The list of topics was agreed with the EC after consultation with the Group of experts on urban mobility nominated by Member States. The following table summarises the topics and the rationale behind their consideration.

Topic of the NBGDs	Rationale
1. Information and communication	To inform stakeholders about the scheme's characteristics and functionalities throughout the process of establishing and running a UVAR, and devise and implement effective communication plans, aiming to make users (including foreigners) able to understand the terms and conditions of the scheme, including fines and enforcement options, and establish an interaction with local authorities.
2. Vehicle types, exemptions and (cross-border) enforcement	To inform stakeholders, using best practices and examples, of the benefits of efficient vehicle identification methods, (including common standards for retrofitted vehicles) exemptions and enforcement rules, also in relation to national legislation. The situation at cross-border points and treatment of foreign vehicles is considered as well.
3. Planning, consultation and design (including definitions and typologies)	To provide information to stakeholders about the UVARs planning, consultation and design cycle. Dialogue with stakeholders, design and inclusions of ancillary transport policies, e.g. parking management and pedestrianisation, are considered.
4. National legal frameworks	To inform stakeholders about the requirements for an efficient and supportive national framework in relation to national and sub-national legislation for UVARs implementation.
5. Evaluation and assessment	To provide information to stakeholders on state-of-the-art techniques and practices for the evaluation and assessment of UVARs schemes. Information on the range of impacts,

Topic of the NBGDs	Rationale
	techniques, barriers and processes is collected, organised and shared, and is ideally drawn from best practices.
6. Technology options and interoperability	To inform stakeholders of the benefits and shortcomings of the available technology options, and of the potential benefits deriving from interoperability and, in general, from the adoption of common approaches.

2. Summary account of the topics selected

Each of the six NBGDs is the result of a participatory process, entailing the following activities described in the Figure II.

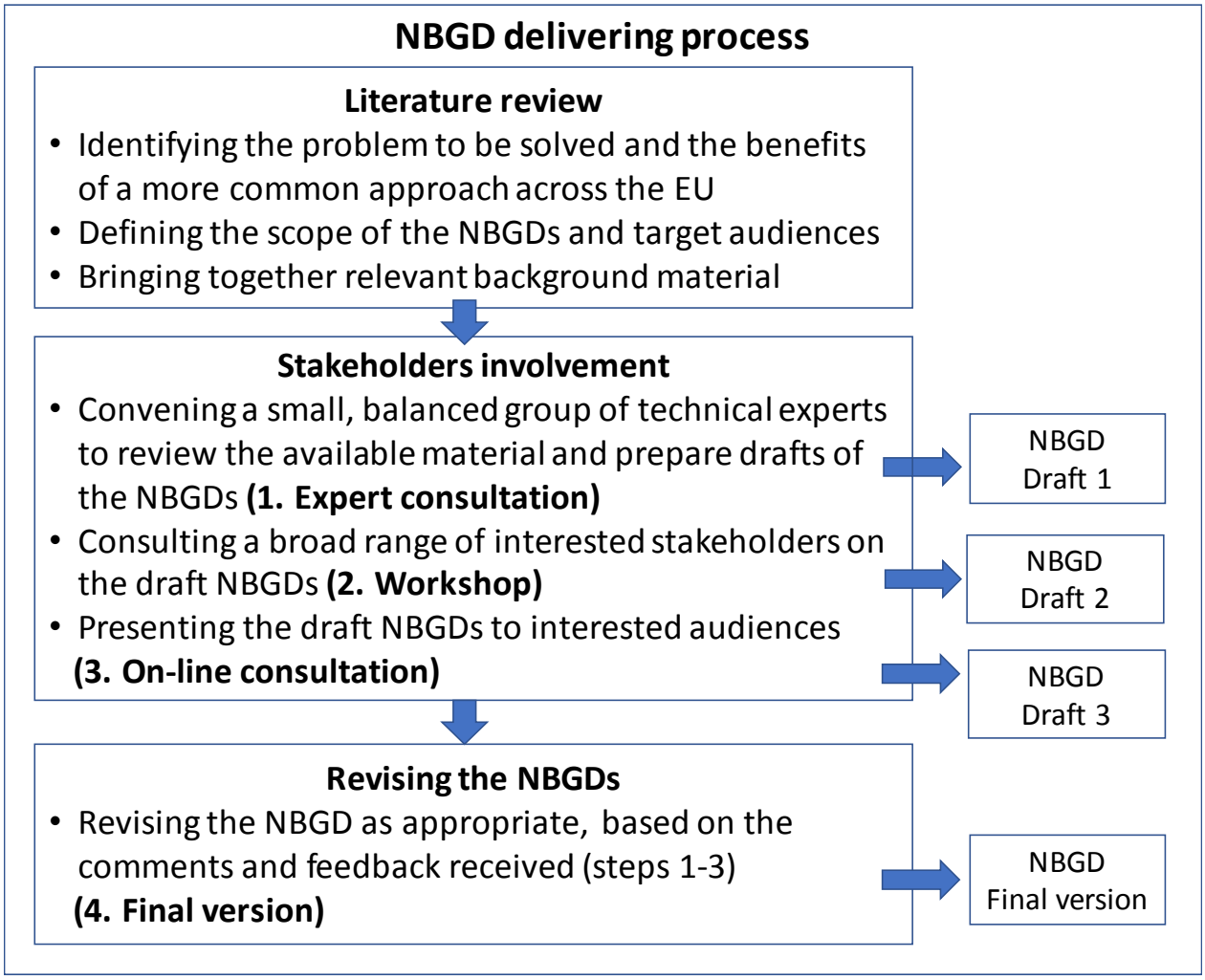


Figure II: The NBGD delivering process

The process distinguishes three phases, each of one described in the following sections:

- Literature review
- Stakeholders involvement
- Drafting the Final Version

Literature review

A literature review has been carried out in order to establish a knowledge base informed by research, EU and national guidance, best practices, technical reports, articles and conference proceedings on UVARs. This activity provided the main input to the first draft of the NBGDs.

Literature review can be divided into three key categories:

1. *Information at the urban level*. This category accounts for the most significant share of available information. It includes i) the CIVITAS initiative knowledge centre, which reports access regulations feasibility and evaluation cases from the municipalities involved in the CIVITAS projects, ii) databases such as ELTIS, the urban mobility observatory, containing case studies dealing with pricing policies and access regulations measures, iii) academic literature on ex-post assessments of access regulations policies, iv) updates on the implementation of long-standing examples of access regulations policies in European cities, e.g. Milan, Rome, Bologna, London, Stockholm, Trondheim, Gothenburg etc.
2. *Information at the urban and national level*. The key reference for this is the website http://urbanaccessregulations.eu/, which provides an updated overview of the implementation of access regulations policies at the urban and national level (for most of the EU countries). In particular, when appropriate, the national level is addressed through the review of national legislation features, e.g. vehicle identification, enforcement practices, etc.
3. *Information at the EU level*. Academic papers and proceedings from research institutes provide comparisons on UVARs schemes.

The methodology underlying literature review relies on the following assumptions:

- *Time horizon: 2011-2015*. The literature review begins with information from the Study on Urban Access Restrictions (ARS)[16] carried out in 2010, which provides extensive information on access regulations schemes. Building on that, the literature review focuses on publications, reports and studies issued from 2010 onward, trying to offer a complete picture of relevant sources concerning UVARs implementation and design in Europe;
- *Qualitative evaluation*. Each source is graded on a qualitative scale from high to low, indicating the quality of its information on the topic of NBGDs. For each source the title, time horizon, urban area involved, and a brief description of contents and useful notes are provided, e.g. types of reports, feasibility studies, evaluation reports, etc.;
- *Cross-cutting interpretation*. Finally, a cross-cutting interpretation of each topic throughout the available literature has been made to find relevant sections and to address relevant topics.

Stakeholder involvement and contributions

The involvement of relevant stakeholders in the discussion and validation of the NBGDs has proved to be of great importance. Each NBGD benefits from two types of stakeholder input:
a) The engagement – through dedicated workshops - of a balanced and representative group of experts providing direct contributions to the NBGDs according to their respective areas of

expertise. The expert engagement is fundamental to draft the first version of the NBGD, together with the contribution of literature review.
b) The involvement – through an ad hoc on-line survey - of a broader group of stakeholders for the circulation and validation of the contents of the NBGDs. This involvement is required to draft the second version of the NBGD, as specified in the following sections.

Expert contributions

A targeted list of experts has been compiled by the authors of this study. Experts have been selected on their direct expertise in the design, implementation and operation of access regulations schemes and systems as well as their broad and concrete experience with technologies adopted in the access control systems in a number of deployments across Europe.

The final list of selected experts is as follows:

- Greg Archer: leads the clean vehicles team at Transport & Environment
- Steve Kearns: Engagement Manager at Transport for London
- Mike McDonald: Emeritus Professor of Transport Engineering at the Transport Research Group of Southampton University
- Fabio Nussio: Head of International Cooperation at Roma Servizi per la Mobilità (Mobility Agency of the City of Rome)
- Adriano Trapuzzano: Ex-Solution Manager at BU Electronic Terrestrial Tolling of Kapsch TrafiCom AG
- Terje Tretvik: Senior Scientist at SINTEF Transport and Society, Transport Research

On 13 April 2015, a coordination meeting was held at the ISINNOVA office in Rome, gathering both the experts and the study team, in order to fine tune a common methodology and agree on the main expected output of each NBGD.

The experts' central contribution consisted in providing general feedback on the key challenges and available options identified by the study team on each NBGD topic. Once these were discussed and agreed on, they helped assess the potential impact of a common European approach and helped identify the key factors leading to the successful implementation of the practices showcased. The experts' allocation across the NBGDs was agreed:

- NBGD on Information and Communication: Steve Kearns and Terje Tretvik;
- NBGD on Vehicle identification, exemptions and enforcement: Greg Archer for Chapter IV on Potential impacts from a common European approach and Alessandro Trapuzzano for Chapter V on Barriers and enablers to a common European approach;
- NBGD on National Legal frameworks: Steve Kearns and Terje Tretvik.
- NBGD on Evaluation and assessment of UVARs schemes: Mike McDonald for Chapter IV on Potential impacts from a common European approach and Greg Archer for Chapter V on Barriers and enablers to a common European approach;
- NBGD on Technology and interoperability: Adriano Trapuzzano for Chapter IV on Potential impacts from a common European approach and Fabio Nussio for Chapter V on Barriers and enablers to a common European approach.

Workshops

At the outset of the study, a contact list of about 100 key stakeholders was compiled, comprising both cities and other relevant stakeholders such as industry, institutions, economic players, citizen representatives, research institutes, and private consultancies.

The figure below shows the UVARs stakeholders distribution in detail.

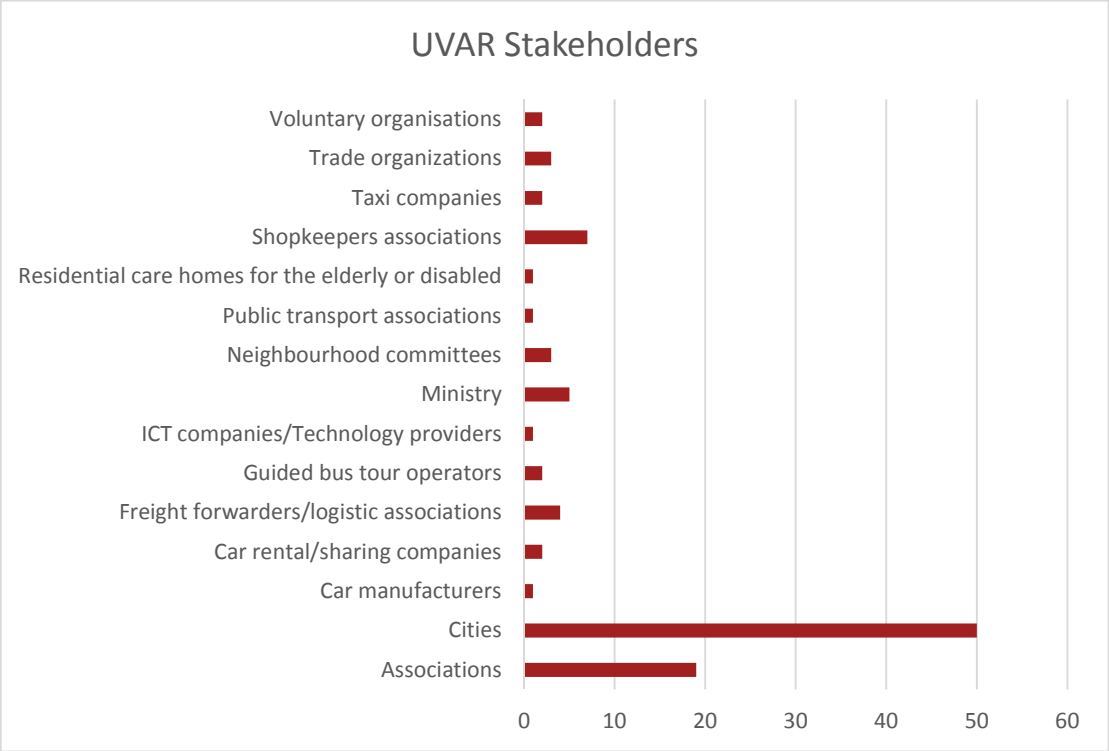


Figure III: Composition of UVARs stakeholders

Urban areas and transport associations (from public transport to passengers and freight) account for the biggest shares, followed by shopkeepers' associations and representatives of Member State Ministries.

Furthermore, a key contributor has been the Advisory Group on Access Regulations of the CIVITAS CAPITAL project, which has provided recommendations for the NBGDs.

From the broad stakeholders' arena, a group ranging between 10 and 15 stakeholders was involved in the Workshops, one for each NBGD, to discuss the first draft of the NBGD and provide the input to prepare the second draft of the NBGD.

The list of the Workshops and the attending participants is the following:

- Stakeholders' workshop on Friday 25 September 2015 in Brussels (first and second NBGD on Information and Communication and Enforcement (including cross-border), vehicle types, their identification and exemptions.

Name	Organization
Kemal Onel	DG MOVE
Mans Lindberg	DG MOVE
Andrea Ricci	ISINNOVA
Maurizio Tomassini	ISINNOVA
Alessandro Distefano	PWC
Fuensanta Martinez Sans	ACEA European Automobile Manufacturers' Association
Yomi Otubushin	BMW Group
Vanessa Holve	EUROCITIES
Marta Marcuzzi	EUROCITIES
Olivier Lenz	FIA Federation Internationale de l'Automobile
Andrew Turner	FIVA Fédération Internationale des Véhicules Anciens
Ian Catlow	London's European Office
Ivo Crè	POLIS
Lynn Regenberg	Robert Bosch GmbH
Lucy Sadler	Sadler Consultants Ltd
Osvaldo Navarro	TPR University of Antwerp

- Stakeholders' workshop on Monday 11th April 2016 in Brussels on the third and fourth NBGD on Planning, Consultation and Design of Urban Vehicle Access Regulations (UVARs) and National legal framework.

Name	Organization
Kemal Onel	EC, DG Move
Maurizio Tomassini	ISINNOVA

Name	Organization
Alessandro Distefano	PwC
Enrico Gaspari	PwC
Peeter Hemming	FIVA
Uzbieta Luheninh	Polish permanent representation
Ivo Cré	Polis
Aurora Garcia de Sandoval	Spanish Traffic Directorate General
Christofe Muhle	German Association of the Automotive Industry
Otubushin Abayomi	Bmw group
Osvaldo Navarro	University of Antwerp
Giacomo Lozzi	Polis
Vanessa Holve	Eurocities
Lucy Sadler	Sadler Consultants

- Stakeholders' workshop on Monday 19 September 2016 in Brussels on the fifth and sixth NBGD on Evaluation and assessment and Technology and interoperability.

Name	Organization
Kemal Onel	EC, DG Move
Andrea Ricci	ISINNOVA
Benedicte Tardivo	Ministere Ecologie, Development Durable de l'Energie et du Climat
Enrico Gaspari	PwC
Ian Catlow	London's European Office
Ivo Cré	POLIS- Deputy Director
Julia Levasier	FIA Federation Internationale de l'Automobile/ADAC German member
Lucy Sadler	Sadler Consultants Ltd
Osvaldo Navarro	TPR University of Antwerp
Philip Stein	Expert in Freight transport
Riccardo Enei	ISINNOVA
Vanessa Holve	EUROCITIES

Overall, stakeholders proved very active in debating and commenting on the topics presented, especially in the closing session, where the audience's involvement in the highlighting of recommendations was particularly relevant.

The stakeholders' point of view was taken into the highest consideration along with their contributions on case studies in the formulation of the second draft of the NBGDs.

Online consultation

Stakeholders' consultation extending to a much larger group than the stakeholders personally involved in the Workshops was ensured through the preparation of an online questionnaire, which was designed and distributed to the UVARs stakeholders' contact list together with the second draft of the NBGD.

The questionnaire aimed at collecting feedback on the second draft of the NBGDs, which had incorporated feedback received during the Brussels workshops.

The questionnaire was divided into four main sections:

1. Stakeholder details: this section collected information on the respondents, including type of organisation, geographical area, and contact details.
2. Questions on the overall clarity, relevance, effectiveness and usefulness of both the NBGDs as a whole, as well as on their contents.
3. Specific questions on each chapter of the NBGDs.
4. A section for additional remarks and suggestions.

In terms of contribution to the NBGD on Information and Communication, the large majority of respondents ranked the clarity, relevance, effectiveness and usefulness of the publication between 7 and 9, out of a scale 1 (min) to 10 (max). Overall, the vast majority of the respondents (72%) considered the formulation of the recommendations to be satisfactory.

Aside from the positive feedback on the draft publication, a number of useful suggestions and remarks were received. For example, stakeholders suggested a more detailed description of the business sector – both local retailers and foreign economic operators- as a special target group of communication and information campaigns, and how modern communication technologies, including social media, will be used to reach this and other groups.

The NBGD on Enforcement (including cross-border), vehicle types, their identification and exemptions benefited from the discussion, which was particularly useful in clarifying and/or fine-tuning some of the concepts developed in the draft NBGD, such as:

- Contributions to a better definition of criteria for the identification of historical vehicles.
- The importance of stressing the relevance of the use of the Euro standard as a key criterion for vehicle identification, associated with the need to consider "real" data on emissions (actual driving conditions) in order to allow local policymakers to properly assess the effectiveness of the scheme in compliance with the regulated pollution values.
- Better definition of the features of NBGDs, i.e. they should be drafted in a clear, simple style and language. The NBGD should provide "practical guidelines" to be used by the cities along with a set of recommendations for cities and not for the European Commission.

The key suggestions for the improvement of the NBGD on Planning, consultation and design (including definitions and typologies) were as follows:

- Further criteria should be included in the recommendations, such as fairness, provision of mobility alternatives, consideration of alternative measures to UVARs, measures taken to address negative effects of UVARs.
- Specific attention should be given to occasional users such as tourists. Occasional users should not be deterred by administrative and language barriers.

The NBGD on National legal framework, amongst others, discussed the following topics, which have been developed in the third draft of the publication:

- Clarify the role of national, regional and local authorities with a higher focus on subsidiarity principle;
- Stress the fact that national legal framework may also differ due to the purpose they were implemented (e.g. in Sweden the national legal framework concerning UVARs has been introduced as a tax law whilst for instance in Germany is rather an environmental law);
- Add in a dimension concerning complaints and mediations;
- Prioritisation of priority areas, some of them being a "must" and others being an add-on;
- Include REC (retrofit certification) standards along with EU emission standards as they are the only two standards recognized at EU level.

The NBGD on Evaluation and assessment received the following feedback from the stakeholders:

- Data requirement for effective UVARs assessment. Sometimes, appropriate assessment of UVARs schemes can be a challenge, particularly in terms of data availability and resources.
- Sometimes, an accurate assessment may be achieved by avoiding the use of data intensive assessment approaches and adopting simplified local approach suited to the information and time available. Other times, particularly with large or controversial schemes, a more detailed assessment may be more appropriate.
- Many methods and tools for evaluation and assessment are already in place at a local, regional, national and EU level, and there is a broad range of good practices. Disseminating information and knowledge sharing could support evaluators in finding the most appropriate techniques.

Concerning the NBGD on Technology and Interoperability, the discussion was particularly useful in clarifying and/or fine-tuning some of the concepts developed in the draft NBGDs, such as:

- Future technological developments in the field of UVARs technologies. It has been stressed that the NBGD should devote space to future technological developments, opening an informative section on the most promising developments;
- The NBGD should include reference to back office aspects related to the technology options, e.g. costs, how data storage should be carried out, etc. This back-office process has a technological dimension and could be included in the NBGD also with the help of examples.

- Interoperability is an important aspect and more emphasis should be given in the guidance document to the several dimensions.

In general, all remarks and comments received have been processed and taken into account in the preparation of the third version of the NBGDs.

The third version of the NBGDs have been made available on the web (through the DG MOVE website), for final input before drafting the Final Version, published in the Annexes.

3. Summary account of the individual NBGDs

A summary account of the role of each NBGDs topic is provided in the following boxes:

NBGD on Information and Communication

Within this set of six non-binding guidance documents on UVARs, this NBGD publication provides an overview of the role and importance of information and communication, which is a fundamental aspect both prior to the implementation of an access regulations scheme and once the scheme is in operation.

While the role of information and communication is particularly crucial in the design and planning phase, as it includes participation and consultation with operators and various types of stakeholders and citizens (see NBGD N°3), this NBGD refers to the notion of customer service, which encompasses information and communication activities required once the UVARs scheme has been designed and approved by local administrations.

Customer service is one of the most important aspects of any UVARs scheme, as without a sound customer relationship management strategy, local as well as non-local and foreign road users may find it difficult to understand the motivations behind the introduction of the scheme, its practical rules, and implications on personal mobility as well as on local and non-local business.

Prior to the entry into force of the scheme, but also during the scheme's operation, the city administration needs to provide reliable and constantly updated information. The population must be informed on the launch of the scheme and provided with information on how the scheme will work. It is essential to also carefully plan and communicate alternative solutions for the various groups of users, such as non-motorised transport new infrastructure, reinforcement of public transport services, park and ride facilities immediately at the borders of the UVARs and the general adaptation of the local circulation plan.

In addition, the communication campaign has to effectively address people potentially affected by the scheme. Communication efforts should not focus solely on users within the area under consideration for the UVARs, but should also give importance to stakeholders outside the selected area, including those crossing international borders as well as foreign users in general. The main challenge at the European level is to simplify travel for citizens on the whole territory of the Union by providing a common approach to communication and information with regard to UVARs schemes across Europe. The EU website urbanaccessregulations.eu can be used to assist wider dissemination.

As the introduction of UVARs often leads to dissent among citizens, transport stakeholders and business operators a proper communication is essential in order to address criticism from the outset and encourage acceptance by the population. In this respect, the way the UVARs is promoted from the start – for instance as part of a wider strategic context and not as an isolated measure - is fundamental. If the positive effects of the scheme can be demonstrated to users, they will more likely change their mobility behaviour.

NBGD on Vehicle types, exemptions and (cross-border) enforcement of successful UVARs schemes across Europe

The topic 'Vehicle types, exemptions and (cross-border) enforcement of successful UVARs schemes across Europe' addresses three different but intertwined and important aspects of UVARs implementation: the choice of technologies for vehicle detection, the adoption of enforcement systems and the rules regarding exemptions.

The primary objective of an urban vehicle access regulations (UVARs) scheme is to regulate the access of certain vehicles (e.g. cars, delivery vehicles and buses) to specific areas, an objective often driven by air quality targets but also by other political and long-term objectives such as reducing congestion, increasing the overall liveability of cities, etc.

In this context, vehicle identification, rules of exemptions and enforcement methods play a fundamental role.

Vehicle identification

Vehicle identification can be carried out through the use of information and communication technologies, e.g. camera systems and Automatic Number Plate Recognition systems (ANPR) or through manual inspections and windscreen stickers. For the former, the identification of vehicles relies on a search for the recognized plate into an online database of released permits, either static (permits released on a permanent basis) or dynamic (requested permits). Other technological options, such as those based on dedicated short-range communications, or DSRC (this frequency has already been standardized at 5.8 GHz) between an on-board unit and a transceiver at the access points, are available. Whatever the identification method, vehicle emission standards based on Euro standards represent an important criterion for traffic regulation.

Exemptions

A key issue for UVARs implementation is the clear definition of exempted vehicles. Every scheme is in fact likely to entail exemptions under specific circumstances, such as emergency vehicles, vehicles driven by or for persons with reduced mobility etc. Therefore, it is essential to have limited, unambiguous exemption rules, where the vehicles can be reliably identified.

Enforcement

Related to vehicle identification is the choice of enforcement techniques; for example, manual, in the case of sticker-based systems, or automatic, relying on databases containing all of the permits issued to allow entrance to authorized vehicles. The treatment of foreign vehicles in the case of automatic enforcement may be problematic, due to the lack of relevant information, such as emission standards, in the national database. Making enforcement effective is fundamental for both scheme managers and users, as weak/ineffective enforcement will lead to the failure of even the "best conceived" scheme.

NBGD on Planning, consultation and design for the development and implementation of a UVARs scheme

Planning, consultation and design for the development and implementation of a UVAR scheme is a complex process requiring adequate provisions in terms of governance (both local, e.g. collaboration between services, and between local and national tiers of government), resource planning (funding instruments, economic and financial assessments), acceptability assessment, etc.

Planning

Planning means integrating the UVARs scheme into an overall vision of transport mobility at urban level, ensuring consistency and non-contradiction of each specific transport policy. The production of a local or regional transport plan is key to this process. The EU promotion of Sustainable Urban Mobility Plans (SUMPs) is critical in this respect. A local/regional SUMP gives in fact the overarching context within which a UVAR scheme can be placed and be effective. It gives the rationale for the UVARs and shows that it is not being developed in isolation.

Consultation

Consultation is part of the overall communication and information process underlying a UVAR scheme. In general, all types of stakeholders (local/national/foreign, frequent/non-frequent, individuals/businesses) should be involved (consulted) as soon the decision to develop a UVAR has been taken at local level. Stakeholder's involvement in the process can take several forms, e.g. the form of specific stakeholder-focused technical consultations before the UVARs scheme implementation. Consultation scope, form and modalities are designed and decided upon in the design phase. In addition to ensuring the proper information of all stakeholders, it also has the potential to reinforce the effectiveness and the acceptability of UVARs, by taking into account the needs of the various stakeholders and associating them to the decision-making process. A systematic, continued and regular consultation even throughout the implementation of the UVARs will allow adjusting its scope, form and modalities, should it have e.g. disproportionate negative impacts on mobility or the local economy.

Design

The design of a UVAR scheme implies the definition of the key characteristic (technical, temporal, economical, etc.) before its introduction and throughout its implementation in order to ensure effectiveness and acceptability. Design should include the envisaged regulations as necessary and appropriate to contribute to solving the identified problems and that all other less restrictive alternative measures on urban logistics and mobility have been considered and proven inadequate. The design should be supported by a proper impact assessment, including a cost and benefit or cost effectiveness analysis from an environmental, social and economic perspective, economic and social impacts of the proposed measures on the local economy and businesses.

NBGD on National legal framework

The current state of national legal frameworks for UVARs schemes is extremely varied, ranging from countries where there are no specific legal provisions to deal with to others where road codes and other specific pieces of legislation offer an explicit legal ground. Local norms (pieces of legislation issued by Regional Governments, Council Resolutions at city level) represent often the regulatory support to the implementation of UVARs schemes both in the absence of national legislation and as local policy features, regardless of the size of the cities/towns.

When there is more than one UVAR scheme to be implemented in the country, a national framework enables UVARs to be set up more easily and with lower costs. Moreover, vehicle operators can more easily be informed and convinced. It allows national issues to be resolved once rather than individually for each scheme, including signage, driver licence penalty points, stickers and permits, enforcement regulations, possible exemptions, fines etc.

Within this set of six non-binding guidance documents on UVARs schemes, the present publication covers the rationale behind the development of national legal frameworks summarising the current situation and identifies priority areas to be included into a national legal framework, especially concerning: the legal basis and principles (e.g. urban, regional, national, European), its type (e.g. air quality legislation, road codes prescription, others), the enforcement approach (i.e. procedures to ensure compliance with access regulations rules, for example through camera, traffic wardens, inspections, etc.), the differentiation criteria by vehicles types (either by emission threshold or fuel type) and transport segment (e.g. private vs. commercial).

NBGD on Evaluation and assessment

The important role of evaluation and assessment in UVARs schemes arises from the acknowledged need for clear procedures to monitor and evaluate the implementation progress and impacts of UVARs schemes so that objectives can unambiguously be defined, the most suitable indicators selected, reliable data collection campaigns outlined, and baselines identified against which outcomes can be compared. A systematic approach to indicator selection should be pursued to analyse impacts, development and implementation progress and to ensure a strict link with scheme objectives. An evaluation plan needs to be defined at the beginning of the UVARs scheme development so that a plan for data collection becomes an integral part of any scheme implementation.

In such a context, evaluation involves a broad spectrum of stakeholders such as institutions, businesses and interest groups as well as those whose responses to the scheme are the prime target of the evaluation. Some stakeholders perceive UVARs schemes negatively because of their physical or financial impacts. Therefore, within the evaluation activities, it is fundamental to develop early outcomes for dissemination to all stakeholder/user groups which have to remain consistent with the long-term evaluation findings as it is. This because it is important that the views and actions of all stakeholders are included in the evaluation process and that they are made aware of evaluation results as soon as possible. This is essential for transparency, which will then improve the acceptance of the measure.

Moreover, it is essential to provide feedback to stakeholders once the UVARs scheme evaluation has been completed. Dissemination of the results will help gather further support for the scheme if it is successful and help gain support for the introduction of similar initiatives elsewhere. If the scheme has been unsuccessful or only partly successful, it is important to

share this so that weaknesses or relevant issues are considered appropriately in similar interventions including the question whether or not to introduce such actions. Adapting the scheme to improve it following assessment can be a useful step. Crucial is then the identification of the most appropriate timing and format to disseminate UVAR outcomes. This is particularly important for schemes with long-term benefits.

Many methods and tools for evaluation and assessment are already in place and there is a broad range of practices. Modern tools and technologies can also provide access to a wider range of data. Thus, further guidance is required to make the best use of resources and ensure a systematic evaluation of UVARs schemes.

The present publication provides an overview of the Evaluation and Assessment of Urban Vehicle Access Regulations (UVARs) Schemes, developing the concepts of evaluation and assessment in the context of reference to available practices and guidance.

NBGD on Technology options and Interoperability

Most UVARs in operation nowadays need technologies for vehicle detection, charging fines and managing exemptions. In a time of rapid technological developments, the capability to implement complex and most efficient UVARs schemes primarily relies on the application of new technologies.

For example, Cooperative ITS (or C-ITS) technologies, which allow vehicles to become connected to each other, and to the infrastructure and other parts of the transport network, are proving that these systems are able to share information, operate safety functions and at the same time be used for road charging or for access regulations. These technologies can in the future provide technological functionalities, in particular for billing fines, vehicle identification and positioning.

Due to the importance of the technological dimension, the main objective of this NBGD is therefore to review the relevant aspects involved in the selection of the technical solutions while supporting the different options with concrete examples on available options.

In this NBGD, the most important technologies are reviewed, i.e. from the Automatic Number Plate Recognition (ANPR), based upon software processing of the plate picture taken by a dedicated, generally digital, TV camera, etc., to technologies based on Dedicated Short-Range Communication - DSRC (Frequency already standardize at 5,8 GHz) between an on-board unit and a trans receiver at the access points. Technologies that exhibit an interesting potential on tolled roads, but can be an option also in the urban context, i.e. GNSS coupled with GPRS technologies, are considered as well.

The issue of interoperability of UVARs systems, the other component of this NBGD, is relevant at EU level, on the grounds that all citizens should be guaranteed free circulation across the Union. While the problem clearly extends way beyond technological issues, harmonized functionalities of the system could play an important facilitating role.

It is stressed that interoperability may have a technological as well as a spatial/geographical dimension. The technological interoperability of a specific option addresses the capability to adapt to different scheme design and characteristics. For example, in terms of vehicle type detection, payment methods, period of operation, e.g. night or selected day time slot and

enlargement of a UVAR area. The spatial/geographical interoperability deals with the capability of the technological options to operate at different scales (urban, regional, national, European). In general, the implementation of UVARs schemes is more concerned with the technological interoperability given the local scale of most UVARs schemes. However, reaching spatial/geographical interoperability may reduce implementation costs and facilitate the movement across borders.

4. Conclusions and recommendations

Taken together, the NBGDs provide a set of guidelines and a number of recommendations that can support local administrators in addressing important aspects, concerning both the UVARs preparation and implementation sides.

The aspects addressed by the NBGDs provide guidance on how to ensure smooth and comprehensive information and communication flows across stakeholders, the advisable types and number of exemptions to be applied, the steps to be undertaken in the design and pre-implementation stages, the attention to the relationships with national legislation and administrative frameworks, the choice of the most appropriate evaluation techniques and technologies for implementation. The indication of a list of barriers and enablers for each topic may serve as ex-ante toolkit for policymakers aiming at evaluating potential implications of UVARs schemes design and implementation.

As repeatedly stressed across the NBGDs, although each city may have its own specific priorities and rationale for introducing a UVAR scheme, it is common sense that a gradual application of common basic principles is beneficial to ensure the consistency and clarity of decision making, while improving the effectiveness and efficiency of the proposed schemes.

It can also clarify roles and competences of the urban, regional, national and EU levels in the context of the subsidiarity principle. Ultimately, the application of common basic principles in the implementation of UVARs schemes across urban areas would contribute to reduce fragmentation and improve efficiency and effectiveness.

The following list of recommendations, classified by each NBGD topic, is meant for policy makers who are planning or implementing a UVAR scheme.

Topic of the NBGDs	Recommendations
1. Information and communication	• Simultaneously to the adoption of a UVAR scheme, **the definition of a clear and comprehensive communication and information strategy should be elaborated** to ensure its smooth implementation and long-term effectiveness. • A UVAR scheme should not be promoted in isolation, but as part of a wider strategic policy. **Local sustainable urban mobility planning (SUMP) can provide the overarching context and rationale within which a UVAR can be placed and promoted**. • **Setting up and communicating appropriate complementary and alternative transport modes and options** is a key factor in changing users' attitudes and ensuring the success of the scheme. • Direct information should not focus solely on the population within the area under consideration for the UVARs. **City administrations should give weight and importance to those stakeholders in locations outside the area** for which the scheme is planned, as

Topic of the NBGDs	Recommendations
	they are among those affected by the introduction of UVARs. • Information and communication should cover frequent, occasional and one-time users with different needs. **Foreign businesses and visitors, and non-local users in general, should have access to high-quality information** about the rules and regulations of UVARs schemes. • **Clear, focused, multilingual information should be available** through a dedicated digital solution and in the supporting communication materials, as well as in the existing **CLARS database[1].** • The expected benefits of the UVARs, as well as the positive results of the scheme in operation, should be clearly communicated, e.g. regarding health issues. Ex post, **independent evaluations of the schemes should be part of a regular assessment that is publicly announced**. • Road signalling to give directions to drivers and warn them about the regulated zones is fundamental. **Care must be taken to provide clear messages when UVARs signs are part of a larger set of signs**. • When allowed by the UVAR's rules, information on accessibility of (alternatively fuelled) vehicles can be **made available to drivers. This should happen in the most cost-effective way making use of digital means where possible** and ensuring easy accessibility and understandability. Relevant data should be easily accessible through existing national access points created under the ITS Directive.[2] • A contemporary communication strategy should embrace a **wide range of communication and information channels,** to better address messages to key target groups. New opportunities offered by **new media**, such as the possibility of directly targeting individuals should be explored further, in conformity with the relevant data protection legislation. • The use of new technology should be further explored,

[1] http://urbanaccessregulations.eu/
[2] https://ec.europa.eu/transport/themes/its/road/action_plan_en

Topic of the NBGDs	Recommendations
	in particular for **establishing an interface between local authorities and third parties** willing to provide information on access regulations as open access data in combination with digital maps or via personal navigation systems.
2. Vehicle types, exemptions and (cross-border) enforcement	• Local authorities **should work towards compliance with the latest Euro standards as a basis for access-to-access regulated areas**, while gradually phasing out older Euro standards, particularly in light of the new real driving emissions tests that will reduce the gaps between the tests and real driving conditions. • Local authorities, together with compliance with the latest Euro standards as a basis for access to LEZs, **could also consider exempting cars running on zero emission devices** such as battery-electric and fuel cell- electric vehicles. • Methods of enforcement regarding foreign vehicles could include **the establishment of national bilateral agreements**, to pursue cross-border enforcement; for example, through collaboration with European debt recovery and vehicle licensing agencies. • Exemptions from local regulations should be **clearly defined to ensure a high level of effectiveness**. Relevant exceptions include e.g. vehicles driven by or for persons with disabilities in order to ensure mobility, referencing the internationally standardised system of badges identifying them as such[17]. Emergency vehicles (e.g. ambulances, fire trucks, police vehicles) must retain access. Through future vehicle procurement, city authorities can measure all relevant part of the public fleet comply with the access conditions. • **Historic vehicles could be exempted from low emission zones** because of their minimal use in the regulated areas combined with their contribution to the preservation of motoring heritage. LEZs would thus disproportionately penalise particularly urban-based owners and businesses servicing historic vehicles since practically no retrofitting possibilities exist. A definition of historic vehicles is included in the Directive 2014/45/EU on periodic roadworthiness tests for motor vehicles and their trailers. • Local authorities, Member States and the EC **should encourage the use of IT solutions** and/or web platforms for the carrying out of UVARs schemes,

Topic of the NBGDs	Recommendations
	thereby contributing to the implementation of the ITS directive. IT solutions for bigger cities could be extended to satellite cities. This will reduce implementation- and maintenance costs and increase levels of acceptance and efficacy. • Local authorities should increase **dissemination to the public** regarding the relation between UVARs schemes and penalties in case of violations.
3. Planning, consultation and design	• **Set up UVARs as part of an integrated planning**. From the point of view of planning and design a key issue of both local and European **added value is an integrated approach**, given that the effectiveness of any kind of UVARs scheme depends on such a strategy. **The common reference to Sustainable Urban Mobility Plans** would be of great benefit to cities aiming at sustainable mobility and compliance with the air quality legislation by implementing a UVAR scheme. • **Ensure an effective stakeholder consultation**. Choosing the best form of consultation is important. The strategy must consist of **structured interaction with a wide range of stakeholders** in a form that is tailored to each group of stakeholders who have an interest in the project under consideration. • **Consider the use of trials**. Although experience tends to show that the level of public acceptability rises significantly once a scheme is operational and functioning efficiently, **trials can be helpful** to be able to introduce a scheme on an experimental basis, thereby calming scepticism of stakeholders who can be reassured that the scheme will be modified if proven to be unsuccessful. The implementation of a sort of **'utility test' before introducing the scheme** in order to ensure its effectiveness and acceptability can assure that such a scheme is the most suitable in contributing to solving the identified problems. • **Invest UVARs-related revenues in sustainable mobility options.** Planning the use of revenues from a UVAR scheme for measures to improve sustainable mobility options like public transport, walking and cycling right from the start, and communicating this is of paramount importance. **Encouraging integrated multimodal transport** (smart tickets, multi-modal travel, travel information and routing, sharing), **deploying smart traffic management systems**, **encouraging fleet renewal** and **measures that**

Topic of the NBGDs	Recommendations
	promote optimised vehicle use including car sharing are actions that can further address the challenges of urban mobility. • **Design a comprehensive UVARs scheme, including enforcement techniques.** A well-designed and well-enforced scheme also achieves high effectiveness. In fact, schemes that are **clear, simple and understandable**, where information is clearly disseminated, are able to achieve high compliance rates.
4. National legal frameworks	• It is important that any national legal framework accounts for **enough flexibility** allowing cities to tackle their differing problems arising from different fleets and at the same time avoid stifling the possibility for innovation to produce new good practice schemes. • Whether national legislation is formulated from a 'top down' or 'bottom up' perspective may determine how effective it will be in facilitating UVAR schemes in cities/regions within its national boundaries. **An optimum combination could be one that reflects significant city/region input, European legislation and non-binding guidance, drawing on examples of good practices in Europe**. • It is important that national frameworks concerning UVARs schemes are designed in a transparent way, **addressing all citizens and reflecting all stakeholder's views,** thereby mitigating scepticism. • National legislation should **be clearly linked to EU and national policy goals** in the fields of for instance air pollution or CO_2 emissions. When under design, a national legal framework should clearly state the goals it is pursuing. • Such legislation should give guidance to cities on **how to establish sustainable mobility alternatives.** In particular, when schemes create revenues through e.g. congestion charges, national legislation could encourage cities to invest these in sustainable modes of transport. • National legislation should be written in such **a way to include common issues which might apply to all UVARs schemes**. An example might be legislation that is drafted to include general reference to issues that could be applied to any prospective UVARs in the

Topic of the NBGDs	Recommendations
	country (e.g. types of vehicles exempt from any UVARs charge, classifications of road that could be included in UVARs scheme, emission levels of vehicles to which a UVAR charge might apply etc.) where possible. • Before the design of a UVAR, a national legal framework should include provisions that allow a scheme to be **subject to a utility test before its introduction** and throughout its implementation to ensure its effectiveness and acceptability. In other words, the necessity for the envisaged regulations should be measured to justify the appropriateness to contribute to solving the identified problems. The decision should be supported by a proper impact assessment including the environmental as well as economic and social impacts of the proposed measures on the local economy and businesses. • A national framework may include provisions and recommendations relating to the necessity to **carry out a consultation process** prior to the possible introduction of UVARs at local level which could involve commercial road transport industry and relating to timely information about such regulations to the commercial road transport operators. • National governments could also consider the creation of a **permanent national consultation and advisory group** to regularly review UVARs and recommend actions to enhance best practice exchange and the participation of private sector stakeholders, including business stakeholders, in its activities. • **The evolution of vehicle technologies** may bring additional challenges that should be taken into account when designing the legislation. **This means that the future of a UVAR should be reconsidered in the light of the development of new technologies.** • The components that may be considered when developing a national legal framework for urban vehicle access regulations can be divided in two categories: **primary contents**, which should necessarily be included, and **secondary contents,** which could be considered. Components that **should be included** in a framework legislation: ○ Vehicles affected; ○ Emission classes and certified retrofit equivalents; ○ Exemptions;

Topic of the NBGDs	Recommendations
	○ Non-discriminatory treatments, e.g. citizens who have no alternative to using vehicles or are unable to gain access to a vehicle with appropriate standards, etc.; ○ Methods for identifying vehicle accessing a UVAR/Retrofit Emission Control (REC) devices; ○ Methods for identifying vehicle eligibility; ○ Road signs; ○ National, regional or local registration databases. Components that **could be included**: ○ Complaints and mediation agency; ○ National website; ○ Assessments and evaluation processes.
5. Evaluation and assessment	• In the evaluation and assessment of UVAR schemes, local municipalities should pay attention to: ○ The **selection of evaluation indicators**, and on how to concretely measure them. ○ The **minimum data requirements** for a meaningful evaluation process and related outcomes. ○ The relation between the **scale of expected impacts** and the **resources allocated** to the evaluation. ○ The establishment of **a baseline (or "do nothing" scenario).** ○ The **application of a cost and benefit analysis** including economic and social impacts of the proposed measures on the local economy and businesses. ○ The **distinction** between the evaluation of the concrete UVARs scheme and that of the long-term strategy defined e.g. at city master plan level. ○ The **assessment of synergic effects** between UVARs and other urban mobility policies and measures. ○ The **engagement of stakeholders** from the outset to jointly select and prioritize evaluation criteria allowing to negotiate conflicting interests at an early stage. ○ The **transparency** ensured by regular communication and dissemination (notably to users and other involved stakeholders) of the evaluation results. • The **engagement of the broader public** at an early stage by dialogue beyond dissemination of evaluation outcome in a responsible way.

