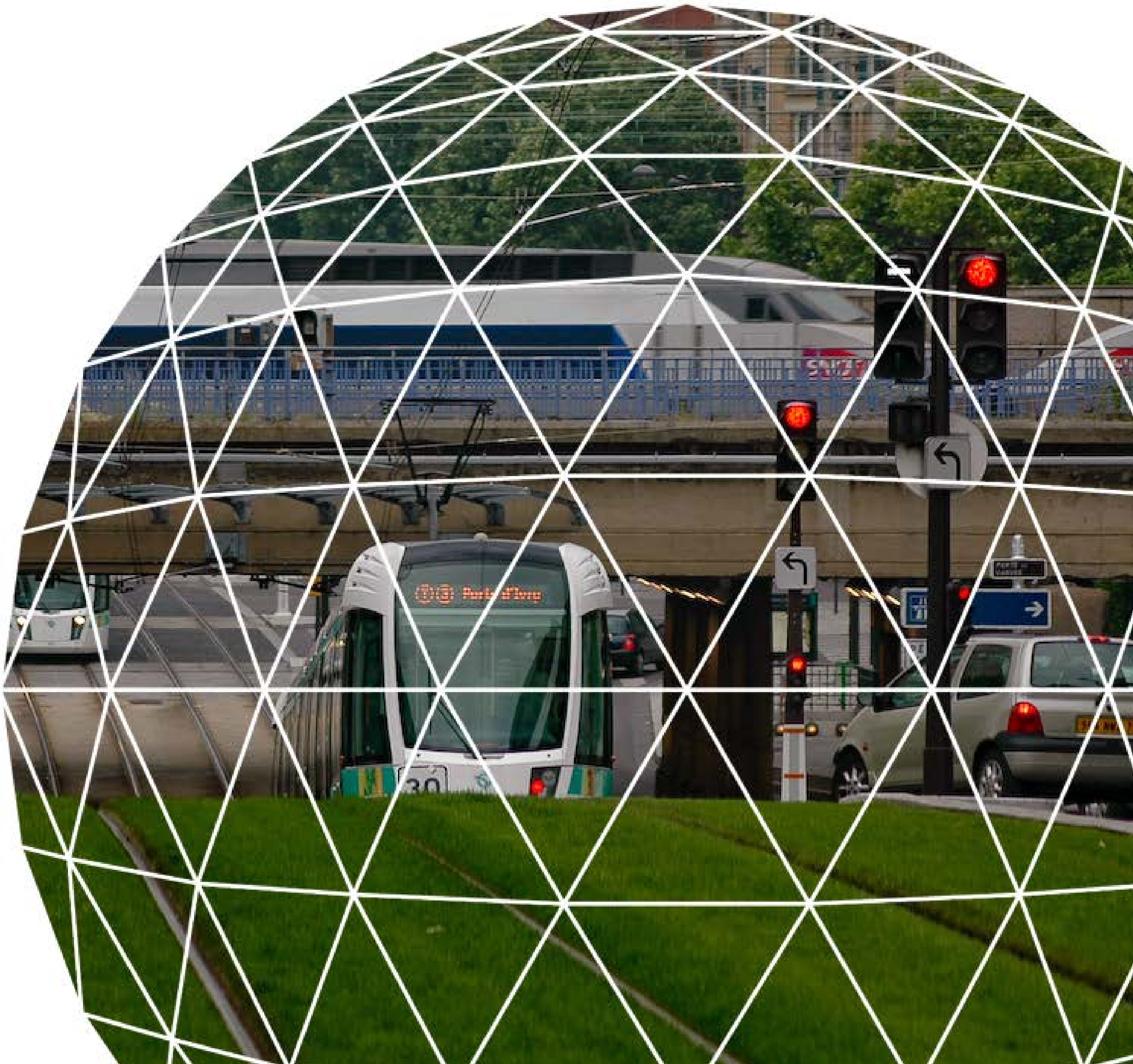
Study on Urban Aspects of the Internalisation of External Costs - MOVE/B4/310-1/2011

Final report

Client: DG MOVE, in the context of the Multiple Framework Service Contract for Economic Assistance (ref TREN/R1/350-2008 lot 2)

Rotterdam, September 2012



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Summary

Transport issues of urbanisation were first tackled by the European Commission (EC) in a Green Paper on Urban Mobility in 2007. In this paper, the European Commission indicated that the main problem is the increasing urban traffic which has resulted in chronic congestion issues as well as noise and health issues. Following the Green Paper, the EC developed an Action Plan, in which twenty measures were proposed "to encourage and help local, regional and national authorities in achieving their goals for sustainable urban mobility." The internalisation of external costs (Action 12) was mentioned as a core issue of the Action Plan, defined within the "polluter pays" principle, i.e. the users should be charged with the costs of the negative impacts, in order to facilitate the transition to cleaner vehicles or transport modes, reduce congestion and reduce peak loads of infrastructure.

This study aims to address Action 12, and consists of:

- an analysis of the general principles and methodologies of internalisation of external costs of urban mobility,
- an overview of present and failed attempts of economic instruments and policy measures, based on 12 case studies specifically on urban road charging and paid parking
- and an assessment of mobility, environmental and socio-economic impacts of the two economic instruments

The methodology builds on desk research, the afore mentioned case-studies, a questionnaire and a workshop with cities and other stakeholders who were asked to provide their input and views.

The following conclusions can be drawn from the study:

On the impacts of measures:

- The analysis of the case studies shows that the charge levels are set in rather pragmatic way and were never explicitly based on external cost estimates.
- The cases on road user charges show that the charge level differs widely.
- The charging schemes do pay off, a decrease in number of vehicles occurs. The road charging cases are generally well documented, though impacts on mobility, emissions, economy and social aspects have not always been studied.
- Concerning the case studies on paid parking, it is concluded that detailed evaluation studies of the impacts of paid parking are lacking, with the exception of the city of Amsterdam.
- Despite the lack of extensive evaluation studies, the available evaluations show that parking policy on the whole can be very effective in reducing the external costs of cars in specific areas.
- Both for congestion charging schemes and parking pricing policies the conclusions on estimated impacts are transferable to other situations and new schemes. However, the precise impacts also depend to some extent on local circumstances and the availability of alternatives for private car transport.