Topic of the NBGDs	Recommendations
	• Assessments should be **neutral** and be done preferably by an independent body to avoid that the assessment of a scheme is performed by the same organisations who are responsible for its successful implementation.
6. Technology options and interoperability	• Consider interoperability and user friendliness when planning a UVARs scheme and its associated technology. **Automatic number plate recognition (ANPR) technologies** are particularly suitable in areas where there are many occasional users, since they do not require the installation of in-vehicle equipment. If the UVAR requires payments, appropriate interfaces to third party payment- and toll service providers who assist the users should be established. • **DSRC should be considered as an alternative or complementary technology** to ANPR where a large proportion of vehicles in the area covered by the UVAR are already equipped with on-board equipment (for example provided by surrounding motorway operators). DSRC-based UVAR schemes should be made fully EETS-compatible to allow interoperability with inter-urban e-tolling schemes and to allow seamless traffic between the interurban and urban environment. • When choosing the technology **factors such as urban topology and UVARs scheme objectives** must also be taken into consideration. • Though promising in terms of interoperability, GNSS solutions in urban areas **face several implementation barriers**, driving up investment costs. (i.e. that additional roadside transmission equipment needs to be installed to improve signals where they are weak). • Keep in mind that **the lack of cross-border agreements on enforcement of UVARs** is currently an issue. An appropriate framework for the exchange of information on toll offenders is being proposed by the Commission, and a similar solution could potentially be used for the cross-border enforcement of UVARs[18]. • In general, the appropriate combination of technologies must cope with the everyday challenges, e.g. public acceptability, privacy issues, legal problems, technical reliability, and EU technological interoperability. Every combination should **be evaluated ex-ante**, through an experimental period where the particularities of the UVARs scheme and the applied technologies itself are tested with all the involved stakeholders and actors.

Topic of the NBGDs	Recommendations
	• Cities in which the worst congestion problems (urban roads) can be located along a cordon around the city centre, the implementation of **cordon charging UVARs schemes** would be a viable choice. In other cases, the set-up of costly roadside equipment (UVARs gantries) in a few important points may be compatible with urban topology. On the contrary, in urban areas with **multiple access** and complex road network, the identification of specific cordons would be more difficult.

[1] Commission Staff Working Document: A call for smarter urban vehicle access regulations. Brussels, 17.12.2013 SWD (2013) 526 final (page 2).
[2] Cordons are the combinations of point-based schemes located to form a continuous or semi-continuous boundary around an area. Cordon schemes are present in Stockholm, in several Norwegian cities, and are the most common in the UK.
[3] UNECE Convention on Road Signs and Signals, of 8 November 1968 (ECE/TRANS/196)
[4] MEMO-12-671_EN.
[5] European Commission DG Move: Results of the public consultation 'The urban dimension of the EU transport policy' (page 41).
[6] SWD (2013) 526 final.
[7] Brussels, 17.12.2013 COM (2013) 913 final
[8] Communication from the commission to the European Parliament, the council, the European Economic and Social Committee and the Committee of the Regions: Together towards competitive and resource-efficient urban mobility. Brussels, 17.12.2013 COM (2013) 913 final (page 5-6).
[9] Commission Staff Working Document: A call for smarter urban vehicle access regulations. Brussels, 17.12.2013 SWD (2013) 526 final (page 7).
[10] UNECE Convention on Road Signs and Signals, of 8 November 1968 (ECE/TRANS/196)
[11] http://ec.europa.eu/transport/themes/urban/urban_mobility/ump_en.htm
[12] WHITE PAPER Roadmap to a Single European Transport Area – Towards a competitive and resource efficient transport system /* COM/2011/0144 final */
[13] Action Plan on urban mobility COM (2009) 490
[14] TREN/A4/103-2/2009: Study on Urban Access Restrictions
[15] Brussels, 17.12.2013 SWD (2013) 526 final
[16] ARS Study – TREN/A4/103-2/2009: Study on Urban Access Restrictions - Final Report, December 2010 http://ec.europa.eu/transport/themes/urban/studies/doc/2010_12_ars_final_report.pdf.
[17] The EU standardised model of parking card for persons with disabilities allows a disabled person who is entitled to use certain parking facilities in his EU country of residence to move more easily in the territory of another EU country and avail themselves of all the parking facilities granted to the card-holders in that EU country. The EU model was introduced by a Council Recommendation in 1998 and updated in 2008. EU Council Recommendation of 3 March 2008, 2008/205/EC
[18] Part of recast of Directive 2004/52/EC

ANNEX 1: The Role of Information and Communication in Urban Vehicle Access Regulations (UVARs) schemes

Glossary

CLARS: Charging, Low Emission Zones, and other Access Regulations Schemes

EC: European Commission

EU: European Union

LEZ: Low Emission Zone

LPG: Liquefied petroleum gas

LTZ: Limited Traffic Zone

NBGD: Non-Binding Guidance Document

SUMP: Sustainable Urban Mobility Plan

UVARs: Urban Vehicle Access Regulations

VMS: Variable Message Signs

CHAPTER I – Introduction

Urban vehicle access regulations schemes (UVARs) are increasing in number across Europe and may not only differ between countries, but also between urban areas within a country. All schemes involve regulations but each UVARs has its own rules: some apply at a certain time of the day or the year, some to (non-)residents only and some require certain permits. Some of the schemes require payment, and exemptions generally vary across Europe. This is especially problematic because users are not always aware of the features of the schemes that are in force in cities they do not visit regularly.

The European Commission DG MOVE has commissioned the publication of a set of six Non-Binding Guidance Documents (NBGD) to support local and regional authorities planning to introduce an access regulation scheme. While there is no one-size-fits-all answer, commonly applicable solutions to shared challenges and concerns can be found, which can lead to a European rapprochement of practices for the benefit of cities, citizens and stakeholders across Europe, including business and industry.

Information and Communication as Customer Service

Within this set of six non-binding guidance documents on UVARs, the present publication provides an overview of the topic of information and communication, which is a fundamental aspect both prior to the implementation of an access regulation scheme and once the scheme is in operation.

While the role of information and communication is particularly crucial in the design and planning phase, as it includes participation and consultation with operators and various types of stakeholders and citizens (see NBGD N°3 of this set, to be elaborated later under this project), the present publication refers to the notion of customer service[1], which encompasses the information and communication activities required once the UVARs scheme has been designed and approved by local administrations.

Customer service is one of the most important aspects of any UVARs scheme, as without a sound customer relationship management strategy, local as well as non-local and foreign road users may find it difficult to understand the motivations behind the introduction of the scheme, its practical rules, and implications on personal mobility as well as on local and non-local businesses.

In addition, experience has demonstrated that effective information and communication can mitigate criticism and lead to the successful and smooth implementation of a scheme, ensuring its long-term effectiveness.

CHAPTER II – The Challenge: Raising Awareness and Providing Instructions

Raising awareness

Once a UVAR scheme has been agreed on by the local administration and a plan for implementation is approved (NBGD N°3 of this set), raising awareness about the UVARs scheme becomes a top priority. At this stage, a key challenge the city administration face is the design of a comprehensive communication strategy setting out the different phases of the communication and information campaign; identifying the key messages as well as the right target groups; and determining the most suitable dissemination and communication tools.

As the introduction of UVARs often raises scepticism among citizens, transport stakeholders and business operators, proper communication is essential in order to address criticism from the outset and encourage acceptance by the population. In this respect, the way the UVARs is promoted from the start - for instance as part of a wider strategic context and not as an isolated measure - is fundamental. If the positive effects of the scheme can be demonstrated to users, they will more likely change their mobility behaviour.

In addition, the communication campaign has to address people potentially affected by the scheme in an effective manner. Communication efforts should not focus solely on users within the area under consideration for the UVARs, but also give importance to stakeholders outside the selected area, including those crossing international borders as well as foreign users in general. It is often those who travel from the city's hinterland who see themselves as being the most adversely affected by the introduction of UVARs, and foreign actors living far from the scheme might also be directly concerned.

UVARs can have an impact on the business sector, commercial road transport operators or any other economic activity implying transport. This potential impact needs to be addressed in time and business need to be informed about any newly approved UVARs. Some transport operations are based on long-term contracts and changes to the requirements can have legal and contractual implications, which would affect certainty and predictability in the administrative and business development of the companies and organisations concerned. Allowing these actors to operate in a predictable environment will not only improve the acceptance of UVARs but also reduce undesired effects on the local economy.

> *Creating awareness of the scheme was only the beginning. The real challenge was to translate this awareness into understanding and then timely action by those affected. A continuous backdrop of hostile or misleading news coverage and speculation about the viability of the scheme meant that the 'paid for' communications had to cut through and provide the voice of authority of accurate information.*
>
> - From the London Congestion Charge[2].

Information

Prior to the entry into force of the scheme, but also during the scheme's operation, the city administration needs to provide reliable and constantly updated information. The population must be prepared for the launch of the scheme and provided with information on how the

scheme will work. Users of the scheme need to be able to understand the information received, gain easy access to it, and be in a position to comply with the rules, including paying and dealing with any penalties which might be imposed. The key aspects to focus on are therefore:

● *What it is* ● *How it works* ● *How to comply* ● *Exemptions & reduced fees*

It is essential to also carefully plan and communicate alternative solutions for the various groups of users, such as non-motorised transport new infrastructure, reinforcement of public transport services, park and ride facilities immediately at the borders of the UVARs and the general adaptation of the local circulation plan.

Accessibility of Information: The European Traveller

The city administration needs to ensure that infrequent and non-local users are not disadvantaged compared to frequent and local users. Often, foreign drivers are unaware of UVARs regulations in cities they visit less frequently. The biggest challenge for them is to know the local regulations, so that they can comply. Simple and easy to follow rules are key in this respect. Reaching foreign customers, including economic operators, requires more efforts from the relevant authorities in terms of strategy, planning and regular updating.

Foreign visitors have to be aware of access-regulated zones, the permits required, and possible exemptions. This information is sometimes published on city websites, but usually only in national languages, or via anecdotal publications offering tips about travelling around Europe. An example of systematic information on UVARs schemes can be found in the website portal, www.urbanaccessregulations.eu.

The main challenge at the European level is to simplify travel for citizens in the whole territory of the Union by providing a common approach to communication and information with regard to UVARs schemes across Europe. It is important that foreign drivers are not placed in a position where they infringe on local regulations because of a lack of access to information.

CHAPTER III – Communication Strategies and Tools across Europe

An overview of past and current UVARs scheme communication strategies can guide local administrators in the preparation or fine-tuning of more effective information campaigns. Communication tools and techniques used prior to and during the scheme, methods for providing reliable and regularly updated information to the public, and procedures for gathering feedback from users vary from scheme to scheme. However, there are some common principles that have proven to be successful across Europe.

From the ARS study[3], it can be seen that most cities circulated information about the scheme and its rules, either prior to implementation (78%), or during the operational phase of the scheme (66%) or both (see figure I). Thus, even if a public information campaign before implementation can help to smooth the launch, as was found for the London Congestion Charge scheme, it is also crucial to disseminate information once the scheme is in operation in order to enhance/maximise people's awareness and, consequently, decrease the number of violations.

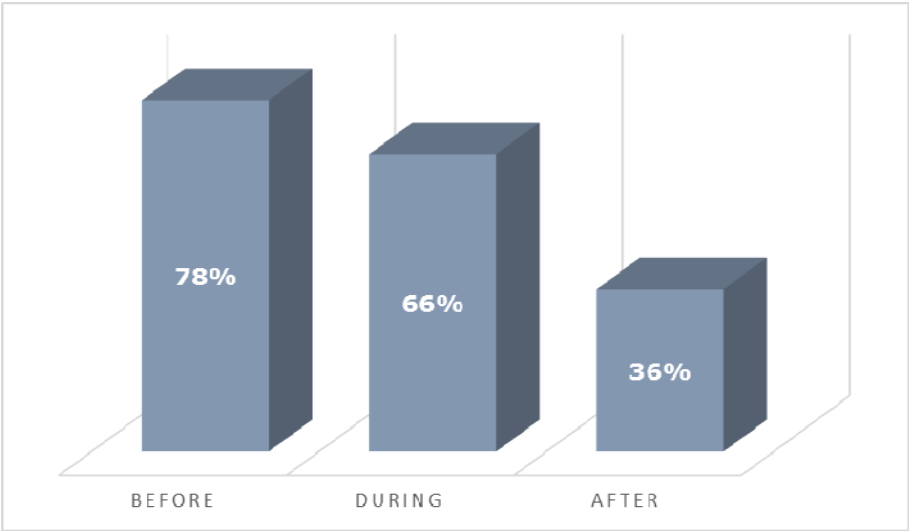


Figure I - Period of dissemination

Formulating the Message

Communication campaigns start with the definition of a core message to explain why the UVARs scheme is being introduced and the improvements it will bring in terms of quality of life. Congestion charging schemes, Limited Traffic Zones, and Low Emission Zones are all access regulations measures that city administrations undertake to reduce congestion and pollution. The use of these UVARs schemes to generate a range of benefits resulting in more pleasant city centres for residents and visitors is a focal point of the message.

LTZ in Bologna [4]

In 2006 Bologna *was the first city in Italy to implement a road pricing policy within its Limited Traffic Zone (LTZ). The city sets a good example of how UVARs scheme benefits can be highlighted in the formulation of a communication campaign, and how the population can be involved in the process. In the context of the CIVITAS MIMOSA project, the Bologna city administration organised several meetings with different stakeholders and continuous awareness campaigns to focus the attention of the population on traffic and pollution issues. At the same time, the municipality began an information campaign to spread awareness of the incentives available to shift to methane or LPG and to promote private vehicle renewal as part of its urban traffic plan. In February and March 2011, a survey was carried out to assess residents' perception of the LTZ, in view of the implementation of a pure car free area within the LTZ. This resulted in a high level of awareness of the road pricing policy. This was due to the extensive effort Bologna put into advertising campaigns both before and during the initiative.*

In case of road-charging schemes, the allocation of revenues is normally part of the information provided in any advertising campaign. This is done to address perceptions that UVARs schemes are being introduced with the primary aim of generating revenue. Clarifying that revenues from the schemes will be invested in improvements to urban mobility (public transport infrastructure, parking places, etc.) mitigates these perceptions and thus increases public support for UVARs.

The Oslo Toll Ring[5]

The toll scheme in Oslo *is one of the first examples of how information about UVARs revenue could be used. Introduced in 1990, the city has explicitly stated that revenues raised from the scheme would fund new infrastructure and that 20% of toll income would be earmarked for public transport (Oslo Package 1 and 2). To reinforce the limits on the use of revenue, the duration of the Norwegian toll schemes was initially limited to the length of time needed to raise the requisite funding for new infrastructure. According to the original agreement, the charges had to be abolished in 2007, when all planned road construction projects would have been paid for. However, a new political compromise was created for another twenty years of investments (Oslo Package 3*[6]*), to continue the pricing scheme in an even extended version, using it also for demand management in order to fight congestion and to guarantee easy access to the city centre.*

As levels of acceptability need to be maintained over time, the key objectives and benefits of UVARs schemes are periodically reiterated so that users are regularly made aware of the purpose and benefits of the regulations in their city. In addition, the success of the operation is part of the message when positive results are achieved in terms of, for example, a decrease in air pollution in the city or an increase in public transport use. Evidence from opinion surveys of the *Oslo and Trondheim*[7] toll rings shows that support for the charges increased when respondents were reminded of the types of measures the revenues were financing.

Although experience tends to show that levels of public acceptance rise significantly once a scheme is operational and functioning effectively, it can be helpful to be able to introduce a scheme as a trial or for an experimental period. This creates an opportunity to qualify and quantify the outcomes of the measure and reduce the fears of some stakeholders, who can be reassured that the scheme will be removed or modified if shown to be ineffective.

The Stockholm Trials[8]

The experimental period was used very successfully in the congestion charging scheme in Stockholm*, which was originally introduced on an experimental basis, closely monitored during the experimental phase and only confirmed as a permanent scheme once it was proven in a real-life situation that it was achieving its aims and objectives.*

Coupled with the concept of a trial period is that of a period of warning rather than immediate enforcement, which has been applied in a number of schemes.

The period of warning in Vitoria-Gasteiz[9]

In the access regulation scheme in Vitoria-Gasteiz*, warning letters rather than fines were sent to those who did not comply with the scheme's regulation. This was of assistance to many people during the initial weeks of the new scheme, and also helped facilitate the scheme's introduction among a wider range of stakeholders.*

Providing Practical Guidance

From the outset, city administrations need to deliver practical instructions in view of the launch. These include the start date of the scheme and other key facts, such as the geographical area affected, how the scheme will be enforced (e.g. via roadside and mobile cameras) and the periods of operation. Foreseen exemptions and alternative options are also key information. Where a charge is planned, more detailed information should be provided to the users, off-site and on-site, such as the level of the charge and possible discounts, methods of payment, information on enforcement, and penalties for non-compliance.

Once the scheme is in force, a key aspect of its effectiveness is the availability of reliable and continuously updated information. An up-to-date integrated information system can serve different objectives. These include the provision of practical information to users (access regulations, geographical extent, periods of operation, payment options, exemptions etc.), information for cities planning a new access regulations scheme (policies, guidance, examples of best practices, etc.) and for management systems for its operation (vehicle registration, payment and enforcement systems, etc.).

The ARS study[10] concludes that only 24% of cities provided information about possible alternative travel options (see figure II). This indicates that many city authorities do not seem to recognise the importance of setting up and communicating appropriate complementary and alternative transport modes and options, which should be available even before the scheme enters into force. For instance, if commuters do not find efficient mobility options, they are more likely to oppose behavioural change and stick to using individual vehicles. This would undermine the success of and support for the scheme.

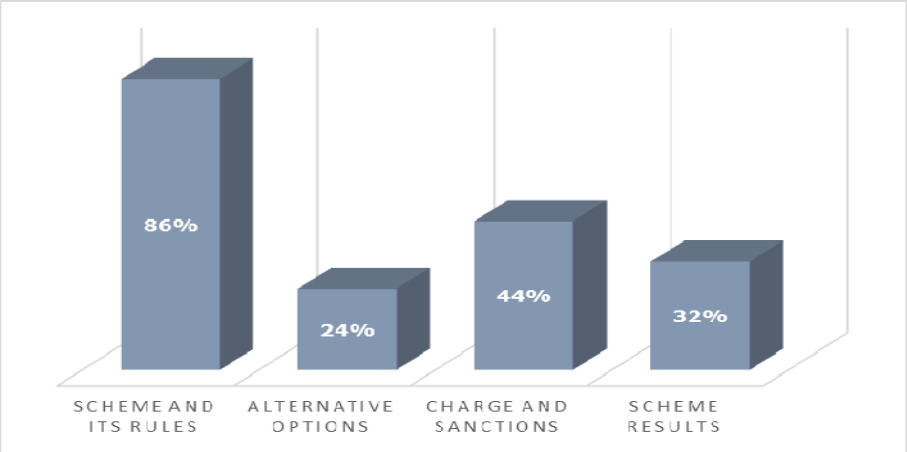


Figure II - Type of information disseminated

Addressing Target Users

The number and diversity of the people to be reached by the communication and information campaign depends on the characteristics of the scheme. However, the main target groups are necessarily private motorised users, residents and businesses in the regulated zone, as well as tourists, coach operators and freight distributors. This last category is a key interlocutor when considering schemes such as Low Emission Zones, which usually also affect light and heavy-duty vehicles.

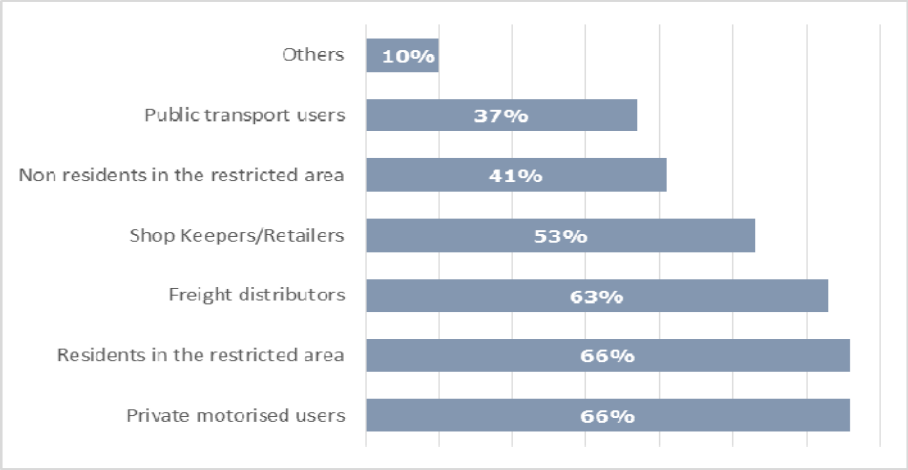


Figure III - People addressed

It can be noted from figure III extracted from the ARS study, that foreign drivers are not a category per se and are only partly covered in the 'Other' 10% in the graph above.

For the London *Congestion Charge, effective communication to close to 100 percent of Londoners was essential to ensure a successful launch. Target audiences included:*

- *All adults in the London area*
- *Drivers residing in Greater London*
- *Exemption and discount groups (22 in total)*
- *Fleets with over 25 vehicles (eligible for TfL's initial 'fleet scheme')*
- *Ethnic minorities living on the boundaries and within the charging zone*
- *Overseas visitors*
- *Central London businesses*

Activating communication and dissemination channels

The main source of information for potential users of a UVAR scheme is the internet (73%), which is now also accessible via mobile devices. Information on access regulation schemes is sometimes well documented in the municipality or on local transport websites.

According to the ARS study results, high-quality information on access regulations rules is provided by German and Norwegian cities and to a slightly lesser extent by municipalities from Sweden, United Kingdom and Belgium. In the Netherlands and Romania, there is a high percentage of cities offering online information on their access regulations schemes, but the information provided is usually only available in the respective local language.

Most cities offer online information on their access regulations schemes, with much information provided in the respective local language(s) and English.

The Transportstyrelsen website[11] provides clear information on congestion taxes in Stockholm and Gothenburg, as well as an explanation of the payment system. Information is provided in both Swedish and English.

Examples of high-quality websites for existing Low Emission Zones include Berlin, Copenhagen and London.[12] Some Italian cities also provide dedicated websites informing the public about LEZs, although, they are often insufficiently publicised and are usually only in Italian.

According to the ARS study[13], other ways to ensure direct contact with the public is by establishing information desks at the municipality, or kiosks on the road where citizens can find more information, respond with questionnaires, or leave suggestions or comments on the access regulations schemes. Other options include providing e-mail addresses and/or postal addresses, to meet the preferences of different target groups. A significant number of cities have used traditional media such as press, radio and television channels, along with leafleting (see figure IV).

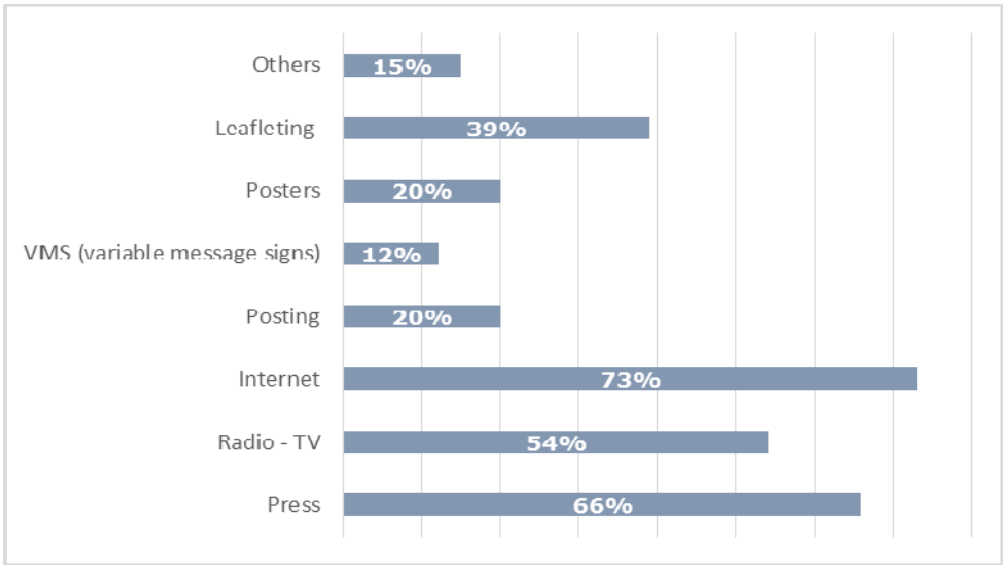


Figure IV - Media used

London's Public Information Campaign

The City of London's public information campaign facilitated the smooth launch of the Congestion Charging scheme using a variety of communication and information channels. Leaflets were distributed to 3 million households and over 35,000 information packs were made available to businesses operating fleets of 25 or more vehicles. A dedicated call centre was created. The scheme was advertised on TV, radio, newspapers, ports authority and on the London Congestion Charge website; face-to-face activity was carried out in boroughs; and e-mails were sent to businesses in and around London.

Road Signalling System

Information to users regarding UVARs schemes is provided on streets, in the form of boundary markers and information signs. Boundary markers are placed near all access roads to enable drivers to avoid crossing boundaries inadvertently and being penalised. Roadside signs are placed at or near the boundaries of the regulated area to inform drivers about regulations, driver's rights, payment possibilities (if applicable) and penalty measures, so that drivers have the option of taking an alternative route. Information signs are also placed on the major access and by-pass routes outside access regulations boundaries. Signs or maps can be used to provide information about alternative routes, parking and for other mobility solutions.

CLARS: The Information Tool for the European Traveller

CLARS (Charging, Low Emission Zones, and other Access Regulations Schemes) is a web-based service supported by the European Commission that provides information on urban access regulations schemes currently in operation, including urban road user tolling, Low Emission Zones and other access regulations schemes across Europe.

The public website serves non-local visitors and EU travellers, by helping them find out about schemes. A member platform supports cities and public authorities in sharing best practices.

The information on each city's scheme is summarised in English and can be searched by city, country, and vehicle type, or via an interactive map. Automatic translations help visitors with other languages. Cities are encouraged to submit information about confirmed schemes to the CLARS platform as part of their communication strategy.

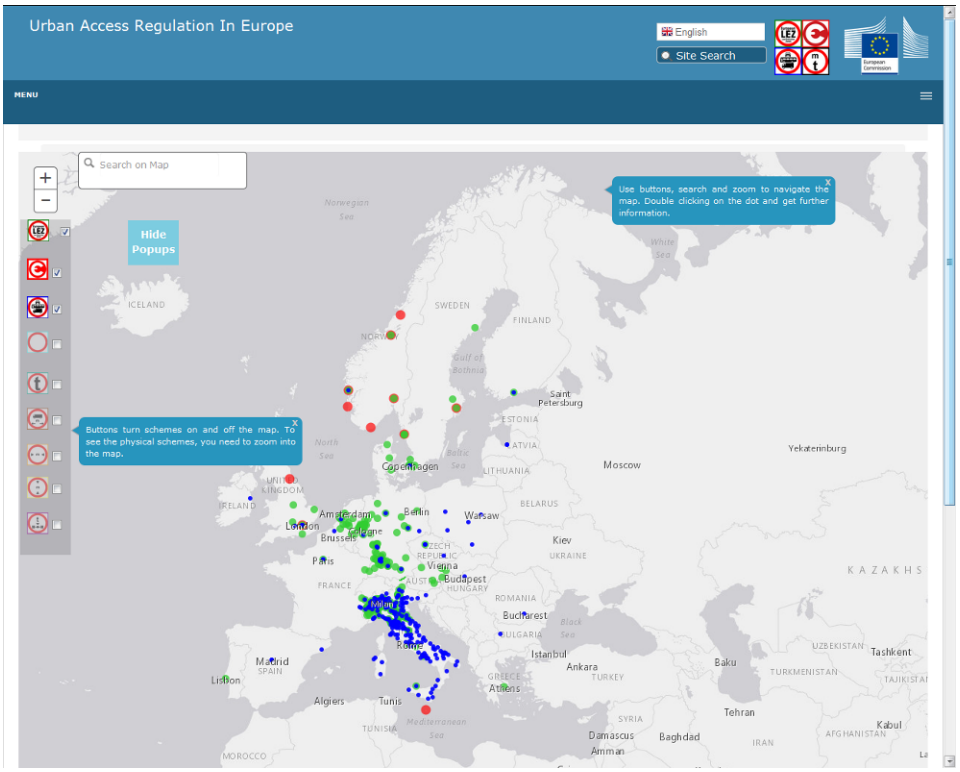


Figure V - CLARS website

For more information please visit**:** http://urbanaccessregulations.eu

CHAPTER IV – Potential Impacts of Effective Communication and Information in European Cities

Benefits to the Local Population

The potential impacts of effective information and communication strategies for UVARs schemes primarily relate to the local population. Early awareness of an access regulation scheme is likely to help citizens to become used to the idea that a change in mobility behaviour is needed to fight against the negative effects of local private vehicle dominated mobility. In general, this leads to increased acceptance of access regulations schemes as a means of improved mobility benefitting the city and its citizens.

Early communication of the technical features of the scheme enables people to become familiar with and comply with the regulations by the time the scheme is implemented. This prevents malfunctioning during the launch and limits unintended violations. These advantages extend into the operational phase of the scheme, as was seen in the city of Rome, where violations decreased during the first year of implementation from a mean daily value of illegal entrances per day of 20%, to a stabilised rate of 8%[14].

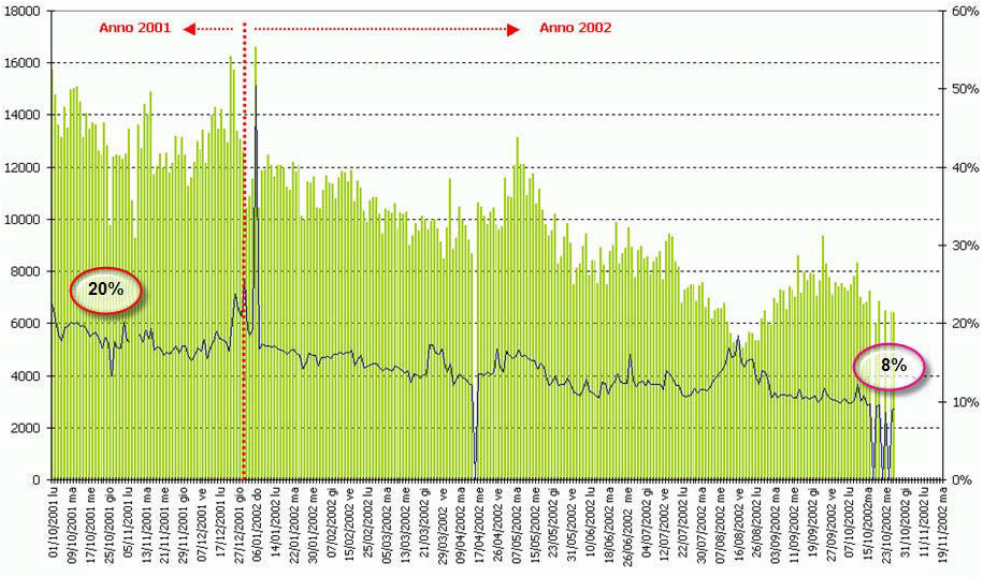


Figure VI - Daily violations in Rome (October 2001 - October 2002)

Benefits to the European Traveller

From a European perspective, the provision of reliable and easy-to-access information on existing schemes to foreigners will ensure and facilitate freedom of movement across countries as well as contribute to completing the transport Single Market. Knowing the rules and procedures of UVARs schemes in every country in advance would enable European travellers and business to drive safely without making unintended violations either because they did not find the information beforehand (via the web) or because signage was insufficiently clear or understandable.

Benefits of a European Rapprochement

The main beneficiaries of a voluntary common approach based on successful European practices would be the cities that are planning and implementing UVARs schemes. An exchange of information between European cities on how local regulations are communicated and disseminated to citizens would pave the way for a gradual rapprochement of methodologies and strategies that would improve the quality of scheme communication and increase cost effectiveness at the city level. Less variation between cities and countries would increase acceptance by citizens and in turn lead to improved compliance and more respect for rules and regulations also abroad.

CHAPTER V – Barriers and Enablers to the Successful Communication of UVARs Schemes

Barriers

- *Addressing Negative Perceptions*

  Barriers are often as much about perception as they are about the reality of the impact that any given UVARs scheme will stimulate. Therefore, it is necessary for a successful communication campaign to address and refute these perceptions. From the practices highlighted in the previous chapters, a number of common misperceptions can be identified.

  A common barrier is the misconception that a UVARs scheme is being introduced with the primary aim of generating revenue. It is vitally important to confront this assertion head on. UVARs schemes are in fact introduced by public sector bodies, whose right to exist is not to make profit in the way a private company would. Any marginal revenues generated by a UVAR scheme are generally used to enhance the urban areas in which they are located. Examples include the provision of additional bus services and public transport information systems, urban area enhancements such as improved street lighting, the creation of pedestrian areas, and tree planting programmes.

  Another common initial reaction to a proposal to introduce a UVAR scheme is the fear of limited access to goods and services in the city. It is essential that alternative modes of transport be enhanced to present an attractive and practical alternative to private vehicles and that these improvements are clearly communicated to the public.

  A frequent perception from the retail sector associated with UVARs schemes is that the volume of business from car-borne customers is superior to that from those who use other modes of transport for access. As the impact on the retail sector is uneven and largely depends on the type of trade generated in the area affected, this situation needs to be clearly analysed in order to establish the likely impact of UVARs and the results articulated to the retail trade, which will form an integral part of any communication strategy.

Enablers

- *Presenting the strategic context*

  Any communication strategy for UVARs schemes must, first and foremost, present the scheme as an integral part of a wider traffic and transport strategy for the area in question and show how the scheme will contribute to the achievement of broader aims and objectives. In addition, complementary policy instruments, information on how revenues from the scheme will be used and appeals to environmental concerns, pro-social values and social justice are critical to increasing acceptability by citizens.
  Communication campaigns need to take into account that levels of acceptability are highly dynamic. They are typically likely to decrease as proposals become more concrete and are closer to implementation, and increase again after implementation. To maintain levels of acceptability, users must be constantly made aware of the purpose and benefits of the UVARs system.

- *Using a Variety of Communication Channels*
  A contemporary communication strategy should embrace new media channels in addition to traditional channels such as public meetings, exhibitions, leaflets, radio, and television. A comprehensive and user-friendly website is expected. However, more direct channels such as e-mail communication, text messages, Twitter and social media in general provide (real-time) access to individual stakeholders who sign up for this information in a way that was not possible in the past.

  Local transport authorities often have access to stakeholder e-mail accounts through the registration process for local transport smartcard tickets. Similarly, many people now register for text messaging services for real-time traffic and travel information in their local area. Local traffic and transport authorities have significant numbers of Twitter followers. All of the above groups can readily receive information on UVARs schemes directly and, in many cases, individually. The novel feature of these channels is that the messages can be targeted to individuals who explicitly sign up to receive this information.

  Research results have shown that the recipients of individually targeted information tend to react more positively than those who receive more general information.

CHAPTER VI – Summary of Recommendations

Although each city may have its own specific priorities and rationale for introducing a UVAR scheme, it is common sense that a gradual rapprochement of basic principles of communication and information strategies at the European level is beneficial to ensure the consistency and clarity of decision making, while improving the effectiveness and efficiency of the proposed schemes. The following is a list of recommendations addressing those local decision makers, who are planning or implementing UVARs schemes.

- Simultaneously to the adoption of a UVAR scheme, **the definition of a clear and comprehensive communication and information strategy should be elaborated** to ensure its smooth implementation and long-term effectiveness.

- A UVAR scheme should not be promoted in isolation, but as part of a wider strategic policy. **Local sustainable urban mobility planning (SUMP) can provide the overarching context and rationale within which a UVAR can be placed and promoted**.

- **Setting up and communicating appropriate complementary and alternative transport modes and options** is a key factor in changing users' attitudes and ensuring the success of the scheme.

- Direct information should not focus solely on the population within the area under consideration for the UVARs. **City administrations should give weight and importance to those stakeholders in locations outside the area** for which the scheme is planned, as they are among those affected by the introduction of UVARs.

- Information and communication should cover frequent, occasional and one-time users with different needs. **Foreign businesses and visitors, and non-local users in general, should have access to high-quality information** about the rules and regulations of UVARs schemes.

- **Clear, focused, multilingual information should be available** through a dedicated digital solution and in the supporting communication materials, as well as in the existing **CLARS database.**

- The expected benefits of the UVARs, as well as the positive results of the scheme in operation, should be clearly communicated, e.g. regarding health issues. Ex post, **independent evaluations of the schemes should be part of a regular assessment that is publicly announced**.

- Road signalling to give directions to drivers and warn them about the regulated zones is fundamental. **Care must be taken to provide clear messages when UVARs signs are part of a larger set of signs**.

- When allowed by the UVAR's rules, information on accessibility of (alternatively fuelled) vehicles can be **made available to drivers. This should happen in the most cost-effective way making use of digital means where possible** and ensuring easy accessibility and understandability. Relevant data should be easily accessible through existing national access points created under the ITS Directive[15].

- A contemporary communication strategy should embrace a **wide range of communication and information channels,** to better address messages to key target groups. New opportunities offered by **new media**, such as the possibility of directly targeting individuals should be explored further, in conformity with the relevant data protection legislation.

- The use of new technology should be further explored, in particular for **establishing an interface between local authorities and third parties** willing to provide information on access regulations as open access data in combination with digital maps or via personal navigation systems.

[1] "Customer service is the ability to provide a service or product in the way that it has been promised", The Magazine for Customer Service Managers & Professionals. http://www.customerservicemanager.com/
[2] Central London Congestion Charging - Impacts monitoring - Fifth Annual Report, July 2007, Transport for London
[3] For a general overview, the analysis done by the ARS study can still be considered a solid reference for facts and trends from which to start. As for the practices of the cities mentioned in the publications, they represent a selection of options currently in operation across Europe. ARS study - Study on Urban Access Restrictions, Final Report, December 2010 - TREN A4/103-2/2009.
http://ec.europa.eu/transport/themes/urban/studies/doc/2010_12_ars_final_report.pdf
[4] CIVITAS MIMOSA – Innovative Cities. Before and after CIVITAS. www.civitas.eu
[5] The Oslo Toll Ring (Norway). Case Study. OSMOSE project. http://www.osmose-os.org/documents/210/OSLO_pric.pdf
[6]http://www.eurometrex.org/Docs/Meetings/oslo_2013/Presentations/Terje-Rognlien-Oslo-Transport-Investment-packages.pdf
[7] Urban road pricing acceptance, Björn Hårsman, Inregia 2001-11-11
http://www.movinginalivableregion.ca/wp-content/uploads/2013/06/urban_road_pricing_acceptance.pdf
[8] Borjesson, M., Eliasson, J., Hugosson, M. B. & Brundell-Freij, K. (2012). The Stockholm congestion charge – 5 years on. Effects, acceptability and lessons learnt.
[9] http://www.eltis.org/sites/eltis/files/case-studies/documents/annex_4_-_vitoria-gasteiz_superblocks.pdf
[10] See note 3
[11] https://transportstyrelsen.se/en/road/Congestion-taxes-in-Stockholm-and-Goteborg/
[12] Rotterdam 2014, Feasibility Study: European City Pass for Low Emission Zones, European Commission, DG Environment, Ecorys
[13] See note 3
[14] See note 3
[15] https://ec.europa.eu/transport/themes/its/road/action_plan_en

ANNEX 2: Vehicle Types, Exemptions and (cross-border) Enforcement of Successful Urban Vehicle Access Regulations (UVARs) schemes

Glossary

ANPR: Automatic Number Plate Recognition system

EC: European Commission

EU: European Union

EUCARIS: EUropean CAR and driving license Information System

HGVs: Heavy Goods Vehicles

M2M: Mobile to Mobile Communication

I2M: Infrastructure to Mobile Communication

IT: Information technologies

ITS: Intelligent Transport System

LEZs: Low Emission Zones

NBGD: Non-Binding Guidance Document

NO_2: Nitrogen dioxide

NO_X Nitrogen oxides

OCR: optical character recognition

PM: Particulate matter

PTWs: Powered Two Wheelers

RDE: Real Driving Emissions tests

REC: retrofit emission control device

UNECE: United Nations Economic Commission for Europe

UVARs: Urban Vehicle Access Regulations

CHAPTER I – Introduction

Vehicle types, exemptions and (cross-border) enforcement of successful UVARs schemes across Europe

The topic 'Vehicle types, exemptions and (cross-border) enforcement of successful UVARs schemes across Europe' addresses three different but intertwined aspects of UVARs implementation: the choice of technologies for vehicle detection, the adoption of enforcement systems and the rules regarding exemptions. To the extent that technologies for vehicle identification are dealt with, this non-binding guidance document (NBGD) overlaps with the one focussing on 'Technology Options and Interoperability' that will be elaborated at a later stage.

The primary objective of an urban vehicle access regulation (UVARs) scheme is to limit the access of certain vehicles, e.g. cars, delivery vehicles, buses, to specific areas, an objective often driven by air quality targets but also by other strategic objectives such as reducing congestion, increasing the overall liveability of cities, etc. In this context, a key issue for implementation is the clear definition of exempted vehicles and a viable approach for vehicle identification. Every scheme is likely to entail exemptions under specific circumstances, such as ambulances, vehicles driven by or for persons with disabilities etc. Therefore, it is essential to have unambiguous, reliable vehicle identification and exemption rules.

Related to vehicle identification is the choice of enforcement frameworks; for example, manual, in the case of sticker-based systems, or automatic, relying on databases containing all of the permits issued to allow entrance to authorized vehicles. Databases can be managed at the local level, e.g. concerning specific exemptions, or at the regional-central level, e.g. as regards emission standards.

In general, UVARs schemes characterised by the use of "high technologies" (e.g. camera systems or Automatic Number Plate Recognition systems (ANPR)) allow for stricter enforcement and an extensive use of personal data whereas "low technologies" such as manual enforcement make UVARs schemes more permeable and at the same time less prone to legal disputes related to privacy and data protection issues.

In such a context, the treatment of foreign vehicles in the automatic enforcement techniques may be problematic, due for example to the lack, in the national database, of all relevant information, such as emission standards.

The main objective of this NBGD is to explain how different types of UVARs can be designed. As for the practices of the cities mentioned in this publication, they represent a selection of options currently in operation across Europe. There is obviously no one-size-fits-all approach. However, if we look at how vehicle identification, exemptions and enforcement have been managed in different contexts, commonly applicable solutions can be identified with a view to reduce the number of different methodologies.

CHAPTER II – The Challenges

To ensure the efficient and effective identification of vehicles, definition of exemptions and adoption of enforcement techniques in urban areas, three types of challenges must be addressed:

1. Trading-off technological costs and data protection concerns for vehicle identification with easier enforcement and management of exemptions;
2. Defining criteria for vehicle identification, including powered two wheelers (PTW), consistent with vehicle retrofitting;
3. Determining treatment of non-local and foreign vehicles in the case of cross-border movements.

Trading-off Technological Costs for Vehicle Identification with Easier Enforcement and Management of Exemptions

Access regulations schemes concern a geographically limited area in which selected typologies of vehicles are restricted, deterred or discouraged from access and use. This feature is independent of the type of access regulations scheme under examination. For instance, the most common types of access regulations schemes entail the existence of an area, a specific road, place, etc., where traffic is restricted.

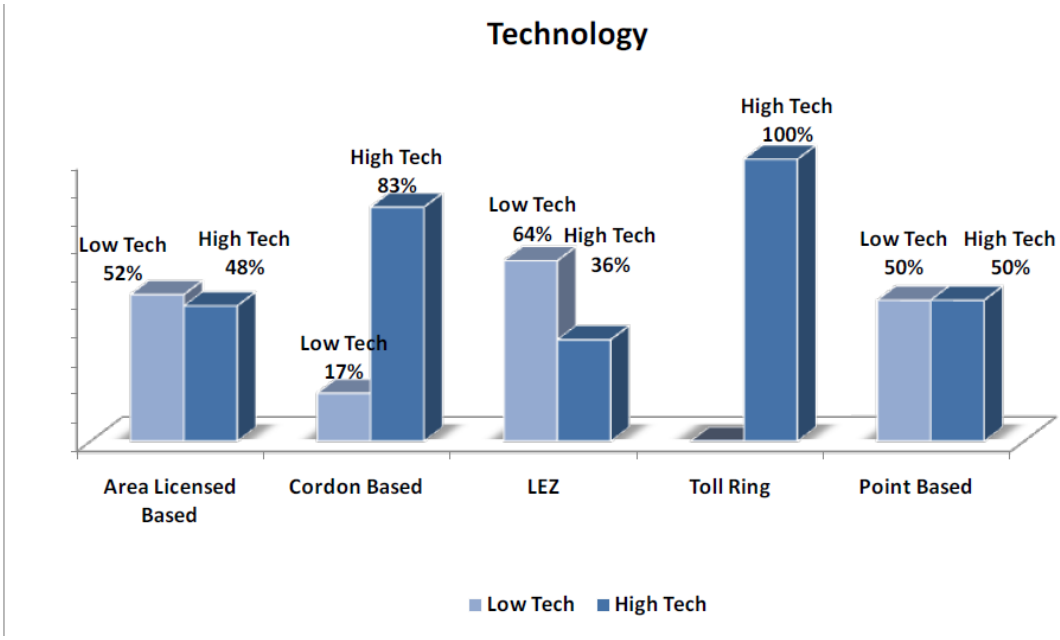
The following list shows examples of the different types of access regulations schemes.

1. Point-based (e.g. vehicles are not permitted to cross a bridge or enter a specific section of the city).
2. Cordon-based: vehicles are not allowed to cross a cordon[1], 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.
3. Toll rings are the application of highway tolling schemes, similar to the 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.
4. Area license-based pricing: a fee is charged for driving within an area during specific hours. The rules may vary by time of day and vehicle type.
5. Distance or time-based: this is essentially a pricing scheme based on the distance or time a vehicle travels along a congested route or in a specified area, and may vary with time, vehicle type and location.

According to the survey carried out in 2010 by the ARS study of 58 cities[2], the level of technology deployed appears not to be correlated with the type of access scheme, as shown in the figure below.

Figure I shows that toll ring or cordon-based schemes overwhelmingly use high-tech solutions whereas others use both high- and low-tech ones, where "high tech" entails some degree of automation through e.g. automatic number plate recognition, while "low tech" is mainly managed "manually".

This evidence suggests that the choice of technology for vehicle identification in the hands of municipalities is independent of the type of access regulations scheme and may depend on other factors that need to be examined.



Source: ARS Study (2009) "Study on Urban Access Restrictions". The LEZ definition in the figure relates to Low Emission Zones UVARs schemes, in which the schemes mainly address the regulations of access to freight vehicles in large areas of the city.

Figure I High and low technologies in UVARs schemes

For instance, enforcement techniques reflect technological choices: high technology options may lead to stricter enforcement whereas low technology choices make the scheme more permeable.

More specifically, the low-technology identification of vehicles can correspond to stopping vehicles at the entrance of regulated zones by controllers checking for a permit to enter or, in the case of Low Emission Zones (LEZs), for the vehicle emission sticker on the windscreen or surveillance of vehicles within the regulated zone.

The choice of the level of technology deployed in vehicle detection, and the corresponding enforcement implications in terms of flexibility and acceptability, is subjected to several trade-offs, such as cost, flexibility (e.g. treatment of exemptions), and flow of traffic.

With regard to costs, access regulations schemes that use high technology for vehicle identification, detection or enforcement functions (e.g. tags, smartcards or ANPR) will tend to have higher set-up costs than paper- or sticker-based schemes.

On the other hand, costs for manual controls during the operational phase are sometimes higher, depending on the number of access points, size of the zone and therefore the number of human resources, frequency of controls, administration costs, funding mechanisms, etc.

The trade-off between stricter enforcement and the cost of implementation depends on the individual characteristics of the urban area in question; in complex and large urban areas, a physically larger scheme will tend to cost more to set up and operate, if all other factors remain equal. However, a single strategic access point, manually enforced, that effectively controls most of the cross-city traffic in a historic urban area could be very effective but might not be an option for a modern city centre.

On the other hand, if a scheme is applied at a small scale, affecting relatively few vehicles or focusing on local fleets, a basic permit management and verification system might be sufficient.

In conclusion, the type of enforcement is subjected to a series of trade-offs, depending on the scale and number of vehicles involved in the access regulations scheme (see Table 1 below).

Table 1 - UVARs enforcement trade-offs

Feature	Technology level	Costs	Exemptions
Enforcement	Low	Low capital costs High operating costs Not all vehicles controlled	Easier management of exemptions
	High	High capital costs Low operating costs All vehicles controlled	More complex regulations schemes, e.g. registration required for foreign vehicles

Source: Our elaboration from ARS Study – TREN/A4/103-2/2009

In terms of flexibility, the management of exemptions is also subject to trade-offs related to technological choice. In fact, stricter enforcement through high technology may increase the complexity and administrative costs of managing exemptions. The typical example is the automatic detection of foreign vehicles, which implies an updated database with all information (retrofitting, emissions standards, cross border access etc.). Manual enforcement mechanisms, e.g. sticker systems as in Germany, could easily manage foreign vehicle exemptions as well as other specific cases, e.g. temporary exemptions, etc. Exemptions should be kept to a minimum, and be clear and focused. In general, the more exemptions, the less effective the UVARs. The key vehicle categories most often entitled to exemptions are the following:

- Diplomatic transport;
- Emergency vehicles (e.g. ambulances, fire trucks, police vehicles);
- Vehicles driven by or for persons with disabilities;
- Local public transportation;

- Military transport;
- Historic vehicles;
- Construction vehicles;
- Key roads (e.g. those being part of the Trans European Transport Network) need to be exempted to comply with the principle of freedom of movement.

In conclusion, trading off between the cost of vehicle identification technologies and increased ease and flexibility in the management of exemptions and enforcement is a complex exercise involving several factors, such as city size, location, vehicle fleet size and composition and the objectives of the UVARs scheme in question. For instance, when primarily addressing congestion, a maximum of compliance (the screening of all vehicles), necessitating the use of high technologies to capture all vehicles entering, may be required.

Defining Criteria for Vehicle Identification, including Powered Two Wheelers (PTW), consistent with Vehicle Retrofitting

When access regulations schemes, in particular LEZs, are set to address environmental targets,[3] as they do in most cases, the following criteria are relevant for vehicle identification:

- Euro standards (the term for European approval standards on the emissions performance of new vehicles over a defined test cycle);
- Standards to include vehicles with zero emissions at source (i.e. Electric, fuel cell, and potentially plug in hybrid that travel at least a certain distance on electric);
- Euro 6 Real Driving Emissions standard as it should enable high pollutants vehicles (e.g. NOx diesel vehicles) to circulate;
- Year of first registration;
- Particular fuel/technology combinations (if they are considered to have particularly positive environmental features, such as alternative fuels);
- Retrofit technologies, which can be used on older vehicles to clean up exhaust emissions, generally particulate matter (PM) or nitrogen oxides (NOx);
- Vehicle types, such as cars, vans, heavy goods vehicles (HGVs), or emergency vehicles, that are to be included or excluded in the respective scope.

While the choice between these options or a combination of these options for access regulations schemes is a decision for the competent authorities, current practices suggest the use of Euro emission standards as key tools for vehicle identification. In doing that, urban municipalities must consider the following condition:

- The use of Euro standards has been progressively tightened to reduce emissions from particulate matter (PM) and nitrogen oxides (NO_x), two of the air pollutants of greatest concern. However, many cities all over Europe experience difficulties in complying with the nitrogen dioxide (NO_2) standard given by the EU Ambient Air Quality Directive (2008/50/EC). Vehicles, especially those utilizing diesel technology, are considered the most important contributor to NOx emissions in cities. The European Commission is currently introducing the Real Driving Emissions (RDE) test, complementary to the test-cycle approval. The test is designed to ensure that emissions from cars and vans respect the limit values set by Euro 6 under normal conditions of use.

Another challenge is the lack of EU legislation on retrofits. Retrofit certification relies on national legislations, given that there is no harmonised EU legislation for retrofit control devices. However, while there is no EU legislation, there is a harmonised UNECE standard that can be used. This means that for new access regulations schemes, national legislation can use the UNECE regulations for the majority of its content, to both reduce work and increase consistency.

Vehicle detection of PTWs is another challenge in UVARs implementation. Pilot projects, such as the one carried out by CIVITAS MIMOSA in the city of Bologna, and data from access regulations schemes currently applied in Rome have demonstrated that controlling access to motorbikes based on emission level is extremely difficult to implement.

First, the feasibility study conducted in 2009 in Bologna concluded that questions concerning mopeds registered prior to 1/7/2007 needed to be asked directly to the owners of powered two wheelers, as information on emission levels was not available from the national public registry. This would include both residents and non-residents.

The collection of this data appeared to be highly complex and seemed to present risks concerning the reliability of the information collected.

Similar problems were faced by the Municipality of Rome during the implementation of a ban on PTWs within the ZTL (Traffic Limited Zone). Where manual controls were not used, automatic vehicle detection instruments failed to distinguish between the PTWs of residents and non-residents, due to a lack of information in the PTW database.

Determining Treatment of Foreign Vehicles

Cross-border exchange of vehicle registration data would facilitate the recognition of foreign vehicles for the purpose of billing and collection of penalties. This would be of particular help in the presence of intensive cross-border flows or a significant number of foreign vehicles entering restricted urban areas, for example, where there is a lot of passenger car traffic from tourists.

EUCARIS (the EUropean CAR and driving license Information System) is the European data exchange mechanism used – among others – for facilitating the cross-border exchange of information on road safety-related traffic offences (e.g. speeding, drunk driving and not stopping at red lights). However, at present there is no EU-wide cross-border data exchange system for the violation of access regulations, such as penalties for non-compliance with emission standards or foreign vehicles with counterfeit parking permits for vehicles driven by or for persons with disabilities. But EUCARIS can also be used for this data exchange and could – if necessary – easily be extended. A cost-benefit analysis in upgrading the EUCARIS system for the exchange of broader violations would provide further insights.

At the moment, other organizations such as EREG (Association of European Vehicle and Driver Registration Authorities) support public authorities working with voluntary cooperation between national registration authorities.

In general, while various mechanisms are adopted to deal with foreign vehicles (discussed later on), only a few schemes actually grant them full exemption, for example the Dutch lorry LEZs.

CHAPTER III – Available options

In terms of available options, vehicle detection for identification and enforcement can be carried out using several methodologies, either alone or in combination. There are three main approaches:

1. Manual methods, particularly in Low Emission Zones, which usually involve enforcement personnel visually checking vehicles travelling within or parked within the scheme area for permits, via stickers or other identification means. Examples of manual vehicle identification usually tend to focus on older-looking vehicles and might use a mixture of manual recording and possibly photography.
2. Automatic vehicle detection (license plate recognition), as in the London congestion charge, where digital cameras and ANPR (automatic number plate recognition) systems record passing number plates and use optical character recognition (OCR) to match them against a vehicle database. Examples of ANPR vehicle identification may include installing a network of cameras on key routes in and out of the access-regulated area and possibly at key junctions within the zone. Alternatively, or as a supplementary measure, mobile ANPR cameras can be used to monitor key junctions. As mentioned above, this kind of approach may lead to data protection and privacy problems, depending on the specific national legislation in force and care needs to be taken that data protection and privacy issues are addressed.
3. Electronic identification, for example through Dedicated Short Range Communication (DSRC) tags and beacons. They are commonly used for toll collection on bridges, highways, roads (an automatic toll booth used in the Durham Charging scheme) and at tunnels and parking facilities. Tags or proximity smartcards can be scanned through a windscreen, and can also be used to trigger bollards controlling access on the public highway.

Trading-off Technological Costs for Vehicle Identification with Easier Enforcement and Management of Exemptions

Table 2 shows a short list of available options[4] focusing on vehicle identification and enforcement approaches. These are examples of good practices in their respective approaches to vehicle detection and enforcement; e.g. manual and/or automatic (electronic).

Table 2 - Vehicle identification and enforcement: an overview

Scheme	Basis	City	Vehicles affected	Enforcement
German LEZs (Umweltzone)	Traffic regulation	73 cities (at February 2016)[5]	Generally, all vehicles, domestic and foreign except motorcycle.	Manual Enforcement; interoperable with the Czech Republic
Sweden - Environmental Zone	Traffic regulation	9 cities[6]	HDV (HGV and bus) domestic and foreign	Manual enforcement scheme applies to foreign

Scheme	Basis	City	Vehicles affected	Enforcement
			vehicles.	vehicles.
Netherlands - LEZ (Milieuzone)	Traffic regulation	13 cities[7]	HGV and light duty, depending on the city, foreign vehicles are not enforced.	Manual enforcement, plus an increasing number of ANPR cameras.
Milan - EcoPass	Charge	Milan	All vehicles Foreign vehicles are exempt if the country of origin does not have Euro standards.	43 entrance points with CCTV and ANPR cameras.
London - LEZ	Charge	Greater London	HDV (HGV, coaches etc.) Foreign vehicles are affected and need to register.	Large network of ANPR cameras.
London – Congestion charge	Charge	Central London	All vehicles except motorcycles Foreign vehicles are affected	Large network of ANPR cameras.
Norway Schemes	Charge	8 cities[8]	All vehicles Foreign vehicles are affected	Schemes are enforced with transponders.
Swedish Schemes	Charge	Gothenburg Stockholm	All vehicles except motorcycles Foreign vehicles are affected	Schemes are enforced with cameras scanning number plates

Source: Our elaboration from http://urbanaccessregulations.eu/

It should be noted that in the Netherlands, an assessment of the impact of the application of high technologies (e.g. camera systems) vis-à-vis manual enforcement can be carried out by comparing the higher compliance rates in Amsterdam (which uses camera systems) to other Dutch cities (which use manual enforcement). However, as in Berlin, higher compliance rates are also seen with well-enforced manual schemes.

With reference to good practices, the following boxes show details regarding the implementation of two access regulations schemes representing, respectively, manual and electronic vehicle identification and enforcement: the German LEZ (Umweltzone) and the London schemes (LEZ and congestion charging), along with good practices for the management of exemptions.

German LEZ (Umweltzone)

The Air Quality Directive (Directive 1999/30/EC) established limit values for the concentration of particulate matter (PM10) and other pollutants such as nitrogen dioxide (NO2) in the local air. In 2005 and 2006, measuring stations in numerous German cities recorded values exceeding these limits. Among the measures analysed by the Federal Environmental Agency, LEZs (Umweltzone) represented the most effective tool to reduce particulate emissions. Around 70 LEZs have already been implemented.

In 2006, the German federal government adopted regulations on the marking (with stickers) of vehicles (Marking Regulations) with the federal council's (Bundesrat) approval. These regulations established provisions on the marking of passenger cars and commercial vehicles in accordance with the quantity of their particulate emissions. They governed vehicle marking only, not the scope of LEZs as such or driving regulations. The regulations allowed cities and municipalities to establish LEZs in areas of high-level particulate emissions, helping to achieve compliance with the EU annual mean concentration limit of PM_{10} and NO_2.

These areas have been marked with the traffic sign 'Umweltzone'. In order to enter into these LEZs, additional signs state which emission stickers need to be displayed. Unmarked vehicles may not enter the green zones. Offenders face a fine of 80 Euros[9] , even if the unmarked vehicle entering the green zone is eligible for the sticker.

Vehicles registered in foreign countries also require the sticker.
As far as information is concerned, the Berlin case represents an example of good practice in managing the German LEZs. Details can be viewed on Berlin's website http://www.stadtentwicklung.berlin.de/ umweltzone/index_en.shtml). A brochure in different languages, e.g. English, French, Italian, Polish, Russian, Spanish and Turkish, can be downloaded.

A national framework sets out vehicle emission standards, and cities choose whether to introduce a LOZ, which emission level, which period of time, and which areas to cover by their LEZ. German LEZs affect all vehicle types except motorcycles. Historic vehicles (they are classified with either an "H" licence plate or a red "07" historic vehicle license) are allowed unrestricted access to any LEZ established by any local authority. The historic vehicles classification is very similar to the one enshrined in Directive 2014/45/EU on periodic roadworthiness tests, which can be considered a good reference towards an aligned definition of

historic vehicles in Europe. This provision also applies to any vehicle older than 30 years registered in foreign EU Member States.

Vehicle owners are required to purchase stickers which denote their vehicle's environmental standard if they are to drive on any local roads passing through the LEZs. These must be displayed inside the windscreen and are then valid for all German LEZs. Emission standards can vary from city to city (colour of the sticker admitted) within the same national framework.

There are four levels of emission class and the boundary signage for each LEZ denotes the emission standard required for entry.

Older vehicles can receive stickers after emission system upgrades, which must be issued directly from a certified local emission repair garage after passing the emission standards test. The scheme has the effect of incentivising owners of diesel vehicles, including cars, to retrofit particulate filters. Encouraging diesel car retrofitting has been done in Germany through various initiatives for a number of years. The Berlin LEZ 2011 assessment[10] showed for instance reductions in PM and NOx emissions after the introduction of the LEZ[11]. At the same time, Germany is subject to two infringement cases for the breach of the EU air quality directive regarding the limit values for PM and NOx.

It is also contested whether data proving a causal link between LEZs and their contribution towards the achievement of the short-term limit values is available from air quality monitoring studies.[12]

London LEZ scheme

The London LEZ began operation in 2008. The aim of the scheme is to improve air quality in the city by deterring the most polluting vehicles from driving in the area. The vehicles affected by the LEZ are older diesel-engine lorries, buses, coaches, large vans, minibuses and other heavy vehicles that are derived from lorries and vans, such as motor caravans and motorised horse boxes. Cars and motorcycles are not affected by the scheme. As a result, the scheme tends to target heavy diesel-powered vehicles, thereby prioritising particulate matter (PM) reduction.

The London LEZ emission standards describe the minimum Euro standard that vehicles must meet to be exempt from a charge. Meeting these emission standards can be done by using vehicles whose engines have been type approved to this standard (or better) or by retrofitting them with exhaust after-treatment technology to raise their emission standards. Further information on story and background of LEZs can be found in the Practice Guidance Measures to Encourage the Uptake of Low Emission Vehicles.[13] Further information on retrofitting can be found in the Practice Guidance Measures to Encourage the Uptake of Retro-Fitted Abatement Equipment on Vehicles.[14]

The London LEZ has the same objectives as the environmentally focussed schemes in Sweden and Germany, and though it formally operates as a road-charging scheme it reminds a LEZ with penalties. The important differentiator is that polluting vehicles are not banned from entering the London LEZ, they simply incur a discouragingly high charge to enter or their drivers risk a penalty if they do not comply. It was set up using a scheme order, which is the same legal basis

as the London Congestion Charge scheme. However, it is not a congestion charge as the objective is not to reduce traffic levels.

Enforcement is with fixed and mobile cameras that read vehicle number plates as vehicles move through the zone, checking them against a database of registered vehicles that:

- meet LEZ emission standards, or
- have paid the daily charge (see below), or
- are either exempt or registered for a 100% discount.

Foreign vehicles are included and need to register online at http://www.tfl.gov.uk/modes/driving/low-emission-zone?cid=pp024.

The London Lorry Control Scheme

The London schemes also involve manual schemes, as in the case of the London Lorry Control Scheme (commonly referred to as 'The London Lorry Ban'). This was designed to help minimise noise pollution in residential areas during certain hours of the day through regulated use of these roads. The Lorry Control Scheme takes the form of controls on the movement of heavy goods vehicles over 18 tonnes maximum gross weight at night and weekends. A small team of five officers manage to cover the prescribed route network across London and actively investigate some 500-600 vehicles a month.

The London Congestion charge

Enforcement and vehicle identification is carried out through cameras and an Automatic Number Plate Recognition (ANPR) system. The benefits of such automated enforcement systems are that high speeds and flows of vehicles can be detected and recorded, and every vehicle can be checked. Drawbacks include the relative inflexibility of fixed camera systems once they are installed, and the up-front capital costs. Automatic Number Plate Recognition cameras provide one part of such an automated system, and are able to capture 90%+ of passing number plates.

With regard to the management of exemptions, fewer exemptions may be conducive to more credibility of the scheme.

In London, as is also the case in Swedish schemes, a small number of vehicles are entitled to an exemption, mainly in the security and public health sector, e.g. vehicles for police and customs personnel, the Coast Guard, medical personnel, vehicles transporting people to medical treatments, rescue vehicles, gas or ethanol vehicles (in Sweden) historic vehicles, and vehicles registered as driven by or for handicapped persons.

Defining Criteria for Vehicle Identification Consistent with Vehicle Retrofitting

The current situation is characterised by the existence of national legislations with some cross-referenced similarities, for example in the types of vehicles and pollutants addressed. With reference to light and heavy duty vehicles, the UNECE (United Nations Economic Commission

for Europe) regulation (NOx and PM) retrofit framework[15] can be used as a reference framework for new LEZs, in order to ensure interoperability.

With regard to PM-based and diesel particulate filters (DPFs), the following practices have been used in pre-UNECE schemes[16] to generate the biggest reduction in (allowed) pollutants.

The London certification scheme requires full filters and a limit of 30% on NO_2 for heavy goods vehicles and vans. The full diesel particulate filters allow for more PM reduction than partial filters (about 95%).

The Danish scheme related to heavy-duty vehicles requires 80% PM reduction and full filters.

New national schemes for retrofitting may now benefit from EU-wide UNECE regulation for a consistent implementation at the EU level.

Treatment of Foreign Vehicles

Where UVARs schemes are enforced through cameras, foreign vehicles can be identified through their registration in national databases, i.e. national vehicle registries or access regulations scheme databases.

Foreign vehicles such as in the London Low Emission Zone scheme, need to register through the Low Emission Zone authority website for the Low Emission Zone scheme. Requiring foreign vehicles to register in specific access regulations scheme databases, allows the identification of foreign vehicles not in the national database.

Methods of enforcement regarding foreign vehicles include the establishment of national bilateral agreements, to pursue cross-border enforcement; for example, through collaboration with European debt recovery and vehicle licensing agencies.

CHAPTER IV – Potential Impacts of a Shared Approach regarding Vehicle Types, Exemptions and Enforcement

The adoption of a shared approach across European cities can potentially lead to a number of positive impacts. In particular, it is believed that the effectiveness, and hence their impact, of measures and policies concerning vehicle identification, enforcement and exemptions can be enhanced, if experiences from other cities are taken into account.

A literature review carried out during the preparation of the NBGDs [17] and insights from cities with long-standing experience in the implementation of UVARs schemes, e.g. London, Stockholm and Rome, show several benefits for the local population in the presence of a well-designed UVARs scheme.

- *Vehicle fleet*. All of the UVARs implementation schemes have an impact on the vehicle fleets, with an increased proportion of lower-emission vehicles circulating. An overview of exemplary impacts on vehicle fleets can be found for the three most recent studies in London, Berlin and the Netherlands[18].
- *Air quality*. Generally, the implementation of UVARs schemes leads to an improvement in air quality. The level of improvement may vary due to different emission standards, vehicles affected, fleet composition, compliance, exemptions, meteorology and topography as well as other local conditions of the different cities.
- *Traffic flows*. Where the UVARs scheme is designed to tackle congestion (e.g. the London and Gothenburg Congestion Charge and the Milan EcoPass, a combined Low Emission Zone and congestion charge scheme), it reduces traffic flow and congestion, which also influences emissions.
- *Economies of scale from wide diffusion of technology*. With respect to vehicle detection and related enforcement systems, there is a wide range of systems in operation. Whether a manual method, automatic number plate recognition or electronic identification is applied will depend on local needs, legal rules and budgets. All methods have strengths and weaknesses. A widespread implementation of sophisticated technologies, such as ANPR and electronic approaches, could lower their cost due to economies of scale. On the other hand, manual methods increase user familiarity by employing systems that are already in use – particularly in the same area.

Common criteria and their positive impacts

A number of possible positive impacts relate to using common criteria.

- *Common principles on exemptions*. Exemptions need to be kept minimal, following clear and simple rules. Common criteria are of relevance here, though exemptions also depend on the type of access regulations scheme. Low emission zone exemptions should be particularly minimised. Traffic limited zone exemptions might often include residents and shop deliveries to ensure that the area can be serviced. But it should be considered that a system that uses a complex system of exemptions without any justification will likely lack credibility and political support.

- *Common criteria for vehicle identification.* A clear benefit of using Euro standards to design a scheme is that these standards delineate emission performance in accordance with commonly accepted standards, based on an approved testing procedure. Furthermore, these criteria can be applied to any vehicle in Europe, and so can be used cross-border.
- *Common criteria for retrofitting***.** Retrofit certification relies on national legislation, given that there is no harmonised EU legislation for retrofit control devices. However, for new schemes, the UNECE (United Nations Economic Commission for Europe) regulation (NOx and PM) retrofit framework for light and heavy duty vehicles can be used as a reference framework for new LEZs, in order to ensure interoperability. This provides an EU-wide consistency and enables good retrofit schemes. A 'shell' national standard can use the UNECE standard for the bulk of the national standard, together with local aspects. The adoption of the UNECE certification schemes would favour European cross-border recognition of retrofit installations. In this context, it should be noted that this UNECE regulation resolves the issue of the lack of a harmonized scheme for the approval of particle filter retrofit kits, which was pointed out by the 2010 ARS survey as a critical issue (by the city of Berlin). The survey stated that this is a market barrier for filter manufacturers and an issue for foreign operators of retrofitted vehicles, who need to get their vehicles properly classified in accordance with German labelling regulations.

Sharing experiences will have a number of positive benefits.

- *Effects of EU dissemination*. Good practice examples will support city authorities in providing relevant information to vehicle operators and evidence to justify proposals to decision makers and, if necessary, help convince dissenting stakeholders.
- *Impacts on economic activities***.** A shared approach concerning the introduction and operation of urban vehicle access regulations schemes can have potential positive impacts on the local economy and European businesses, in particular those active in the commercial road transport sector. SMEs, which constitute the bulk of the affected businesses, will experience an increased level of legal and contractual certainty and predictability in their administrative and business development.

CHAPTER V – Barriers and Enablers to a Shared Approach

A shared approach at the EU level on enforcement, vehicle identification and exemptions would increase acceptance levels and compliance with UVARs schemes, while enhancing awareness of enforcement processes.

The following are key barriers and enablers for the realisation of this objective:

Barriers

- *The Euro standards as vehicle identification criteria*.
  One drawback when adopting the Euro standard as a key criterion for vehicle identification across Europe is that information about an individual vehicle's Euro standard is not always easy for the scheme operator to access, particularly for older vehicles. In this case, age-based proxies for vehicles could simplify the registration/certification process for vehicles where Euro standard information is not easy to access.

  However, while the age of the vehicle is widely used as a surrogate for the Euro standard, there is no exact correlation between the age of a vehicle and its Euro standard. New Euro standards are in fact introduced through the system of Whole Vehicle Type Approvals. This first applies to all new type approvals, then one year later to all new registrations and finally the year after that to End of Series Type Approvals. Choosing the year for all new registrations as the implementation date for a new Euro standard will therefore mean that some vehicles one year older actually meet the new Euro standard and that some vehicles one year younger do not. A similar challenge is faced with retrofitted vehicles, where an older vehicle achieves a higher Euro standard as a result of improvements to the exhaust after treatment system and/or a replacement engine.

- *The gap between actual and Euro standard emissions and specific pollutants emitted on road*.
  Euro standards, that is, the maximum levels of pollution permitted from cars, vans and trucks, have been progressively tightened, notably for both particulate matter and nitrogen oxides, two of the air pollutants of greatest concern. Low Emission Zones therefore widely use Euro standards as the basis for restricting access to more polluting vehicles.

  However, actual road emissions, particularly from diesel vehicles, and with reference to specific pollutants, such as nitrogen dioxide, may be much higher than what is prescribed by Euro standards, e.g. Euro 5, making it necessary to reduce the gap between actual emissions and Euro standards through the introduction of Real Driving Emissions tests. After the procedure is duly consolidated, Real world driving emissions factors should be used by cities to properly model the pollutant concentrations in the vehicle access regulation area and to decide which emission standards should be set.

- *Foreign vehicles.*
  The presence of foreign vehicles, freight distributors and private car owners may represent a barrier to the implementation of common approaches. Access regulations schemes need to ensure the right to freedom of movement and non-discrimination between national and foreign vehicles. Furthermore, collection of penalties from foreign drivers where there is no manual enforcement, may be problematic, but bi-lateral agreements and debt collection agencies are options that are successfully used.

- *The complexity of UVARs schemes: the legal framework for data protection*.
  Today in Europe, UVARs legal frameworks, enforcement bodies and processes can be quite different. This makes it difficult to replicate or easily understand UVARs schemes. Other concerns include the storage of information that could be used to identify people and store details about their driving habits and daily life, contravening legislation on data protection (such as that regarding personally identifiable information). Furthermore, the current differing data protection cultures in the EU and the different perceived value of high data protection standards influence UVARs technology for enforcement and vehicle identification.

- *Potential equity problems*.
  The application of UVARs schemes using mainly Euro standards can require vehicle operators to replace or retrofit their vehicle, or use alternatives, e.g. to procure less polluting vehicles - the "polluter pays principle". Financial incentives to encourage the replacement or retrofitting of older vehicles, can help support this change. Equity problems can also be addressed using well administered "hardship exemptions", as in the Netherlands and Germany. These allow exemptions from charges/penalties in LEZs for those on very low incomes or low-margin businesses that depend on their vehicles but cannot afford to buy new vehicles to access LEZs[19]. Alternatively, or in association with hardship exemptions, the provision of comfortable and easily accessible public transport solutions could also address equity problems.

Enablers

- *Dissemination of good practices***.**
  The dissemination of good practices, through web sites, initiatives, information days, media reports, EU funded project research dissemination activities etc., represents a strong enabler favouring the adoption of a shared approach across European cities. Disseminating good practices and guidelines would allow cities and Member States to benefit from experiences made and, where appropriate, foster a more common approach to issues such as vehicle categories, enforcement and exemptions. This would increase awareness of and compliance with UVARs schemes for private and freight transport, while leaving cities the flexibility to adapt the schemes to their local circumstances.

- *Technological development*.
  Technology is playing an increasingly important role in the implementation of UVARs schemes by reducing operational costs and increasing efficiency. For example, mature and efficient technologies as camera for vehicle identification (ANPR technologies) are continuously improving video camera quality, reducing maintenance costs. Furthermore, new technological developments in the fields of data storage and communications, e.g. smart apps, cloud storage facilities, open data, M2M and I2M communication, could facilitate vehicle identification and enforcement techniques.

- *Improvement of real-world emission tests.*
  The real world driving emission standards is an ongoing process[20], which, once consolidated, should help achieve further reductions in Euro standard emissions. Real world driving emission factors should be used by cities to properly model the pollutant concentrations in the vehicle access regulation area and to decide which emission standard should be set.

- *Full access to UVARs information and common approaches in foreign vehicle identification and enforcement, including retrofitting*
  This would ensure the implementation of a level playing field among operators and citizens. Enabling factors would build on the insights from existing legislation (e.g. UNECE for retrofitting) and the activity of pan-European bodies (e.g. EUCARIS for cross-border information on foreign vehicle violations).

CHAPTER VI – Summary of Recommendations

Taking into consideration the complexity of EU urban areas and the impossibility of finding a "one size-fits-all" solution, the following recommendations are intended to facilitate moving towards a common framework for vehicle identification, enforcement and exemptions across urban areas.

- Local authorities **should work towards compliance with the latest Euro standards as a basis for access-to-access regulated areas**, while gradually phasing out older Euro standards, particularly in light of the new real driving emissions tests that will reduce the gaps between the tests and real driving condition.

- Local authorities, together with compliance with the latest Euro standards as a basis for access to LEZs, **could also consider exempting cars running on zero emission devices** such as battery-electric and fuel cell- electric vehicles.

- Methods of enforcement regarding foreign vehicles could include **the establishment of national bilateral agreements**, to pursue cross-border enforcement; for example, through collaboration with European debt recovery and vehicle licensing agencies.

- Exemptions from local regulations should be **clearly defined to ensure a high level of effectiveness**. Relevant exceptions include e.g. vehicles driven by or for persons with disabilities in order to ensure mobility, referencing the internationally standardised system of badges identifying them as such[21]. Emergency vehicles (e.g. ambulances, fire trucks, police vehicles) must retain access. Through future vehicle procurement, city authorities can measure all relevant part of the public fleet comply with the access conditions.

- **Historic vehicles could be exempted from low emission zones** because of their minimal use in the regulated areas combined with their contribution to the preservation of motoring heritage. LEZs would thus disproportionately penalise particularly urban-based owners and businesses servicing historic vehicles since practically no retrofitting possibilities exist. A definition of historic vehicles is included in the Directive 2014/45/EU on periodic roadworthiness tests for motor vehicles and their trailers.

- Local authorities, Member States and the EC **should encourage the use of IT solutions** and/or web platforms for the carrying out of UVARs schemes, thereby contributing to the implementation of the ITS directive. IT solutions for bigger cities could be extended to satellite cities. This will reduce implementation- and maintenance costs and increase levels of acceptance and efficacy.

- Local authorities should increase **dissemination to the public** regarding the relation between UVARs schemes and penalties in case of violations.

[1] *Cordons are the combinations of point-based schemes located to form a continuous or semi-continuous boundary around an area. Cordon schemes are present in Stockholm, in several Norwegian cities, and are the most common in the UK.*

[2] *ARS Study – TREN/A4/103-2/2009: Study on Urban Access Restrictions - Final Report, December 2010* http://ec.europa.eu/transport/themes/urban/studies/doc/2010_12_ars_final_report.pdf

[3] *As stressed in the EC Commission Staff Working Document SWD (2013) 526 Final, "Low emission zones (LEZ) are seen by many cities as a solution to the widespread non-compliance with EU air quality limit values for particulate matter and nitrous dioxide*.

[4] *The table could be updated with additional information, e.g. time-based schemes, as a result of the discussion among stakeholders*

[5] *From the http://urbanaccessregulations.eu/ web site*

[6] *From the http://urbanaccessregulations.eu/ web site*

[7] *From the http://urbanaccessregulations.eu/ web site*

[8] *From the http://urbanaccessregulations.eu/ web site*

[9] *As in most of the German LEZs at 2015. For an overview http://urbanaccessregulations.eu/countries-mainmenu-147/germany-mainmenu-61*

[10] *Sadler Consultants, "Low Emission Zones in Europe, 2011*

[11] *See footnote 10 for details*

[12] *Claire Holman, Roy Harrison, Xavier Querol "Review of the efficacy of low emission zones to improve urban air quality in European cities" Atmospheric Environment 111 (2015) 161e169, Elsevier*

[13] *Defra, "Local Air Quality Management Practice Guidance 2 Practice Guidance to Local Authorities on Low Emissions Zones", February 2009*

[14] *Defra, "Local Air Quality Management Practice Guidance 3 Practice Guidance to Local Authorities on Measures to Encourage the Uptake of Low Emission Vehicles", February 2009. More in general, the final version of the NBGD will provide full references to all studies and publications used as background material*

[15] *Regulation on uniform provisions concerning the approval of Retrofit Emission Control Devices (REC) for heavy duty vehicles, agricultural and forestry tractors and non-road mobile machinery equipped with compression ignition engines, ECE/TRANS/WP.29/2013/119. UNECE World Forum for Harmonization of Vehicle Regulations (WP.29), Adopted 13 November 2013.* http://www.unece.org/fileadmin/DAM/trans/doc/2013/wp29grpe/ECE-TRANS-WP29-GRPE-2013-09e.pdf.

[16] *Sadler Consultants, "Low Emission Zones in Europe", 2011*

[17] *About 60 sources have been classified in five categories; 1. City brochures or presentations, 2. Implementation and evaluation reports, 3. Websites, 4. Academic literature, 5. Feasibility studies*

[18] *See for example, the report from Sadler Consultants, "Low Emission Zones in Europe", 2011*

[19] See Sadler Consulant, 2011 "Low Emission Zones in Europe".

[20] The European Commission is working towards September 2017 as a target date for Worldwide Harmonised Light-Duty Test Procedure (WLTP) to be in place, coinciding with the timing for the entry into force of RDE testing for NOx. http://europa.eu/rapid/press-release_MEMO-16-168_it.htm

[21] The EU standardised model of parking card for persons with disabilities allows a disabled person who is entitled to use certain parking facilities in his EU country of residence to move more easily in the territory of another EU country and avail themselves of all the parking facilities granted to the card-holders in that EU country. The EU model was introduced by a Council Recommendation in 1998 and updated in 2008. EU Council Recommendation of 3 March 2008, 2008/205/EC

ANNEX 3: Planning, Consultation and Design of Urban Vehicle Access Regulations (UVARs) schemes

Glossary

ACS: Automatic Access Control System

EC: European Commission

EU: European Union

LEZ: Low Emission Zone

LTZ: Limited Traffic Zone

NBGD: Non-Binding Guidance Document

SUMP: Sustainable Urban Mobility Plan

UVARs: Urban Vehicle Access Regulations

CHAPTER I – Introduction

Planning, consultation and design of Urban Vehicle Access Regulations (UVARs) schemes

Urban vehicle access regulations (UVARs) schemes are increasing in number across Europe and may not only differ between countries, but also between urban areas within a country. All schemes involve regulations but each UVARs has its own rules: some apply at a certain time of the day or the year, some to (non-)residents only and some require certain permits. Some of the schemes require payment, and exemptions generally vary across Europe. This is especially problematic because users are not always aware of the features of the schemes that are in force in cities they do not visit regularly.

The European Commission's Directorate-General for Mobility and Transport (DG MOVE) has commissioned the publication of a set of six Non-Binding Guidance Documents (NBGDs) to support local authorities planning to introduce an access regulations scheme. While there is no one-size-fits-all approach, commonly applicable solutions to shared challenges and concerns can be established, which will lead to shared best practices for the benefit of cities, citizens and stakeholders across Europe, including business and industry.

Within this set of six non-binding guidance documents on UVARs, the present publication provides an overview of the Planning, Consultation and Design of Urban Vehicle Access Regulations (UVARs) Schemes.

CHAPTER II – The Challenges

Planning and design for the development of a UVAR is a complex process requiring adequate provisions in terms of governance. Locally, regarding collaboration between services but also extending to the relation between local and national tiers of government; resource planning (funding instruments, economic and financial assessments), acceptability, provision of mobility alternatives as well as ex-ante and ex-post assessments.

The main objective of this NBGD is to take the reader through the main steps of the planning and design process of a UVAR, identifying the decision steps, illustrating some of them through examples of good and bad practices and highlighting the main pillars of successful planning, consultation and design, notably (but not exclusively):

- How to include a UVAR scheme in broader urban mobility policies (planning);
- How to engage in an ad hoc dialogue with users and stakeholders starting in the earliest stages of the design process (consultation);
- How to ensure that all modes of transport are exploited in the most efficient way and
- How to build information and awareness campaigns into the process (design).

Types of schemes

The first and most important point is the clear identification of the scheme's objectives. Tackling congestion and /or emissions are often interdependent goals, but setting priorities has implications for the scheme to be adopted. The essential features of the system implementing the UVARs, i.e. the boundaries and types of vehicles to be regulated are generally described within the scheme.

UVARs schemes can broadly be classified into four types:

1) *Point based* regulations concern bridge crossings or the entrance into certain small sections of the city.
2) *Cordon based* regulations apply when crossing a cordon, which may vary according to the time of the day, the direction of travel, the vehicle type and the location on the cordon. There can be a number of cordons with different rules/fees.
3) *Area licence based* regulations apply when driving within a certain area during a certain period of time. The rules may vary according to the time of the day and the vehicle type.
4) *Distance or time based* regulations are essentially pricing regulations based on the distance or time a vehicle travels along a (congested) route or in a specified area, and may vary according to the time of the day or the vehicle type and location.

Point based charges are reasonably commonplace, but they are generally limited to specific small locations and not spread across the network.

Cordons are the typical form of both permit based and pricing access regulations. Their main advantages are their flexibility with regard to time of day and vehicle type, with each individual trip into the area potentially subject to a charge.

Similar schemes are used in Stockholm and Milan, recognized throughout Europe as the most relevant UVARs schemes based on pricing.

Area licensing or entry permit schemes are applied to regulate access to areas mainly in the inner core of cities. Their main attraction is that they are simple to understand and straightforward to implement; rules may vary according to time and vehicle type.

The London Congestion Charge is the most well-known example of this type of measure. Users pay a daily charge to enter or be within the charging zone, and they can enter and exit as many times as they like during the day. The charge is operational between the hours of 07.00 and 18.00 Monday through Friday.

Almost every scheme implemented has multiple objectives, from reducing large traffic volume/congestion to improving air quality. In the case of LEZs the main objective is air quality, whereas in the toll ring schemes the main objective is traffic reduction followed by revenue generating component to finance sustainable transportation.

In many schemes, the targeted traffic is mainly passenger cars. In the case of LEZs, in which of the 13 countries with LEZs in operation or planning, most affect all vehicles, only Denmark and Sweden still only address (heavy duty) freight vehicles (http://urbanaccessregulations.eu/). Coaches are also impacted by all sorts of UVARs.

Scheme features

For each scheme, several features must be defined in the planning/feasibility phases.

Specifically:

- Area affected, vehicles affected, start date & phases
- Entry criteria
    - Adoption of charging
    - Pricing (per day/per trip) if charging is adopted
    - Vehicle types and emission standards
- Vehicle identification and entry permit distribution process
- Level of technology deployed (high: automatic system, low: manual management)
- Level of exceptions, which should be chosen carefully and can affect the success and impact of the scheme[1]
- Time of operation (24h/specific slots)

Enforcement proceeds in parallel with technological choice: "high technologies", i.e. camera-based or satellite-based enforcement systems imply stricter enforcement, whereas "low technologies" such as window stickers or paper vignettes may result in lower level of enforcement to the zone in question. More specifically, enforcement through "low technologies" happens when vehicles are irregularly controlled by checking for permits or stickers. This can be by stopping the vehicle in or entering the regulated zone or by enforcing against vehicles parked or delivering in the zone.