Lessons for practical implementation of measures:

- Setting an appropriate configuration of the charge scheme (level and structure) is difficult and no one-size-fits all solution seems to exists, due to local (amongst other things) geographical, historical and political circumstances.

- Both urban road charging and parking policies in practice prove to be self-financing schemes, that are capable of reducing negative externalities of urban mobility.
- Reasons for implementing a pricing scheme differ amongst cities, but both stakeholder organisations and cities see congestion and air pollution as the most important negative externalities of urban mobility.
- A success factor that stands out is the importance of monitoring and enforcement; both are considered critical in ensuring an effective scheme and creating public acceptance.
- Earmarking the revenues from a scheme for transport is regarded as promising as well, helping to raise the public acceptance of a scheme.
- Some individual road charging and paid parking cases also show other interesting aspects, such as free on-board units (Singapore), which could be marked as best practices.

Comparing the results with those of the IMPACT study:

- At a more aggregated level we can conclude that the charge levels found in the case studies are within reasonable ranges when compared with the typical estimates for congestion costs in urban areas.
- The case studies show that for the charging schemes that have been implemented, the levels differ widely and are decided case by case. Although this is not done on the basis of estimates of the congestion or other external costs, these existing schemes are rather effective in reducing the external effects.
- The methodological overview and recommendations as well as the external cost values provided in the IMPACT handbook could be updated and further developed with regard to cost estimates in urban areas.
- However, urban pricing schemes are generally not based on external cost estimates, so in that respect the update of the handbook is not a necessity for further development of urban congestion pricing and parking fees.

Recommendations:

- For any city investigating implementing road charging or paid parking, it is important to clearly define the policy goals. Reducing the negative externalities from urban transport is probably one of the major goals to keep the cities accessible, attractive and liveable. Urban congestion is seen as an important externality, together with air pollution.
- Several policy measures could be used to combat congestion, in most cases a combination of measures is seen. Incorporating a pricing scheme into integrated urban mobility solutions is deemed favourable not only by cities but also by stakeholder organisations.
- If road charging or a parking policy is implemented, it is important to communicate how the revenues are spent. Raising public awareness and acceptance are considered important for the success of a pricing scheme.
- Although the transferability of results between cities is difficult, there is evidence of (at least) the level of mobility impacts of different urban road charging schemes. A charge of less than € 1 per day (PPP adjusted) will not yield results, a charge of around € 7 per day leads to substantial decrease of number of vehicles in the charging zone (up to 45% decrease).
- Implementing a road charging scheme in a city remains a tailor made solution. It is recommended to test a foreseen scheme through a trial case period, in order to judge if the anticipated results occur.
- In order to determine whether a scheme (be it road user charging or paid parking policy) has any effect, monitoring is essential.
- Apart from creating acceptability (before introduction), monitoring also allows for the ability to determine whether the scheme helps achieving policy goals (during implementation), thereby creating acceptance.

Role of the European Commission

- The EC could be focused on supporting or stimulating the development of charging (differentiated for instance in place and time), e.g. by gathering and dissemination of best practices. Although difficult due to the limited transferability, the stimulation of well designed and implemented pricing schemes can also be performed through both research and overlapping EU policies.
- At this moment there is no need to for existing stakeholders to have any EC legal requirements with regard to design of internalisation measures. Also from the perspective of subsidiarity this seems not desirable for stakeholders.

Overall, it can be concluded that when pricing schemes are correctly implemented, they can be successful in reducing external effects of urban mobility. When sufficiently adapted to the local circumstances, pricing schemes can prove to be self-financing and generate net revenues to the city. Acceptability of the scheme can be improved through good communication upfront, a clear use of the revenues and by regular feedback to the users about the monitoring results of the scheme.

Possible future role of the EC

Overall we can discern 4 levels of policy interventions for the EC:

1. Increased/adapted regulatory measures (harmonisation: technology, charging regimes)
2. Increased coordination (between different cities, between related types of policy interventions)
3. Improved communication / additional promotion of best practices (attract more cities)
4. Do nothing, continue current policy

Given the apparent positive results of our study (cities implementing pricing schemes have observed substantial reduction of mobility related externalities) and the viewpoints of the stakeholders that have reacted within the framework of this study, we conclude that the first policy action for the EC can be positioned on the second and third level.

However, assuming that the number of cities implementing pricing schemes is likely to increase we expect that there might be a need for a more regulatory role (level 1) for the EC. Without trying to be exhaustive, we could expect regulation in areas like the harmonisation of charging/payment technologies and/or charging regimes (for instance charging based on GPS or license plate registration and differentiated in time and place, payment by cell phone or credit card, etc.), to prevent a patchwork of technologies and/or regimes across Europe. However, these steps will become relevant only if a substantial larger amount of cities have introduced similar pricing schemes.

1 Introduction

1.1 Background of the assignment

Transport issues of urbanisation were first tackled by the European Commission in a Green Paper on Urban Mobility in 2007 (COM(2007)551). In this paper, the European Commission indicated that the main problem is the increasing urban traffic which has resulted in chronic congestion issues. The Commission stated that the congestion costs and their implications rose up to 100 billion euros annually, i.e. 1% of the EU's GDP. Additionally, urban road traffic was responsible for a significant part of CO_2 emissions and the majority of other pollutants. A comparison of this information with the Commission's targets of pollution abatement, updated in the White Paper on Transport (2011) reveals the necessity of reviewing and re-evaluating these external impacts as well as the general principles which guide the policy making for urban transport so far, for both passenger and freight transport. More specifically, the White Paper explicitly highlights the importance of an EU framework for urban road user charging and access restriction schemes and their applications, including a legal and validated operational and technical framework covering vehicle and infrastructure applications (action 32).

The urban mobility policies were debated by local, regional and national authorities and this resulted in the Commission's Green Paper and its associated Action Plan. The stakeholders provided important input for this Action Plan which proposed *short and medium term practical actions to be launched progressively until 2012, addressing specific issues related to urban mobility in an integrated way.*

The internalisation of external costs (Action 12) was mentioned as a core issue of the Action Plan, defined within the "polluter pays" principle, i.e. the users should be charged with the costs of the negative impacts, in order to facilitate the transition to cleaner vehicles or transport modes, reduce congestion and reduce peak loads of infrastructure.

The Commission defined a conceptual framework for the internalisation of external costs and, through Action 12, undertook to monetise these as a first step on the way to achieving the goal of greener urban transport. The Commission's strategy for internalisation of external costs distinguished the private (direct user costs such as fuel costs) from the external costs (such as congestion, air pollution, noise etc.). As the general principle for internalisation "social marginal cost pricing"[1] was proposed; transport prices should correspond to the additional short-term cost created by one extra vehicle using the infrastructure. Besides the additional charges, the aim was also to achieve internalisation through non-economic measures, such as regulation and the use of technology (e.g. Intelligent Transport Systems).

1.2 Objectives of the assignment

The assignment of the implementation of action 12 on the internalisation of external cost has the following objectives:

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[1] The EU-funded UNITE project provided estimations of social marginal cost pricing for all transport modes based on case studies. More recently the IMPACT study (Internalisation Measures and Policies for All external Cost of Transport) assessed the available methods for estimating external costs and provided a consistent, scientifically sound framework.

1. To provide a comprehensive overview of the general principles guiding the urban aspects of internalisation of external costs generated by all modes of urban transport and of the methodologies for quantifying externalities across the Member States
2. To provide a comprehensive overview of the failed, existing and planned practice, policy measures and economic instruments relating to the urban aspects of internalisation of external costs generated by transport across the Member States
3. To provide best practices, conclusions and recommendations on the methodological and practical aspects of the internalisation of external costs generated by transport in urban areas

Chapter 3 provides the material to reach objective one. Chapter 4 (describing case studies) together with chapter 5 (which assesses the impacts of economic instruments) cover objective 2. Chapter 6 provides conclusions and recommendations based on practice and theory, thereby reaching objective 3. Chapter 2 goes into detail on the scoping of the assignment, paragraph 1.3 describes the outline of the report in more detail.

1.3 Outline of the report

This report includes:
- A description on the scoping of the assignment (chapter 2)
- An analysis of the general principles and methodologies of internalisation of external costs (chapter 3)
- An overview of present and failed attempts of economic instruments and policy measures, based on 12 case studies (chapter 4)
- An assessment of mobility, environmental and socio-economic impacts of economic instruments (chapter 5)
- The conclusions and recommendations (chapter 6).

2 Scoping of the assignment

Pricing instruments focus

For a study like this, it is important on the on-set to define clearly what forms part of the analysis, and what doesn't, since there are many instruments currently in use to influence the mobility behaviour of consumers and producers. In this study a clear focus is put on *pricing and charging* as economic instruments for the internalisation of external costs for all modes of urban transport.

For the purpose of this study, a charge that can be seen as internalising external costs is defined as payment by the vehicle user for the use of specific infrastructure or for the entry of a specific zone, which is related to the use (the distance driven within the zone, the time within the zone, or the number of passages into the zone). This means e.g. that the German 'Umweltplakette', which is a windscreen sticker testifying that the car meets strict emission regulations and is valid for the life of the car, is not considered as such a charge. Likewise, in the example of Rome, where access to the restricted zone is granted on the basis of an annual payment (allowing for an unlimited amount of entrances once the payment is made), this payment is not considered as a charge for the purpose of this study. The same is true for a fine for unauthorised entering of a pedestrian zone.

In general, parking fees are regarded as a pricing instrument; regulation of parking space is not regarded as a pricing instrument. Public transport subsidies, prices of public transport and national taxes are outside the scope of this study. Those and other alternative instruments should not be ignored, but should always be dealt with in relation to the pricing/charging which is the core business of the study.

External costs to be covered

External costs to be taken into account are costs of congestion, noise, air pollution, climate change, accidents and tear and wear for the use of the infrastructure; maintenance (non tear and wear related) of infrastructure is outside the scope of the study.

Inclusion of all urban modes of transport

All urban modes or transport should be included: private car, mopeds/motorcycles, cycling, walking, metro, bus, tram, urban trains, be they for passenger or freight transport. It is important to mention that not for all modes all externalities are relevant (e.g. for cycling only safety, for bus congestion, noise and emissions). An overview will be given of the externalities to be included per mode, and the available information for the estimation of external costs in an urban context will be provided. For the case studies, the study is confined to road user charging and paid parking. More on this in paragraph 3.5

Cases studies: selection primarily based on data availability

The primary criterion for case study selection is data availability, in particular concerning the impacts of pricing and paid parking on mobility, the environment, safety and the economy.

The case studies will focus on examples of schemes that were implemented, and we will also include failed cases, to explore the fail factors related to attempts to introduce charging instruments. Case studies with both ex ante and ex post evaluation are preferred whenever possible.

3 General principles and methodologies

3.1 Introduction

In this first task we discuss relevant aspects of the design of internalisation measures. First, the design of internalisation measures depends on the objectives governments want to achieve by implementing the measures. Reducing air pollutant emissions of traffic in the inner city may require a different type of internalisation measure than reducing congestion or collecting revenues to finance public transport services.

Secondly, the main theoretical principles for internalisation of external costs, or transport pricing more in general, are discussed.

Thirdly, an overview is provided of methodologies for quantification and valuation of the external costs of urban mobility (congestion, noise, air pollution, climate change, accidents and tear and wear caused by use of infrastructure), especially focussed on the urban aspects of these costs. Finally, an overview of (policy) instruments for internalisation in an urban context is presented.