Concerning the time of operation (or of enforcement) of the schemes, the day time slots are the most often adopted, being consistent with the pattern of demand for private trips; schemes

aiming to minimize environmental impacts (i.e. LEZ) are generally enforced 24 hours a day and 365 days a year.

Involvement of stakeholders

Regardless of the solution adopted, citizen representatives, service providers and supply chain operators need to be involved when cities begin designing a UVAR. The latter category is particularly important for LEZ-type schemes.

It is advisable to make careful consideration of the information management in phases of stakeholder involvement, ensuring enough information to answer questions. Taking into account the often-conflicting interests between some of the parties, for instance business sector concerns about loss of revenues caused by vehicle access regulations vs. other citizens aiming to reduce congestion, the identification of what aspects play major roles in enabling the adoption, deployment and operation of a UVAR is of paramount importance. This situation points to the recognition that critical factors deserve the utmost attention throughout the decision-making and implementation processes: if adequately dealt with, they can determine the success of the scheme. Conversely, an underestimation of these same critical factors can easily lead to failure.

A systematic, continued and regular consultation even throughout the implementation of the UVARs will allow adjusting its scope, form and modalities, should it have disproportionate negative impacts on mobility or the local economy.

Therefore, both before the implementation of an access regulations scheme and once the UVAR is operative, managing the relationship with users (both citizens and operators) is a key aspect that needs to be carefully considered in order to ensure the long-term effectiveness of the scheme.

Customer service can be one of the most significant expenses of any access regulations scheme. However, a sound customer relationship management strategy can facilitate acceptance by helping road users understand the rules, the charges – where applicable – and any resulting fines.

Mobility demand

An important issue to be raised and resolved is the availability of a wide range of mobility modes by the time the UVARs scheme enters into operation. A viable strategy is to incentivize collective transport by exempting not only local public transport but also incoming intercity, long-distance coach and tourism by coach from UVARs. Specific attention should be given in fact to occasional users. In general, when planning UVARs schemes, occasional users should not be deterred by administrative and language barriers.

A significant effort should be made to strengthen public transport both by redesigning at least some of the services and by investing in additional capacity, but also efforts to promote walking, cycling and logistic options should be undertaken.

Upfront investments in public transport (including public bike schemes), walking and cycling will in almost all cases be necessary to absorb increased demand and to provide affordable mobility

for low-income citizens. Such investments, for instance in infrastructure and campaigns for sustainable urban mobility can also help to create confidence in the fact that the implementation of a UVAR scheme will provide tangible benefits. Especially congestion charging schemes are more effective when they provide visible benefits to the majority of travellers through less traffic, better conditions for walking and cycling and improved public transport access and reliability.

CHAPTER III – Available options

Nowadays many UVARs schemes are operational throughout Europe so a large knowledge base exists, even if it is rarely disseminated and shared[2].
In this chapter, a limited number of cases is briefly described, focusing on specific choices or experiences.

One of the most important steps and the most challenging issue is the involvement of citizens and all stakeholders, in order to build up the largest possible consensus relating to the specific policy implementation.

Choosing the best form of consultation

The strategy must consist of structured interaction with stakeholders in a form that is tailored to each group of stakeholders choosing the most appropriate form of consultation for each stakeholder group.

This means meetings for the general public, which can usually be defined as those members of the public who have an interest in the project as they feel that they will directly (or even indirectly) be impacted by it either positively or negatively. Additionally, bi- and multilateral meetings with defined stakeholder groups such as freight operators, retailers, major public service institutions such as hospitals, schools and colleges as well as particular interest groups such as emergency services, cyclists, motor cyclists and handicapped persons.

Of course, there will inevitably be some overlap within categories of stakeholders and individuals may have more than a single defined interest, e.g. one person might be a local resident, business owner, motorist and cyclist within or near the area in question at the same time, representing multiple interests.

Proper selection of the area of consultation

The consultation process should not focus solely on stakeholders within the area under consideration for the UVARs. It should give equal weight and importance to those stakeholders in locations outside the area under consideration. It is often people in these areas who will see themselves as most adversely affected by the introduction of a UVAR. A communication strategy, while conveying the benefits to be gained in the UVARs area, should also incorporate measures to mitigate the adverse impacts of the proposed scheme particularly in the areas adjacent to it. Examples of these mitigating or complementary measures could include the provision of enhanced public transport services and the mitigation of unnecessary traffic detours (for example through street closures, creation of one-way streets, the introduction of traffic management measures, etc.).

Two-stage consultation and beyond

Another key factor that should be emphasised is the form of consultation and the need for transparency with stakeholders. For the consultation process to be effective, it is essential that stakeholders are part of a genuine interactive and inclusive process. One means of achieving this is to have a two-stage process, in which the second stage of consultation considers comments that have been made by stakeholders during the initial consultation. The process of

scheme development can happen almost organically during the conceptual design and initial stages. It is however preferable in many ways that this is made explicitly transparent and leads to a second consultation stage. This makes clear to stakeholders that their views have been considered in the final design.

Experience shows that comprehensive UVARs schemes implemented at the urban level have sometimes failed to proceed beyond the planning stage. Public scepticism has impeded the introduction of major regulatory schemes for instance in the cases of the Cities of Edinburgh and Manchester where the public was given the opportunity to vote exclusively on the issue. The negative fate of Edinburgh's congestion charging scheme, which was prepared over nearly a decade, was decided by public referendum in February 2005. As this example shows, a UVAR, like other innovations, has to take into account public sentiments, developing the most flexible and efficient approaches. The main reason for the rejection in this case was that at the time of the referendum, the actual plans for quite complex schemes were not well developed and therefore very difficult to communicate to the public.

Trials (experimental periods)

Another tool at the disposal of project and programme managers is a trial or experimental period. Some UVARs schemes are often perceived as being so radical that their incontrovertible introduction is seen as being a step too big for some stakeholders. Experience shows that the level of public acceptability rises significantly once a scheme is operational and functioning efficiently. It is however helpful to be able to introduce a scheme on a trial or experimental basis, thereby calming the scepticism of some stakeholders who would like to be reassured that the scheme would be modified if shown to be unsuccessful. This device was used very successfully in the road pricing scheme in Stockholm, which was originally introduced on an experimental basis. It was closely monitored during the experimental phase and only confirmed as a permanent scheme once it was proven in a real-life situation that the scheme was achieving its aims and objectives.

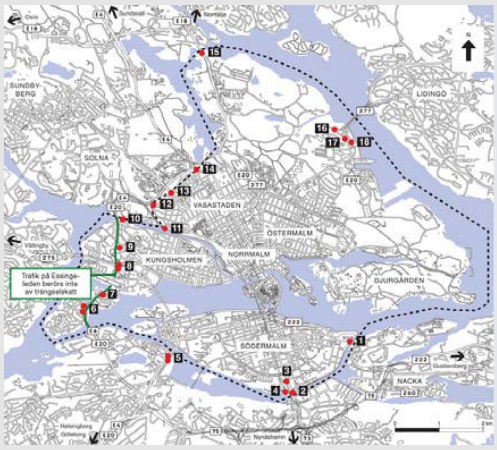
Coupled with the concept of a trial period is that of a period of warning rather than enforcement. This has been applied across a number of schemes including the access regulation scheme in Vitoria-Gasteiz[3] and has been used in many LEZs, e.g. in Germany, where in many areas warning letters rather than fines are sent to those people who transgress the scheme's regulations. This not only is of genuine assistance to many people during the initial weeks of a new scheme, it also helps to facilitate the scheme's introduction among a wider range of stakeholders.

However, trials need to be carefully implemented. The danger with trials, if they are not fully implemented or enforced, is that they have little impact or immediate impacts and therefore could lead to the rejection of a scheme.

A best practice example is the trial in Stockholm[4]:

The case of Stockholm

The so-called *Stockholm trial* consisted of two parts: a congestion charging scheme that was in place between 3 Jan and 31 July 2006, and an increase in the public transport supply that was in place between 31 August 2005 and 31 December 2006.



The system features 18 control points located at Stockholm city entrances and exits. Vehicles are automatically recorded by cameras capturing the number plates. Images of vehicles equipped with an electronic onboard unit (transponder) for direct debit payment are also identified in this way.
The cost for passing a control point is SEK 10, 15 or 20 depending on the time of the day. The maximum amount payable per vehicle and day is SEK 60. No congestion charge is levied in the evenings or at night nor on Saturdays, Sundays, public holidays or the day before a public holiday.
Various exemptions, such as for taxis, buses, alternatively fuelled cars mean that about 30% of trips are free of charge.
There is no opportunity to pay at the control points. More than 60% of the payments are made automatically through transponder/direct debit. The rest are either paid at local shops (7-eleven etc.) or through bank transfers, or paid through direct transfer or using a "virtual shop" on the Internet, where payments can be made using credit or debit cards.

The results of the trial exceeded the expectations. In fact, rather than the modeled 10 -15% reduction in traffic to/from the inner part of the city, traffic was actually reduced by 20-25%.
Accessibility showed a significant improvement as the queue time decreased by 30-50%. Emission levels were reduced on average by 14% (Carbon monoxide. CO -14%, Particles. PM10 total -13%, Volatile organic compounds, VOC -13%) averaging a reduction of 2.5% over the county.
Several reports show that the reductions of congestion and travel time were noticeable" to the naked eye" for deliveries, taxis, etc.
The positive results of the trial were essential to gain a very high approval level from citizens to deploy the system on a permanent basis.

In fact, at the end of the trial phase and after the results' evaluation a referendum has been launched. The opinion went from a clear no to a clear yes in less than a year and today most

citizens are in favour of the congestion charge. Furthermore, the city learnt a lot from the trial phase and the final measure is consequently much user-friendlier than the initial trial.

Stockholm today, after 8 years of congestion charging has exactly the same number of vehicles passing through as 2006 –in spite of an increase of 100,000 inhabitants and no increases of the fees until 2016 when the charging zone was extended to an important peripheral motorway (Essingeleden) and the fines were raised. This might be interpreted as a signal that traffic has been increasing in the peripheral areas of the city.

It is worth mentioning that there was an opportunity to carry out a Cost Benefit Analysis (CBA) both ex ante and ex post to assess whether the operation of a UVAR scheme is sustainable from a financial perspective in addition to the inherent economic savings of external costs. This can facilitate the implementation of investment plans in public transport and other alternative mobility solutions.

The implications for UVARs schemes are relevant: UVARs schemes should be subject to a trial period before their introduction and be monitored throughout their implementation in order to ensure their effectiveness and acceptability. It should be justified that the envisaged regulation is necessary and that it is proportional and appropriate to contribute to solving the identified problems. The decision should be supported by a proper impact assessment, including a cost and benefit analysis from an environmental, social and economic perspective, including the economic and social impacts of the proposed measures on the local economy and businesses.

Flexibility of design

One requirement that a UVAR should comply with is a long operational life. A robust design builds in a degree of flexibility to adapt to evolving regulatory policies, such as favoring the access to non-fossil fuelled vehicles and retrofits, as in the case of Milan[5].

The Milan Eco Pass evolution into congestion charging

Milan, along with London and Stockholm, represents one of the most successful UVARs systems based on charging.

What should be noted about Milan are the features in the original scheme design that contributed towards its operational flexibility. In fact, on 2 January 2008 the so-called Ecopass system started operating in the Milan central city ring zone known as the "Cerchia dei Bastioni".

ECOPASS is a Limited Traffic Zone (LTZ) scheme: vehicles are charged to enter the area and the fee structure is based on the vehicles' emission standards, with the following goals:

- Reduce road congestion within the urban area;
- Improve transport safety across the modes;
- Improve the quality of public transport;

- Introduce technical innovation;
- Improve the quality of the environment and
- Improve road freight distribution.

The Ecopass scheme was originally also very effective, however, it reduced in effectiveness as the scheme was not developed and the emissions standards and costs were not tightened.

In 2011, the change of the political party in the administration led to the decision to pose the following questions to citizens in a referendum:

"Would you like to extend the charged zone to the whole city and to all vehicle categories to fund policies for sustainable mobility?" As the results were very clear (80% YES 20% NO) the decision was made to turn the system into a congestion charging in the so-called Area C. As must be done in the design of each UVAR, a set of scenarios was drafted, modelled and compared for vehicle flows and their expected emissions.
The Area C trial was carried out in 2011, the vote in 2012 after an 18-months trial. A legal case resulted in a stop of the scheme shortly before the vote – making people more aware of the schemes' advantages.

According to the City of Milan, evidence in Area C after its inclusion in the congestion charging zone, has confirmed the effectiveness of the scheme in reducing traffic close to 30%. From an environmental point of view, Area C brought another important positive effect as PM10 was reduced by 47% between 2011 and 2014. Inside Area C, PM 10 concentrations measured during the first year of implementation were up to 52% lower compared to outside the zone, with health benefits for resident population and city users. One last important result of the reduction in traffic in the city is the decline in personal injuries by 25% and in total accidents by 50%.

Extensive planning

There is growing consensus in urban areas across Europe regarding the traffic and transportation policies that local or regional areas wish to adopt. A typical set of urban transport policy goals could read as follows (no ranking):

• Reduce congestion
• Reduce energy consumption and traffic emissions
• Improve quality of life in city centres
• Increase market share of clean vehicles in private & public fleets
• Increase efficiency of transport systems
• Promote efficient multi-modal mobility solutions
• Facilitate freight delivery and services
• Enhance road safety
• Decrease parking pressure

The policy goals above could apply to the vast majority of urban areas within the European Union. A UVAR scheme can contribute to the achievement of these policy goals as it can act as a focus.
The production of a local or regional transport plan is key to this process. The EU promotion of Sustainable Urban Mobility Plans (SUMPs) is critical in this respect. A local / regional SUMP gives

the overarching context within which a UVAR can be placed. It gives the rationale for the UVARs and shows that it is not being developed in isolation.
Vitoria Gasteiz and Rome give two examples for the introduction of UVARs schemes in a context of integrated mobility planning. Contrary to the example of Stockholm and Milan, both cities have adopted a permission-based scheme.

In the case of Vitoria, the redesign of mobility in the central area was fostered by the availability of a new tram line and included planning new public transport services, a reallocation of space to cycling and walking and new rules for freight deliveries[6].

The case of Vitoria Gasteiz

Vitoria Gasteiz is a medium-sized city in the Basque region of Spain.
Specifically, the Sustainable Mobility Plan of Vitoria-Gasteiz establishes a network of main roads along which all motorized vehicles, both public (bus, tram and taxis) and private can circulate. The aim is to disincentive the traffic in the rest of the network. Therefore, the Sustainable Mobility Plan of Vitoria-Gasteiz has developed the so-called superblock concept. A superblock is a geographical space delineated by main streets covering several city blocks. The superblocks concept establishes a hierarchy of streets, according to their volumes of traffic, by separating the (strategic) crossing roads from the ones just covered by local traffic. One of the objectives of the superblock concept is in fact to reduce the traffic inside the superblocks themselves.

New non-motorized areas appear in the inner sections of superblocks. These areas are reserved for pedestrians, cyclists, service and emergency vehicles, residents, and freight distribution, with speed limits to ensure the "peaceful coexistence" of pedestrians, cyclists and motorists. This is supported by the discouragement of crossing traffic flows through the superblocks. In this framework, a new access control system has been developed to prevent vehicles from entering the pedestrianized streets.

Cameras have been installed to register number plates at the entry and exit points of the area, delineating the pedestrian priority area of the Central Superblock (S-1).

The main objective of the overall policy and of the measure is then to control access to the city centre and to create synergy with the new tram line. Additionally, the new access regulation scheme contributes to the superblock concept by giving priority to local traffic over crossing traffic, and redistributing traffic flows from local streets to main roads. The quality of the air and public spaces has been improved thanks to better management of the demand for private vehicles in the city centre.

The scheme is based on the permit distribution concept and on the ground enforcement system that works by reading the number plates of all vehicles entering and leaving the city centre. If the vehicle entering the regulated zone takes less than a certain time to exit the regulated area, the system considers it as a 'passing-through' vehicle and the driver is fined.

Otherwise, the vehicle is identified as a resident or a goods distribution vehicle and thus has permission to circulate within the zone. The access regulation scheme has in place a "white list" of vehicles that includes public transport services, municipal police, firefighting vehicles, street cleaning services and residents. During periods for loading and unloading goods, the system does not operate, in order to allow access for freight vehicles.

The impacts of implementation have been evaluated by counting the new traffic flows of different vehicles entering the regulated zone (-60%). Additionally, by using that information it has been estimated that there is a related decrease in emissions (CO2 -4%). In the large area of the superblock a telephone survey was conducted with citizens, which showed broad support of the population and a large degree of consensus.

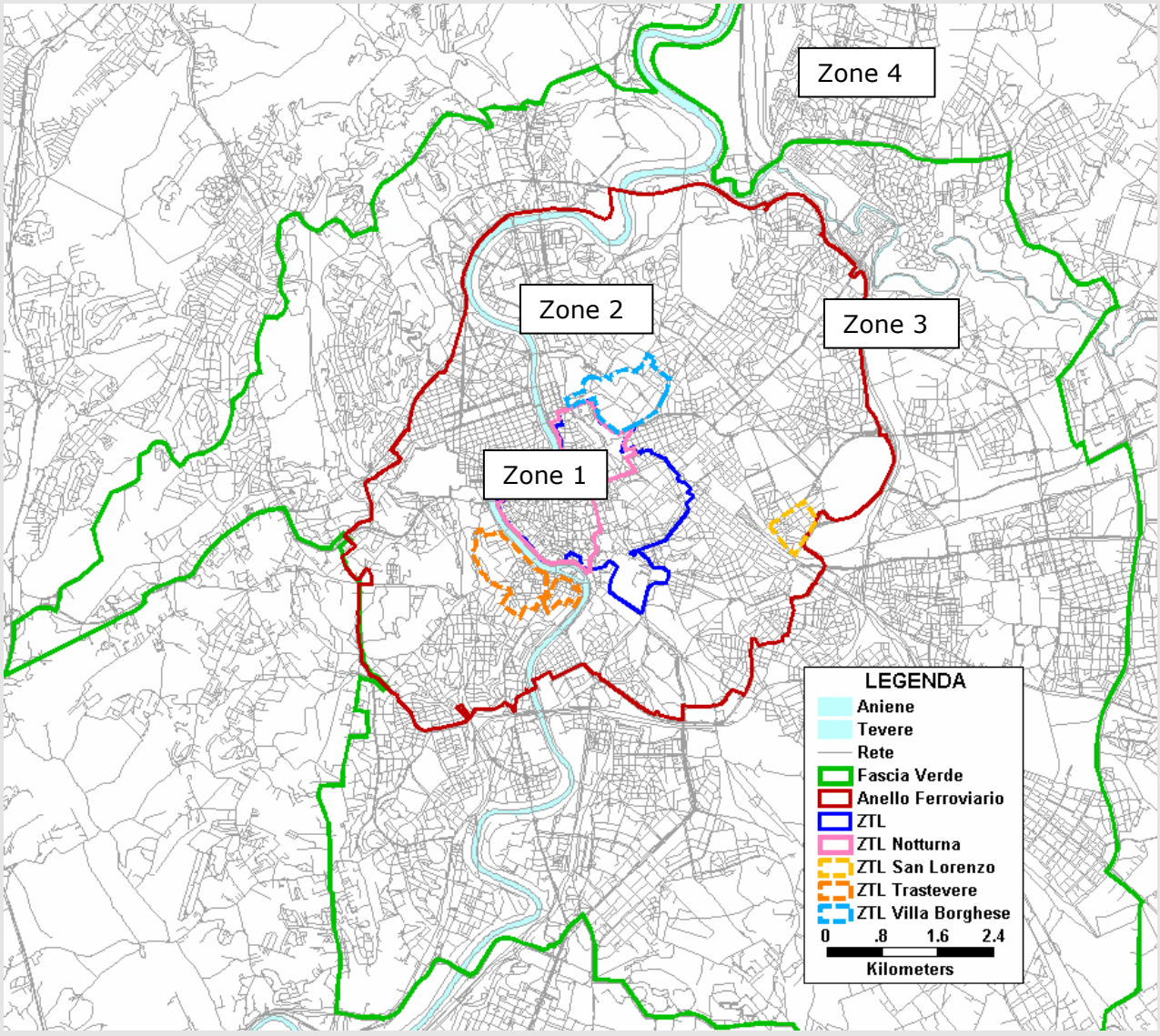
The city of Rome represents an extreme example of the mobility struggles engendered by the historical city's infrastructure and the concentration of many functions (public, private, retail, entertainment) in the central area.

Due to the lack of a diffuse and effective public transport system, most trips are made with private vehicles.

Because of these circumstances, since the mid-1990s the high-level strategy for improved mobility has been established including the set-up of UVARs schemes.

The case of Rome

The basic features of the transport plan drafted in the late 1990s envisages the zoning of the city into four main almost concentric areas, each one with a specific mobility plan and a specific set of policies.
The central areas (Zone 1 historical centre, 2 and 3) are managed through access regulations policies mostly based on the environmental performance of the vehicles.
An important component of mobility planning in the area subject to access regulation relies on the on street parking charging, which acts as an additional disincentive to the high demand of inbound car trips.



Since the 1990s, Rome has chosen to regulate the access of private vehicles to the very inner part of the city. These rules were however poorly defined and badly enforced and as a result congestion in the central area was only marginally reduced.
At the end of the 1990s the decision was made to adopt an automatic access control system (ACS) based upon Close circuit TV (CCTV) cameras with Automatic number plate recognotion (ANPR) functions.
The scheme became operative on 1 October 2001 after a long struggle to coordinate the system and its enforcement.
This was the first scheme of its type in Italy. Since then about 100 ACRs have been established across the country. This represents the largest number of UVARs schemes in any EU Member State. Access to regulated zones is based upon the distribution of permits according to restrictive regulations, with a white list (permit database) of authorised vehicles fully integrated into the scheme's enforcement process.

After the successful experience with the ACS in the historical centre, the access regulations scheme in force from 6 am to 6.30 pm led to a general reduction of 25% of traffic flows during the whole day and not just during the regulated hours. Three additional ACS have been designed and deployed in areas that are mainly dedicated to leisure activities. These have specific scheme features.
Today, permits to circulate in the Limited Traffic Zones of "old town", "Trastevere", "San Lorenzo" and "Testaccio" are distributed to only a few specific categories of users: permanent or temporary residents, business owners in the city centre etc.

To add some flexibility to a quite rigid scheme, it has been decided to permit access to doctors and taxis from other cities.
Daily permits are given for access to weddings, funerals, removals and other special events and construction works on private housing within the ZTLs.
In addition, multiday permits are issued for companies performing maintenance or loading / unloading goods within the Zona a Traffico Limitato (=LTZ) upon presentation of the corresponding documentation.

Among the available options, it is wortwhile to mention the London Ultra-LEZ[7] as a type of scheme coordinating several related schemes and aims (LEZ and charging schemes) and 'nesting' a tighter scheme within existing schemes.

Alternative options

Providing alternative options for the mobility demand is another key factor.

As the cost benefit results, can be favourable, net revenues generated by congestion charging can be re-invested into the transport system as a whole. Many urban mobility measures exist that aim at balancing supply and demand. Their cost and effectiveness vary and promoting them can enhance the effectiveness of UVARs based on congestion charging.

Encouraging integrated multimodal transport (smart tickets, multi-modal travel, travel information and routing, sharing), deploying smart traffic management systems, encouraging fleet renewal and measures that promote optimised vehicle use, including car sharing are actions that can further address the challenges of urban mobility.
Additionally, new public transport concepts including flexibility, quality and efficiency while remaining affordable, can also be supported by such a re-investment.

As well as funding, public transport improvements, revenues may also be available to make improvements for pedestrians, cyclist and other road users. Some targeted revenue spending in the affected areas for other purposes may also be viable. Public confidence that revenues will be used for transportation improvement is an important element of any congestion charging strategy.

CHAPTER IV – Potential impacts of a shared European approach in planning, consultation and design

Several benefits for cities in the presence of a well-designed UVARs scheme, such as impacts on vehicle fleets, air quality, traffic flows, etc. have already been pointed out (see NBGD n°2 on Vehicle Types, Exemptions and (Cross-border) Enforcement). There are also elements of European added value and benefits for local policy makers from the widespread adoption of UVARs schemes in line with existing good practices, such as common principles on exemptions, common criteria for vehicle identification and the effects of EU dissemination.

From the point of view of planning and design, a key element contributing to both local and European added value is an integrated approach, as the effectiveness of any UVARs scheme depends on such an overarching strategy. The common reference to Sustainable Urban Transport Plans (SUMPs) is of great benefit to cities aiming at sustainable mobility by implementing a UVAR scheme.

The EU has been particularly proactive in promoting SUMPs at the local level across Europe. SUMPs have been very influential and have become a key element in policy formation in many European cities and regions.

Often the initial step when contemplating the introduction of a UVAR scheme is policy formulation. It is generally the case that a UVAR must be part of a policy framework that articulates the strategy and rationale of its implementation.

Devising an appropriate policy package can be considerably facilitated by the framework provided by the EU, for instance when making use of it by introducing a SUMP. Guidance relating to SUMPs articulates policy areas relating to congestion and the environment and provides a template for the formulation of policies.

Of course, there are also many other associated publications that the EU has produced that are of direct assistance to agencies promoting UVARs schemes. These include relevant EU Directives, Transport Green Papers, Non-Binding Guidance Documents, and specific publications with direct relevance to UVARs such as Action Plans on Urban Mobility, Guidelines for ITS Deployment in Urban Areas etc.[8] These and others are available sources of information for advocates of UVARs schemes.

Another important element is to undertake traffic and environmental modelling of the effects of a proposed scheme. Traffic and environmental data modelling can help identify the issues and design the best solution. Modelling the proposed scheme can then help to assess its likely impacts which can be used during discussions with stakeholders.

Critical to the successful outcome of the modelling exercise is that of realistic data input. These inputs, such as emissions factors based on sound science and describing actual emission performance on roads, should be used. They should represent common, harmonised and scientifically agreed community databases about the atmospheric emission performance of the vehicles. An example is the pollutant emission factors commonly used at European level, for instance the "EMEP/EEA air pollutant emission inventory guidebook" or the "Handbook Emission Factors for Road Transport". Furthermore, these criteria can be applied to any vehicle in Europe and so can be used across countries.

The choice of enforcement and payment technology will be one of the key decisions facing cities and regions implementing UVARs schemes. The choice can range from "low technologies" such as window stickers or paper vignettes to "high technologies", i.e. camera-based or satellite-based systems. The choice of technology will inevitably depend on a number of factors such as cost, public acceptability, interoperability, back office technological capacity etc. Ultimately, the decision as to which form of technology is chosen will lie with the administration introducing the scheme. While acknowledging the importance and desirability of interoperability in the choice of technology, other factors will also play their role in this decision[9].

This guidance is an opportunity to add value and draw attention to the fact that cohesion can promote interoperability while fully respecting decisions taken by local administrations.

A common issue that has been experienced by those cities that have introduced UVARs schemes is the difficulty they have in collecting fines from vehicles registered abroad (see NBGD number 2 on "Vehicle types, exemptions and (cross–border) enforcement").

There is a key role for Member States in sharing records and databases of foreign vehicles to help European cities and regions with the operation of UVARs schemes. This necessitates a high degree of co-ordination but would produce an asset of considerable benefit to many existing schemes and those cities and regions that are contemplating the implementation of UVARs schemes in their areas.

CHAPTER V – Barriers and Enablers to a Shared Approach

Barriers

- *Weak support for UVARs schemes as isolated measures*
  A lesson learnt in previous research is that a majority of the public tend to be critical about UVARs schemes when presented as isolated measures. There is generally widespread support for introducing measures that will reduce congestion and substantially improve public transport. However, there is often skepticism about the principle of road user charging. Reasons include the view that it is fundamentally unfair to charge residents for driving around the city, that charging will not reduce congestion and that realistic transport alternatives are not and will not be available. UVARs need to be part of a strategy that includes other measures to solve congestion like an improved public transport offer and better infrastructure for walking and cycling.

- *Adjustment of the local laws for the effective realization of traffic limitations*
  Another lesson learnt is that changes in national and/or local legislation may be required in order to implement a preferred scheme design in a city. Delays due to the promotion of adjustments in the legal framework and/or the approval process should be expected when establishing a schedule for the implementation of any kind of scheme.

- Difficulty of finding support for directly implementing full-scale schemes
  From a political point of view, implementing full-scale schemes is challenging. Instead of full-scale schemes, demonstration projects have therefore been carried out in some cities in order to learn more about how the technology works, how it affects the attitudes of users and the general public. One lesson learnt in the Stockholm case is that this approach also provides experiences that enable cities to proceed with consultations leading to the development of a more appropriate full-scale UVARs scheme. An option to overcome this obstacle is to consider running demonstration projects as a first step on the way towards full implementation.

- *Passing from manual to automatic control*
  UVARs schemes are based on technological choice: "high technologies", i.e. camera-based or satellite-based systems, imply stricter enforcement whereas "low technologies" such as window stickers and paper vignettes yield higher permeability. The decision to adopt "high technology" choices means automatic detection of violations with relevant files sent to a database accessible to operators responsible for enforcement procedures. The number of affected vehicles can play a role in the decision since the advantage of automatic control increases with higher numbers.

- *Changes in citizens' mobility habits*
  The UVARs scheme will definitely change the mobility choices of citizens in the affected part of the city. Planning the scheme means also taking into account citizen complaints and taking them carefully into account to ease the change. If the process is not adequately forecasted and planned, this could become an obstacle capable of leading to the failure of the scheme in the beginning phase. Again, a trial period could be considered.

- *Privacy issues*
  Despite the many potential benefits of Intelligent Transport Systems (ITS), the technology largely used in UVARs schemes, both charged and based on permits, and the associated increase in vehicle/infrastructure electronics and communications raises security and privacy issues. When left unaddressed, they could jeopardise the wider deployment of ITS and associated UVARs schemes. ITS technologies must ensure the integrity, confidentiality and secure handling of data, including personal and financial details and guarantee that citizens' rights are fully protected. This action is mentioned in the ITS Action Plan and the European Commission carried out a study in 2012 on this matter[10]. Concrete guidance regarding personal data protection for specific applications and aspects of ITS in the form of a Privacy Impact Assessment template for ITS applications and services could address this issue.

- *Foreign vehicles*
  The lack of a common European approach to the introduction and operation of UVARs affects primarily foreign economic operators and vehicles. Although collection of data and penalties might prove more difficult for foreign vehicles, mechanisms exist to enable it is crucial that UVARs are designed with a concern not to discriminate, even indirectly, foreign operators and foreign vehicles and to preserve the EU fundamental freedoms (especially the free movement of goods and persons and the freedom to provide services). These concerns can be partly alleviated by ensuring the proper EU-wide consultation and multilingual information dissemination for the affected economic sectors.

Enablers

- *High level policies towards traffic flow reduction and mode rebalancing*
  UVARs scheme applications have demonstrated clear results in traffic flow reduction and the increase of other more sustainable modes as well as the setting up of strategic plans such as SUMPs. European cities that wish to reduce increasing congestion and environmental deterioration can act as drivers for UVARs scheme adoption with the design and implementation of alternatives for transit traffic. The reduction of traffic leads to benefits from an environmental point of view, particularly with regard to air pollutant and CO2 emissions.

  The UVARs schemes implemented in European cities have demonstrated improved environmental conditions. For example, the CURACAO project shows a 13-21% reduction in CO2 emissions in the zone as well as an 8-18% reduction in pollutant emissions.

- *Recovery of areas with an increase in road safety and of "soft modes"*
  Where UVARs schemes are working regularly, new pedestrian sub-areas have been created, road speed has been reduced and road safety improvements as well as the promotion of soft and active modes (like cycling and walking) are carried out, attracting new users willing to move into these no longer congested zones. The business sector reactions vary across the many urban settlements where a UVAR is in operation. In the London congestion charge case, ten years after the deployment, the business sector has acknowledged benefits[11].

- *Agreement with stakeholders on UVARs policies in the specific areas*

Although the active co-operation of stakeholders in transport decision-making is still rare in practice, participation in the planning of urban mobility is now becoming increasingly recognized as an essential part of the planning process. City authorities must engage in an ad hoc dialogue with users and stakeholders, leading to negotiations. This engagement must take place in the very early stages of the UVARs lifecycle with the dual objectives of (a) obtaining user needs explicitly and incorporating them into the scheme design and (b) ensuring transparency. Dedicated consultation exercises must be launched to address business concerns with particular regard to tourism operators.

UVARs schemes affect a number of goals and interested parties. Building coalitions between several of these interests is crucial. Their effects should be closely monitored and there should be the possibility of redesigning the system after a certain period of time should problems arise.

- *Increase of resources for mobility projects*
  After the initial set-up, costs and operational costs are taken into account, UVARs schemes can generate significant revenues for improving sustainable mobility options like public transport, walking and cycling. UVARs schemes are more likely to be accepted if the legislation allows for revenues, including fines, to be used directly for improving mobility and livability of cities. Regulation of revenue use is thus an important driver since a high level of acceptance greatly facilitates implementation.

  The ability of local governments to introduce elements of flexibility in terms of the choice of the scheme is crucial and the experiences show that support tends to increase after implementation. A driver is to undertake measures to increase options for people affected by the system when it is implemented. It is also important to adjust the scheme design to accommodate unnecessary and unwanted side effects.

- *Adequate marketing and advertising to citizens, clarifying the scheme's objectives, timetable and exemptions*
  Emphasis should be placed on providing information regarding the scheme's objectives and effects on traffic as part of a mobility strategy. This information has to be provided both before and after implementation. A complete information plan early in the implementation process and a budget with adequate resources for the work are fundamental elements of every successful UVARs scheme. Experience from existing implementations is useful for cities considering this scheme. Schemes that have been proved successful elsewhere are often more easily accepted. Therefore, building on previous experience and increasing consistency between new schemes and existing ones can be beneficial to public acceptance of the new scheme.

- *Part of the EU strategy for urban areas and for the application of SUMPs*
  The European Commission adopted the Action Plan on urban mobility in 2009 and the Urban Mobility Package in 2013. The Sustainable Urban Mobility Plan (SUMP) concept featuring therein considers the functional urban area and foresees that plans are developed co-operatively across different policy areas and sectors, across different levels of government and administration and in co-operation with citizens and other stakeholders. The Commission has actively promoted this concept for several years. Guidelines have been produced providing local authorities with a clear framework for the development and implementation of such a plan. Member States need to promote these practices at the national level and to ensure the right legislative and support conditions for their local authorities.

- *Adequate support towards UVARs policy choices in cities*
  Implementing the 2011 Transport White Paper 'Roadmap to a Single European Transport Area', the European Commission published an Urban Mobility Package in 2013 that addresses initiatives 31, 32 and 33 of the White Paper. Initiative 32 foresees the development of a package for urban road user charging and access regulations schemes. The EC-funded CLARS Platform (www.urbanaccessregulations.eu and www.urbanaccessregulations.eu/public-authorities) was created to provide both support to authorities operating urban access regulations by displaying best practice and sharing experience and knowledge and to disseminate information for vehicle operators. The public website provides detailed information on over 500 European schemes. CLARS has public authority members from most European countries, providing useful UVARs information including guidance, best practice, impacts and contacts for those considering, planning or operating schemes as well as a secretariat to answer UVARs-related questions from members and to disseminate update newsletters.

CHAPTER VI – Summary of Recommendations

Although each city has its own specific priorities and rationale for introducing a UVAR scheme, following certain principles set out in a non-binding guidance at European level covering design, planning and implementation are considered helpful in ensuring the consistency and clarity of decision-making and the freedoms guaranteed in the Treaties.

The following is a list of recommendations addressing local decision makers who are planning or implementing UVARs schemes:

- **Set up UVARs as part of an integrated planning**. From the point of view of planning and design a key issue of both local and European **added value is an integrated approach**, given that the effectiveness of any kind of UVARs scheme depends on such a strategy. **The common reference to Sustainable Urban Mobility Plans** would be of great benefit to cities aiming at sustainable mobility and compliance with the air quality legislation by implementing a UVAR scheme.

- **Ensure an effective stakeholder consultation**. Choosing the best form of consultation is important. The strategy must consist of **structured interaction with a wide range of stakeholders** in a form that is tailored to each group of stakeholders who have an interest in the project under consideration.

- **Consider the use of trials**. Although experience tends to show that the level of public acceptability rises significantly once a scheme is operational and functioning efficiently, **trials can be helpful** to be able to introduce a scheme on an experimental basis, thereby calming scepticism of stakeholders who can be reassured that the scheme will be modified if proven to be unsuccessful. The implementation of a sort of **'utility test' before introducing the scheme** in order to ensure its effectiveness and acceptability can assure that such a scheme is the most suitable in contributing to solving the identified problems.

- **Invest UVARs-related revenues in sustainable mobility options.** Planning the use of revenues from a UVAR scheme for measures to improve sustainable mobility options like public transport, walking and cycling right from the start, and communicating this is of paramount importance. **Encouraging integrated multimodal transport** (smart tickets, multi-modal travel, travel information and routing, sharing), **deploying smart traffic management systems**, **encouraging fleet renewal** and **measures that promote optimised vehicle use** including car sharing are actions that can further address the challenges of urban mobility.

- **Design a comprehensive UVARs scheme, including enforcement techniques**. A well-designed and well-enforced scheme also achieves high effectiveness. In fact, schemes that are **clear, simple and understandable**, where information is clearly disseminated, are able to achieve high compliance rates.

[1] For a more extensive outline of vehicle identification, enforcement and exemption issues, NBGD n°2 "Vehicle Types, Exemptions and (Cross-border) Enforcement of Successful Urban Vehicle Access Regulations (UVAR) Schemes across Europe"

[2] An overview at national level on design and implementation of UVAR schemes is also provided in the NBGD n° 4 "National legal frameworks for Urban Vehicle Access Regulations (UVAR)"

[3] http://www.civitas.eu/content/superblocks-model

[4] The description of the Stockholm UVAR scheme is based on J. Eliasson "Cost-benefit analysis of the Stockholm congestion charging system" Transek AB (2006)

[5] The description of the UVAR scheme in Milan has benefitted from the contribution of the Milan Municipality

[6] The description of the Vitoria-Gasteiz UVAR scheme is based on implementation of the Vitoria-Gasteiz policies in the CIVITAS MODERN project (2012)

[7] https://tfl.gov.uk/modes/driving/ultra-low-emission-zone

[8] WHITE PAPER Roadmap to a Single European Transport Area – Towards a competitive and resource efficient transport system Brussels, 28.3.2011 COM (2011) 144 final;
Green Paper - Towards a new culture for urban mobility COM/2007/0551 final; Action Plan on Urban Mobility COM/2009/0490 final;
http://ec.europa.eu/transport/themes/its/road/action_plan/doc/2013-urban-its-expert_group-guidelines-on-traffic-management.pdf ;
Together towards competitive and resource-efficient urban mobility COM (2013) 913 final
CLARS Platform, including CIVITAS e-course on UVARs http://www.urbanaccessregulations.eu/public-authorities

[9] These issues will be the object of the NBGD n°6 on "Technology and interoperability"

[10] Rapp TRANS, "ITS & Personal Data Protection Final Report", 2012

[11] http://leftfootforward.org/2013/02/ten-years-of-the-congestion-charge/

ANNEX 4: National legal frameworks for Urban Vehicle Access Regulations (UVARs) schemes

Glossary

AR: Access Regulation

CAFS: Cleaner Air for Scotland Strategy

CAZ: Congestion Access Zone

CLARS: Charging, Low Emission Zones, and other Access Regulation Schemes

CS: Charging Scheme

CO2: Carbon dioxide

DPF: Diesel Particulate Filter

EC: European Commission

ECJ: European Court of Justice

EEV: Enhanced environmentally friendly vehicle

EU: European Union

EUCARIS: European Car and Driving Licence Information System

HDV: Heavy Duty Vehicle

LAQM: Local Air Quality Management

LEZ: Low Emission Zone

LDV: Light Duty Vehicle

LTZ: Limited Traffic Zone

LV: Limit Value

MS: Member State

NBGD: Non-Binding Guidance Document

NGV: Natural Gas Vehicle

NLEF: National Low Emission Framework

NMF: National Modelling Framework

PM: Particulate Matter

QR: Quick Response

REC: Retrofit Emission Control

RTRA: Road Traffic Regulations Act

SUMP: Sustainable Urban Mobility Plan

TEN-T: Trans-European Transport Networks

TRO: Traffic Regulation Orders

UNECE REC: United Nations Economic Commission for Europe Retrofit Emission Certificate

UVARs: Urban Vehicle Access Regulations

VRN: Vehicle Registration Number

CHAPTER I – Introduction

The present publication covers the rationale behind the development of new national legal frameworks on Member State (MS) level, tries to summarize the current situation and identifies priority areas to be considered in national legal frameworks.

As recent trends, have seen increasing fusion of congestion and environmental issues within the context of UVARs, the present document may refer both to Low Emission Zone (LEZ) and Charging Schemes (CSs) but also only one of them. However, as national legal frameworks have been established primarily for UVARs with emission aspects (e.g. LEZs or carbon or noise standards), this document primarily refers to LEZs.

National legal frameworks for Urban Vehicle Access Regulations (UVARs) Schemes

The current state of national legal frameworks for UVARs schemes is extremely varied, ranging from countries where there are no specific legal provisions to deal with, to others where road codes and other specific pieces of legislation offer an explicit legal base. Currently, there are more than 500 different UVARs schemes throughout Europe[1]. In most MSs, road codes integrate the legal basis for UVARs, in some countries (e.g. Denmark, Germany and Sweden) national legislation lays down ad-hoc rules while in others (e.g. Austria and Estonia) national legislation includes generic provisions on traffic measures. In the absence of national legislation, local norms represent the regulatory support to the implementation of UVARs schemes (e.g. Italy).

To prevent unnecessary complexity for stakeholders, it would be useful if MSs could agree on a national legal framework, building on good practice examples. In line with the subsidiarity principle that sets out clear boundaries to the competencies of the EU level when it comes to legislation at local level, the European Union (EU) does not have a mandate to provide for common standards of UVARs initiatives. However, national legal frameworks must be in line with the basic principles of the Treaties (e.g. the Internal Market and the Freedom of Movement) and have to be proportional and non-discriminatory[2].