3.2 The objectives of internalisation

Internalisation of external costs has strong roots in EU Legislation. Even the EU Treaty includes the polluter pays principle, Article 191 paragraph 2 states:

> *"Union policy on the environment shall aim at a high level of protection taking into account the diversity of situations in the various regions of the Union. It shall be based on the precautionary principle and on the principles that preventive action should be taken, that environmental damage should as a priority be rectified at source and that the polluter should pay."*

Based on Verhoef (2004), the IMPACT project distinguished three main objectives of internalisation of external costs (CE Delft et al, 2008):

1. Influencing behaviour, to improve the efficiency of the transport system by:
   - Reducing environmental impacts of traffic and enhance traffic safety.
   - Allowing a free flow of traffic (i.e. reducing congestion).
2. Generating revenues, to:
   - Finance new, extended or modernised infrastructure (which may in turn be related to the aim of improving freer flow of traffic).
   - Finance public transport services[2].
   - Cover costs of infrastructure management, operation and maintenance.
   - Finance mitigation measures and alternatives for private car use
   - Finance the general budget (or reduce other taxes such as labour taxes).

[2] This purpose for generating revenues has been added to the ones mentioned in IMPACT, as particularly in a urban context this can be relevant as part of a policy strategy for developing alternatives for private car use.

3. Increasing fairness, to:
   - Make the polluter/user pay (polluter pays principle).
   - Level out the income distribution or avoid overburdening of socially vulnerable groups.
   - Prevent changes in income distribution.
   - Level the playing field for the competition between transport modes.

The three objectives are related to each other. Revenues can be used to improve the efficiency, safety or environmental performance of transport. Therefore, although the infrastructure investment costs as a basis for pricing schemes are outside the scope of this study, the *use* of revenues for infrastructure investments or improving public transport services, can still be relevant. An example is the London congestion charge, where charges aimed at reducing congestion were used for improving public transport services. Using the revenues of transport pricing schemes within the transport sector is often regarded to be fair and is promoted to gain public acceptance.

From the stakeholder consultation:

Earmarking of the revenues

The most important factor for the acceptability of road charges mentioned by the stakeholders is the earmarking of the revenues for transport and the transparency of the spending. This sets the charges out from normal taxes, which feed the general public budget. Views differ on how the revenues should be spent, although the stakeholders seem to agree on public transport infrastructure and operations. Other uses mentioned are: infrastructure for walking and cycling, support for electric vehicles, promotion of alternative fuels, stimulation of mobility management schemes, city tunnels and noise barriers. Furthermore, some stakeholders mention that the introduction of a road charge should be compensated with lower national taxes in order to keep the same tax burden.

Last but not least, the reasoning of the polluter pays and user pays principles are based on the idea of fairness but are also closely related to the efficiency arguments of getting the prices right. Below we elaborate the various objectives further.

The first objective of internalisation relates to the various types of induced user behaviour. The types of behavioural changes that are stimulated depend on the design of the instrument. A congestion charge stimulates users to avoid the congestion area using the vehicle types to and during the period in which it applies. Users are stimulated to use other vehicle types or alternative transport modes, as well as to shift to the periods in which the charge does not apply. Furthermore, some reduction of (the growth in) total mobility in the congestion zone can be expected. Parking fees give incentives to limit parking durations and to park cars outside the area in which the fees apply. In addition they stimulate users to use alternative modes, as the relative cost of car use compared to alternative modes increases. Fees that are differentiated by vehicle type (e.g. the Euro emission standard) or include exemptions for certain vehicle types (e.g. electric vehicles) provide additional incentives for other types of behavioural changes, i.e. to buy cleaner or electric cars. The relationship between price changes and user responses on an aggregated level are described by so called price elasticities (see text box).

Box 3.1. Prices affect transport behaviour in many ways

The impact of pricing measures on user choices depends on the types of incentives. These depend on the type and design of the pricing instrument. A *fuel tax*, for example, provides a broad range of incentives: to buy and use vehicles that are more fuel efficient, to apply eco-driving, to increase vehicle occupancy rates (e.g. by car pooling), to shift to more fuel efficient modes (e.g. cycling, public transport), to reduce distances and in some cases even to reduce the number of trips.

A *congestion charge* can also provide a broad range of incentives, but of a different kind, such as a shift to roads, time windows and vehicles to which the charge does not apply. In addition it can also give an incentive for reduced car ownership, increase vehicle occupancy rates (e.g. by car pooling) and in some cases even to reduce the number of trips, or change the destination.

The relation between a price change (e.g. a change in fuel price per litre of fuel) and a change in behaviour (e.g. a reduction in vehicle-kilometres of passenger cars) on an aggregated level is expressed in a so-called price elasticity. It should be emphasized that price elasticities are valid only for a specific relationship. More information on price elasticities can be found in: PBL and CE Delft (2010) and the report "Transportation Elasticities, How Prices and Other Factors Affect Travel Behavior, 24 November 2011, Todd Litman, Victoria Transport Policy Institute".

The second objective of many internalisation policies, although often not very prominently stated, is the generation of revenues. Internalisation can be regarded as an economically sound and efficient way to generate revenues. In case of high revenues from internalisation it could facilitate reducing distorting taxes, e.g. labour taxes. However, this should be considered at a national level rather than in an urban context. In case the revenues are used for improving the efficiency, safety or environmental performance of transport, this can also contribute indirectly to the first objective.

The third objective of internalisation is to improve fairness. In this context 'fairness' means first of all that users pay the cost they impose on society. Generally it is regarded unfair if users are either used as cash cows or in the contrary heavily subsidised by the government without social benefits in return. Another aspect of fairness is related to income distribution and the affordability of mobility. This is usually a condition that internalisation measures should meet rather than an aim of internalisation policies. Pricing measures that would result in significant parts of the population not having access to sufficient and affordable mobility, would be highly controversial. Last but not least, fairness also means that the various transport modes are treated equally and are competing in a level playing field. This is often a key argument for implementing internalisation measures, in particular regarding the promotion of transport modes with relatively low external costs (e.g. rail transport).

In the urban context all three objectives can be relevant. Internalisation policies that were implemented often targeted a combination of these various objectives. However the first objective, to influence behaviour, is generally the dominant one. Urban internalisation measures usually aim at reducing air pollution, reducing congestion and/or improving accessibility.

3.3 Theoretical foundations for the principles of internalisation

In the context of economics, internalisation of external costs refers to marginal social cost pricing, which is based on economic welfare theory. The primary reason for internalisation is a more efficient economy by ensuring that prices equal marginal social costs. The theory behind this approach is further explained in the following text box.

Box 3.2 Internalisation of external cost - marginal social cost pricing

Transport gives rise to various types of external effects which pose costs to society. External effects of transport are by definition the consequences not taken into account by those making decisions on transport. The fundamental reason for this is that there is no well functioning market, where the originators of external effects can buy the right to do so directly from those affected by the external effects. Therefore the market clearing process does not lead to an efficient outcome, from a societal point of view.

The notion of external costs originates in the economics literature with Pigou (1912) who also formulated the first internalisation strategy: namely a regulatory levy on the price of the activity creating the externality set on a level equal to the corresponding marginal external costs. This levy is known as the Pigovian tax. To explain the basic idea in the context of transport, transport users will then take account of the additional external effects of their transport decisions in just the same way as they would do with private costs and hence the transport market can do its proper work in achieving social efficiency. In other words, the proper incentives are given to ensure that the costs of transport do not exceed the benefits to society.

The translation from theoretical Pigovian taxes (often referred to as Marginal Social Cost Pricing) to practice is not a simple one, as the nature of the externality renders it difficult to get the information required for imposing the charge at the source of the externality and subsequently for setting the tax at the right level. The information challenges concern both the identification of how the externality is related to the transport activity (i.e. what is the source of the externality) and what the related (marginal) external costs are.

There are limits to both the level of detail of the estimation of external costs and the way users can take account of differentiated charges. As an example: external congestion cost levels may vary from minute to minute, transport users may not fully understand such differentiated charges or not be able to take full account of such varying taxes and charges and even then, technological solutions to charge such rapidly varying taxes and charges are not straightforward either. Still, Marginal Social Cost Pricing is more efficient when the charge structures better reflect the actual marginal cost.

The theoretically 'first best' solution, regulatory Pigovian charges based on marginal external cost levels, may not be appropriate or feasible when all theoretical conditions are not achievable or not known, or when a multitude of motives and aims are at stake, and thus prices need to be set conditional to constraints of imperfections. Hence, deviations from Marginal Social Cost Pricing may be needed, because:

- first-best pricing is not applied throughout the whole network considered or for all competing modes,
- pure Marginal Social Cost Pricing requires a technological system which may be too complex or expensive to implement. This is related to transaction and administrative costs.
- revenues from pure Marginal Social Cost Pricing may be insufficient to cover total infrastructure costs.

Source: IMPACT, 2008

Apart from the theoretical concept of marginal social cost pricing, 'internalisation' sometimes also refers to more pragmatic ways of transport pricing. A first alternative approach to marginal social cost pricing that is often considered is *average cost pricing*. This means that charges are set at the level of the average infrastructure costs and/or external costs. An example of this approach is infrastructure charging on motorways, e.g. the German Maut or French motorway tolls. In the urban context some parking policies aim at covering the average cost of parking space and facilities.

Both Marginal Social Cost Pricing and average cost pricing are also referred to as an application of the 'polluter pays principle' (paying for external effects) and the 'user pays principle' (paying for the infrastructure costs).

A third approach to pricing policy says that the tax is set at a level which is estimated to be sufficient to achieve a given (environmental) objective. This approach can be traced back to Baumol (1972) and Baumol and Oates (1975). In addition to Pigovian, average cost based and *Baumol taxes*, other approaches exist.

Box 3.3 Differences between Baumol and MSCP

There are some similarities between Baumol pricing and MSCP. In both cases, reducing external effects is usually a main objective. However, there are also important differences between the two. MSCP means that charges are set at the level of the marginal costs. The impacts of such charges will generally be a reduction of the external effects. The impact, however, depends on the charge levels, structure and last but not least the price sensitivity of the users. Baumol charging starts from a certain goal that is set. The charge level is then set at such a level that this goal is met. Such Baumol charges can be higher or lower than what would be calculated from marginal costs, depending on the goal that is set.

Moreover, many pricing instruments are not based on this type of principles but are introduced simply for generating revenues. An important principle for taxes which aim at generating revenue is to cause the smallest possible distortion to the sector by charging goods that have a low price elasticity. This approach is called *Ramsey pricing*.

Table 3.1 gives an overview of the main pricing principles and the relationship with the objectives of internalisation. It lists which objective is the most important for each principle.

Table 3.1 Relationship between pricing principles and objectives

Pricing principle	Main objectives
Marginal Social Cost Pricing	Influencing behaviour, to improve the efficiency of the transport system (aimed at overall welfare)
Average cost pricing	Generating revenues and increasing fairness
Baumol pricing	Influencing behaviour, aimed at specific objective
Ramsey pricing	Generating revenues
Other principles	Varying

The first best approach — based on theoretical economic considerations — is the first (the Pigovian) approach: this way of taxing (in a perfect market) results in the most efficient use of resources. However, as also explained in IMPACT (CE Delft, 2008a), see text box 3.2, there are several reasons for deviating from marginal social cost pricing.

In the urban context, marginal social cost pricing is usually not fully applied at national level and in neighbouring cities. Therefore and because of other deviations of the perfect world in which

MSCP can be regarded as optimal, even from a theoretical point of view it is not straightforward what pricing principle is to be preferred. It is important to emphasize that urban internalisation measures are usually developed as a response to specific problems with urban traffic, in particular air pollution, congestion or low accessibility. In such cases, where measures target specific objectives, a more pragmatic approach may be appropriate.