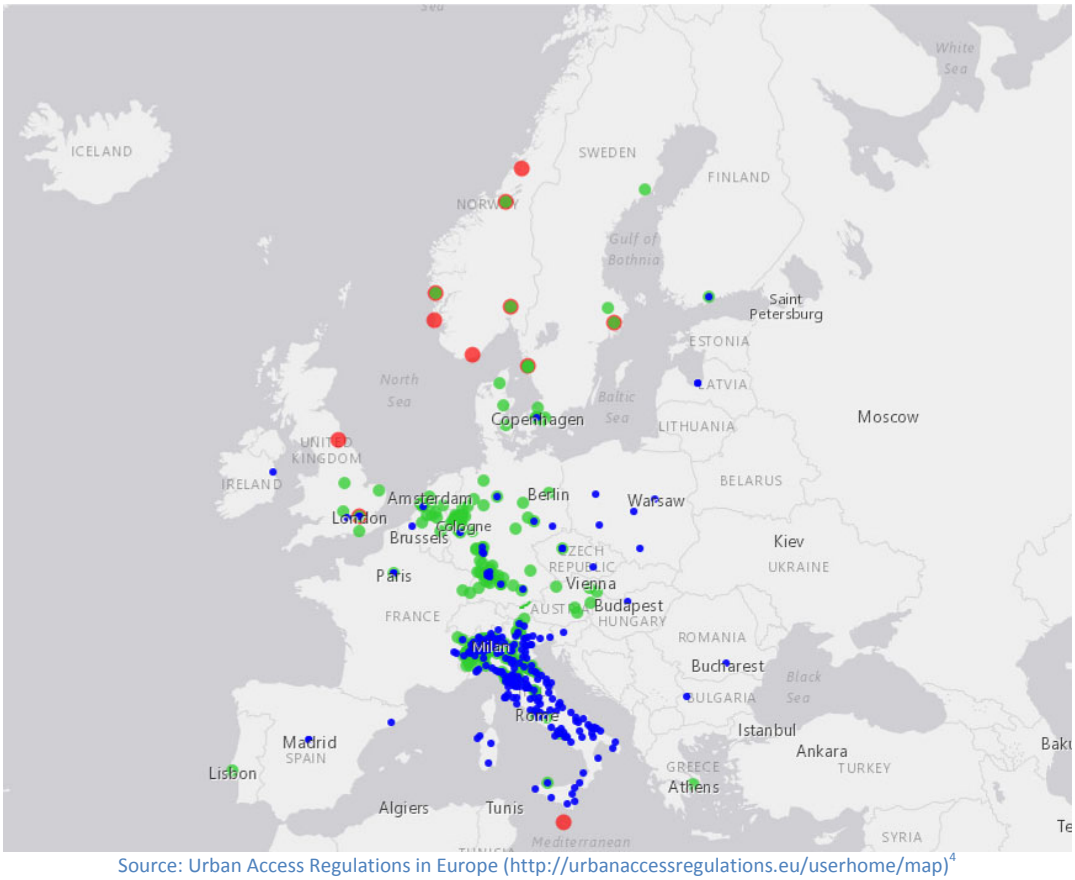
Moreover, they should include provisions concerning (i) vehicles affected; (ii) emission classes and certified retrofit equivalent (e.g. German LEZ scheme); (iii) exemptions; (iv) Non-discriminatory treatments, e.g. citizens who have no alternative to using vehicles or are unable to gain access to a vehicle with appropriate standards, etc.; (v) REC devices; (vi) methods for identifying vehicle eligibility and (vii) road signs. As optional, they could also include provisions for (i) a complaints and mediation agency, (ii) national databases and a uniform (iii) assessment and evaluation process.

When there is more than one UVARs scheme to be implemented in the country, a national framework enables UVARs to be set up more easily and with lower costs. Moreover, users can easier be informed and convinced that issues of nationwide interest will be resolved once by a compatible approach rather than individually for each scheme including signage, driver licence penalty points, stickers and permits, regulations enforcement, possible exemptions, etc.

The main barrier to the adoption of a new national framework is that many established schemes are already in place at city level each with different criteria concerning legal basis, charging, enforcement approach and affected vehicle types.

CHAPTER II – The Challenges brought by the developed approaches within each country

As illustrated in the following figure, there are currently more than 500 UVARs schemes[3], including CSs (red dots), LEZs (green dots), and other ARs (blue dots).



Source: Urban Access Regulations in Europe (http://urbanaccessregulations.eu/userhome/map)[4]

Figure I- UVARs schemes throughout Europe

The approaches taken towards UVARs

Each Member State (in some cases each city/region) has defined its own criteria for its scheme creating a fragmentation of schemes throughout Europe. More in detail also due to the purpose of their introduction (e.g. legal base in tax or environmental law), UVARs differentiate by:

1. Design relating to purpose:
    - Vehicle type (e.g. zero emissions and low carbon vehicles);
    - Air quality legislation;
    - Tail-pipe emission Limit Values (LVs) (e.g. PM_{10}, $PM_{2.5}$, etc.);
    - Road codes;

   - Euro emission standards (e.g. Euro 6, etc.);
   - Noise values (under discussion in Austria).
2. Charging:
   - Charging per trip;
   - Charging per day or hours;
   - Charing per permit;
   - No charging.
3. Enforcement approach:
   - Camera;
   - Manual;
   - Transponder;
   - Police;
   - Traffic wardens.
4. Affected vehicle types (examples):
   - All except "clean" vehicles;
   - All except special vehicle categories (e.g. military vehicles, rescue vehicles, vehicles driven for and by people with disabilities, historic vehicles, car sharing (car club) vehicles, etc.);
   - Only freight vehicles.
5. EU level policy drivers[5]:
   - Goal of phasing out conventional vehicles in urban areas by 2050;
   - Goal of essentially Carbon Dioxide (CO2)-free urban logistics by 2030;
   - Improving sustainable mobility;
   - Improving air quality;
   - Reducing congestion.

Overall, UVARs schemes may be area based or point/link based, controlled by signals or physical infrastructure, involve charging, vary by time/day or by vehicle type, and may be subject to different types of enforcement. They may also be used to address a series of problems which range from reducing air pollution to managing congestion. This is mainly due to various local differences. That said, most (LEZ) schemes use standard vehicle characteristics, are permanent bans of vehicles not meeting the standards and allow vehicles to meet the set standards by the retrofitting of Diesel Particulate Filters (DPFs)[6]. But this is not always the case, as there are some (LEZ) schemes that are time-limited, do not allow retrofitting or allow Nitric oxide and nitrogen dioxide (NOx) retrofitting or that charge for entry conversely to banning vehicles. Other access regulations often focus on reducing car traffic, for example from commuters or individual tourists to protect the quality of the access regulated area.

In most countries, the legal basis for UVARs schemes is integrated in the road code though in some countries (e.g. Denmark, Germany and Sweden), national legislation laid down ad-hoc rules whilst in other ones (e.g. Austria and Estonia), national legislation provides for generic provisions on traffic measures. In the absence of national legislation, local norms represent the regulatory support to the implementation of UVARs schemes. In Italy for instance, there is a flexible regional framework, which set out minimum standards and requirements that can be further built up, in terms of: vehicles affected, hours of operation and types of location.

In addition to the abovementioned characteristics, UVARs schemes may differentiate according to their mandatory degree at national level, namely the degree through which a piece of UVARs legislation is more or less binding.

More into detail, these can be as follows:

- *No options***:** in case the MS does not envisage the adoption of UVARs schemes;

- *Framework law* in case the MS allows cities or regions to decide themselves whether or not to adopt UVARs schemes;
- *Binding Guidance that leading to the compulsory adoption of a regulation at national level***:** in case the MS provides binding guidance about how to design and implement UVARs schemes leading to the compulsory adoption of such regulation at local level under certain conditions and;
- *Non-Binding Guidance***:** in case the MS provides non-binding guidance about how to design and implement UVARs schemes.

The following paragraphs present four case studies of countries that have implemented a national legal framework.

Case studies of EU Member States that have implemented a national legal framework[7]

Denmark

There is a national framework about access regulations in Denmark, which however comprises only the municipalities of Copenhagen, Aarhus, Frederiksberg, Odense and Aalborg. This regulation, which the parliament approved in December 2006, does not allow the introduction of UVARs schemes in other cities.

The same rules apply to all UVARs schemes, even if issues concerning location and transit roads are individual. The decision to establish a UVAR scheme and its boundaries is taken by the City Council, which however, before adopting the scheme, shall carry out a public consultation. At least 14 months should pass between the entry into force of the regulation and coming into force of the scheme, in order to allow road users to get acquainted with the new regulation.

UVARs schemes apply only to diesel Heavy Duty Vehicles (HDV) and buses of more than 3.5 tonnes. As from 1 July 2010, all HDVs over 3.5 tons and over 4 years old shall be equipped with an approved retrofit particular filter or meet EURO 4 standards and they shall show an Environmental zone sticker on the front windscreen. Foreign buses and HDV must meet the particle filter requirement, and as from November 2011, when driving in a UVAR shall carry a Danish low-emission zone label as well.

The Danish low-emission-zone label is unique for each vehicle as it includes the vehicle's nationality and the Vehicle Registration Number (VRN). In special cases, vehicles can be granted temporary exemption from the Danish UVARs areas. There may also be cases in which vehicles receive permission to drive for a limited period; in this case, the sticker is of red colour. Historic busses and HDV (registered in Denmark for "veteran driving") that are registered in a foreign country and are more than 30 years old are exempted.

Germany

The Thirty-Fifth Ordinance on the Implementation of the Federal Emission Control Act (Ordinance on the marking of vehicles) as well as the Federal Emission Control Ordinance (35. BImSchV) are the national legal frameworks in place regarding vehicle access regulation in German LEZs. They were introduced to mitigate air pollution caused by PM and nitrogen oxide. The regulations set out the standards and vehicles affected, allowing federal state flexibility on implementation, in order to suit local conditions. Moreover, they set out provisions on the marking of passenger cars and commercial vehicles in accordance with the quantity of their particulate emissions. Each municipality can choose whether to implement a scheme and its scope.

Details of the 4 emission classes defined under the Thirty Fifth Ordinance are shown in the table below.

Table 1- German UVARs emissions standards

European emission standard	Emissions group	First registration passenger car	First registration HDV	Sticker
Diesel engines				
Euro 1 or less	1	Before 1 January 1997	before 1 October 1996	None
Euro 2 or Euro 1 with retrofit	2	From 1 January 1997 to 31 December 2000	from 1 October 1996 to 30 September 2001	
Euro 3 or Euro 2 with retrofit	3	From 1 January 2001 to 31 December 2005	from 1 October 2001 to 30 September 2006	
Euro 4 and higher or Euro 3 with retrofit	4	From 1 January 2006	from 1 October 2006	
Petrol engines				
Euro 1 or less*	1	Before 1 January 1993	before 1 January 1993	none
Euro 1 and higher	4	From 1 January 1993	from 1 January 1993	

* vehicles which do not meet group 4 criteria

** Annex XXIII to Road Traffic Registration Regulations (StVZO) or equivalent or 52nd Ordinance on derogations to the StVZO or equivalent

Source: Low emission zone / emissions-control sticker on the Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety

Mandatory exemptions include: ambulances and doctor's emergency vehicles, vehicles driven by severely handicapped people. Other exemptions include those vehicles granted special traffic rights (e.g. garbage collection, road cleaning vehicles, police, fire brigade, military, historic vehicles, agricultural or forestry tractors, two or three-wheeled motor vehicles).

The Netherlands

There is a national legal basis for LEZ only affecting HDV in the Netherlands (*Reglement Verkeersregels en Verkeerstekens*) which incorporates the access standards for entering the zone (Euro IV or newer). Simultaneously to the adoption of the regulation, the Netherlands introduced a national road sign to indicate a LEZ.

For Light Duty Vehicles (LDVs) the procedure for a legal basis for environmental zones is in progress with the date of expected introduction being 1 January 2017.

Until that time not all UVARs schemes have the same standards and whether LDVs are affected vary from city to city. Also, access regulation for passenger cars and light duty vehicles are not uniform among cities (e.g. Utrecht differs from Rotterdam).

UVARs schemes for HDV are based on an agreement between municipalities, superior authorities and sectoral organisations. A municipality needs to take a local juridical decision to explain why they want to introduce a UVAR scheme prior to the scheme's implementation. All zones for HDV adopt Euro standards as the criterion for access regulation[8], otherwise the access of LDV and passenger cars is linked to the date of the first vehicle registration in relation to the date of introduction of higher Euro standards.

Enforcement is carried out by Automatic Number Plate Recognition (ANPR) linked to the national vehicle registration system, and some foreign vehicle registration systems (when available). Enforcement is also possible by traffic wardens.

Sweden

Sweden has a (non-binding) national framework of access regulations and congestion charging in the cities of Stockholm[9] and Gothenburg. Only the scope and the charging model adopted vary for each city.

Driven by a bottom-up approach (a pilot scheme was launched in Gothenburg and then scaled up at national level), the legislation concerning access regulations has been drafted by the traffic authority that received a mandate from the national government.

Regulations at city level are based on the rules laid down in the Swedish Road Traffic Ordinance (SFS 1998:1276, Chapter 4, 22-24 §§) and have been driven by NOx and Particular Matter (PM) emission reductions. This Ordinance has been amended twice: in 2002 when higher requirements to retrofitted engines were introduced and 2007 when the criteria for the exclusion/inclusion of vehicles within a UVAR scheme changed from the registration/matriculation year criteria to the emission class criteria.

Municipalities can decide whether to adopt a UVAR and determine the geographical scope while the framework laid down at national level is not compulsory to use. But if the local authority decides to use it then it has to be respected in the city as follows:

- Buses and HDV heavier than 3.5 tonnes are allowed access, if they have been registered in Sweden for six years; and buses and HDVs heavier than 3.5 tonnes and which are more than 30 years old are allowed access into LEZs no matter how long they have been registered in Sweden;
- Vehicles shall carry information about their eligibility while in the UVARs area if such information is not available in the national database for road vehicles.

The exemptions from the rules mentioned above are based on the EU environmental classification system[10]. There are no stickers to confer access to the zone in Denmark, but free-flow toll systems are used.

United Kingdom

In the UK, responsibility for meeting air quality LVs is devolved to the national administrations in Scotland, Wales and Northern Ireland (and from them, as in England, to local administrations). Administrations have developed a collective approach to UVARs, and to date several access regulations schemes have been implemented across the UK. The active schemes,

including a single LEZ, have generally been developed, implemented, and managed by roads authorities (local, regional, and national) working together with their partner organisations[11]. The two main legal procedures by which UVARs traffic or parking control criteria have been introduced to an area (or zone) are as follows[12]:

- Traffic Regulation Orders (TROs) under the Road Traffic Regulations Act (RTRA) 1984 for enforceable regulations on the public highway. TROs are commonly introduced to manage traffic flow at specific locations, to define on-street parking conditions, or as part of a broader traffic management scheme. Highway authorities are empowered under the RTRA 1984 to introduce TROs to regulate the speed, movement and parking of vehicles and to regulate pedestrian movement and
- Planning agreements, such as Section 106 agreements of the Town and Country Planning Act 1990, for introduction of obligations for development sites and private land. However, planning authorities can only impose conditions on planning permits where there is a clear land-use planning justification for doing so.

Following implementation of UVARs in a series of English towns and cities (Brighton, Durham, Norwich, Reading, and Oxford) in December 2015 the UK government announced support for the introduction of "Clean Air Zones" in five cities around England.

In Scotland, at least three major cities (Edinburgh, Aberdeen and Glasgow) have considered LEZ UVARs in detailed studies. However, none has yet developed a robust business case for implementation. With this in mind, the Scottish Government developed the Cleaner Air for Scotland (CAFS) Strategy[13] in 2015 to provide a national strategy to achieve the best possible air quality for Scotland. CAFS includes a commitment to build a National Modelling Framework (NMF) to provide evidence for decision making and a National Low Emission Framework (NLEF, including UVARs measures) to improve air quality. In NLEF there is a clear recognition that the UVARs measures chosen for each area may differ, however they need to be consistent, well defined, and coherent.

CHAPTER III – Available options for pursuing the introduction of a national legal framework

To avoid unnecessary confusion for stakeholders and to facilitate public acceptance, a definition of the forms and objectives of UVARs schemes would be beneficial. While the decisions about defining, and implementing access regulations should be made at national or local level, there is considerable potential for shared evidence and agreement on European level regarding empirical principles particularly on issues such as vehicle characteristics, enforcement methodologies, information and communication, evaluation of effectiveness, exemptions etc.

The affected industries are also advocating for a consensual common European approach to UVARs schemes. However cross-border alignment is often not possible due to the wide range of sometimes conflicting approaches to UVARs in Europe and the variation in such schemes already in operation. Obviously, the subsidiarity principle applies, limiting EU level intervention.

However, there also appears to be consensus (especially across professions, organisations, and political parties) on the need for guidance to assist national governments in their legal decision making process. National governments could consider both a bottom-up approach – leveraging on the "local practices" that proved to work in the best way – or a top-down approach, levering on an exchange of best practices among Member States.

In any case, Member States should be assisted in issues such as how to proceed in their decision-making process (e.g. which criteria to consider, which impacts to assess etc.)[14].

Partially drawing down from the study "City Pass" framework for harmonisation of European LEZ scheme[15], the following paragraphs provide guidance for national governments on national legal frameworks.

However, before presenting the key components of such framework, it is necessary to introduce the key elements to consider when national legal frameworks for urban vehicle access regulations are developed.

Legal and institutional framework for the implementation of UVARs national framework

A national legal framework can be set up to enable sufficient flexibility for each city or region (e.g. in Germany), must be in line with the EU legal principles and provide a clear division of roles and responsibilities between national and municipal authorities.

The following table provides an outline of the possible roles and responsibilities of national and local authorities for the implementation of a national legal framework.

Table 2- Roles and responsibilities for the implementation of a national legal framework

National government	• National analysis of UVARs impact and cost benefit analysis; • National urban air quality legislation and mobility strategy; • UVARs national legislation, including: ○ Legal basis for municipalities to establish UVARs

	○ Definition of LEZ pollutant emission classes and sticker design ○ National schedule for UVARs phases ○ Definition and criteria for UVARs vehicle exemptions ○ Retrofit approval scheme based on UNECE REC Regulation ○ Incentives and complementary measures to support UVARs implementation ○ National system for sale of stickers and approval of exemptions • National UVARs database and website • National vehicle database with emission characteristics and exchange of vehicle data with other participating countries • New Retrofit certification (which should comply with UNECE REC retrofit standards) • Nominate the competent authorities for ○ Issuing of stickers and exemptions ○ Type-approval, installation and inspection of REC devices and ○ Identification of emissions standards for national vehicles. • Capitalise on national stakeholder and interested parties' discussions.
Local government	• Information to the public and stakeholders, both at city and national level as well as EU websites • Local stakeholder and public consultation and participation • Local UVARs air quality assessment, impact assessment and cost-benefit analysis • Local air quality management plan (Air Quality Directive), consistent with national air quality strategy • Sustainable urban mobility plan (SUMP) • Decision on which vehicle types are regulated (HDV, LDV etc.) • Timescales • UVARs boundaries and exempted routes (transit, port, airport) • Enforcement method and infrastructure • Information to the public and stakeholders • Signage compliant with national standards • Monitoring and ex-post evaluation of UVARs effectiveness and cost-benefit.

Source: Elaboration on COWI-ECORYS (2014) Feasibility study: European city pass for low emission zones. Annex A: Standards and Guidance Document. European Commission, DG Environment.

As mentioned above, the EU is not directly involved in urban traffic regulations. However, any national UVARs framework has to take into account EU Treaty[16] principles, especially the Freedom of Movement (FoM)[17]. Any UVARs scheme is a potential regulation to the free movement of goods and services although it can be justified under the Treaty.

This means that[18]:

- UVARs schemes may not provide for tighter standards for vehicles registered abroad[19];
- Emission standards should comply with emissions standards in force (i.e. Euro standard, PM or PM & NOx REC retrofit or age proxy to Euro standard);

- Retrofit certification should comply with UNECE REC retrofit standards;
- Motorways and Trans-European Transport Network (TEN-T) key roads need to be exempted from UVARs schemes, or a reasonable diversion shall be guaranteed.

Moreover, it is settled case-law[20] of the European Court of Justice (ECJ) that, to be compatible with the Treaty, any non-discriminatory restriction of intra-Community trade shall be proportional. Thus, any UVARs scheme needs to respect this requirement.

It is the responsibility of national governments to make sure that the national UVARs framework does not infringe on the FoM, MSs may decide to notify the framework or individual schemes outside a framework to the EC and enter in a dialogue prior to the measures entering into force.

Key components of a UVARs framework

The components that may be considered when developing a national legal framework for urban vehicle access regulations can be divided in two categories: those that should be included and those that could. These are[21]:

1) Components that should be included in a framework legislation:
    - Vehicles affected;
    - Emission classes and certified retrofit equivalents;
    - Exemptions;
    - Non-discriminatory treatments, e.g. citizens who have no alternative to using vehicles or are unable to gain access to a vehicle with appropriate standards, etc.;
    - REC devices;
    - Methods for identifying vehicle eligibility;
    - Road signs;
    - National registration databases.
2) Components that could be included:
    - Complaints and mediation agency;
    - National website;
    - Assessments and evaluation processes.

Vehicles affected
A national legal framework should define the vehicles affected by the schemes. Vehicles may include HDV or LDV, two or four stroke engines etc.

Emission classes and certified retrofit equivalents
Emission criteria for the exclusion/inclusion of vehicles within a UVAR scheme could be based on emission standards in force (i.e. Euro standard, PM or PM & NOx REC retrofit).

As for retrofit certification, they should comply with EU-wide UNECE REC retrofit standards. To avoid legal challenges, criteria must be EU-wide applicable and not discriminatory for national vehicles.

Exemptions[22]
When exemptions and procedures to obtain these vary from city to city, an unwieldy bureaucratic burden for national and international fleet operators is created. To avoid this, exemptions should be defined and administered at national level in order to be clearly defined,

limited in number and duration and administered in a clear and transparent manner in order to improve the scheme effectiveness and fairness.

The key vehicle categories most often entitled to exemptions are the following:

- Diplomatic transport;
- Emergency vehicles (e.g. ambulances, fire trucks, police vehicles);
- Vehicles driven by or for handicapped persons;
- Local public transportation;
- Military transport;
- Historic vehicles.

Where residents are exempted (more often for non-LEZ schemes), these exemptions may need to be implemented locally to avoid residents of one UVARs obtaining access to all other schemes.

Equal treatment aspects

UVARs schemes naturally discriminate against certain vehicles. It is imperative that the needs and requirements of vulnerable road users are fully safeguarded in any scheme. Thus, when designing a scheme, a proposed UVARs needs to take into account citizens who have no alternative to a vehicle or are unable to gain access to a vehicle with appropriate standards. Options include measures such as exemptions for vehicles of persons with disabilities, financial incentives to retrofit vehicles, improved public transport and hardship exemptions.

Retrofit emission control devices

REC devices can bring older vehicles into compliance with a higher Euro standard for specific pollutants (e.g. PM and NOx). This allows vehicles to be qualified for a higher pollutant emission class through retrofitting. This can facilitate acceptance of a strict UVARs scheme as generally the costs of retrofitting are lower than the replacement of a vehicle.

Among retrofit technologies, worth mentioning is also fuel switching (e.g. LPG retrofit) and the use of alternative fuels (i.e. LPG, CNG, LNG, electricity, hydrogen, biofuels and synthetic fuels as defined in Directive 2014/94/EU). In this respect, it is also important to establish a procedure under which users can claim access to the UVARs scheme.

To enable UVARs schemes to properly assess whether a vehicle has been correctly retrofitted, standard vehicle documentation enabling cross-border recognition of vehicle age, size, weight, retrofit, fuel-switching (LPG retrofit), CO2 emissions and Euro standards could be embedded into a national scheme.

Similarly, if the scheme uses age as a proxy for Euro standard due to lack of Euro information on the national database, options to identify early compliers may be considered – when this can be proven.

Methods for the identification of vehicle eligibility

There are different methods for the identification of the eligibility of a vehicle. These mainly are stickers (e.g. Germany), a number plate recognition system (e.g. London and Milan) and vehicle registration documents. If stickers were to be adopted, a national framework should set the standards for national stickers to facilitate the introduction of mutually recognized UVARs stickers across the country.

In this respect, the COWI-ECORYS study suggests an approach developed on the basis of the German sticker model that is taken as an example. For each pollutant emission class, a sticker colour is suggested while the nationality and license plate number of the vehicle could be entered in the white field. Stickers should be non-reusable, non-fading and forgery-proof. A new

feature may be added to provide a unique identifier number encoded in barcode or Quick Response (QR) code at the bottom of the sticker to enable rapid scanning during manual enforcement.

Source: COWI & ECORYS (2014) Feasibility study: European city pass for low emission zones. Annex A: Standards and Guidance Document. European Commission, DG Environment.

Figure II- Conceptual sticker appearance

Visual sticker identification may facilitate enforcement since it can immediately be detected whether a non-eligible vehicle has entered a zone. However, as such enforcement is manual and requires time-consuming surveillance, some Member States opt for more innovative systems such as camera enforcement (e.g. free-flow toll stations or ANPR).

Road signs

Information to users regarding UVARs schemes is provided on streets in the form of boundary markers and information signs. It would be beneficial if a national legal framework provides a consistent approach towards UVARs road signs to be easily recognisable by drivers warning them about the regulated zones.

National registration databases

This would be a database combining a vehicle registration dataset (with Euro standard where possible and age otherwise), a sticker dataset and where camera enforcement is being used, an exemptions dataset as well.

This would facilitate the automatic recognition of the emission class of vehicles and provide an "electronic UVARs certificate" containing the registered emission characteristics of a vehicle, to be used as documentation when purchasing stickers and for on-line confirmation of vehicle characteristics during manual enforcement.

A database shall be protected against fraud and unauthorised access and should include standards for data exchange between national and local databases of vehicle emission qualifications as well as for international data exchange between national databases consistent with European Car and Driving Licence Information System (EUCARIS)[23] standards.

Provisions may also exist to enable city authorities and UVARs operators in foreign countries to access the registration process from abroad. There may be options for joint databases.

Complaints and mediation agency

A complaints and mediation agency could be created at national level dealing with all complaints concerning UVARs and mediating issues with road users.

National website

A national website could be created to support road users informing them about new UVARs scheme adoptions, amendments to the schemes in force etc.

The website would provide for a common information database on schemes across the country.

This would also allow for effective journey planning. This central point could also be used as a notice board / consultation mechanism for newly proposed zones and enable effective publication of scheme data to facilitate the development of smartphone apps and the incorporation of information into satellite navigation systems.

Assessment and evaluation process

This is the evaluation of the environmental, health and socioeconomic impacts due to the implementation of a UVARs scheme and the evaluation of the interactions between the scheme and other policies and measures at the national or EU level.

Such analysis would confirm the benefit, cost-effectiveness and necessity of any UVAR scheme. Furthermore, it would strengthen the decision-making process allowing policymakers to promote the scheme to local citizens and verify whether a UVARs scheme has achieved its initial objectives and/or whether it generated ancillary effects.

In this respect, a national framework could

- Set up an evaluation framework that ensures the necessary level of comprehensiveness;
- Set up a standard definition of key assessment indicators and corresponding metrics;
- Set up methodologies to use in Cost Benefit Analysis (including how to conduct surveys etc.) and Cost Effectiveness Analysis (e.g. to achieve the EU air quality level);
- Recommend data requirements for the UVARs impact areas as different data sets are available in different cities.

CHAPTER IV – Potential Impacts due to the introduction of a national legal framework

Countries and regions with coordinated UVARs schemes and with a national legal framework in place have advantages for the mobility of their citizens and businesses. Local UVARs schemes would for instance adopt harmonised criteria, or they would have a list of criteria at the national level to draw from.

Accordingly, the potential impacts of a common approach in national legal frameworks for UVARs are manifold.

National legal frameworks would create economies of scale for vehicles, reducing the numbers of different access regulations schemes at national level. This could be beneficial for vehicle operators as well as reduce the cost of implementation, compliance and enforcement.

This means that the adoption of a common approach at national level would enable:

- The establishment of a common set of (maybe progressively stricter) UVARs criteria easier for residents, businesses and travellers to understand and adapt to;
- The facilitation of mutual recognition and interchangeability of national UVARs stickers;
- A consistent approach to vehicle exemptions meaning that road users would not need to study and understand the different access rules of each single scheme;
- The avoidance of fleet migration to less regulated areas;
- The provision of an established flexible framework for cities and regions that have not yet adopted a UVARs scheme and make the implementation of schemes by cities more effective and efficient.

Road users could comprehend the scheme more easily and could be easier convinced. Furthermore, it would allow UVARs national implementation issues (e.g. signage, driver licence penalty points, stickers and permits, enforcement, exemptions etc.) to be resolved once instead of individually for each UVARs scheme. A national framework would enable any UVARs scheme to be set up more easily and with lower costs, providing a significant benefit and administrative saving for cities.

A common approach in the definition of national legal frameworks would facilitate enormously the diffusion of best practices across the EU.

CHAPTER V – Barriers and Enablers for the introduction of a national legal framework

Barriers

- *Fragmentation of schemes*
  The main barrier towards the adoption of new national frameworks is the existence of many established schemes already in force at local level. Each of them may have different criteria concerning their legal basis, charging and enforcement approaches and vehicle type limitations.

- *Additional costs*
  Additional barriers include the additional costs that a country would incur to introduce such legislation. Costs include initial and operational costs.

- *Implications on transport services*
  Moreover, businesses, logistics operators and coach operators that have adapted their fleets and dispatching procedures to an existing UVARs scheme may be critical towards changes that necessitate fleet reorganisations or the replacement of vehicles to adapt to new UVARs criteria, creating an additional barrier towards the introduction of a national legal framework.

- *Integration of different points of views*
  Law making at national level is inevitably a longer process as it is influenced by many stakeholders. Authorities introducing legislation generally wish to incorporate a broad spectrum of views in order to prevent unnecessary conflicts.

  A barrier may also be the different views that may occur between different levels of government concerning policy requirements and priorities. In such cases, the local level could work together with other experienced municipalities to act within its own responsibilities. Additional barriers may include the identification methodologies adopted. If stickers are used, this should be mutually accepted by other cities. Besides the diverse nature of schemes described above, a recent trend towards the fusion of congestion and environmental issues within the context of UVARs can be detected which could be interpreted as an additional potential barrier to UVARs implementation. This could blur the distinction between congestion focused schemes and those whose primary rationale focusses on environmental issues.
  On the other hand, it should be stressed that this trend could also be interpreted as an enabler, as the schemes can be more effective at tackling both environmental and congestion issues simultaneously.

Enablers

The following enablers can be mentioned in ensuring a national legal framework:

- *Defining the roadmap to implementation*
  A roadmap to implementation (similar to the Dutch framework) is useful including a set of steps required to carry out before the implementation and envisaging phasing-in periods in which road users have time to ensure compliance of their vehicles. A well-

functioning coordination between national and regional levels making sure that all interests are adequately represented is beneficial.

There are a number of different UVARs schemes already in force from which new national schemes can benefit incorporating best practices. The EC has assembled numerous examples of good practices which can help to inform law making at a national level. It is up to national law-makers to use those examples in the most productive and efficient way.

Helsinki
In Finland, city authorities are working on a potential scheme consulting on options and once a preferred scheme has been chosen, the city works in conjunction with the Finnish national government to produce the requisite national legislation to allow the implementation of the scheme.

Scotland
In Scotland, local, regional and national organisations have worked together across professions to produce the CAFS. It describes how, building on work to date on Local Air Quality Management (LAQM), a NLEF will be developed, informed by evidence from a NMF to implement UVARs schemes where appropriate.

- *Enhancing intergovernmental cooperation*
  Cooperation at regional level to form partnerships to increase the influence on central government:

Northern Powerhouse in UK and Randstad
Large city based authorities across the North of England from Liverpool in the west to Hull and Newcastle-upon-Tyne in the east, including Manchester, Sheffield and Leeds, have formed a partnership to lobby central government across a wide range of areas of mutual interest including UVARs.
The Randstad agglomeration in the Netherlands (Amsterdam, Rotterdam, The Hague, Utrecht and surrounding areas) represents a longer standing and more formalised arrangement between urban areas.

- *Non-discrimination*
  Occasional users should not face unduly complicated or restrictive criteria deterring or effectively prohibiting them from legitimate access.

- *Setting up a system of incentives and investing in infrastructure*
  A system of incentives such as the following can be introduced:
  - Subsidies (e.g. offering loans for the purchase of cars or commercial vehicles compliant with the new UVARs scheme);
  - Tax incentives (e.g. for supporting the retrofitting of private cars or commercial vehicles with an approved DPFs);
  - A transition period in which road users have time to adapt to the new scheme;
  - Complementary measures such as improved public transport, freight logistics etc.

  Infrastructure investments like developing an electric vehicle charging infrastructure and supporting the delivery of a hydrogen fuel system.

CHAPTER VI – Summary of recommendations

Although each national government may have its own specific priorities and rationale for introducing a national UVARs framework, it is common sense that a common approach at national level would be beneficial to ensure the consistency and clarity of decision-making while improving the effectiveness and efficiency of the proposed schemes. The following is a list of recommendations addressing those national governments which are planning or implementing a national UVARs framework:

- It is important that any national legal framework accounts for **enough flexibility** allowing cities to tackle their differing problems arising from different fleets and at the same time avoid stifling the possibility for innovation to produce new good practice schemes.

- Whether national legislation is formulated from a 'top down' or 'bottom up' perspective may determine how effective it will be in facilitating UVAR schemes in cities/regions within its national boundaries. **An optimum combination could be one that reflects significant city/region input, European legislation and non-binding guidance, drawing on examples of good practices in Europe**.

- It is important that national frameworks concerning UVARs schemes are designed in a transparent way **addressing all citizens and reflecting all stakeholder's views** thereby mitigating scepticism.

- National legislation should **be clearly linked to EU and national policy goals** in the fields of for instance air pollution or CO_2 emissions. When under design, a national legal framework should clearly state the goals it is pursuing.

- Such legislation should give guidance to cities on **how to establish sustainable mobility alternatives.** In particular, when schemes create revenues through e.g. congestion charges, national legislation could encourage cities to invest these in sustainable modes of transport.

- National legislation should be written in such **a way to include common issues which might apply to all UVARs schemes**. An example might be legislation that is drafted to include general reference to issues that could be applied to any prospective UVARs in the country (e.g. types of vehicles exempt from any UVARs charge, classifications of road that could be included in UVARs scheme, emission levels of vehicles to which a UVAR charge might apply etc.) where possible.

- Before the design of a UVAR, a national legal framework should include provisions that allow a scheme to be **subject to a utility test before its introduction** and throughout its implementation to ensure its effectiveness and acceptability. In other words, the necessity for the envisaged regulations should be measured to justify the appropriateness to contribute to solving the identified problems. The decision should be supported by a proper impact assessment including the environmental as well as economic and social impacts of the proposed measures on the local economy and businesses.

- A national framework may include provisions and recommendations relating to the necessity to **carry out a consultation process** prior to the possible introduction of UVARs at local level which could involve commercial road transport industry and relating to timely information about such regulations to the commercial road transport operators.

- National governments could also consider the creation of a **permanent national consultation and advisory group** to regularly review UVARs and recommend actions to enhance best practice exchange and the participation of private sector stakeholders, including business stakeholders, in its activities.

- **The evolution of vehicle technologies** may bring additional challenges that should be taken into account when designing the legislation. **This means that the future of a UVAR should be reconsidered in the light of the development of new technologies**.

- The components that may be considered when developing a national legal framework for urban vehicle access regulations can be divided in two categories: **primary contents**, which should necessarily be included, and **secondary contents,** which could be considered. Components that **should be included** in a framework legislation:
    - Vehicles affected;
    - Emission classes and certified retrofit equivalents;
    - Exemptions;
    - Non-discriminatory treatments, e.g. citizens who have no alternative to using vehicles or are unable to gain access to a vehicle with appropriate standards, etc.;
    - Methods for identifying vehicle accessing a UVAR/Retrofit Emission Control (REC) devices;
    - Methods for identifying vehicle eligibility;
    - Road signs;
    - National, regional or local registration databases.

  Components that **could be included**:
    - Complaints and mediation agency;
    - National website;
    - Assessments and evaluation processes.

ANNEX I – Legal basis at country level

Austria
The Austrian Air Pollution Act (Immissionsschutzgesetz-Luft) regulates traffic measures (Art. 14) like spatial and temporal restrictions on the movement of all or certain types of heavy duty vehicles. The measures include, among others, traffic free days, number plate measures, parking restrictions or bans on certain roads for heavy duty vehicles.

A special IG-L Emission Class Identification Badge Order for cars has been legislated in Austria. This legal order enables the identification of the emission class of cars and to impose and control bans of cars with certain emission standards in low emission zones (http://www.akkp.at/).

The latter can be enacted at regional level by the Governor (Landeshauptmann) as well as speed reductions or night driving bans.

Parking space management ("Parkraumbewirtschaftung") is another instrument which is in force in several Austrian cities. It is for instance one of Vienna's central tools to reduce car traffic and air pollution.

Belgium
Several cities have already adopted a UVAR scheme though there is not a framework at national level. The reasons for the development and implementation of a scheme at city level are mainly related to congestion problems and their impacts in terms of noise and emissions, the preservation of city centre and quality of life:

The Highway Code[24] namely 'Arrêté royal portant règlement général sur la police de la circulation routière et de l'usage de la voie publique' regulates access regulations specifying the type of vehicles that can access to :

- Roads for pedestrians, cyclists, motorcyclists (art. 22d – Traffic on the roads for pedestrians, cyclists, motorcyclists);
- Pedestrian areas (art. 22e – Traffic in pedestrian areas);
- Plays streets (*rues réservées au jeu*) (art. 22f – Traffic in plays streets);
- Roads reserved to agricultural vehicles, pedestrians, cyclists, motorcyclists (art. 22g – Traffic on the roads reserved to agricultural vehicles, pedestrians, cyclists, motorcyclists).

Cities and municipalities through city's Mayor Decrees develop urban freight transport regulations for access regulations and/or delivery time, while the local police are responsible for enforcement and control.

Bulgaria
The National Agency of Road Infrastructures introduces prohibitions for public and special use of individual roads for some types of vehicles when it is necessary for providing traffic safety[25]. Such prohibitions are introduced upon coordination with the bodies of the Ministry of Home Affairs, and for the special lay-by sectors with the Ministry of Defence (Chapter III, art. 9, par. 4, 5).

Croatia
There is no legal basis for access regulation.

Czech Republic
There is a national legal framework for Low Emission Zones (http://www.mzp.cz/cz/nizkoemisni_zony) and some cities have already adopted an access regulation scheme mainly for freight transport.

In Prague for instance, the objectives of the road pricing are the reduction of congestion, the improvement of air quality, the prevention of climate change and the raise of funds for transport. The legislation foresees the possibility of charging non-residents or business users for entering in the restricted zones[26]. Historic vehicles are exempted from the aforementioned national legal framework.

Estonia
The Estonian Highway Code[27] does not consider access regulations schemes. The Traffic Act[28] regulates general regulations on traffic of motorized vehicles (§ 48).

Finland
There is no legal basis for access regulation.

France
The French Highway Code[29] regulates movement prohibitions and regulations (section 3 articles R411-18 – R411-24)68. Article R411-18 lay down that the prefect may temporarily forbid the movement of one or more classes of vehicles on certain portions of the road network. Orders of Minister of Home Affairs and the Minister of Transport may prohibit the movement of categories of vehicles during specific periods on portions or the entire road network. For measures aiming at limiting the extent and effects of pollution peaks on the population, the prefect defines perimeter of areas, movement suspension or regulation and information sources and modalities (art. R411-19).

In the urban areas, there are three special traffic zones (e.g. *zones de circulation particulières en milieu urbain*): pedestrian area, pedestrian-priority zone (*zone de rencontre*), and zone 30:

- In the pedestrian areas, as defined under the art. R110-2, only vehicles needed to service the internal area are allowed to move to (art. R110-2);
- The pedestrian priority zone is open to all forms of transport but pedestrians have priority over all other forms of transport except trams. Motorised vehicles are limited to 20 km/h and may only stop and park in designated areas;
- In the zone 30, vehicles are limited to a speed of 30 km/h. In this area, cyclists and pedestrians benefit from improved safety.

More recently additional rules have been introduced by French authorities. These are:

- Decree No. 2016-847 of June 28, 2016 referring to Access restriction areas;
- Decree of 21 June 2016 establishing the nomenclature of vehicles classified according to their level of emissions of air pollutants pursuant to Article R.318-2 of the Highway Code;
- Decree No. 2016-858 of 29 June 2016 on air quality certificates;
- Decree of 29 June 2016 on rules for issuing and affixing air quality certificates - Decree of 29 June 2016 fixing the rate of the fee for issuing the air quality certificate;
- Decree No 2016-848 of 28 June 2016 on the list of cities of more than 100,000 and more than 250 000 inhabitants mentioned in Articles L. 221-2 and L. 222-4 of the Environment Code;

- Order of 28 June 2016 establishing the lists of cities of more than 100,000 and 250,000 inhabitants in accordance with Article R. 221-2 of the Environment Code.

Greece
There is not a national legal framework concerning UVARs. In the Athenian access regulation scheme (Ring), to reduce traffic congestion, vehicles are not allowed to access in the central area. The regulations do not apply to foreign vehicles who are visiting the country, or to rental cars. The access regulation scheme has been established through the Decision of the Greek Directorate of Road Construction Works Studies (*Διεύθυνση Μελετών Έργων Οδοποιίας – ΔΜΕΟ*), which set the area boundaries, vehicles regulations based on license plate number and time slots. In the Legislative Act 181/16.09.2009[30], the establishment of the Athenian Green Ring represents one of the measures to tackle air pollution from road traffic.

Hungary
There is not a national legal framework in place. However, according to the Hungarian legal basis, UVARs schemes may be adopted by the municipalities. By acts of the Parliament, municipalities are entitled to issue decrees on UVARs within the boundaries of the city and decide on the type and level of the regulation that however shall be in line with the acts and the decrees governing road transport and the Hungarian Highway Code (*Közlekedés Rendészeti Szabályok – KRESZ*).

Also, municipalities are entitled by the Act on Municipalities and the Road Transport Act to impose the basic types of regulations like parking/protected zones and weight regulation.

For instance, such regulations include:

- Parking zones, protected zones: a fee is charged for parking in the zone, parking in the zone is prohibited, access to the zone is prohibited or limited by type of motor vehicle, by the time or date of the access, by the aim of the access etc. (for example the Castle District in Budapest is a protected area which means that only pass holders may drive into the zone);
- Weight regulations: motor vehicles with a weight above a given level may not pass bridges or be driven on specific roads within the city (for example the downtown of the City of Szentendre cannot be accessed by vehicles over 3.5 tonnes).

Ireland
The main reason for the implementation of an access regulation scheme is the improvement of accessibility by preventing congestion. In Dublin, a scheme called 'College Green Bus Corridor' delivered improved speed, punctuality and reliability for public transport, improved taxi speeds, a traffic calmed environment with easier access for shoppers and businesses in the area and an improved environment with less delays for pedestrians[31].

In Cork, the scheme objectives were to provide a safer, healthier, more comfortable environment for pedestrians and cyclists in the city centre, reduce lane capacity on the main arterial route, redirect motor traffic, increase the numbers of cycle parking facilities within the city centre, enhance citizen awareness on sustainable transport patterns, promote access to the city centre by public transport, reduce traffic levels[32].

Italy

The Italian Highway code[33] regulates traffic in built-up areas (art. 7). Municipalities may restrict the movement of all or selected vehicles categories by order of the Mayor to prevent pollution and to protect the artistic, environmental and natural heritage, in accordance with the directions given by the Minister of Infrastructure and Transport, after consultation with the Minister of Environment and Protection of Natural Resources and the Minister for Cultural and Environmental Heritage, within their respective competences.

By decision of the Council, Municipalities shall define pedestrian and access regulation areas (ZTL – Zona a Traffico Limitato) considering traffic effects on road safety, health, public order, environmental and cultural heritage and territory. Under distress conditions, amendment or addition to the Council decision, the measure may be adopted by order of the Mayor. Moreover, municipalities shall define other relevant urban areas in respect of which there are special traffic requirements. Municipalities shall make subject to charging the entry or movement of motor vehicles within the access regulation areas.