In practice, urban internalisation policies are usually not explicitly based on one or more of the pricing principles that were discussed. Price structures and levels are usually based on rather pragmatic considerations. If they can be linked to a principle, in most cases it will be closest to the Baumol approach.

However, with such more pragmatic approaches there is a risk of either under-pricing or overpricing (certain types of) transport. To avoid this, estimates of the external and infrastructure cost could be used as a basis to check whether charge levels are at a reasonable level or at least order of magnitude. However, in that case, also price incentives from national pricing schemes should be taken into account.

Finally, it should be understood that internalisation of external costs, independent of the pricing principle applied, aims at reducing externalities through paying the “right price”. Internalisation will not lead to zero emissions, no congestion or no traffic accidents. Whatever the price of entering a city centre for private cars, there will be users willing to pay the price; only a complete restriction in a certain area will lead to zero car movements.

From the stakeholder consultation:

Congestion is the most important negative externality

The participants in the consultation agree that congestion is the most important negative externality to address, closely followed by air pollution. For other externalities, opinions differ.

3.4 The methods for quantification and valuation of external costs

An important step with respect to the design of internalisation measures is the quantification of the external effects and valuing them for translation into external costs. Estimations of external costs can (and preferably should) be used for setting tariff levels for economic internalisation measures. The type of external costs to be included depends on the objective (and related principles) of the internalisation strategy. For example, in case the internalisation is meant to improve the economic efficiency of the urban transport system, marginal social cost pricing could be applied and data on marginal external costs is needed. However, if the objective is to cover all external and infrastructure costs by the internalisation strategy, a charge based on average costs could be applied.

In this study we cover the following external costs: costs of congestion, noise, air pollution, climate change, accidents and wear and tear costs caused by the use of infrastructure.

The discussion of methods for the quantification and valuation of external costs consists of:
1. An overview of state-of-the-art methods to quantify and valuate external costs.
2. An overview of methodologies for the estimation of external costs as applied to the design of urban internalisation measures.

The first part is elaborated below. The second part will result in an overview of the case studies (see chapter 4) and relevant information from the stakeholder consultation (annex D). A comparison of these methodologies with the ones recommended by IMPACT will be made in chapter 6.

The table below provides an overview of the cost categories that are included in this study. Which cost categories are the most relevant depends on the transport mode (see cost estimates that are presented further on in this section).

Table 3.2 Relevant cost categories per transport mode

	Cost category						
Transport mode	Wear &tear	Climate	Air pollution	Noise	Accidents	Conges -tion	Upstream *
Car	X	X	X	X	X	X	X
Truck	X	X	X	X	X	X	X
Mopeds/motorcycle	X	X	X	X	X	X	X
Cycling					X		
Bus	X	X	X	X	X	X	X
Train	X	X	X	X	X		X
Tram	X	X	X	X	X		X
Metro	X	X	X	X	X		X

* Upstream includes electricity/fuel production

The valuation of externalities will be based on the methodologies presented in IMPACT. For the IMPACT handbook on external cost, a meta-analysis of external cost valuation approaches has been carried out. The approaches presented in the handbook can be considered as the state-of-the-art. A detailed overview of the valuation of the various cost categories in IMPACT is provided in **Annex A.**

Wear and tear costs of infrastructure were not included in the IMPACT handbook. These costs can be partly based on the annual running costs (i.e. expenditures). However, with respect to the wear and tear costs with a lifetime above one or two years, capital costs should be estimated. This could be done by capitalisation of historical expenditure data (Perpetual Inventory Method (PIM)) or by the assessment of the future financing needs of the present network (Synthetic Method). In the PIM approach the annual depreciation costs are estimated by distributing the relevant expenditures over the lifetime of the infrastructure asset concerned. In addition to the depreciation costs interest costs are estimated by using an appropriate interest rate. The sum of depreciation and interest costs equal capital costs. The Synthetic Method of calculating capital costs for the infrastructure asset estimates a replacement value. Considering the age, past and projected traffic loads and the physical condition of the asset, depreciation and interest costs are calculated in a way similar to the PIM approach.

A very rough estimation of the wear and tear costs or road transport in the various Member States is provided by the IMPACT study (Frauenhofer-ISI et al., 2008). Based on the UNITE country accounts and some national studies on infrastructure costs this study estimates the variable infrastructure costs – which could be considered to be equal to the wear and tear costs – by applying some simple value transfer rules. The uncertainty in the resulting cost figures is large and they should therefore be considered as rough indications of the wear and tear costs in the EU Member States. In Table 3.3 the wear and tear costs for urban roads are presented[3]. For busses and Heavy Goods Vehicles (trucks) these costs are significantly higher than for passenger cars, which could be explained by the fact that due tot their rather high axle loads these vehicles are responsible for a large part of the road damages.

From the stakeholder consultation:

Alternatives for addressing negative externalities

According to the stakeholder organisations, the most adequate policy instruments to address all negative externalities are, in order of effectiveness:

- *improvements in public transport,*
- *land use planning,*
- *walking and cycling improvements.*

These instruments primarily address congestion, accidents, climate change and air pollution. Somewhat less effective are:

- *paid parking,*
- *urban congestion charging,*
- *green zones.*

The first two mainly address congestion, the last one air pollution.

[3] The wear and tear costs of cycling and walking are negligible and hence not presented in this table.

Table 3.3 Indications of the wear and tear costs on urban roads (€/vkm)

COUNTRY	Urban roads - Euro per vehicle kilometre								
	SmallCar	**BigCar**	**MCycle**	**Bus/Coach**	**LDV/Van**	**HGV5.5t**	**HGV12t**	**HGV24t**	**HGV40t**
Austria	0,004636	0,004665	0,004635	0,274647	0,004669	0,006317	0,039363	0,254985	0,394047
Belgium	0,005448	0,005467	0,005447	0,19093	0,005471	0,006602	0,029303	0,177424	0,272952
Bulgaria	0,001257	0,001261	0,001256	0,044854	0,001262	0,001528	0,006864	0,041679	0,064133
Switzerland	0,004099	0,004137	0,004097	0,360968	0,004143	0,00632	0,049997	0,334981	0,518777
Cyprus	0,004127	0,00416	0,004125	0,327019	0,004166	0,006136	0,045655	0,303506	0,469804
Czech Rep.	0,002541	0,00255	0,00254	0,089818	0,002552	0,003084	0,013766	0,083463	0,128413
Germany	0,002778	0,002801	0,002776	0,222323	0,002805	0,004144	0,031014	0,206336	0,319407
Denmark	0,000711	0,000715	0,000711	0,035123	0,000715	0,000925	0,005137	0,032617	0,05034
Estonia	0,024564	0,024672	0,024558	1,053785	0,02469	0,030969	0,156935	0,978838	1,508913
Spain	0,000343	0,000348	0,000343	0,042867	0,000348	0,000608	0,005812	0,039771	0,061672
Finland	0,002323	0,002347	0,002321	0,232046	0,002351	0,003752	0,031868	0,215318	0,333632
France	0,000759	0,000764	0,000758	0,047523	0,000764	0,00105	0,006773	0,044117	0,068202
Greece	0,002269	0,002284	0,002268	0,139261	0,002286	0,003122	0,019888	0,129285	0,199839
Hungary	0,012375	0,012425	0,012372	0,495377	0,012434	0,01538	0,074495	0,460206	0,708964
Ireland	0,011852	0,011881	0,01185	0,28849	0,011885	0,013573	0,047431	0,268345	0,410821
Italy	0,000281	0,000282	0,000281	0,015905	0,000283	0,000378	0,00229	0,014767	0,022814
Lithuania	0,00903	0,009066	0,009028	0,353198	0,009072	0,011171	0,053294	0,328136	0,505392
Luxemburg	0,009355	0,009399	0,009352	0,433774	0,009407	0,011996	0,063941	0,402868	0,621455
Latvia	0,003301	0,003319	0,0033	0,170016	0,003322	0,004339	0,024743	0,157876	0,243739
Malta	0,00053	0,000531	0,00053	0,014365	0,000531	0,000616	0,002309	0,013357	0,020483
Netherlands	0,002138	0,002146	0,002138	0,073393	0,002147	0,002582	0,011302	0,068204	0,104902
Norway	0,007581	0,007643	0,007577	0,594728	0,007653	0,011235	0,083095	0,551972	0,854367

Poland	0,002952	0,002963	0,002951	0,108353	0,002965	0,003608	0,016508	0,100677	0,154961
Portugal	0,001768	0,001773	0,001768	0,046902	0,001774	0,002049	0,007573	0,043615	0,066861
Romania	0,00123	0,001235	0,00123	0,044862	0,001236	0,001502	0,006842	0,041685	0,064156
Sweden	0,003484	0,003512	0,003482	0,274258	0,003517	0,005169	0,038309	0,25454	0,393996
Slovenia	0,009811	0,009846	0,009808	0,351978	0,009853	0,01194	0,053817	0,327061	0,503286
Slovakia	0,000871	0,000874	0,000871	0,028004	0,000874	0,00104	0,004361	0,026028	0,040002
United Kingdom	0,002719	0,002736	0,002717	0,171115	0,002739	0,003766	0,024376	0,158853	0,245581
AVERAGE EUR-29	0,002176	0,002188	0,002175	0,117695	0,00219	0,002895	0,017033	0,109283	0,168778

The IMPACT handbook contains an overview of external cost values. In most cases these were values for one selected EU Member State (Germany). The table below provides a brief summary of the total marginal external costs in urban areas from the IMPACT handbook. The external costs of cycling and walking are generally assumed to be negligible.

Table 3.4 Total marginal external costs in urban areas from IMPACT handbook

Mode	Total marginal external cost $€_{2000}$ per 1,000 passenger-km	Total marginal external cost $€_{2000}$ per 1,000 tonne-km
Car –petrol	35	
Car-diesel	43	
Passenger train –electric	3	
Passenger train – diesel	19	
Truck		28
Freight train - electric		2
Freight train – diesel		13

Source: IMPACT handbook. Note: These data apply for Germany. The data is based on the average fleet and includes air pollution, climate change, noise (day time) and accidents costs (congestion, upstream and wear&tear costs not included).

Some of the values in the handbook are not fully representative for the current situation, e.g. because the emission factors of vehicles and the composition of fleets have changed, accident rates are different, etc. In addition they are all at the price level of 2000, while for this study a more recent price level is to be preferred.

The very recent study CE Delft et al. (2011) contains an up-to-date overview of external costs (both marginal and average values), based on the IMPACT methodology. An overview of the cost estimates from this study is shown in Table 3.5. For accidents and noise, marginal external costs expressed in vehicle kilometres have been converted into costs expressed in passenger or tonne kilometres through the use of conversion factors from CE Delft et al. (2011). For noise, the range in the marginal external costs for the different vehicle categories represents the range of external costs in urban areas with a high and low population density.

From the stakeholder consultation:

Pricing policies are needed in combination with other instruments

Some cities, which are operating or preparing a road charging scheme, have extensively looked at alternatives and concluded that none of the alternatives can bring the desired results without road charging. But the stakeholders also stress that success lies in the combination measures, to obtain integrated urban mobility solutions.