As for the enforcement approach, infringements are subject to the payment of administrative sanctions set in the Highway Code itself. In the Emilia Romagna and Lombardy regions, penalties are set by the Regional Laws.

There is no Italian national Low Emission Zone scheme. There are however regional schemes for the regions of Lombardy, Piemonte, Emilia-Romagna and Umbria, Bolzano and Trentino Provinces. The regional schemes have similar standards, with slight differences from region to region. The regional schemes include also other measures, such as financial assistance for cleaner vehicles and better public transport.

In Florence, the air quality framework of the traffic regulation measures is given, among the others, by:

- The Council Directive 1999/30/EC of 22 April 1999 relating to limit values for sulphur dioxide, nitrogen dioxide and oxides of nitrogen, particulate matter and lead in ambient air;
- The Directive 2000/69/EC of the European Parliament and of the Council of 16 November 2000 relating to limit values for benzene and carbon monoxide in ambient air;
- The Directive 2008/50/EC of the European Parliament and of the Council of 21 May 2008 on ambient air quality and cleaner air for Europe;

Latvia

According to the Latvia legal basis, UVARs schemes may be adopted by the municipalities through spatial planning process (for instance Urban Road Tolls). UVARs scheme and its boundaries are taken by the City Council and before adopting the scheme, shall carry out a public consultation. The Law on Taxes and Fees and its associated Regulation of the Cabinet of Ministers allows municipalities to charge a fee for transport access in special regime zones.

In national level, there is also Road traffic law and Regulation of the Cabinet of Ministers by which traffic may be prohibited or restricted by the City Council if needed.

Lithuania
In Lithuania, there is no specific regulation or legislation on national level on access regulation schemes. Decisions on urban freight transport regulations are taken on municipal level. Regulations include weight limitation, height limitation or total lorry ban.

Luxemburg
The City Council is responsible for taking any measures necessary to regulate traffic and parking on local roads in its urban territory and on state roads located within the town. To ensure traffic flows and public safety during unforeseen events, the *Collège échevinal* may ratify special measures through emergency regulations.

Malta
Traffic regulations in the Maltese cities of Valletta and Mdina have been implemented through the adoption of subsidiary legislations.

In Valletta, the access regulation scheme rules are given by the Vehicle Access Zones (Control) Regulations[34]. According to this Subsidiary Legislation (S.L.65.31), any Council of the city may establish one or more charging zones. The charging areas shall be those prescribed and controlled access within the respective charging zone shall remain in force throughout the periods and days of the week prescribed in the S.L.65.31. In the S.L.65.31, the First Schedule specifies the localities designated as charging zones and prescribed periods for Valletta. S.L.65.31 also regulates the controlling access into the charging zone by the use of Vehicle Access Control System (art. 4), the vehicles access (art. 5), the exemptions (art. 6) and the conditions under which exemptions may be granted (art. 7). In any charging zone, pedestrian areas may be established in which vehicles access shall be prohibited or restricted (art. 12). The Controlled Vehicular Access (CVA) system in Valletta, which was launched on the 1st of May 2007 forms an integral part of the Maltese Government's commitment to increase accessibility in the Capital City.

As for Mdina, access has been restricted by the Mdina (Regulation of Access and Transit of Vehicles) Regulations and 2004 (S.L.65.27)[35]. These Regulations prohibit access to vehicles, other than karrozzin (carriage drawn by a horse) within the city at any time, in any street or square. S.L.65.27 also regulates the exemptions (art. 3) and temporary access through permits granted by the Mdina Local Council (art. 4).

Poland
In Poland, access regulation schemes have been implemented in Krakow and Gdansk.

The Regulation of the Minister Infrastructure on 'periodic traffic regulations and prohibition of certain types of vehicles on the road of 31 July 2007', in particular, related to the ban on the traffic of vehicles on definite time.

In Krakow, The City Council adopted a transport policy with the Resolution XVIII/225/07 City Council on 4 July 2007. The Policy set the reduction of traffic as a goal to be achieved through limited traffic and parking zones (*strefy ograniczonego ruchu i parkowania*), parking fees and the implementation of the new traffic arrangements in the city centre[36].

In the centre of Krakow, there are three limited traffic and parking zones:

- Zone A prohibits vehicle traffic and is designated only for pedestrians and cyclists;
- Zone B gives priority to pedestrians and the maximum driving speed should not exceed 20km/h. Parking is permitted only in designated areas;

- Zone C where parking time limitations for vehicles are not obligatory. Parking cards can be purchased at kiosks, post offices, the City Hall of Krakow, and from traffic wardens patrolling parking zones.

The information boards D-44 signal entrance to the zone where parking fees are collected. Parking fees are enforced using parking cards or subscribed parking permits. Parking cars in these zones without payment of parking fees is prohibited, except in the case of vehicles belonging to person or organizations granted free access and parking public transportation vehicles in designated areas. Parking cards are forms filled out individually and may be purchased at kiosks, post offices, commercial facilities marked with special icons, and from patrolling traffic wardens. Parking cards may also be ordered at the Parking Zone Office; subscribed parking permits can only be obtained at the Parking Zone Office. The addressed zones and the related fees are set the City Council Resolution XXXII/268/03 of 26 November 2003[37].

Portugal
In Portugal, several cities have already adopted an access regulations scheme. The Portuguese Highway Code provides for temporary or permanent traffic regulations of certain vehicles and related sanctions (art. 10). Moreover, the regulations have to be preceded by public communications.

Romania
In Romania, several cities have already adopted an access regulations scheme. The Romanian Highway code regulates vehicles access in pedestrian area (art. 192): only residents and vehicles providing public services "from door to door" can access in the addressed area.

City councils approved UVARs schemes focused mainly on charging issues. By setting the fee contents, most of the city or local council decisions address also areas, vehicle types and time slots regulations.

Slovakia
According to the available information on the national legal basis, UVARs scheme are implemented only on temporary basis (e.g. road maintenance, construction, etc.).

There is no special programme for access regulations for urban freight transport in the Slovak Republic[38].

Slovenia
The Slovenian Road Transport Act[39] does not include specific provisions for traffic regulations.

As for urban freight transport, regulations are adopted at the municipal level in order to control the transport in a specific city centre. At city level, municipal authorities regulate transport based on their own decrees. As for Ljubljana, the Decree on Road Traffic Regulation provides for regulation of traffic[40].

Spain
In Spain, the municipalities introduced UVARs schemes mainly to reduce congestion in city centres rather than environmental or cost related aspects.

According to the Spanish Constitution[41], municipalities could autonomously manage their respective interests (art. 137). The Law 7/1985[42] established areas in which municipalities exercise jurisdiction, including traffic management of vehicles and people on urban roads (art. 25, paragraph 2b) and the Law on Traffic and Road Safety[43] detailed among the powers of municipalities the closure of urban streets if needed (art. 7, paragraph f)[44].

There is no legal basis for the access regulations schemes at national level; Councils set legal rules at local level. As for Madrid, three access regulations schemes had been implemented (*Áreas de Prioridad Residencial – APR*): APR Embajadores, APR Letras and APR Cortes. For instance, the objectives of Decree[45] for such access regulation schemes of Letras and Cortes were to establish areas boundaries, access conditions and functioning. A new vehicle categorisation was recently agreed at national level. It is likely to serve as a basis of the establishment of UVARs across the country.

[1] Sadler Consultants, Low Emission Zones in Europe for ADEME, final report, 2011.
[2] Court of Justice Case 120/78.
[3] 509 registered in the urbanaccessregulations website.
[4] The CLARS Platform and the www.urbanaccessregulations.eu website provides support to both stakeholders in terms of a single portal for information, registration and payment for UVARs, and for city authorities to spread and share best practice, guidance and experience.
[5] So far UVARs have been mainly focused on the first two aspects. However, they are likely to be increasingly used as part of the toolkit to achieve the last two.
[6] ISIS & PwC (2010) Study on Urban Access Restrictions (TREN A4/103-2/2009). Rome.
[7] The description of other approaches at MS level is presented in Annex.
[8] According to the "Stimulering schone vrachtauto's en milieuzonering", signed by the Dutch government, municipalities and other stakeholders.
[9] It is worth mentioning that in Stockholm first a trial phase was carried out, then it was evaluated and then a referendum took place to ask citizens whether they wanted the UVAR scheme.
[10] Diesel or gas Euro 3 vehicles matriculated in Sweden within eight-year time; Euro 4 vehicles until the end of 2016 or for eight years from the time of their matriculation in Sweden; Euro 4 vehicles with retrofitted engines until the end of 2016; Euro 5 vehicles with retrofitted engines until the end of 2020; Euro 5 vehicles or EEV until the end of 2020 or for eight years from the time of their matriculation in Sweden; Gas or ethanol vehicles; Euro 6 vehicles with retrofitted engines. All non-commercial historic heavy goods vehicles are exempted from the provisions.
[11] DEFRA, 2007, The Air Quality Strategy for England, Scotland, Wales and Northern Ireland. Available at https://ukair.defra.gov.uk/assets/documents/reports/cat07/0803180937_DA_AQ_Inventory_Report_2005.pdf
[12] Local Air Quality Management Practice Guidance 2 Practice Guidance to Local Authorities on Low Emissions Zones, February 2009. Available at https://laqm.defra.gov.uk/assets/pb13577laqmpracticeguidance2090216.pdf
[13] The Scottish Government, Edinburgh (2015) "CLEANER AIR FOR SCOTLAND. THE ROAD TO A HEALTHIER FUTURE". Available at: http://www.gov.scot/Resource/0048/00488493.pdf
[14] ISIS & PwC (2010) Study on Urban Access Restrictions (TREN A4/103-2/2009). Rome.
[15] COWI-ECORYS (2014) Feasibility study: European city pass for low emission zones. Annex A: Standards and Guidance Document. European Commission, DG Environment. Available at: http://urbanaccessregulations.eu/european-union-policy.
[16] Treaty on European Union, Consolidated versions 2012/C 326/01 (OJ No. 2012/C 326/01). http://eur-lex.europa.eu/JOHtml.do?uri=OJ:C:2012:326:SOM:EN:HTML.
[17] Full information on all schemes can be found on the CLARS website (www.urbanaccessregulations.eu), which ensures that information is available and reduces any FoM issues, by ensuring that vehicle operators can find out where schemes are.
[18] Sadler Consultants, Low Emission Zones in Europe for ADEME, final report, 2011.
[19] As in the case of the Dutch lorry LEZs, foreign vehicles are exempted – which is legally allowed; but such an exemption would not be allowed for national vehicles where foreign vehicles are affected.
[20] European Court of Justice Case 120/78 whose ruling stipulates that "a regulation applying to both imported and to domestic goods that produces an effect equivalent to a quantitative import restriction is an unlawful restriction on the free movement of goods.
[21] The following section has been developed levering on the contents of: COWI-ECORYS (2014) Feasibility study: European city pass for low emission zones. Annex A: Standards and Guidance Document. European Commission, DG Environment.
[22] For further explanation see document Vehicle Types, Exemptions and (Cross-border) Enforcement of Successful UVAR Schemes across Europe Non-binding guidance documents on UVAR schemes N° 2/6).
[23] EUCARIS is the EUropean CAR and driving license Information System, https://www.eucaris.net/.
[24] DECEMBRE 1975 - Arrêté royal portant règlement général sur la police de la circulation routière et de l'usage de la voie publique (M.B. 09.12.1975). Available at http://www.code-de-la-route.be/wet.php?wet=1
[25] Law for the Roads. Available at https://www.mvr.bg/NR/rdonlyres/8714091D-3F2D-4C6E-9544-90BA1F8D2C9C/0/04_Law_Trafic_EN.pdf
[26] Commission for Integrated Transport, 2006, World review of road pricing: Phase 2 - final report. Available at http://cfit.independent.gov.uk/pubs/2006/wrrp/wrrp2/03.htm.
[27] Estonian Traffic Code (Liikluseeskiri). Available at http://www.legaltext.ee/en/andmebaas/tekst.asp?loc=text&dok=X50043K1&pg=1&tyyp=SITE_X&query=traffic&ptyyp=I&keel=en
[28] Estonian Traffic Act (*Liiklusseadus*). Available at http://www.legaltext.ee/en/andmebaas/tekst.asp?loc=text&dok=X50012K5&keel=en&pg=1&ptyyp=I&tyyp=SITE_X&query=traffic
[29] Code de la route (Section 3 : interdictions et restrictions de la circulation) 1er janvier 1996 (mis à jour le 18 mars 2010) Prévention des risques. Avalable at http://www.legifrance.gouv.fr/

[30] ΠΡΑΞΗ ΝΟΜΟΘΕΤΙΚΟΥ ΠΕΡΙΕΧΟΜΕΝΟΥ (ΦΕΚ Α΄ 181/16.09.2009). Available at http://www.athens-recycling.com/gr/component/content/article/35-news/81-fekcar2009

[31] Dublin City Council, New traffic management scheme for College Green comes into effect on July 27th. Available at http://www.dublincity.ie/PRESS/DCCPRESSPACKS/Pages/NewtrafficmanagementschemeforCollegeGreencomesintoeffectonJuly27th.aspx

[32] CIVITAS, MIRACLES Project Deliverable D 4.2 REPORT ON EVALUATION RESULTS Annex 4 – 2nd Implementation Report for Cork, Version N°4.0 31st March 2006. Available at http://www.civitas.eu/sites/default/files/d_2_2-annex_-_implem_report_2_-_cork_v4_0.pdf

[33] The Italian Highway code (Legislative Decree No. 285 April 30, 1992 amended) consists of 245 articles. It is accompanied by a Regulation implementation that includes 408 articles and 19 appendices. The Highway Code came into force on 1 January 1993. Available at http://www.aci.it/index.php?id=61

[34] Subsidiary Legislation 65.31 Vehicle Access Zones (Control) Regulations 1st May, 2007. Legal Notice 105 of 2007, as amended by Legal Notices 408 of 2007 and 269 of 2008; and Act XV of 2009. Available at http://www.justiceservices.gov.mt/DownloadDocument.aspx?app=lom&itemid=9213

[35] Subsidiary Legislation 65.27 Mdina (Restriction of Access and Transit of Vehicles) Regulations 13th July, 2004 Legal Notice 359 of 2004, as amended by Legal Notices 329 of 2005 and 408 of 2007 and 269 of 2008; and Act XV of 2009. Available at http://www.justiceservices.gov.mt/DownloadDocument.aspx?app=lom&itemid=9210

[36] BIP, Polityka transportowa. Available at http://www.bip.krakow.pl/?sub_dok_id=19585

[37] Uchwała nr XXXII/268/03 Rady Miasta Krakowa z dnia 26 listopada 2003 r. Available at http://www.bip.krakow.pl/_inc/rada/uchwaly/show_pdf.php?id=17657

[38] BESTUFS, DELIVERABLE D 2.2 Best Practice Handbook (Year 2006), Theme 3: Control and Enforcement in Urban Freight Transport, Theme 4: City Access Restriction Schemes. Available at http://www.bestufs.net/download/BESTUFS_II/key_issuesII/BESTUFS_BPH2.pdf

[39] Zakon o Prevozih v Cestnem Prometu Neuradno Prečiščeno Besedilo (ZPCP-2-NPB1). Available at http://www.dz-rs.si/index.php?id=101&vt=7&sm=k&q=Zakon+o+prevozih+v+cestnem+prometu&mandate=-1&unid=UPB|503636466CA0F147C125753500486333&showdoc=1

[40] BESTUFS, DELIVERABLE D 2.2 Best Practice Handbook (Year 2006), Theme 3: Control and Enforcement in Urban Freight Transport, Theme 4: City Access Restriction Schemes. Available at http://www.bestufs.net/download/BESTUFS_II/key_issuesII/BESTUFS_BPH2.pdf

[41] Spanish Constitution of 29 December 1978. Available at http://www.servat.unibe.ch/icl/sp00000_.html

[42] Ley 7/1985, de 2 de abril, Reguladora de las Bases del Régimen Local. Available at http://noticias.juridicas.com/base_datos/Admin/l7-1985.html

[43] Texto articulado de la Ley sobre Tráfico, Circulación y Seguridad Vial aprobado por RDL 339/1990. Available at http://noticias.juridicas.com/base_datos/Admin/rdleg339-1990.html

[44] Dirección General de Tráfico, TEMA 37 el la circulación urbana: su regulación. Competencias de los municipios. El peatón y su comportamiento: circulación de peatones por vías urbanas e interurbanas. Pasos para peatones. Prioridad de paso de los vehículos sobre los peatones: excepciones. Problemas específicos de las zonas escolares. Available at http://www.dgt.es/was6/portal/contenidos/documentos/la_dgt/recursos_humanos_empleo/oposiciones/TEMA_037.doc

[45] Official Gazette of the Community of Madrid - No. 71, Wednesday 25/03/2009. Available at http://www.madrid.org/cs/Satellite?blobcol=urlordenpdf&blobheader=application%2Fpdf&blobkey=id&blobtable=CM_Orden_BOCM&blobwhere=1142537192339&ssbinary=true

ANNEX 5: Evaluation and Assessment of Urban Vehicle Access Regulations (UVARs) schemes

Glossary

CBA = Cost-Benefit Analysis

EC = European Commission

ERMES group = European Research on Mobile Emission Sources group

LEZ = Low Emission Zone

LTZ = Limited Traffic Zone

PT = Public Transport

SUMP = Sustainable Urban Mobility Plan

UVARs = Urban Vehicle Access Regulations

CHAPTER I – Introduction

The number of European cities implementing urban vehicle access regulations (UVARs) schemes is constantly growing. In addition to the high degree of urbanisation, new trends such as e-commerce (i.e. change in number and size of deliveries and trips to town centres) are contributing to further growth in the demand for urban transport. This rise in demand, together with an associated increase in congestion and its costs and environmental impact is expected to lead to more urban vehicle access regulations. Schemes, such as Low Emission Zones (LEZs) or Public Habituation Zones), can be valuable instruments to help meet local air quality and quality of city life (i.e. liveable cities) targets. In this framework, *"Among the regulations implemented in Europe very few have been comprehensively and independently evaluated. There is a lack of understanding of what works and what does not work and which access regulations are the most effective. To improve urban accessibility and make effective use of urban transport infrastructure there needs to be a better understanding and evaluation of the broad range of impacts of access regulations".*[1]

There is a need for harmonised procedures to monitor and evaluate the implementation progress and impacts of UVARs schemes so that objectives can unambiguously be defined, the most suitable indicators from different indicator options selected, reliable data collection campaigns outlined, and baselines identified against which outcomes of access regulations can be compared. A systematic approach to indicator selection should be pursued to analyse impacts, development and implementation progress and to ensure a strict link with access regulations scheme objectives. An evaluation plan needs to be defined at the beginning of the UVAR scheme development so that a plan for data collection becomes an integral part of any access regulations scheme implementation.

Stakeholder engagement is essential during a UVAR scheme's development and implementation. Users, residents and local businesses and other civil society organisations as well as motorists and professional drivers on one hand, and pedestrians and cyclists on the other, play an increasingly important role and need to be involved at an early stage as potential barriers and enablers will vary between different stakeholder group interests. Consequently, process evaluation should be part of any evaluation process to allow for reflection on new issues arising, to detect problems in a timely way and to identify potential successes and the need for scheme readjustment. Early public dialogue and the consideration of the political side in representative democratic environments are crucial to be successful.

The provision of updated information and monitored findings to local stakeholder groups, policy and planning decision makers and potential funding bodies can help to demonstrate the different benefits of an access regulation scheme that it will deliver to stakeholders and the local community. The timely dissemination of relevant and accurate data at appropriate stages of the process to inform the public can help to reduce any unexpected reactions from interest groups.

Assessments can be key to identify the most effective types of access regulations schemes, ensure an effective scheme is designed and modified once in place where needed, to gain stakeholder support and to compare with other schemes elsewhere.

Many methods and tools for evaluation and assessment of urban policy measures are already in place at local, regional, Member State and EU level and there is a broad range of good practices outlined elsewhere. Modern tools and technologies can also provide access to a wider range of

data. Thus, further guidance is required to make the best use out of these resources and ensure a systematic evaluation of UVAR schemes.

The European Commission's Directorate-General for Mobility and Transport (DG MOVE) has commissioned the publication of a set of six Non-Binding Guidance Documents (NBGDs) to support local authorities planning to introduce an access regulation scheme. While there is obviously no one-size-fits-all approach for such UVARs schemes, commonly applicable solutions to shared challenges and concerns can be found leading to a sharing of best practices for the benefit of city governments, citizens and stakeholders across Europe, including business, industry and civil society.

Within this set of six non-binding guidance documents on UVARs, the present publication provides an overview of the Evaluation and Assessment of Urban Vehicle Access Regulations (UVARs) Schemes. The purpose of this document is to outline the overall structure and framework for potential assessment, and draw from good practice to provide inspiration and a high-level guidance for UVARs evaluation.

CHAPTER II – The Challenges

More and more European cities have become interested in planning and implementing transport demand management strategies based on controlling vehicle access to dedicated urban areas. UVARs schemes vary considerably in scale, character and aims but generally have objectives to address environmental or congestion problems. Other objectives may relate to improving the physical environment (liveability, well-being) in cities, increasing safety for pedestrians and cyclists as well as enabling the prioritisation of public transport and soft modes (i.e. walking and cycling). Access regulations schemes will often involve varying degrees of change to the city environment and control regimes and these may impact access for emergency vehicles, motorised deliveries, taxis, visiting coaches, residents and visitors arriving by car. Access controls may involve charging and complex systems will require sophisticated enforcement measures. To understand the outcomes achieved by implementing such a diversity of access regulations schemes, a comprehensive and coherent approach to evaluation is necessary.

Evaluation of any UVARs scheme is essential to determine whether it has met its objectives, to help refine and improve scheme delivery and to provide evidence for continuing support of the scheme. Evaluation not only allows for a feedback on the effectiveness of the UVARs scheme but it also helps to determine whether the chosen type of UVARs is appropriate for the city development, whether there are any issues with its implementation and support and whether there are any ongoing concerns and potential conflicts that need to be resolved when implementing the scheme. The evaluation process has then to be designed in such a way that it is able to identify the detail of any changes needed to optimise the UVARs scheme over time.

A correct allocation of evaluation resources is also crucial to perform a sound assessment. This translates in appropriately considering the scale of potential impacts rather than the cost of the evaluation of the UVARs scheme itself. With this aim, it must be noted that while the impact of a scheme is often related to its physical or operational scale, sometimes even very small UVARs schemes may result in considerable changes involving both positive and negative effects. These are often related to changes in network conditions. Thus, for a small scheme with a low cost of implementation which results in substantial impacts, the costs of a comprehensive and effective evaluation may be significantly higher than the cost of the implementation of the scheme itself. However, there is an understanding that assessments and the resources they require need to be proportional to the scheme and city. What might be practical, affordable or feasible for a large controversial scheme in a large city may not be appropriate for a small more standard scheme in a small town. Also, the more controversial the scheme, the more assessment is generally required.

Evaluation involves a broad spectrum of stakeholders such as public administrations, businesses and civil society organisations as well as those whose responses to the scheme are the primary target of the evaluation. Some stakeholders perceive UVARs schemes negatively because of their physical (i.e. restriction of free movement) or financial impacts. Therefore, within the evaluation activities, it is fundamental to develop early outcomes for dissemination to all stakeholder/interest groups which have to use consistent indicators/metrics for the long-term evaluation findings. This because it is important that concerns are addressed at an early stage within the assessment process where possible and that stakeholders are engaged in the evaluation process and made aware of evaluation results as soon as possible. This is essential for transparency, which will then improve the acceptance of the UVARs measure.

It is absolutely essential to provide feedback to stakeholders once the UVARs scheme evaluation has been completed. Besides, another approach may foresee to involve stakeholders already in the evaluation design, in order to address concerns among stakeholders already at a very early stage and negotiate potential conflicts at the normative level. Dissemination of the results and co-creation of the evaluation design and selection of indicators used for the assessment will help garner further support for the scheme if it is successful and help gain support for the introduction of similar initiatives elsewhere. If the scheme has been unsuccessful or only partly successful, it is important to share this so that weaknesses or relevant issues are considered appropriately regarding similar interventions including the question whether or not to introduce such actions. Crucial is then the identification of the most appropriate timing and format and audience to disseminate UVARs outcomes. This is particularly important for schemes with long-term benefits and a high level of acceptability.

To guarantee that all relevant information and data is collected and irrelevant data excluded, the evaluation plan has to focus on the main goals of the UVARs scheme. The measure objectives need to be clearly defined in order to be able to develop an effective evaluation plan. This should be done in the context of a long-term strategy defined at city master plan level. UVARs schemes can have a number of objectives and implications such as reducing traffic congestion, reaching environmental targets, increasing the liveability and life quality in cities, increasing awareness on and possible adoption of alternative modes of transport (e.g. public transport, walking and cycling) or raising funds to enhance the quality of local transport. The objectives of each UVARs scheme should be clearly defined taking into account better regulations principles and subject to cost benefit/cost effectiveness analysis; this may include the analysis of social and environmental costs and cost reductions with implementing a UVARs scheme.

It is important to select the most suitable indicators to measure impacts once objectives and the likely extent of the effects of a particular UVARs scheme have been identified. As there are often many indicator options to measure impacts (e.g. for congestion levels and liveability indicators), the decision on which indicators to consider is crucial for a sound evaluation within a given amount of resources allocated. Indicators must closely relate to the objectives and thus the degree to which the objectives have been reached to be determined. The set of indicators to be considered should then guarantee a minimum level of relevance (i.e. have a significant importance for the evaluation process), completeness (i.e. the set of indicators should consider all aspects of the system/concept under evaluation and allow a systemic perspective), availability (i.e. readily available for entry into the monitoring system), measurability (i.e. the identified indicators should be capable of being measured objectively or subjectively), reliability (i.e. clarity of definition and ease of aggregation), familiarity (i.e. easy to understand) and independence (i.e. small changes in the measurements of an indicator should not impact preferences assigned to other indicators within the evaluation framework).

An assessment of a UVARs scheme will be undertaken prior to implementation as part of the process of scheme definition. The appraisal process to estimate potential impacts ex-ante will provide clarity of objectives and a background of understanding of likely levels of change which can be used to specify an evaluation plan. It can be expected that such an appraisal process could benefit from a co-creation process made together with relevant stakeholder groups to negotiate conflicting interests and gain a joint understanding of which indicators to be selected and prioritized at an early stage.

It is then important to undertake an assessment prior to implementation which estimates and projects potential impacts sufficiently to define an effective evaluation plan in order to suitably manage the potentially large behavioural changes.

It is essential to gather and project data before (ex-ante) and after (ex-post) the measure is implemented to guarantee an effective and coherent assessment of the scheme.[2] This allows for a direct comparison of both situations. The ex-post situation provides a final set of evaluation measurements which can be compared to a 'do-nothing' or 'business-as-usual' scenario to assess the effectiveness of the UVARs measure implemented. During the ex-post assessment, particular attention should be given to avoid overemphasizing highly visible and evident barriers and drivers while underestimating the more complex ones.[3] Hence, the development of a sound baseline against which change can be measured is particularly important.

In this framework, two different types of data can be used: data already available for analysis (e.g. ticket sales, statistics on issued fines, traffic counts and public transport passenger surveys) and data that needs to be specifically collected.[4] It is then mandatory not to rely entirely on existing data which is not tailored specifically to the assessment of UVARs scheme impacts, especially where these do not cover the data requirements and it may be advisable to add additional data collection methods as part of the preparation of the scheme where possible. Consequently, it should not use irrelevant information where completeness, accuracy and relevance cannot be guaranteed.

Mobility data can relate to either individual/collective private/public transport or commercial transport. For both types, the information to be collected can be behaviour-related and/or movement related. Behaviour-related data is typically collected by interviews or questionnaires but can also be gathered by direct observation (e.g. of drivers at access gates). Statistically sound behavioural data can often be used to better understand why monitored changes have occurred. This can be particularly useful to separate UVARs effects from those of other urban mobility policy and planning measures.

In most cases, a UVARs scheme is only part of the urban mobility and development planning of a city, which usually has many different interventions to improve urban mobility, citizens' liveability and city well-being. An important challenge in undertaking impact evaluation of a UVARs scheme is the ability to demonstrate that the observed outcomes and impacts are an outcome of the scheme, ruling out the influence of other initiatives or local, regional or even national policy measures (e.g. national/regional scrapping schemes and LEZs). There are a number of ways to achieve this. One method is by contextualising the results within the spatial study area. When estimating the effect of a group of policy and planning measures having similar main objectives and existing in the same spatial area, differences in the timing of implementation of the various measures may help to identify the contribution of each measure to goal achievements, as can comparing with similar cities without UVARs. A city can also decide to implement a UVARs just within a 'pilot area' to assess the potential impacts during the trial and decide whether to extend the scheme at city level, if this can have appropriate and scalable impacts.

When a scheme is implemented, there may be a short-term settling-in period followed by longer-term change. The immediate effects can be measured following the settling-in period. This short-run evaluation may be followed by longer-term evaluations. Short-run as defined in this document covers one year or the UVARs scheme duration and uses data before and after the implementation of a measure. Long-term evaluation activities are carried out after the project's initial funding has expired e.g. by carrying out a CBA or a lifecycle analysis) or involve

time series data collection over several years (e.g. by ongoing surveys or regular long-term effect surveys). Long-term evaluation can then enable a comparison between long-term and short-term impacts of the measure. This is essential for UVARs schemes as impacts in the short-term could be considerably different in the long-term because of potential 'rebound effects'. This concerns for instance the perception of low enforcement leading to low compliance, a charge being accepted rather than having a deterrent effect, a charge or emissions standard that is not increased/tightened becoming less effective, poor measure support and upkeep or changes in background conditions (legislation) as well as cases in which positive impacts are only measurable in the long-term. For a sound evaluation, an appropriately long-term evaluation/monitoring plan has to be set up.

In both short and long-term situations, it is important to capture and investigate what has actually happened over time since the scheme was launched. However, it is highly likely that other measures will have been implemented in the city in parallel which will have changed the context within which the scheme is considered. This is making the evaluation more complex and such context issues need to be identified and taken into account. Examples include changes in public transport services/fares and regarding parking measures. For a good assessment, it is necessary to open the perspective and capture the detail of the contextual changes and their relationship to the UVARs scheme.

Lastly, there are several key issues related to impacts that have to be considered in the particular context of UVARs schemes.

From an environmental and climate perspective, effects of UVARs schemes on local air quality or in reducing GHG emissions are important driving factors in a decision-making process to introduce regulation on urban access. Thus, the choice of environmental indicators is crucial to correctly consider local regulation concerning air quality and GHG emission issues. Also, a change in road and parking capacity requirements to create space for other urban land use change (e.g. public open space) and to enhance green infrastructures (e.g. trees helping to protect local biodiversity) can be considered to be associated environmental benefits together with the potential for reduced noise pollution. As environmental outcomes often rely on changes in traffic conditions, there can be a clear link between transport and environmental indicators. This is similar for liveability and quality of life indicators for cities. Visions of liveable cities are commonly related to less motorized vehicles and increased public space in urban environments.

Within the local and regional context, understanding the accessibility outcomes of mobility and transport policies and investments is an increasingly important issue. Institutional settings are more and more under scrutiny and a neutral and multi-disciplinary assessment of them has to be performed including representatives of different stakeholder groups. Significant social and socio-spatial equity concerns strongly influence a UVAR scheme's acceptability and questions concerning the proper role for different user groups and on an appropriate allocation of any collected resources are growing.

Social and socio-spatial equity can be investigated along three different dimensions: horizontal, vertical and longitudinal equity. Horizontal equity is about opportunities for user groups who in other respects are equal. Vertical equity deals with impacts on user groups that are unequal, e.g. regarding the financial resources they have available, particularly for those who are worse off after the introduction of a UVAR scheme because they have for their travelling relations no adequate public transport solutions available. Longitudinal equity is related to the difference between the present and past situation, means before and after the motorized vehicle access restriction.

In the case of a congestion charging scheme, vertical and longitudinal equities are often considered as the two most critical equity dimensions. That is why the equity effects of congestion charging are often an important part of public scepticism to the implementation of UVARs schemes. Therefore – as stated by Eliasson and Mattsson (2006) – analysis of equity effects has to be carried out for specific cities and city regions, and specific congestion pricing and refund schemes to be able to draw any conclusions on the equity effects of congestion pricing, for example for persons who have to daily commute from work to home.

Considering socio-economic effects, reductions in travel time and improvements in travel time reliability are often the most direct and tangible effects of UVARs schemes. Less congested roads lead to more flexibility for travellers and cost reductions for businesses depending on motorised vehicle access. On the other hand, lower health-care expenditure may occur because of improved local air quality and increasing attractiveness for active mobility like walking and cycling is an example of indirect or co-benefits of a UVARs scheme strategy. Gains in travel time may also be translated into other benefits such as public transit volumes or the conversion of road capacities to other transport modes (e.g. cycling) that may also produce local public health benefits. The effect of UVARs schemes on retail businesses within the area of application of the regulation is of outmost importance in the assessment. Walking shopping areas have a potential to prosper as a result of demographics, increased gas prices, public policies encouraging higher densities and changing life style preferences.[5]

Air quality impacts are also affected by other causes than direct vehicle emissions so short term assessments are difficult and care needs to be taken when identifying the air quality impact of the individual UVARs. The same applies to the choice of pollutant chosen to be monitored (e.g. emissions or concentrations, PM_{10}, Black Carbon, $PM_{2.5}$, NOx or NO_2 as well as the vehicle fleet characteristics). On the other hand, with cities in Europe meanwhile exceeding at numerous days a year the emission limits for NOx or particulate matter, the introduction of access restrictions, for example for diesel cars and light duty vehicles, are only a matter of time. In Germany, several cities are already being on trial due to exceeding limit values. The winter of 2016-17 saw a very large number of cities exceeding the daily limit values for particulate matter and NO_2. Increasing numbers of these cities have been implementing temporary UVARs during times of high pollution, or predicted high pollution. These include voluntary or mandatory bans, temporary LEZs with standards between Euro 1 and 6.

Ideally the appraisal of UVARs schemes is based on sound (social) CBA where all the different benefits (travel time savings, reduced emissions, liveability, etc.) and costs (investment and operating costs) are defined and monetized. In addition, co-benefits can be measured, for example the increase of active mobility by making cycling and walking more attractive while restricting motorized vehicle access. The potential reduction of social and environmental costs can be similarly factorized and introduced into the cost analysis. However, such calculations are often complex and time consuming and may not be practically feasible within each UVARs scheme's implementation.

Finally, in many cases, the objectives of a UVARs scheme are formulated also in terms of improvements in traffic conditions. Hence the effects should be considered by using transport-related indicators such as reductions in queues and time delays. This should include their weighted severity, congestion indexes, average travel speed, changes in traffic volumes both across the UVARs boundaries and concerning the whole network, modal shift, change in vehicle-kilometres travelled and average travel distances.

CHAPTER III – Available options

Many options exist to carry out a sound evaluation of urban mobility measures such as UVARs schemes. The type of evaluation to be conducted depends on a number of factors. These include the objectives of the evaluation itself as well as the objectives of the specific UVARs scheme being evaluated. The type of methodology chosen may also depend on resource constraints while the aims of the UVARs scheme will determine how best to carry out the evaluation as it will focus on assessing the extent to which the scheme's objectives have been met. Where the comprehensiveness of an evaluation is limited by the available resources, a simple and well-designed evaluation should nonetheless be conducted. This can be as powerful as a more complex one.

Regardless of the evaluation methodology adopted, the indicators selected in most cases should satisfy the following criteria:

- *Reliability*: clarity of definition and ease of aggregation
- *Familiarity*: the indicators should be easy to understand
- *Non-redundancy*: different indicators should not measure the same aspect of an assessment criterion; and
- *Independence*: the measurement of an indicator should not impact preferences assigned to other indicators of the impact evaluation model. Nonetheless, it might be useful having two slightly different ways of measuring particularly difficult data to assess sensitivity, particularly where data is not as extensive or certain as would be ideal.

Familiarity and Independence can be an issue for stakeholders. However, some metrics may be difficult to understand or sufficiently explain but useful for UVARs scheme development, especially where data is uncertain.

The SMART methodology is often applied to assess each indicator in an objective and quantified way. Such an approach requires the selected indicators to be[6]:

- Specific: evaluating exactly the mobility aspects which are relevant for sustainable mobility
- Measurable: with sufficient accurateness, based on existing or easily collectable data in order to create a methodology which is applicable for cities of varying size, region or development, have the capability of detecting relevant changes in sustainability, both positive and negative in a time-based way allowing a frequent update in order to monitor the evolution of sustainable mobility measures
- Complete: covering the whole range of sustainable mobility including all relevant types of mobility users, transport modes, mobility impacts etc.
- Technology neutral: not excluding or monopolizing specific solutions; and
- Scalable: as indicator evaluation, must be independent from city size, most indicators are relative to population, the geographical and spatial area, etc.

The following are some of the most used and well-recognised methodologies to assess the impacts of UVARs schemes:

CIVITAS Evaluation Framework[7]

The CIVITAS Initiative brings together cities that have or are implementing sustainable urban transport policy measures. One of the main aims is to achieve a significant change in the modal split towards more sustainable transport modes, thus providing cleaner and better transport in cities. Evaluation is fundamental to understand the nature and extent of impacts resulting from the measures. This means that evaluation outcomes can also be consulted by other cities.

The CIVITAS methodology takes into consideration both impact and process evaluation. Impact evaluation proves changes related to an intervention which was designed and realised to reach a formulated goal. Such evaluation seeks to answer cause-and-effect questions by looking for the changes in outcome that are directly attributable to the measure. The results of the impact evaluation should identify the degree to which the stated goals have been reached so useful information for decision making can be provided. Based on the UVAR's results, the decision to extend the scheme to other city areas, to keep it as it is or modify it can be documented by evidence.

Process evaluation is intended to identify and assess the positive and negative factors which have influenced the measure's implementation process. It should identify barriers such as overlapping situations or unpredictable events standing in the way of achieving the measure's objectives and drivers welcoming effects stimulating or amplifying positive outcomes of the UVARs scheme implemented. Thus, it can provide information useful to improve the project as under field conditions unforeseen situations and unexpected behavioural responses can shape measures and change initial strategies in a way that is anything but trivial.

The CIVITAS evaluation framework consists of a number of core criteria and indicators. The main strength of this approach is that this list of core indicators can be accompanied by local (case-specific) indicators, e.g. jointly developed with stakeholders. This allows project-specific details to be considered in the overall evaluation. Within the evaluation framework, both impact and process evaluations are described. Once potential impacts have been identified, a suitable set of indicators is selected to quantify potential measure's effects. CIVITAS Plus II is using a set of 31 indicators gradually developed through the previous editions of the CIVITAS initiative during which more than 200 sustainable mobility transport measures have been assessed in cities across Europe.[8]

The chosen indicators belong to one of the five impact areas considered by the CIVITAS evaluation framework including one or more criteria under which the indicators are allocated (see Table 1). An advantage of this approach is the large body of related evidence already collected. A disadvantage is that it assumes that the economic impacts are only benefits and costs. Unfortunately, it does not include an important element in the economic assessment, which is “losses” (retail businesses, including HORECA).

Table 1: CIVITAS Impact areas and related criteria

	IMPACT AREAS				
	Economy	**Energy**	**Environment**	**Society**	**Transport**
CRITERIA	• Benefits/losses • Costs	• Energy consumption	• Pollution/ Nuisance • Resource consumption	• Acceptance • Accessibility • Employment • Equity • Health • Security	• Quality of service • Safety

This methodology foresees the participation of all kinds of stakeholders involved in transport at city and project level.

"Access Restriction for Freight Vehicles in Brescia (IT)": a CIVITAS MODERN project measure[9]

In the historic centre of Brescia, the pedestrianisation of main historical squares with a substantial reorganisation of freight movement by means of access regulations has been carried out to reach a higher environmental quality and liveability in the city.
In order to monitor the measured outputs information on load factors and the frequency of accesses to the historic centre has been collected during its implementation. The data has been used to understand whether freight operators have rationalized their deliveries by optimizing vehicles' capacities and reducing the frequency of accesses to the historic city centre.

Figure I: Pedestrianization and restrictive measures implementation in Corso Mameli

The main impact has been represented by 18%, 14.5% and 2.5% decreases in the number of vans, trucks and articulated lorry deliveries respectively *(Source: CIVITAS MODERN, Final Evaluation Report, 2012)*. Moreover, the load factor increased by 12% *(Source: CIVITAS MODERN, Final Evaluation Report, 2012)*. Additionally, the data collected by the LTZ cameras showed that the pedestrianization and the regulatory measures have contributed also to a reduction of 9.2% in the number of private passenger cars accessing the historic city centre. Stakeholder acceptance of the new local freight distribution centre created in parallel with the freight access regulation has been assessed through a survey circulated

among the 15 most important commercial freight operators in Brescia. The results confirmed the growing interest of local freight operators in developing an innovative urban freight distribution centre to avoid traffic congestion within the historical city centre.

The TIDE Approach[10]

The TIDE evaluation approach allows the assessment of measure impacts on a flexible set of quantified and qualitative effects which in turn allows measures to be compared to the business-as-usual case or for different measures to be compared.
Key characteristics of the TIDE assessment method are the following:

- It is intended for municipalities to assess a policy and planning measure's impact in a holistic way (economic, social and environmental effects)
- It combines quantified and qualitative effects into an overall performance score
- It is primarily intended for ex-ante assessments and estimates, but also applicable to ex-post evaluations
- It can include economic viability indicators when data is available and allow for it
- It can be applied to urban transport policy and planning measures with different impacts and scales (investment, affected area etc.)
- It is not intended to displace more sophisticated assessments usually applied to large-scale projects; and
- It allows the visualisation of large range of impacts.

The TIDE approach is characterised by eight implementation steps, namely:

1. *Describe project and alternatives:* The planned project and alternatives including the reference (Business-As-Usual) case are described. The assessment details (e.g. the period assessed) are determined.
2. *Identify effects and indicators:* The effects on which measures should be assessed and the performance–indicators of these effects are identified. The TIDE impact assessment method uses two main categories for effects: quantifiable effects (e.g. local air pollution, investment and operating costs, revenues etc.) and qualitative (in case of impossible or too difficult measurement in quantitative terms).
3. *Impact assessment:* The magnitude of each effect selected in step 2 is determined for Business-As-Usual, the proposed scheme and any alternatives.
4. *Normalisation:* The performance figures are converted into relative numbers.
5. *Effect weighting:* The importance of the effects is defined by a weighted value.
6. *Visualisation and interpretation:* Final scores for each measure are calculated from the normalised performance and weighting value which can be displayed in graphs.
7. *Sensitivity analysis:* The significance of individual effects is assessed to test the effect of less–reliable assumptions/values.
8. *Communication of results:* The results and key information about the assessment process are communicated to the decision makers.

TIDE assessment process for Urban road user charging (RUC)

Implementing urban RUC systems is usually very costly. Besides the investment and operational costs, the schemes can have considerable economic effects on private and commercial transport users. Such measures usually face considerable opposition. These

points justify a detailed and arduous ex-ante assessment including economic viability indicators.

Examples of relevant assessments are readily available in literature. Several CBAs have been conducted for congestion charging schemes in European cities such as London, Stockholm and Milan. These assessments can provide information particularly in predicting the proposed scheme's impacts. While these evaluations show that many of the relevant effects can be quantified and monetised, they also show that others are difficult or impossible to quantify. Therefore, qualitative effects should be assessed in addition to the monetised effects.

Urban RUC schemes affect the local transport system in various ways. They usually reduce the traffic within the charged zone, they can shift traffic to other times of the day, induce a modal shift and/or alter route and destination preferences. Any assessment of such schemes should incorporate all different effects inside and outside the zone (see Table 2).

Another important aspect is to consider from whose point of view the assessment is made. The fees constitute a benefit for the scheme's operator, but a cost for transport users or different groups in society. Differentiating the costs and benefits by group can help to identify options available to reduce any imbalances. The TIDE assessment method can also compare different urban road user charging scheme designs (e.g. distance based vs. single entrance fee) in order to identify the optimum choice.

Table 2: Potential impacts of a road user charging scheme

Effect	Comments	Recommended data type
Travel time/ Travel time reliability	Relevance fluctuates and so does the price for/by different user groups and modes (e.g. business/private trips, goods transport). Effects inside and outside the zone should be assessed.	Quantitative
Traffic safety	Effects from altered traffic volumes and speeds can be expected. Change in mode choices and a general reduction in car usage can also have an impact on 'third parties', such as pedestrians and cyclists.	Quantitative
Local air pollution	Can be differentiated according to the individual pollutants (NOx, PM10, CO). The monetisation factor usually includes effects on human health and built environment etc. Monetisation factors may vary for urban and non– urban areas.	Quantitative
GHG emissions	Mitigation effects from modal shift or avoided trips and detours can increase emissions.	Quantitative
Noise	Relatively accurate quantitative estimates are possible. Otherwise it should be included in the qualitative assessment.	Quant./Qual.
Vibration	Can be relevant especially in areas with significant HDV traffic.	Qualitative

Residential attractiveness	RUC can affect the attractiveness and thus rents of housing in the zone. These are difficult to predict and should therefore be assessed qualitatively.	Qualitative
Commercial attractiveness	RUC can affect the attractiveness of shops and businesses within the zone.	Qualitative
Equity	Implications with horizontal equity (e.g. people living or working inside or outside the zone or having different transport needs) and vertical equity (factors related to income) can occur.	Qualitative
Investment costs	The municipality's interest depends on whether these are borne by the municipality or can be sourced out.	Quantitative
Operation costs		
Revenues and penalty payments	Assumed as a benefit for the city or private operator.	Quantitative
Taxes (e.g. fuel duties)	This affects the municipal budget.	Quantitative
Compliance costs	Includes fees and penalty payments borne by the transport user and is thus important from the users' perspective. The impact is higher on low-income households.	Quantitative
Effects on parking	Influences parking space utilisation and consequently the revenue from parking, charging etc.	Quantitative
PT use	Influences public transport revenues, its occupancy rate and the need for additional vehicles.	Quantitative
Modal Share of walking and cycling	New infrastructure investments might be required. Increasing their share might also be an objective for the city.	Quantitative

Source: TIDE Impact Assessment Handbook

In addition to the potential set of impacts identified for road user charging schemes by TIDE, the effects outside the immediate zone of such schemes application should be considered. Among others, the potential rebound effects can be represented by a redirection of traffic to other routes/zones that are not charged, or longer driving distances as banned vehicles try to bypass these zones.

Additional urban indicators currently used

As highlighted by the CH4LLENGE project, systematic monitoring and evaluation increases the efficiency of the planning process and implementation of measures, helps to optimise the use of resources and provides empirical evidence for future planning and appraisal of transport measures.[11] Consequently, the choice of indicators is an essential step in order to achieve a cost-effective monitoring and evaluation process. CH4LLENGE foresees five indicator categories,[12] namely:

1. Outcome Indicators: measuring the actual impacts for the SUMP objectives.

2. Transport Activity Indicators: intermediate outcome indicators of instruments describe changes in the transport system and can be related to the success of strategies.
3. Output Indicators: measuring the extent to which policy instruments have been implemented and services improved.
4. Input indicators: providing information on the amount of resources required for delivering the plan, including cost. These indicators help to provide transparency on the plan implementation and allow an evaluation of the resource effectiveness.
5. Contextual indicators: giving information on external developments that have an influence on the successful implementation of SUMPs.

Table 3: Example for different indicator categories

SUMP Element		Measured by	
Objective	Reduce local air pollution from transport	Number of days exceeding critical air pollution levels	Outcome Indicator
Strategy	Increase use of non-motorised modes	Share of walking and cycling trips	Transport Activity Indicator
Instruments	Build segregated cycle lanes Pedestrianise city centre shopping street	Km of segregated cycle lanes built % completion of pedestrianisation of city centre	Output Indicators
Resources	Investment and maintenance costs	Transport investment and maintenance costs for new / improved infrastructure	Input Indicators

[Source: Monitoring and evaluation – Assessing the impact of measures and evaluating mobility planning processes, CH4LLENGE project]

At global level, under the frame of Sustainable Mobility Project 2.0[13] (SMP2.0) and following successful implementation of SMP2.0 process in Bangkok, Campinas, Chengdu, Hamburg, Indore, Lisbon, the World Business Council for Sustainable Development (WBCSD) has created a globally applicable tool to support cities developing fact-based and integrated sustainable urban mobility plans based on 19 sustainable mobility indicators.
Such indicators provide cities with a practical tool to constitute a fact-based and holistic diagnosis of their mobility system, monitor its evolution over time and evaluate the impact of selected solutions. They are presented as a comprehensive set spanning four dimensions of sustainable mobility. Three of the four dimensions are inspired by the pillars of sustainable development and refer to sustainable resource use and the impacts of mobility in cities:

1. Global environment
2. Quality of life in the city
3. Economic success

The fourth dimension has been added to consider the performance of the mobility system itself in the city:

4. Mobility system performance

The research carried out within SMP2.0 has resulted in the following set of 19 indicators:

1. Affordability of public transport for the poorest group
2. Accessibility for mobility-impaired groups
3. Air polluting emissions
4. Noise hindrance
5. Fatalities
6. Access to mobility services
7. Quality of public area
8. Urban functional diversity
9. Commuting travel time
10. Economic opportunity
11. Net public finance
12. Mobility space usage
13. Emissions of greenhouse gases
14. Congestion and delays
15. Energy efficiency
16. Opportunity for active mobility
17. Intermodal integration
18. Comfort and pleasure
19. Security

CBA and Cost Effectiveness, MCA and MAMCA Methods

Cost-Benefit Analyses (CBAs) are widely used to assess transport projects or measures, especially in the case of large–scale infrastructure projects. In a CBA, the project's impacts are expressed in monetary terms and the costs and benefits are compared using specific economic viability indicators such as Benefit–to–Cost–Ratio (BCR) or Net–Present–Value (NPV). These indicators demonstrate the economic efficiency of the measure considered. A CBA relates the measure impacts to those of a reference case (such as the Business–As–Usual) to demonstrate whether the measure will result in net benefit or not. A weak aspect of CBAs is the extensive data needed and the uncertainties surrounding the monetary value of some factors as all effects need to be quantified and monetised.

Another common form of economic evaluation is the Cost Effectiveness Analysis. This approach entails the total cost of actions to be evaluated alongside a defined outcome to produce a cost-effectiveness ratio. The assumption in Cost Effectiveness Analysis is that the objectives of interventions being compared are adequately captured in the measure of the outcome used.

Cost Effectiveness Analysis is closely related to Cost-Benefit Analysis since both represent economic evaluations of alternative resource use and measure costs in the same way. CBA is however used to address only those types of alternatives where the outcomes can be measured in terms of their monetary values. Before starting the cost analysis, it is necessary to know about the availability of cost data, how to measure effectiveness, which alternatives are being considered and what their effects are.

Choosing the appropriate type of economic analysis for the needs of the particular scheme will depend on the available economic and human resources and the aims of the evaluation. Taking quality of life into account is a powerful measure for the evaluation of schemes aiming at lowering congestion and GHG emissions where improvement in citizens' health may be an outcome.

Multi-Criteria Analyses (MCAs) are gradually becoming well-recognised methods for transport project assessments. The approach is based on the scoring, ranging and weighting of quantitative and qualitative effects and is typically used for choosing the best measure from a range of possibilities. The method makes it possible to assess difficult–to–quantify effects or to monetise effects by assigning them weighting values and performance scores drawn by experts and/or decision makers or stakeholders. In that way, MCA provides a good opportunity for stakeholder engagement.
The MCA is mainly organised into the following phases:

- Phase 1: Definition of the projects or actions to be judged
- Phase 2: Definition of judgment criteria
- Phase 3: Analysis of the impacts of the actions
- Phase 4: Judgment of the effects of the actions in terms of each of the selected criteria
- Phase 5: Aggregation of judgments

Table 4: CBA and MCA comparison

	CBA	MCA
When	Primarily ex-ante and possibly ex-post	ex-post and ex-ante
Where	Primarily large scale	Micro-scale
What	Quantifiable and measurable "hard" effects	Perception of the effect, including "soft" ones
Why	Efficiency	Effectiveness
How many	Single criterion and result	Multiple criteria and indicators
Priority/Ranking	Output (support to decision makers)	Input (integration of decision maker's preferences)

Source: Comparing cost benefit and multi-criteria analysis: the evaluation of neighbourhoods' sustainable mobility", Beria, P., Maltese, I., Mariotti, I.

Stakeholders' involvement is of importance when the effects of an access regulation scheme have to be assessed. To this end, the multi-actor, multi-criteria analysis (MAMCA[14]) offers a methodology to focus the discussion among stakeholders. Based on a detailed analysis of each stakeholder group, the MAMCA shows an evaluation of the different possible alternatives from the perspective of each stakeholder. It uses the stakeholders' objectives as the criteria for the evaluation. Hence, it is possible to clearly identify the alternatives that receive the most support from the different actors.

The MAMCA provides a step-by-step approach applicable for a thorough evaluation of urban mobility projects. Stakeholders' preferences are taken into account in the evaluation at each stage of the decision process, thereby increasing the chances of success of any initiative. Not only business-as-usual and the demonstration are assessed but also various possible future scenarios to identify the parameters that determine whether a concept is appealing to a stakeholder or not.

Air pollution assessment[15]

The latest EU Directive on Ambient Air Quality and Cleaner Air for Europe (2008/50/EC) defines legally binding limit values for the most hazardous pollutants, including NO2 and PM10. Member States transposed this directive into national legislation and annually report air pollution levels to the EU. In case of elevated pollution levels an action, plan needs to be prepared to ensure reduction of pollution levels and compliance.

One of the main objectives of UVARs schemes is to improve human health by reducing exposure to harmful air pollutants such as fine particulate matters (PM_{10} and $PM_{2.5}$) and nitrogen dioxide (NO2). According to the European Environment Agency, the single main source of these pollutants in many urban areas is road traffic. LEZs in particular are established to reduce the number of older, more polluting vehicles within problem areas and to accelerate the share and use of cleaner vehicles. This includes either newer vehicles that comply with more stringent vehicle emission standards and/or older vehicles that have been retrofitted with emission reduction technology such as particulate filters.

Both help to significantly reduce tailpipe emissions and, thus, lower direct exposure to hazardous air pollutants in inner cities. However, in some cases drivers may reorganise their trip by circuiting the LEZ instead of replacing their vehicles or shifting transport modes which ultimately puts the strain on other areas, however this has in practice rarely been observed and avoiding through traffic is generally advantageous for city centres where LEZs are usually implemented. This largely depends on the LEZ scheme design and size. Conversely, the cleaner vehicles wanting to enter the LEZ also often travel from or through the surrounding area, with a positive impact on the air quality of the surrounding area.

The Berlin "Umweltzone"[16]

Due to exceeding thresholds of PM10 and NOx in the inner-city Berlin developed a clean air action plan to tackle emission reduction. Within this context, a "Umweltzone" (environmental zone) was established in 2008 to reduce pollutant emissions from road transport.

Effects from the emission of diesel soot and nitrogen oxides

Based on the changes of the fleet mix – determined by annual licence plate surveys – the impact of the low emission zone on the emission of pollutants was calculated. The same total mileage per vehicle category was assumed for each year, but it was allocated to the changed proportions of the different emission standards in each year. Retrofitting with particulate filters, in so far as is known, was not taken into account. However, the data on this was incomplete, as pertinent information from the licensing authority in Berlin about the retrofitting was available only for vehicles registered in Berlin that hold an 80 % share

of the vehicle fleet on the road, whereas the technical information on vehicles not registered in Berlin was delivered by the Federal Motor Transport Authority, which was not able to provide data about retrofitting with diesel particulate filters. In addition to emissions of the actual fleet, which was determined by the licence plate survey, emissions of a trend scenario without a low emission zone were calculated as well.
For the whole fleet, and thus the road traffic in Berlin, stage 1 of the low emission zone showed a decrease of 24 % in soot emissions in the first year and a decrease of 32 % in the second year compared to the trend development without a low emission zone. With the 2nd stage, the emission of pollutants decreased by 173 tons from 299 tons per year (trend development) to 126 tons per year in 2010. This means 58 % less soot particles compared to the trend without low emission zone, and 40 % less compared to the 1st stage having an emission of pollutants of 424 tons in 2009. The emission of nitrogen oxide was also reduced by the low emission zone. With the 2nd stage, approximately 1,517 tons of nitrogen oxide compared with the trend development and 424 tons compared with stage 1 were avoided. The reduction of emissions was achieved by the modernisation of motor vehicles and trucks in equal proportions. This shows the importance of involving motorcars in the low emission zone regulation.
Despite exceptional authorisations, the reduction potential of the 2nd stage was exceeded by about 88 %.

Effects on air quality

Evaluating the impact of the low emission zone on the air quality is based on studies regarding the change of the $PM_{2.5}$ share of source groups from 2007, which is the year before the introduction of the low emission zone. It is furthermore based on the evaluation of data on air quality for PM, NO and also carbon-based particles being a characteristic constituent of diesel engine emissions.
The evaluations revealed, with regard to particulate matter PM10, that without the existence of a low emission zone, the mean annual value for 2010 would have increased by about 2 µg/m3 respectively 7 %. By implementing the low emission zone were avoided 10 exceedance days of the 24-hours limit value on roads. Owing to the low emission zone, the nitrogen dioxide pollution for roads decreased by about 5 %. The decrease in traffic-related incremental pollution caused by soot particles is a significant improvement for human health, as they are an especially toxic source of particulate matter. This incremental pollution on roads decreased by more than 50 %. Due to the low emission zone, the traffic-related pollution for residents on main roads was significantly reduced. Thus, the level of pollution continues to approach the level of the urban background.

The Quiet Zones and the Naples LTZ Case[17]

The strong increase in urbanization and the related traffic congestion has produced problems regarding air and noise pollution. In a recent European Environment Agency report,[18] it is estimated that at least 100 million Europeans are exposed to road traffic noise levels detrimental to health on a daily basis. In European cities with populations of more than 250,000 inhabitants, more than 62% of the population are exposed to long-term average road traffic noise levels exceeding 55 dB L_{den} (i.e. Day-evening-night equivalent level measured in decibels: A-weighted equivalent noise level, measured over the 24 hour period, with a 10 dB penalty added to the levels between 23.00 and 07.00 hours and a 5 dB penalty added to the levels between 19.00 and 23.00 hours to reflect

people's extra sensitivity to noise during the night and the evening) and more than 42% of people in the same urban areas are exposed to long-term average road noise levels higher than 50 dB L_{night}.[19]

The new concept of Quiet zone (Q-zone) – an area where a low level of traffic noise is guaranteed by the reservation of access only to low noise vehicles[20] – is becoming accepted by local people. The difference with conventional UVARs schemes is that in these zones each vehicle has to meet clear acoustic requirements to be considered adequate for access.

In such regulated zones, vehicles allowed to enter should not exceed a certain noise emission level. In this framework, electric vehicles or engine / vehicle size, stop-start technology, low rolling resistance of tyres and hybrid technology are all examples of technical features that vehicles could be used for quiet access regulation zones, if enforcement mechanisms are in place.

In 2013, the Second University of Naples (Caserta, Italy) carried out a study to analyse possible variations in the sound levels and in the subjective soundscape perception as a consequence of the implementation of a LTZ in the historic centre of Naples (Figure II, left).

The study was based on the comparison between campaigns of objective measurements and subjective survey (Figure II, right).

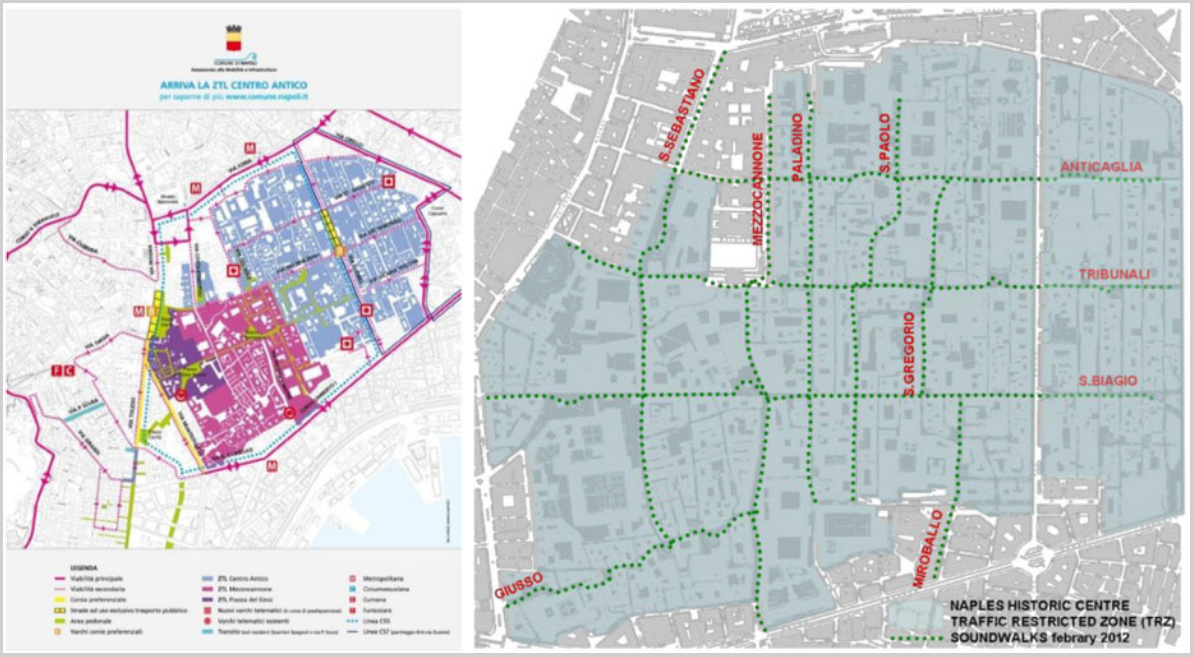


Figure II: Naples Historic Centre LTZ (left), soundwalks' paths 2012A, 2012P, 2013P (right) (Maffei et al., 2013a).

The first campaign of objective measurements concerned the sound levels before the introduction of the LTZ (2012A). The second and the third ones were carried out immediately after the implementation of the LTZ (2012P) and one year later (2013P) (Figure, right). The results show that after a short period in which a reduction of the environmental sound level was experienced, the noise increased again (Figure III).

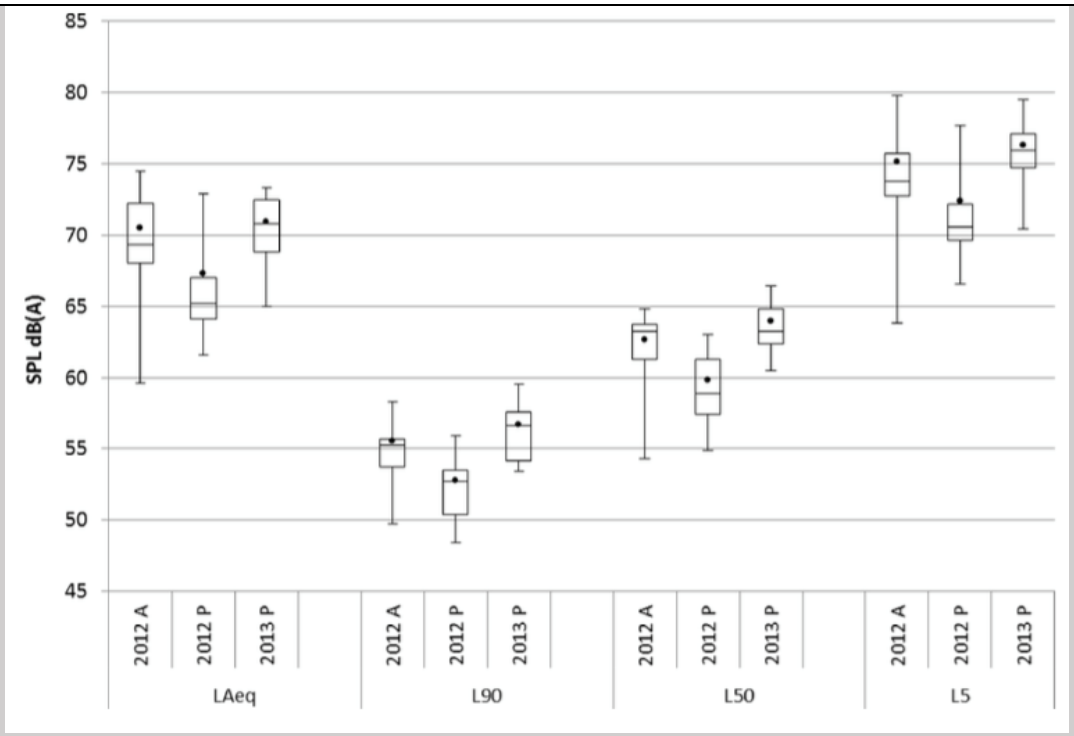


Figure III: Variation of the equivalent and percentile levels for the entire soundwalk over the years (Maffei et al., 2013a)

A possible explanation of this trend could be an insufficiently restrictive policy for vehicle access by the municipality (e.g. increased number of electric vehicles and HDV allowed at any time of the day causing road surface noise and too many temporary permits issued). The subjective surveys supported this interpretation. The noise level deteriorated between 2012 and 2013. Moreover, the percentage of people not noticing any sound variation due to the LTZ increased from 17% to 45%. The differences between the ex-ante and ex-post condition were probably more evident to people interviewed shortly after the introduction of the scheme while perceptual drift could have occurred over time.

This experience on traffic noise abatement measure turns out to be a useful example to consider for avoiding a deterioration of good results achieved in the short term. To this end, besides noise specifications for vehicles authorised to enter the Q-zones, noise reduction techniques, such as low noise tyres and low noise road surfaces may be implemented in the zone in order to fully achieve the main goal of noise reduction.

Then to assess the achieved noise decrease, a proper noise testing method considering the actual driving conditions and providing the basis to evaluate new propulsion technologies like hybrid and pure electric vehicles needs to be foreseen. In this framework, the European Automobile Manufacturers' Association (ACEA) gave a proposal on new vehicle subcategories and new limit values in August 2010[21] based on the new collected monitoring data from ECE R51 method, based on ISO 362:2007, which was prepared by WG42, a joint workgroup of ISO TC43/SC1 "Noise" and ISO TC22 "Road vehicles" and amended by WP29 in 2007 to be implemented in Directive 2007/34/EC.[22]

CHAPTER IV – Potential Impacts of a Common Approach for UVAR Evaluation and Assessment

A common approach to UVARs evaluation has benefits for the local implementation and on the national as well as international levels. A common framework providing overarching e.g. indicators, requirements of the evaluation, under which good practice aspects was identified as appropriate for the city and scheme.

At a local level, the use of a well-structured and widely agreed approach to evaluation will provide a sound and credible outcome. This credibility may be important for the long-term acceptance of a UVARs scheme by clearly identifying the scale and distribution of impacts geographically, operationally and across stakeholder/user groups. It will also enable any issues to be identified which could be addressed to improve the performance of the scheme against its objectives. The adoption of a common good practice approach will provide outcomes which are more convincing for local action groups who may have a negative view of the UVARs scheme, particularly those concerned about its specific impact on their own interests.

The ready access to media and internet communications makes the promotion of news particularly important. This applies not only for information directly targeted to local population and media, but also for publications at conferences and in journals. The latter are increasingly valuable in raising the profile of a city to attract funding and business opportunities. The credibility of results presented in such situations will be enhanced if the evaluation has followed an accepted common approach.

From a public engagement perspective, a good plan at the beginning of a participatory process may be beneficial for all participants, as it draws the main path enabling also a consensus on the process flow to be followed by all actors involved. Nonetheless, an engagement plan should be flexible and adaptable to new circumstances that stakeholders might introduce. A common professional methodology for public engagement will then be an added value for integrating feedback gained about citizens' needs for an accessible, inclusive, safe and sustainable urban mobility environment, and local information and knowledge on best practice experiences as part of an evaluation approach commonly agreed upon.

National and international legislation and guidelines are in place covering areas such as atmospheric and noise pollution as well as societal and congestion targets. All areas can be addressed by UVARs schemes. A common approach to evaluation enables the achievement of targets to be verified, both absolutely and for comparisons. The use of indicators appropriate to the schemes objectives and common approaches to their determination is particularly important. It should however be noted that the use of common indicators alone will not guarantee sound outcomes as it is crucial where and how they are measured.

The adoption of a recognised process evaluation activity should provide learning outcomes which a city could find useful in the implementation of a wide range of urban sustainability schemes. Then, a common overarching (good practice) to evaluation enables the output to contribute to a growing body of evidence on the effects of UVARs schemes. This will generate value for cities across Europe. Lessons learned from comparative analysis can only be drawn if a common approach is adopted in which indicators are measured in a similar way.

UVARs schemes vary considerably in scale, character, content and the context in which they are implemented. It is this variation which makes a common approach useful, within which the

different aspects of different schemes can be appropriately assessed and could be added to an international database for comparison. Direct comparisons in terms of what any scheme can be expected to achieve are more affected by the differences in the cities and schemes (geography, enforcement, standards, exemptions, political culture, pre-existing fleet and vehicle levels, etc.), to make these more important sources of variation than the assessment method used.

A shared approach allows being able to monitor the progress of the scheme as it develops and modify as appropriate.

A common methodology framework gives also the opportunity for best practice and innovation within the aspects set out in the common approach framework.

The interpretation of the results of a UVARs scheme evaluation may require external inputs such as the value of time or standard levels of noise acceptability. A common approach provides these.

CHAPTER V – Barriers and Enablers to a Common Approach

Barriers

The principal barriers to a common approach to evaluation and assessment of UVARs schemes arise from local circumstances that hinder the application of common practices.

- *Data quality and availability*
  One of the most common issues is insufficient, unavailable or inappropriate data upon which to base the assessment. The required data takes many forms. For example, air pollution monitoring information, emissions or activity data, noise monitoring, traffic monitoring, public transport usage, walking and cycling and local economic data. In particular, in some locations data will not have been compiled before the scheme is established making any robust ex-ante analysis impossible. Good scheme design requires it to be based upon excellent baseline information. But sometimes this is simply unavailable and the urgency to introduce the scheme or limited budgets make sufficient data collection impossible. Where data is unavailable, it is often impossible to follow common approaches to evaluation and assessment that can be extremely data demanding.

- *Cumulated effects due to other initiatives in place*
  Even where data is available, it is sometimes difficult to evaluate the impact of the scheme separately from existing local trends. For example, if a central shopping district is receiving a downturn in trade as a result of expanding e-commerce, it may be impossible to disaggregate these effects from those of a UVARs scheme without a long-time series of data from before the introduction of the regulation. In these situations, it may be possible to use a common approach to evaluation and assessment.

- *Short vs. long term effects assessment*
  Similarly, there is often an urgency to assess the short-term effects of a regulation leaving insufficient time for rebound and other effects to fully develop. This makes comparison of the effectiveness of a scheme with those that have been in operation for a long time impossible. Once a scheme has been in place for several years, there may also be some reluctance amongst local politicians and officials to undertake a comprehensive evaluation. This can be out of concern that such an assessment might expose an existing scheme generally accepted as effective to be less effective than planned or simply to avoid further discussion based on political disagreement. Specifically, when new evidence that could be used by stakeholders that were critical towards the scheme. For this reason and because of budgetary constraints, it may be impossible to secure local buy-in or resources to perform an evaluation of a scheme in a way consistent with common best practice should it be demanding concerning resources.

- *Local data vs. 'default data'*
  Another commonly overlooked barrier is whether to use local data and information or widely used common "default data" within the assessment. For example, any assessment of the air quality impacts of a scheme will rely on the use of emission factors from which it is possible to estimate the emissions from individual vehicles and model the effect of traffic on air quality. Additionally, it is advisable to consider also other PM emitters, the breaking system and tyres of all circulating vehicles. But emission factors are estimates

and subject to uncertainty. The most common emission models rely on data from the ERMES group[23] but there is often disagreement between individual practitioners on the optimal factors. For example, ERMES has not yet revised emissions factors for NOx from Euro 6 diesel cars despite widespread evidence these are presently significantly underestimated. If a local assessment was to use higher factors based on current knowledge or even better local measurements, this may represent best practice but not a common approach. Similarly, the widely used common assessment methods mentioned in this publication are all robust methods but could be improved and tailored for local circumstances.

- *Loss of data during changes at the top*
  Projects often undergo change in ownership from the phase of planning to the phase of construction/execution, and to the phase of continued operation. Therefore, it is important to focus on transfer of background material and data within the organizational framework in order to both obtain and store relevant data (ex-ante as well as ex-post) and convey the need of evaluation and assessment.

- *Additional benefits not foreseen*
  It may be that the scheme has additional benefits not envisaged at the outset, and therefore not in the previous assessments or indicators.

Enablers

The most important enablers for a common approach to evaluation and assessment are:

1. Availability of data to perform the assessment and evaluation
2. Political will and buy-in
3. Adequate budgets and resources for scheme assessment; and
4. Identification of a suitable common assessment method.

- *Availability of data*
  Data issues are discussed above but are a key prerequisite to be able to apply standardised assessment methodologies. While in the absence of local data default information can be used, this may adversely affect how accurate the local assessment is concerning the impact of the scheme. In such instances, a more accurate assessment may be achieved by avoiding the use of data intensive assessment approaches and adopting a greatly simplified local approach suited to the information and time available.

- *Political will and buy-in*
  One of the key challenges for any evaluation will be to assess the scheme against its initial objectives. While best practice should have defined the objectives, the assessment may find this not clear. A key enabler is therefore to ensure the initial scheme design as well as that assessment and monitoring has also followed established best practice. In many cases, may be rather unclear what the best practice is. Best practice remains an issue of context and has to be negotiated among different stakeholder interests in the local environment. Such stakeholders and public engagement at an early stage is a success factor for later implementation. Where this is not the case, it may be difficult to determine whether goals have been met. A common approach involves a wide range of stakeholder groups in a clear structured way and leads to more widespread ownership of the measure and the evaluation of the results.

- *Adequate budget and resources*
  As mentioned above, having the resources and support to perform a scheme evaluation and assessment is often one of the principal challenges. Securing buy-in and budgets to perform such assessments as part of the original process of designing the scheme is therefore important. This will also help to ensure that the data needed to perform the assessment is available. If funds are allocated from revenues raised for the assessment before the scheme enters into force, it will be much easier to ensure adequate resources than after the event.

- *Identification of most suitable assessment methodologies*
  One of the key challenges is to select one of the standard approaches outlined in this document that best suits the local needs. Making a choice as part of the scheme design process can be beneficial, particularly in identifying the data that will be necessary to perform the evaluation. Designing the scheme in a way consistent with best practice will also facilitate best practice assessment and evaluation.

CHAPTER VI – Summary of recommendations

Evaluation is critical to the successful development of individual UVARs schemes: *ex ante* evaluation is necessary to support the decision and planning process while *ex post* evaluation must provide evidence on the extent to which the scheme objectives addressed by the UVARs scheme have been achieved and support the identification of possible improvement areas and the corresponding policy and planning measures.

Each scheme deserves its own, custom tailored evaluation system: as discussed in this guidance document, devising the most appropriate UVARs scheme depends on the scheme objectives and on the overall policy and planning context, on political prioritisation and preferences, on the resources available, on technological and organisational choices, on availability of data and in general on the specific characteristics of the UVARs scheme itself.

Nevertheless, a common approach to devising UVARs evaluation concepts would facilitate the adoption of best practices to both improve UVARs schemes in general and facilitate comparability. A best practice common approach would look particularly into the following areas:

- In the evaluation and assessment of UVAR schemes, local municipalities should pay attention to:
    - The **selection of evaluation indicators**, and on how to concretely measure them.
    - The **minimum data requirements** for a meaningful evaluation process and related outcomes.
    - The relation between the **scale of expected impacts** and the **resources allocated** to the evaluation.
    - The establishment of a **baseline (or "do nothing" scenario).**
    - The **application of a cost and benefit analysis** including economic and social impacts of the proposed measures on the local economy and businesses.
    - The **distinction** between the evaluation of the concrete UVARs scheme and that of the long-term strategy defined e.g. at city master plan level.
    - The **assessment of synergic effects** between UVARs and other urban mobility policies and measures.
    - The **engagement of stakeholders** from the outset to jointly select and prioritize evaluation criteria allowing to negotiate conflicting interests at an early stage.
    - The **transparency** ensured by regular communication and dissemination (notably to users and other involved stakeholders) of the evaluation results.
- The **engagement of the broader public** at an early stage by dialogue beyond dissemination of evaluation outcome in a responsible way.
- Assessments should be **neutral** and be done preferably by an independent body to avoid that the assessment of a scheme is performed by the same organisations who are responsible for its successful implementation.

[1] COMMISSION STAFF WORKING DOCUMENT A call for smarter urban vehicle access regulations Accompanying the document COMMUNICATION FROM THE COMMISSION TO THE EUROPEAN PARLIAMENT, THE COUNCIL, THE EUROPEAN ECONOMIC AND SOCIAL COMMITTEE AND THE COMMITTEE OF THE REGIONS Together towards competitive and resource-efficient urban mobility – SWD/2013/0526 final.
[2] "CIVITAS INSIGHT – Long-Term Evaluation in CIVITAS", CIVITAS Insight N°11, May 2016.
[3] "Framework for Evaluation" CIVITAS POINTER, McDonald M., Richard Hall R., Van de Lindt M., Emmert S., (2009).
[4] "Evaluation matters: A practitioners' guide to sound evaluation for urban mobility measures", Dziekan, K., Riedel, V., Müller, S., Abraham, M., Kettner, S., Daubi, S. – Waxmann Lehrbuch (2013).
[5] "Business Performance in Walkable Shopping Areas", Hack G. – Robert wood Johnson Foundation, Technical Report (November 2013).
[6] "How to Monitor Sustainable Mobility in Cities? Literature Review in the Frame of Creating a Set of Sustainable Mobility Indicators", Gillis, D., Semanjski, I., Lauwers, D. – December 2015.
[7] "CIVITAS WIKI – Coordination, evaluation and dissemination of CIVITAS PLUS II", Van Rooijen, T. and Nesterova, N. (2013).
[8] "Applied framework for evaluation in CIVITAS PLUS II", CIVITAS WIKI – Coordination, evaluation and dissemination of CIVITAS PLUS II, May 2013.
[9] http://www.civitas.eu/content/access-restrictions-freight-vehicles
[10] "TIDE Impact Assessment Handbook: Practitioners' handbook for cost benefit and impact analysis of innovative urban transport measures" [http://www.tide-innovation.eu/]
[11] http://www.sump-challenges.eu/content/monitoring-and-evaluation
[12] "Monitoring and evaluation Assessing the impact of measures and evaluating mobility planning processes", CH4LLENGE – Addressing Key Challenges of Sustainable Urban Mobility Planning project, March 2016.
[13] http://www.wbcsd.org/Projects/smp2
[14] The model is based on research undertaken by Prof. dr. Cathy Macharis, developer of the Multi-Actor Multi-Criteria Analysis methodology. The state of use applications of the approach is reported in several research papers. See, e.g., MACHARIS, C., TURCKSIN, L., & LEBEAU, K. (2012). Multi-Actor Multi-Criteria Analysis (MAMCA) as a tool to support sustainable decisions: State of use. In: Decision Support Systems, vol. 54(1), pp. 610-620.
[15] "Low Emission Zone (LEZ). Vehicle Travel Restriction to Improve Air Quality in Inner Cities", GIZ, 2014.
[16] "The Environment and Consumer Protection: One Year Low Emission Zone, Stage 2 in Berlin – Analysis of the effect on emissions from road traffic and on the air quality in Berlin", Senate Department for Health, 2011 Berlin.
[17] "Electric Vehicles and Urban Noise Control Policies", L. Maffei, M. Masullo, Department of Architecture and Industrial Design – Second University of Naples, Archives of Acoustics – IPPT Vol. 39, No. 3, pp. 333–341 (2014).
[18] European Environment Agency (2014), Noise in Europe 2014, EEA Report No 10/2014.
[19] European Environment Agency (2012), The contribution of transport to air quality TERM 2012: Transport indicators tracking progress towards environmental targets in Europe.
[20] The new concept of quiet zone (Q-zone) has been defined within the City Hush project that proposed a new acoustic classification of the urban areas (from the quietest class, class A, to the noisiest class, class E) based on the exterior noise levels of vehicles [http://www.cityhush.eu/].
[21] "Monitoring procedure in the vehicle noise regulation – Final report", ACEA, 27 August 2010.
[22] "Noise criteria for vehicles to enter Q-Zones", CITYHUSH project, 2011.
[23] http://www.ermes-group.eu/web/who_we_are

ANNEX 6: Technology options and interoperability for Urban Vehicle Access Regulations (UVARs) schemes

Glossary

ANPR	Automatic Number Plate Recognition
ASECAP	Association Européenne des Concessionnaires d'Autoroutes
CEN	Comité Européen de Normalisation
DSRC	Dedicated Short Range Communication
EC	European Commission
EETS	European Electronic Toll Service
EFC	Electronic Fee Collection
ETC	Electronic Toll Collection
ETSI	European Telecommunications Standards Institute
EU	European Union
GIS	Geographical Information System
GNSS	Global Navigation Satellite System
GPRS	General Packet Radio Service
GPS	Global Positioning System
GSM	Global System for Mobile
ICT	Information and Communication Technologies
ISO	International Organisation for Standardization
ITS	Intelligent Transport Systems
LEZs	Low Emission Zones
OBU	On-Board Unit
OCR	Optical Character Recognition
RFID	Radio Frequency Identification
UVARs	Urban Vehicle Access Regulations
V2I	Vehicle to Infrastructure
V2V	Vehicle to Vehicle
ZTLs	Zone a Traffico Limitato (Limited Traffic Zone)

CHAPTER I – Introduction

This NBGD on 'Technology options and interoperability' is meant to provide an overview of technological options, both current and likely to be developed in the near future, for the implementation of UVARs schemes and their interoperability. In such a context, interoperability of UVARs schemes in Europe may have a technological as well as a spatial/geographical dimension.

The technological interoperability of a specific option relates to the capability to comply with different UVAR activities; for example, to detect vehicle types, to allow for payment methods, to set period of operation, e.g. night or specific day time slot, etc.

The spatial/geographical interoperability deals with the capability of technological options to operate at different scale (urban, regional, national or European).

The implementation of UVARs schemes primarily deals with a limited geographical scale (urban scale) and therefore pursuing technological interoperability represents a key interest to local government.

The range of technological options supporting UVARs scheme implementation has broadened considerably in recent years, for instance through the further development of global positioning systems and mobile technologies. It is reasonable to expect that this trend will continue. Technological options unveil indeed new opportunities in terms of easing operating characteristics e.g. making methods of payment and access available on-line, via web site registration.

However, despite the greater opportunities from technological development, the selection of the most appropriate technology still relies on trading-off a considerable number of factors.

They range from the extent and types of roads to be covered, the types and numbers of road users to be charged or enforced to emergent data protection and privacy issues. The most sophisticated technological solutions as GNSS-GSM based technologies raise technical challenges in urban areas, e.g. precision of localisation in urban canyons.

The main objective of this NBGD is therefore to review the relevant aspects involved in the selection of the technical solutions while supporting the different options with concrete examples on available options.

CHAPTER II – The challenges

As discussed in the NBGD on Vehicle Types, Exemptions and (Cross-border) Enforcement[1], the role of technology applications adopted in the implementation of the different types of UVARs schemes is strongly correlated with the type of UVARs schemes under examination.

The following table shows the relationship between the role of technologies and the UVARs functionalities.

UVARs functionalities	Technologies					
	Low Tech.	ANPR	RFID/DSRC	GNSS	Tachograph	Mobile Tech.
Vehicle detection, e.g. Low Emission Zones (LEZs)	√	√	√			
Charging, e.g. congestion charging	√	√	√	√	√	√

A low level of technology is used for the implementation of permit access schemes for a number of Low Emission Zones in which the low-technology identification of vehicles can correspond to stopping vehicles at the entrance of or within the regulated zone, checking a permit to enter or the vehicle emission sticker on the windscreen of vehicles or enforcing on parking cars by municipality staff. Low-technology solutions also involve urban redesign, as street and parking space redesign and boulders positioning.

There are many factors that affect the enforcement technology decision which can include practical, financial, social or political reasons. Generally, low-technology solutions may be a more favourable choice for smaller UVARs schemes with fewer vehicles and high-technology options for larger and more complex UVARs schemes with more vehicles as well as charging schemes.

At the same time, high technology may be associated to toll rings or cordon-based schemes entailing some degree of automation through for example automatic number plate recognition (ANPR) or fully automatic electronic charging schemes and vehicle identification techniques as, for example, LEZs in London and the Netherlands or over 200 ZTLs in Italy.

Focusing on the UVARs scheme characterised by an important role of technology, five types of technologies can be identified[2], four of which (the no. 1, 2, 3 and 4in the list below) are relevant in urban areas:

1. Automatic number plate recognition cameras (ANPR)
2. Dedicated short-range communication (DSRC)
3. Passive radio-frequency identification systems (RFID tags)
4. Satellite positioning (GNSS) coupled with mobile communications (GSM)
5. Digital tachograph

Overview of technological options

1. Video cameras or ANPR (Automatic Number Plate Recognition) are widespread technologies utilizing fibre optic or broadband to convey information from roadside cameras to a hub site where information is processed. They do not require on-board units (OBUs) and costly roadside equipment. In terms of enforcement, a potential limit is the lack of harmonisation of vehicle license plates which can make the identification of the vehicle problematic (also in presence of adverse weather conditions). However, recent and likely future technological developments may overcome these shortcomings. This technology requires vehicles to be registered in the local database before approaching the scheme. Data protection and legal issues concerning the registration of foreign vehicles and harmonisation between local and national database may arise from the application of the technology depending on the Member State. For example, in Germany the picture needs to capture who is driving, while in the Netherlands the driver may not be identified[3]. For ANPR manufacturing there are no CEN standards to date, but ISO standards are applicable.

- Example: Applications in cordon-based or area-based UVARs schemes: e.g. London, Milan, Stockholm.

2. DSRC (Dedicated Short-Range Communication) is a widely-adopted technology in Europe for electronic payments both in urban areas, trunk roads and nationwide networks, and is specifically appropriate for charging schemes rather than other UVARs scheme types, e.g. LEZs. The technology is based on radio communication between a mobile device inside the vehicle (OBU) and fixed roadside equipment. The OBU microwave technology (DSRC 5.8 Ghz) allows the tolls to be levied electronically as soon as the vehicle approaches the fixed roadside equipment without stopping. In urban areas, the most appropriate technological version of DSRC applications is the one defined as multi-lane free flow (MLFF) in which vehicles do not need to slow down to pay the toll. The association of DSRC with ANPR technologies for enforcement has become a common standard. The technology is generally not perceived as raising privacy issues despite the fact that users must save personal data stored in the OBU.

- Example: Applications in urban areas such as Florence and the Norwegian cities (e.g. Oslo, Trondheim); Trunk roads, road- and motorway networks, bridges and tunnels in roughly half EU Member States.

3. RFID (Radio-frequency) is a technological option with similar performance levels to DSRC. This technology also uses ANPR technologies for enforcement. Compared to the DSRC technologies, its main advantage is the lower cost of tags (~€1), which are stickers with inbuilt antennas that resonate the signal from the roadside equipment. The main geographical area of application is the US, with no significant applications in Europe yet (except for the access point regulation in the Mersey Tunnels and Gateway Bridge in the UK, and Turkey). The main reasons for the lack of deployment in the EU are: historical strong presence of the competing DSRC technology; lower reliability of the technology compared to DSRC, particularly in free flow and high speeds; presence of different, incompatible standards, which make interoperability harder to achieve; and, last but not least, the fact that the use of passive RFID is forbidden by the European legislation in place (Directive 2004/52/EC).

- Example: Applications on US motorways (e.g. North Carolina), Turkish motorways.

4. GNSS (Global Navigation Satellite System) coupled with GSM technology requires the interplay of four components:

1) A GNSS OBU module which allows users with a compatible device to determine their position, velocity and local time by processing signals from satellites in space;

2) A GSM module securing GPRS data communication from the OBU to the back office and vice versa; and, optionally,

3) A microwave module (DSRC transceiver) to communicate with fixed and mobile enforcement points, e.g. control gantries provided with DSRC and/or ANPR technologies;

4) Fixed and/or mobile control gantries.

From an economic point of view, this option requires less roadside equipment than DSRC/ANPR options but costs of the GNSS OBU module are higher than DSRC OBU units in the order of magnitude of a factor ten[4]. However, in the long run, GNSS-based options may prove cost-effective: the cost of GNSS+GSM OBUs is falling and the technology offers higher flexibility of the application (e.g. through the ability to update the maps) – it allows changing the UVAR's conditions (position, time, period of day) at virtually no cost.

Furthermore, interoperability of GNSS-based systems has proven to be effective both geographically and with reference to existing DSRC applications.

Data protection and data privacy may be an issue because of the relevant amount of information collected with the possibility to create individual movement profiles.

Concerning the urban areas in Europe, there are promising signals[5] from the potential use of the current improved performance in urban canyons of Galileo (the European GNSS). Several ongoing trials (e.g. in the Greater Copenhagen area) and in the past (Eindhoven[6]) show promising results. On the other hand, in the London trials carried out between 2004 and 2007 the scale and density of tall buildings and the configuration of relatively narrow streets, particularly in the City of London, prevented the level of precision location of vehicles[7]. Singapore is planning to shift the DSRC-based technology to the new Global Navigation Satellite System (GNSS)-based ERP system, which will be operational from 2020[8]. The urban road infrastructure manager interested in such a system, using also the first European Geostationary Navigation Overlay Service (EGNOS) services, lies in the possibility to distinguish areas where different rules/ pricing schemes are applied, i.e. to select roads in dense urban areas inside/ outside the UVARs area. Other interesting features are the real-time monitoring of vehicle itineraries and stops according to permits and the reliable positioning of urban regulated fleets.

- Example: From 1 January 2014, Slovakia's Skytoll system added additional 1st, 2nd and 3rd class roads (urban roads) to the GNSS-based charged network, expanding the total chargeable road network for heavy goods vehicles.
- In Brussels, HGVs pay tolls using GNSS-GSM OBUs on all streets.
- In the period from October 2010 to July 2011, the EGNOS2road (E2R) project[9] assessed the added value/ economic benefits of EGNOS with respect to the GPS for the road sector, specifically for two applications: road tolling and tracking & tracing of professional fleets. EGNOS is operational and provides three services over Europe augmenting the GPS position in terms of enhanced accuracy and integrity information: EGNOS Open Service (EGNOS OS) and EGNOS Safety Of Life (EGNOS SoL) broadcasted via the satellites' signal, and EGNOS Commercial Service (EGNOS CS) distributed to professional users through terrestrial networks via a server named EDAS. E2R key findings are that EGNOS OS generally enhances the position measured using GPS only in all extra-urban and urban environments. The two operators involved in E2R, SAT (Italian motorway) and RSM (Rome

Mobility Agency) evaluated the added value of EGNOS with respect to GPS standalone, and concluded that the benefits rely on enabling a more robust and reliable positioning.

5. Tachograph-based technology is based on an OBU connected to the vehicle odometer. The technology does not raise privacy issues and limits the roadside equipment needed to border crossings apart of the use of ANPR technologies for enforcement. On the other hand, the OBU is expensive. Since the first national application in Switzerland (2001), a certain degree of partial interoperability[10] has been reached in accordance with the CEN DSRC 5.8 GHz standards successfully implemented in Austria. However, the technology is today applied on heavy goods vehicles only and it is of limited relevance in urban areas.

- Example: Application on the Swiss road network

Trading off the technological options' characteristics

The following table focuses on the comparison between four relevant aspects (implications) for each technological option concerning their application in UVARs schemes:

- Costs
- Privacy
- Interoperability
- Enforcement

The comparison does not include low-technology options, e.g. manually enforced schemes, which are generally cheaper to implement, but can be more expensive to enforce due the employment of personnel.

Technological option	Costs	Privacy	Interoperability	Enforcement
Automatic Number Plate Recognition (ANPR)	Generally low implementation costs: no expensive roadside equipment or OBUs. However, high back office expenditures may incur due to the need to manually check all registered non-compliance events.	Vehicle driver identification may be a problem depending on Member States' legislation and vehicle database access.	There are neither European standards on ANPR, nor is there standardization concerning license plates. However, the technology has proven to be interoperable with other solutions in electronic toll collection.	This is primarily a technology for enforcement. Widely applied in UVARs and non-urban schemes. Lack of access to foreign vehicle registration databases is a major issue for enforcement
Dedicated Short Range Communication (DSRC)	The technology needs an OBU which is generally cheap. However, roadside equipment's (gantries) for tolling and	No major privacy issues are implied given that the position of the vehicle is not monitored. Personal	The technology is subject to European standardization, notably CEN and ETSI rules make the technology interoperable (e.g. with interurban tolling schemes and	This technology is primarily for data collection while ANPR technologies are needed for enforcement.

Technological option	Costs	Privacy	Interoperability	Enforcement
	enforcement is costly is particular high where a dense road network and access points are involved.	information may however be needed to operate the OBU.	commercial parking).	
RFID (Radio-frequency)	The costs are similar to the DSRC technology except for lower reliability in free flow and at high speeds and the cheaper on-board devices (RFID tags).	No privacy issues raised.	In the US, where the technology is mainly implemented, wider geographical interoperability has been reached, although the use of different standards prevents nationwide interoperability.	Roadside equipment, i.e. gantries is required. ANPR technologies are needed for enforcement
Global Navigation Satellite Systems (GNSS)	The OBU price is much higher than in the DSRC solutions.	Data protection may be an issue due to the significant required amount of information collected from the users.	The technology is potentially interoperable, although currently there is no example of an OBU that can be used to pay tolls in two GNSS-based schemes. However, GNSS OBUs provided by several actors are used in one GNSS- and many DSRC-based schemes (e.g. in Belgium – a GNSS scheme – and France, Spain, Portugal, Austria, Denmark – all DSRC.	Roadside equipment, e.g. gantries with DSRC antennas and/or ANPR cameras is required for enforcement.
Tachograph	Despite of part of the maintenance cost paid by the user, the implementation costs are high (OBUs and roadside equipment).	No data protection and privacy issues.	Some interoperability with border countries has been realized through the DSRC module in the OBU.	Enforcement gantries and ANPR still needed for enforcement.

The table shows that the final choice of the technology option for any UVARs scheme which aims to be cost-effective in the long term has to be made after trading off a certain number of factors.

In urban areas, Automatic Number Plate Recognition (ANPR) has been in service for many years. In everyday operations, it offers convenience of use and robustness and does not require OBUs (interoperability is not required). However, the cost to run such systems relative to other high-technology options may be high in consideration of the manual verification of detected offences.

Schemes combining Dedicated Short Range Communication (DSRC) with ANPR technologies for enforcement, particularly in motorways, e.g. TELEPASS, have been implemented in numerous systems for tolling motorways as well as deployed on main routes and fixed infrastructure (tunnels, bridges) in a certain number of European Member States. However, in urban areas, the need of monitoring access gantries and the presence of physical barriers due to the urban topology, make the DSRC implementation not particularly widespread (apart from Singapore and Norwegian cities).

GNSS solutions in urban areas face several challenges: firstly, additional roadside equipment needs to be installed to improve transmission signals where they are weak (e.g. in urban canyons), requiring additional investment costs. Furthermore, compared to the DSRC equipment, which has the advantage of being cheap to procure and easy to use, the OBUs required for GNSS-based schemes are still rather expensive. Another important barrier is enforcement, for in order to avoid additional investments for access gantries, the risk of high non- compliance rates is high. On the other hand, a standard OBU system across the European Union and even beyond for all motorized roadside vehicles may allow a comprehensive road user charging, road side access and capacity management, representing a potential standard component in future vehicles.

Future technological options

Other technological developments may in the future support the implementation of UVARs schemes. Among them, it is worthwhile to mention the following[11]:

- Cooperative Intelligent Transport Systems (ITS) which allow vehicles to become connected to each other, and to the infrastructure and other parts of the transport network. These systems are designed to share information and today focus on road safety and traffic efficiency but could in the future also be used for road charging or for access regulation.
- Existing in-vehicle applications such as telematics for vehicle and driver management, eCall, usage-based insurance (UBI) and different types of Event Data Recorders (EDRs).

Chapter III - Available options

This chapter focuses on the illustration of examples of different technological options implemented today in UVARs schemes in Europe. Despite the fact that technological options usually work in combination, the available options described in this chapter have been identified according to the prevailing operating technology, in order to flag examples of technological solutions representative of specific types of technologies. Namely, two types of technological solutions have been identified:

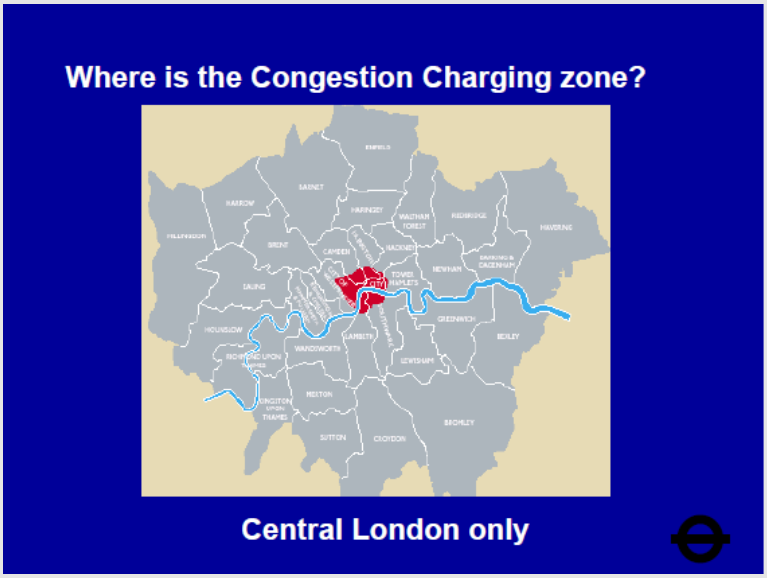
- Automatic Number Plate Recognition (ANPR)-based technologies as used in London, Stockholm and Milan;
- Dedicated Short Range Communication (DSRC)-based technologies as used in some Nordic European cities, e.g. Oslo.

The following boxes describe for each urban area the technological characteristics of the UVARs schemes while the final section focuses on lessons learned.

ANPR-based technologies

London

The London congestion charge entered into force on 17 February 2003. It was introduced by Transport for London (TfL) in February 2003, following an extensive public and stakeholder consultation and was extended westwards in February 2007. The charge was initially set at £5, then raised on 4 July 2005 to £8, £10 in 2011 and £11.5 at the time of drafting of this text. The daily charge must be paid by the registered keeper of a vehicle that enters, leaves or moves around within the congestion charge zone between 7 a.m. and 6 p.m.



Source: Steve Kearns, Transport for London "Congestion charge in London"

As stressed by Transport for London[12], there are no barriers or tollbooths. Instead, drivers are paying to register their Vehicle Registration Number (VRN) in a database. ANPR-based technologies read a vehicle's number plate as it enters, leaves or drives within the charging

zone and check it against the database of those who have paid the charge or those who do not have to pay (because they are exempt or registered for a 100 per cent discount). Once a VRN has been matched, the photographic images of the vehicle are automatically deleted from the database.
The daily charge can be paid before or on the day of travel, by telephone, text message, online and by post. Drivers have up to midnight on the day of travel to pay the £11.50 charge or £14.00 if they pay the next charging day after travelling in the zone.
The charge can also be paid via Congestion Charging Auto Pay which is an automated payment system that has a discounted daily charge rate of £10.50. Drivers need to register with TfL to pay via Auto Pay and it will automatically record the number of charging days a vehicle travels within the charging zone each month.
On 2004-2005 several technological trials were carried out by Transport for London in order to test other technological options based on a) GNSS reception (satellite positioning) b) GSM (mobile phone) and c) DSRC (tag and beacon).

Vehicles were fitted with On Board Units (OBU) which communicated with GPS satellites, identifying the location of the vehicle. OBUs needed to be permanently installed with access to a power supply in a vehicle. The units should ideally be part of the vehicle build and retrofitting of units was likely to be problematic.
It was found that the scale and density of tall buildings and the configuration of relatively narrow streets, particularly in the City of London, prevented the level of precision in locating vehicles.

Mobile telephone technology (GSM) is based on a network of cells which form the framework for communication. Generally, the denser the urban area, the smaller the cell sizes are. At that time, in London the cells sizes were not refined enough to facilitate identification of vehicles to the degree of precision that was required.

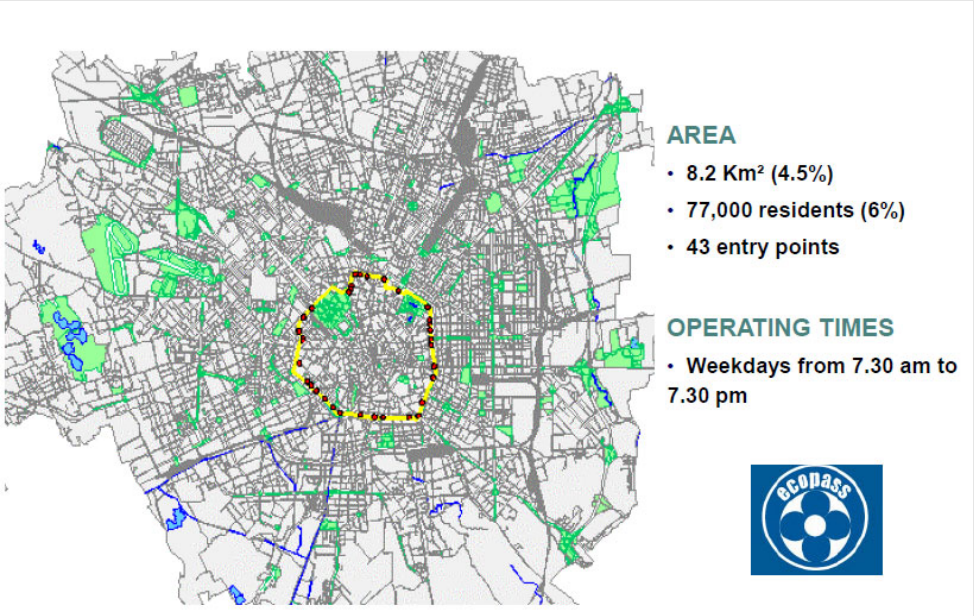
Dedicated Short Range Communication (DSRC) with tag (Transponder) & Beacon involve communication between roadside beacons and transponders placed in vehicle windscreens. Technology can be either microwave or infrared-based. Initial findings produced when DSRC was originally trialled during Stage 1 at two locations in Inner London produced encouraging results and it was decided to undertake further trials. An area was chosen where the local borough council, Southwark, was consistent with the concept of Congestion Charging. Representatives of Transport for London attended a number of public meetings to inform major stakeholders such as community and neighbourhood groups about the trials. The major critical aspect of public interest relating to the trials focused on the installation of roadside equipment in connection with the DSRC element of the trial. Due to the characteristics of the London roads, it was concluded that the installation of "gantries" (roadside equipment for tolling and enforcement) would not be considered an option.

In conclusion, some of the technological options (mobile communication and the use of satellite positioning) were considered promising, also in the light of additional pilot tests results, but not yet ready for their widespread implementation.

On the contrary, the pilot tests focused on the improvement of ANPR technologies notably by the replacement of analogue cameras with digital cameras ones and by undertaking the image processing in roadside cabinets adjacent to the enforcement cameras which provided benefits in terms of enhanced image quality. There are considerable cost savings associated with the transfer of data by broadband rather than by fibre optic transmission.

Milan

In January 2012, the city of Milan implemented a congestion charging scheme, known as AREA C. The AREA C system was designed to replace the previous scheme (ECOPASS), implemented in 2008.



Source: A. Martino "Milano: from pollution charge to congestion charge" TrT

The ECOPASS scheme was a Low Emission Zone in which vehicles were charged to enter the area and the fee structure was based on the vehicles' emission standards. The underlying technological architecture was based on the ANPR approach, which relied on 43 Closed Circuit Television (CCTV) access points installed along an area of 8.2 km². As a vehicle passed under the access points, the car number plate was matched against information stored in the national motor register database to determine the vehicle category (and emission standards) on the basis of which the charge was determined. Technical specification concerning interfaces with the national Ministry of Transportation database were defined and agreed upon.

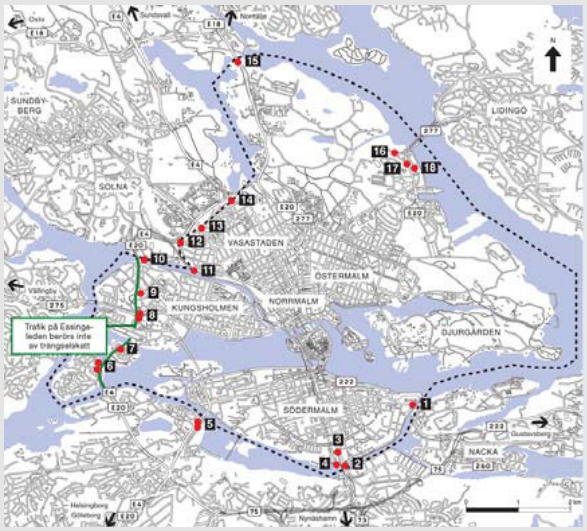
However, the implementation of the system was undermined by several technical problems as the automatic number plate reading devises triggered the levying of thousands of erroneous fines. This was then resolved. Other motivations, as the need to tighten the ECOPASS standards to relieve congestion and to cover implementation costs, led to replace the ECOPASS system with the Area C system.

On June 2011, stakeholders and citizens' involvement through public consultation led to the new congestion charge Area C which started operating in Milan on 16 January 2012. The scheme is now in force every working day from 7:30am-7:30pm with no charging to access the city on weekends and public holidays but in the latest revision of the scheme a further free entrance slot has been implemented on Thursday evenings (the cameras stop working at 6pm instead of 7:30 pm in order to encourage weekday shopping activities).

New ICT platforms were set up and cars entering Area C are now detected by a system of 43 electronic gates (of which seven are reserved for public transport vehicles), equipped with ANPR (Automatic Number Plate Recognition) digital camera and the respective data processing technologies.

Stockholm

The Stockholm congestion charging system was introduced as a pilot between 3 January 2006 and 31 July 2006. Through a referendum in September 2006, the residents of Stockholm voted for the reintroduction of the congestion charging system in August 2007 and this has been operational since then.



Source: Jonas Eliasson, KTH Royal Institute of Technology "The Stockholm congestion charges: an overview"

The congestion charging system consists of a cordon with 18 payment gates situated around the inner city with a time-differentiated toll being charged in each direction. On 1 January 2016, congestion taxes have been increased in the inner-city parts of Stockholm and congestion tax is now been charged on an additional access point[13].

Originally the technological framework relied on a combination of RFID technologies and ANPR for enforcement purpose. Wireless RFID technology was supplied by the Norwegian company Q-Free. The system worked by using a Q-Free on-board unit and roadside technology in combination with an operational system. Payments were made via a number of channels including direct debit triggered by the recognition of the on-board electronic tag. Q-Free cameras detected and recorded car number plate images using Automated Number Plate Recognition (ANPR) software to identify those vehicles without tags, and were also used to verify tag readings and provide evidence to support the enforcement of non-payers.

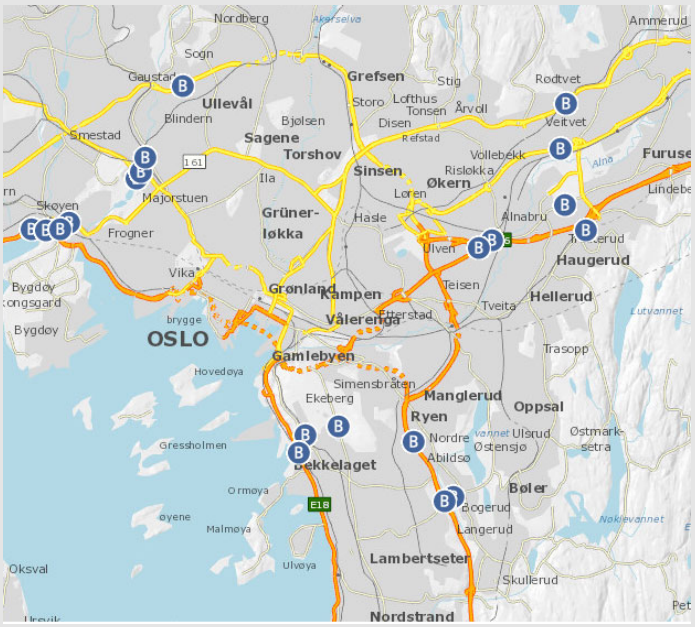
When the charging schemes were reintroduced after the public consultation, the automatic camera identification ANPR system, originally intended only as a secondary means of vehicle identification, became the basic technology option replacing the use of transponders.

Now vehicles are registered and identified automatically at control points through a photograph of their number plate. The flow of traffic is not affected as drivers do not have to stop or slow down. Payment is made in arrears (either by a bill in the post or direct payment for registered users); there is no need to pay at the roadside.

DSRC-based technologies

Oslo

The Oslo "toll cordon" is the largest urban toll scheme in Norway. It is in operation since 1990. It is a classic cordon pricing scheme with 19 toll stations installed around the centre of Oslo. Vehicles driving into the city centre are subject to a fee when passing the toll cordon. Every vehicle accessing the city centre necessarily has to pass a toll cordon control station.



Source: http://www.autopass.no/

The underlying technology is a combination of DSRC technologies and ANPR for enforcement. Since 2008, the charging system is fully automatic. It is based on On-Board Units (OBU), specifically AutoPass tags based on DSRC (provider Tecsidel) and Automatic Number Plate Recognition (ANPR) technology for vehicles not equipped with OBUs.

In 2007, the three Scandinavian countries of Sweden, Norway and Denmark initiated the AutoPASS-EasyGo cooperation, meaning that everyone with an electronic tag from one of the cooperating cities and countries could use their own tag as a means of payment at the toll

stations in all other countries involved in the cooperation. During 2013, this cooperation was extended to include Austria for all vehicles over 3.5 tonnes.[14]. According to estimates, 50 % of Norwegian vehicles are equipped with the AutoPASS OBU.

In summary, the following DSRC-ANPR technology characteristics need to be underlined in the Norwegian case:

- DSRC system is based on the European CEN standard
- The open standard is owned and managed by the NPRA (Norwegian Public Roads Administration)
- Standardised hardware and software applies for all the Norwegian urban tolling projects
- Full national (and Nordic, i.e. Denmark, Sweden and Norway) interoperability allowing motorists to use the same OBU in all Norwegian and Nordic tolling schemes; and
- The AutoPASS system is owned by the NPRA comprising technical specifications, OBUs and all road side equipment.

In terms of cost effectiveness, approx. 220.000 vehicles pass the toll ring in Oslo daily (the road with the most traffic having 46.000 vehicles daily). Approx. 40% of all drivers in the Oslo region pass the toll ring daily. The gross revenue in the three years from 2011 to 2014 has been more than EUR 80m annually. Operational expenditure is approx. 11% which is significantly less than the cost of administrating the taxes. Thus, the toll ring system might be considered as an effective toll collection system for road use charging[15].

Lessons learned from the available options

Drawing conclusions on the technology options available for the implementation of UVARs schemes, it emerges that the technological options should not be regarded as an "either-or" but as complementary options.

Urban topology can be considered as another factor affecting the most appropriate technological option.

In fact, urban topology matters: in Stockholm and Oslo, where the worst congestion problems (urban roads) can be located along a natural cordon around the city centre, the implementation of cordon charging UVARs schemes is the viable option. In urban areas with multiple access options such as in Milan or in London, the identification of a cordon is more difficult.

Cordon charging systems as in Norway combine Dedicated Short-Range Communication (DSRC) and ANPR technologies. When a vehicle passes a charging point, it is detected, identified by the on-board unit and a charge may be deducted from the smart card. Vehicles detected without an on-board unit or smart card are photographed for enforcement purposes and Automatic Number Plate Recognition (ANPR) technology is used to identify exempt vehicles or allow for enforcement.

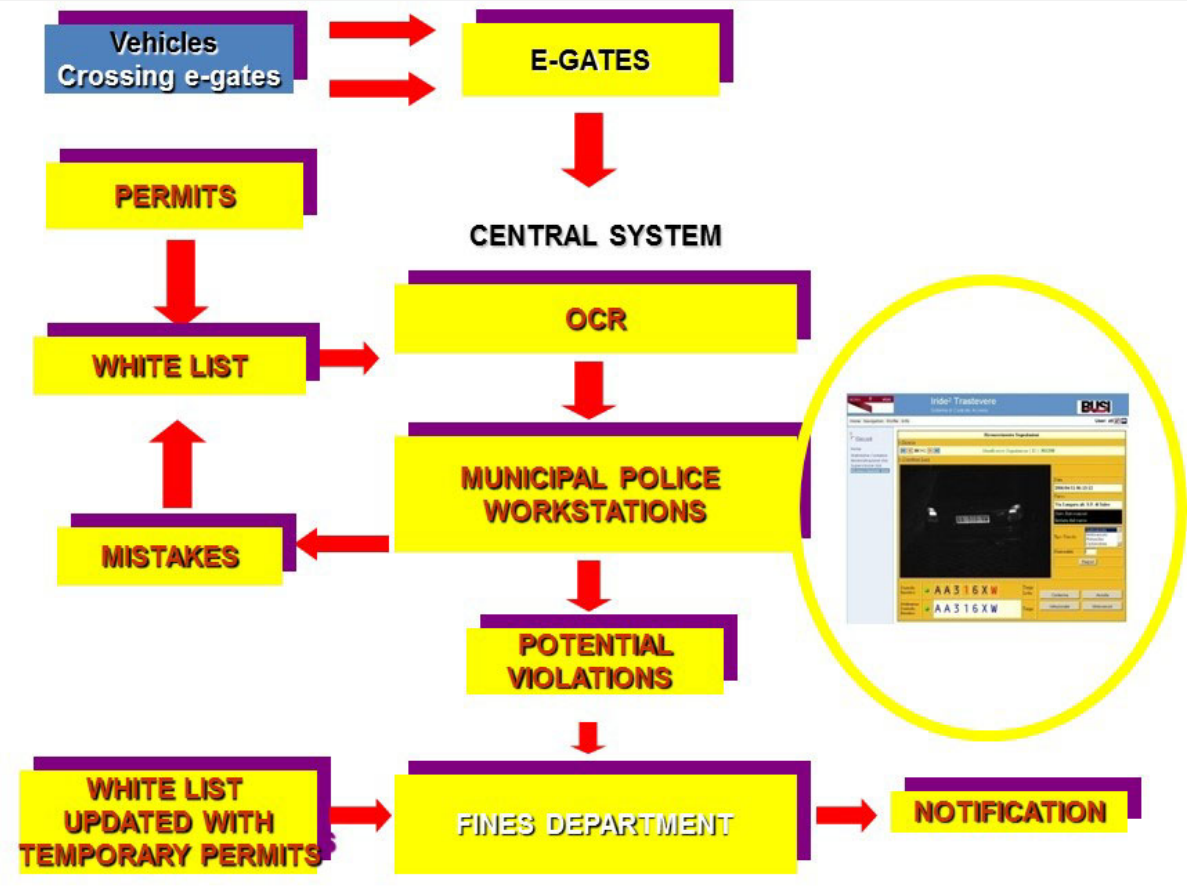
However, the roadside equipment (gantries) that needs to be installed to read OBUs in DSRC solutions may be not compatible with the urban environment as it was demonstrated in the London trials[16].

In dense cities, such as Milan or London, using Automatic Number Plate Recognition (ANPR) technologies is an option. Drivers purchase a permit and their vehicle is then added to an electronic list; automatic cameras record vehicles crossing cordons (or entering certain areas) and check number plates against the list.

ANPR-based systems are also appropriate where passenger cars represent the largest segment of traffic and the number plate identification is reliable according to technological developments, e.g. using digital cameras. This solution offers generally low capital and operational expenditures. However, back office operation expenditures may be higher when the operation has to deal with a greater share of foreign vehicles.

An example of back office activities with an indicative cost estimation is provided in the following box with reference to the case of Rome Municipality ZTL.

The technological system operating in the Rome ZTL is a network of 42 electronic gates using ANPR for various schemes (daily or nightly schemes, different zones, etc.) of access control, permit management, exemptions, e.g. persons with disabilities, and enforcement. The simplified architecture of functions underlying the enforcement process is depicted in the following diagram:



Source: F. Nussio, "Mobility Agency of the City of Rome, Mobility Masterplan, ITS and LTZ in Rome", 2015

The system checks the violating vehicles not in real-time, and the process needs to be completed with the fine notification to the vehicle owner within the time limit imposed by the national Code. Operating costs for the management of the enforcement system operations, e.g. violation and permit management, interface with the municipality police database and with the public vehicle owner register, including technical maintenance and labour cost for checking violations, are €4-5 million/year. Such expenditures are compensated by revenues coming from issuing permits. Higher costs need to be considered in case of quasi real-time systems, where the timing for violation and payments is tight.

CHAPTER IV – Potential impacts of a common European approach on UVARs technology and interoperability

As mentioned in previous chapters, technological options in UVARs schemes depend on various factors, notably the individual UVARs characteristics, as well as city size, traffic conditions, existing road infrastructures, urban architecture and, last but not least, the available budget for the implementation of a UVARs scheme.

Depending on the objectives of the UVARs scheme (for instance to limit the access of certain vehicles to specific areas vs. to reduce congestion or to increase the overall air quality and liveability of the city etc.), technology options and their combination could also change.

Interoperability plays an important role in consideration of the potential impacts at European level.

More interoperability could enable road users to easily obtain access to cities throughout the European Union with a limited number of electronic devices in the vehicle. This is more evident in the case of UVARs schemes with similar objectives but it could also be useful where the objectives are different.

Assuming the common adoption of the "polluter or user pays" principles where charges are directly related to the costs that users impose on environment and infrastructure, interoperability is essential to provide infrastructure charging policies with a flexible tool.

According to the Directive 2004/52/EC and Decision 2009/750/EC, the European electronic Toll Service (EETS) will be the tool to achieve interoperability of tolling services on the entire European Union road network. With a single service provider, subscription contract and on-board unit, EETS will facilitate daily operations for road users, improve traffic flows and reduce congestion. To function correctly, the EETS requires the systems, including UVARs, to comply with a minimum number of standards, particularly in the sphere of interfaces (communication between the vehicles and the roadside infrastructure; back-office data exchange).

Interoperable innovative technologies could also potentially play a key role for UVARs not implying a charging scheme. The ITS Directive 2010/40/EU sets the framework for the deployment of harmonized and interoperable intelligent transport systems.

In the previous chapters, it has been stressed that ANPR is the most used technology in European UVARs, notably because it does not require the installation of any on-board equipment in the user's vehicle. The performance and features of ANPR are continuously improving, enabling new fields of applications. Indeed, the global ANPR system market is expected to grow at a compound annual growth rate (CAGR) of more than 12% in the next 4-5 years[17]. At the same time, the increasing penetration in the fleet of light vehicles of on-board equipment using the DSRC technology could eventually make the latter a viable alternative or supplementary technology to ANPR also in the urban context. The use of GNSS-based solutions in urban areas, although promising in terms of interoperability, faces several implementation barriers: in particular, additional roadside transmission equipment needs to be installed to improve signals where they are weak (e.g. in urban canyons), driving up investment costs. An ongoing project to implement a GNSS-based solution in Singapore will provide evidence on the viability of such solution in the urban context.

The lack of an adequate mechanism from cross-border enforcement of compliance to UVARs is a major problem. Tools for the exchange of information on the identity of road users established in different Member States already exist, and their use to support the enforcement of compliance to UVARs should be considered in the future.

CHAPTER V – Barriers and enablers to a common approach

Barriers

- *ANPR mistakes and license plate standardisation*
  Demonstrations across Europe show that the technology needed for automatic number plate recognition (ANPR) is reliable and affordable, though it may have a rate of non-recognition (up to 10%) in the real operational environment, if the equipment is poorly set up. Errors in notification and recognition especially during the launch of the system can create negative reactions. Non-detection and incorrect reads in ANPR systems can be strongly reduced by overlapping camera readings and supporting machine systems with human interaction. Hence, the UVARs scheme needs to be supported by a well-tested operational scheme able to reduce such problems.

- *DSRC limitations in urban areas*
  DSRC technologies use in general inexpensive OBUs but they require the installation of costly roadside equipment. DSRC is normally associated with ANPR technologies for enforcement to identify vehicles without the OBU. Even if this technology is subject to European standardization, this double system is seen as complicated to be managed and expensive.

- *GNSS systems are not yet ready to operate on their own in full-scale UVARs systems*
  There are still several problems that have to be solved before a GNSS system can be implemented at full-scale in potential UVARs schemes. GNSS-based systems require a OBU installed in all cars crossing the UVARs area and such installation may be costly for the vehicle's owner or for the system operator, depending on who finances the on-board equipment. Also, much further work needs to be carried out concerning methodological, software, and technical issues, i.e. vehicle detection in urban canyon, loss of signals, etc. The general problem with a GNSS-based system is that it has to operate the whole time the car is in the UVARs area. A cordon-based system is much less demanding for the technology only needs to be in action when a cordon is crossed, reducing enforcement and control to primarily checking vehicles crossing cordons.

- *Use of GNSS system for regulated fleet needs to be regulated by contract*
  For regulated fleets like tourist coaches, public transport or delivery vehicles, the adoption of GNSS/EGNOS solutions for monitoring and control need an appropriate regulative framework. A penalty can be applied in case of non-compliance only in case a law establishing the application of a sanction is in force and the GNSS/EGNOS equipment is approved and certified.

- *Equipment could not work properly*
  Demonstrations in trials and pilot across Europe[18] have shown problems with various OBUs regarding loss of battery power, poor quality of GNSS reception and loss of signals notably when the system was set up. Recommendations are to undertake extensive testing of prototypes before implementing the final product and to check the quality of the GNSS signal received when installing the equipment. For instance, loss of signals could be compensated by specific technical methods, like dead reckoning systems and real-time map matching, which are able to calculate the current position by using a previously determined – or a fixed – position and updating that position based upon

known or estimated speeds over elapsed time and trajectory. Running small-scale pilots that include analyses of the log data may be also necessary in most cases.

- *Privacy issues*
  Despite of the many potential benefits of Intelligent Transport Systems (ITS), the associated increase in vehicle/infrastructure electronics and communications raises data security and privacy issues. ITS technologies should in fact ensure the integrity, confidentiality and secure handling of data including personal and financial details ensuring the full protection of citizens' rights.

Enablers

- *ANPR systems work sufficiently well*
  ANPR technologies benefit generally from low implementation costs: no OBUs are required. They are frequently used in UVARs schemes implementation, even if due to a rate of failure in vehicle recognition, a small share of vehicles could not be identified. However, implementations in London and Stockholm show that ANPR systems can ensure a high compliance rate.

- *Systems based on DSRC can be integrated with ANPR*
  UVAR technical systems can be designed to integrate multiple technologies. If the UVARs schemes' objectives call for several zones or time-differentiated fees, it could be advised to use DSRC. Even in such a case, ANPR should be anyway a necessary complement for enforcement purposes. With cordon based ANPR, the image of the non-compliant car's license plate is processed by an Optical Character Recognition OCR system. Where data reliability does not reach the required threshold, the image is manually controlled and checked against the central database. In case of DSRC, vehicles equipped with OBUs are automatically authorized, decreasing the operator's back office workload.

- *Use of GNSS/EGNOS system to support regulated fleet*
  For specific fleets subject to regulation in urban areas like public transport, coaches for touristic purposes or delivery vehicles, a GNSS-based system is already used for monitoring purposes and quality control. However, due to the complex networks and driving environments, as well as political or commercial barriers, a GNSS-based system has some limitations such as extra costs derived from the need of inspections requiring personnel efforts in case of claims in order to verify data reliability. Future adoption of the EGNOS system for regulated fleets could enhance such applications already based on GNSS.

- *Transition to low carbon economy*
  Transport is the backbone of the economy, essential for the functioning of the European single market and the free movement of people and goods. The global transition towards a low-carbon economy has started, supported by the Paris Climate Agreement[19]. Transport will need to play an important role in this transition. In this sense, the EC communication "A European Strategy for Low-Emission Mobility" [20] states that the EC will propose and create enabling conditions for low carbon-emission mobility, by advocating e.g. fair and efficient pricing in transport. Cities account for 23% of transport CO_2 emissions[21] and many urban areas are in breach of air pollution limits. The strategy will depend on cities and local authorities and in such a context the UVARs technological

options (e.g. technologies for vehicle detecting) can play an important role, supporting the implementation of sustainable urban mobility planning.

VI Summary of recommendations

Taking into consideration the complexity of implementing UVARs schemes in the European Union and the impossibility of finding a "one size-fits-all" technical solution, the following recommendations are based on the insights from available technical options and stakeholders' contributions, to pursue increased interoperability and effectiveness.

- Consider interoperability and user friendliness when planning a UVARs scheme and its associated technology. **Automatic number plate recognition (ANPR) technologies** are particularly suitable in areas where there are many occasional users, since they do not require the installation of in-vehicle equipment. If the UVAR requires payments, appropriate interfaces to third party payment- and toll service providers who assist the users should be established.

- **DSRC should be considered as an alternative or complementary technology** to ANPR where a large proportion of vehicles in the area covered by the UVAR are already equipped with on-board equipment (for example provided by surrounding motorway operators). DSRC-based UVAR schemes should be made fully EETS-compatible to allow interoperability with inter-urban e-tolling schemes and to allow seamless traffic between the interurban and urban environment.

- When choosing the technology **factors such as urban topology and UVARs scheme objectives** must also be taken into consideration.

- Though promising in terms of interoperability, GNSS solutions in urban areas **face several implementation barriers**, driving up investment costs. (i.e. that additional roadside transmission equipment needs to be installed to improve signals where they are weak).

- Keep in mind that **the lack of cross-border agreements on enforcement of UVARs** is currently an issue. An appropriate framework for the exchange of information on toll offenders is being proposed by the Commission, and a similar solution could potentially be used for the cross-border enforcement of UVARs.[22]

- In general, the appropriate combination of technologies must cope with the everyday challenges, e.g. public acceptability, privacy issues, legal problems, technical reliability, and EU technological interoperability. Every combination should **be evaluated ex-ante**, through an experimental period where the particularities of the UVARs scheme and the applied technologies itself are tested with all the involved stakeholders and actors.

- Cities in which the worst congestion problems (urban roads) can be located along a cordon around the city centre, the implementation of **cordon charging UVARs schemes** would be a viable choice. In other cases, the set-up of costly roadside equipment (UVARs gantries) in a few important points may be compatible with urban topology. On the contrary, in urban areas with **multiple access** and complex road network, the identification of specific cordons would be more difficult.

[1] NBGD n° 2 "Vehicle Types, Exemptions and (Cross-border) Enforcement of Successful Urban Vehicle Access Regulations (UVAR) Schemes across Europe"
[2] The overview is based on the exhaustive introduction to the key technological categories, from the point of view of charging technologies, that can be found in "Technology options for the European Electronic Toll Service", European Parliament Study 2014
[3] Technology options for the European Electronic Toll Service", European Parliament Study 2014
[4] In 2014, the average costs of DSRC OBUs range between €5 and €10, against about €100 in case of GNSS OBU ("Technology options for the European Electronic Toll Service", European Parliament Study 2014)
[5] A review of current development in GNSS applications in Europe is "GNSS Adoption in Road User Charging in Europe, Issue 1, European GNSS Agency, 2015".
[6] https://www-03.ibm.com/press/us/en/pressrelease/29507.wss
[7] S. Kearns, "Congestion charging trials in London", Transport for London, 2007
[8]https://www.lta.gov.sg/content/ltaweb/en/roads-and-motoring/managing-traffic-and-congestion/electronic-road-pricing-erp.html
[9] TREN/G4/41-2010- SI2.573856
[10] Partial, or one way interoperability. happens when a system designed in one country can be used to pay charges electronically in a second country, but the unit in the second country cannot be used to pay charges in the first country.
[11] "Technology options for the European Electronic Toll Service", European Parliament Study 2014
[12] Transport for London "Congestion charge factsheet" http://content.tfl.gov.uk/congestion-charge-factsheet.pdf
[13] Swedish Transport Administration, "On 1 January 2016, congestion taxes in Stockholm will be raised and congestion tax will be levied on Essingeleden"
[14], "Road Tolling in Norway – a brief introduction", Norwegian Public Roads Administration, Astrid Fortun/Erik Furuseth, 2007
[15] Information from ELTIS database Oslo. Toll ring system http://www.eltis.org/discover/case-studies/oslo-toll-ring-system
[16] S. Kearns, "Congestion charging trials in London", Transport for London, 2007
[17] Automatic Number Plate Recognition System Market by Type (Mobile, Fixed, Portable), Application (Traffic Management, Law Enforcement, Toll Collection, Parking Areas), & Geography - Analysis & Forecast to 2020, December 2015
[18] PRoGR€SS (Pricing Road Use for Greater Responsibility, Efficiency and Sustainability in Cities Competitive and Sustainable Growth Programme), at an early stage to EGNOS2Road (2010) assessing the added value/ economic benefits of EGNOS with respect to the GPS for the road sector
[19] At the Paris climate conference (COP21) in December 2015, 195 countries adopted the first-ever universal, legally binding global climate deal. https://ec.europa.eu/clima/policies/international/negotiations/paris/index_en.htm
[20] SWD (2016) 244 final.
[21] EC communication SWD (2016) 244 Final
[22] Part of the recast of Directive 2004/52/EC

EN MI-02-16-269-EN-N

Publications Office

doi: 10.2832/64096