Table 3.5 Average and marginal external cost at day-time in 2008, excl. congestion & up/downstream emissions (€$_{2008}$ per 1,000 pass.-km or tonne-km)

	Car		Motorc./ mopeds		Buses/ coaches		LDV*		HGV		Rail pass.		Rail freight	
	AC	MC	AC	MC	AC	MC	AC	MC	AC	MC	AC	MC	AC	MC
Accidents	32.3	28.8	156.6		12.3		56.2		10.2	6.8	0.6		0.2	
Air pollution (metropolitan areas)	15.7	15.7	31.8	31.8	11.7	11.7	88.5	88.5	11.4	11.4	7.0	7.0	--	--
Air pollution (other urban areas)	8.0	8.0	7.4	7.4	15.2	15.2	37.9	37.9	7.9	7.9	2.8	2.8	--	--
Climate change (assuming €25 per t of CO_2)	3.0	3.0	1.9	1.9	1.6	1.6	7.6	7.6	1.7	1.7	0.3	0.3	0.2	0.2
Noise	1.7	5.2-12.5	14.4	16.5-39.8	1.6	4.3-10.5	6.3	56.4-137*	1.8	7.9-19.1	1.2	2.2-4.4	1.0	0.9-2.3
Total (metropolitan)	53.8		205.6		28.8		161.9		27.1		9.8		1.8	
Total (other urban)	46.1		181.8		24.5		111.3		23.6		5.6		1.8	
Upstream emissions	3.4		2.3		1.5		8.4		1.7		3.9		0.8	

Source: CE Delft et al. (2011)

* Marginal external costs for light duty vehicles are expressed in Euro per 1,000 tonne kilometres, assuming 0.8 tonne per vehicle.

AC=average costs, MC=marginal costs

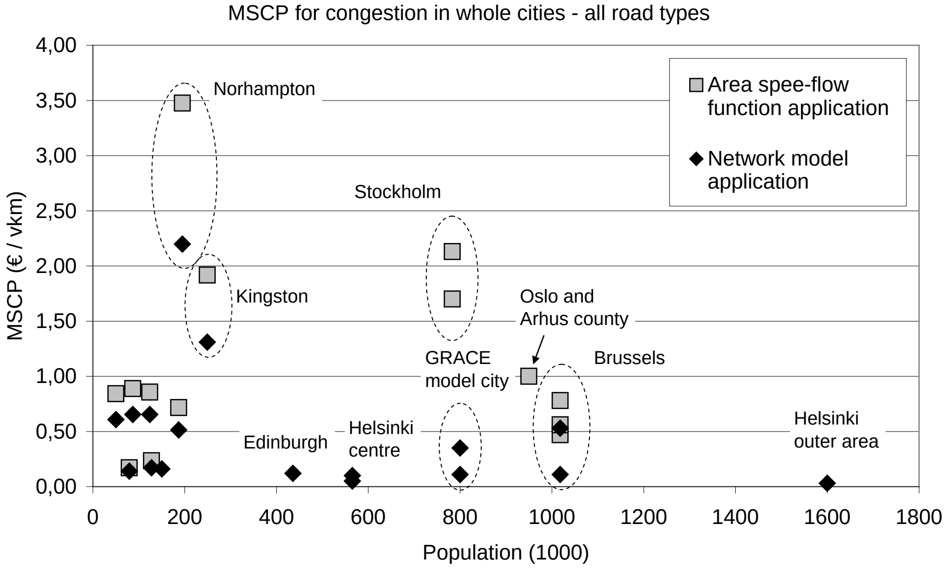
Congestion costs are not included in the data shown so far. Congestion costs depend strongly on local situations. The IMPACT handbook included an overview of various urban congestion cost estimates from previous studies, see figure 3.1[4]. This figure makes clear that congestion cost values vary widely, as do the congestion levels themselves. All values in this graph for cities with a population of less than 200,000 inhabitants stem from one and the study for the UK. In most of these cities (Cambridge, York, Norwich, Lincoln, Bedford and Hereford, represented by the 'cloud' in the lower left side of the graph) , the congestion costs are in the range of € 0.15 to € 0.89 per vehicle-kilometre. However, in the case of Kingston and Northampton the congestion costs are considerably higher. Most of the estimates for the larger cities stem from the UNITE project. Again most values are somewhere between roughly € 0,10 and € 1 per vehicle-kilometre. In a few cases, congestion costs are much higher up to a few euro. The size of the city is in itself not a significant explaining factor.

From the stakeholder consultation:

Effects outside the road charging zone

Some stakeholders are worried about an increase in congestion outside the charging zone. London indicated that thorough investigation shows that no negative social effects are found outside the charging zone and only a slight increase in traffic growth. But it was noted that good alternatives were provided in the form of improved public transport.

Figure 3.1 Marginal social congestion costs in urban areas according to different studies



Source: Compilation of results from various studies (all values translated to price level 2000): UNITE, 2002c; TRENEN-II-STRAN, 1999; GRACE, 2006a; Newbery and Santos, 2002; Prud'homme and Kopp, 2006. MC-ICAM, 2004.

When adding up the marginal external costs of climate change, air pollution, noise , accidents and wear and tear in urban areas from the previous overviews, it becomes clear that for cars these are about 5 to 7 cents per passenger-km, which is about 8 to 11 cents per vehicle-kilometre. The congestion costs (of at least 10 cents per vehicle-km) are therefore in almost every case dominant

[4] Some more details on this graph from IMPACT will be added in the next version

in urban areas. For trucks, the share of wear and tear costs and the other external costs is higher than for passenger cars. Congestion costs per vehicle-km for trucks are about 3.5 times higher than for cars. All together, also for trucks congestion costs are very important and many cases represent the largest share in the total external costs.

3.5 The methods of internalisation

In this final step we briefly discuss the policy measures that could be applied to internalize the external costs of urban mobility. Table 3.6 provides an overview of both the theoretically first best and the main options for second-best internalisation measures that could be applied on a urban scale. In this table, all measures that can be taken at an urban level are printed bold. Except for congestion costs, these measures that can be taken at an urban level are second best. However, at a local level they can be quite effective, as we will see in the following chapters.

For costs that are directly related to fuel consumption, i.e. climate costs, fuel taxation is the first best internalisation measure. For all other cost categories, a distance related charge that is differentiated to the relevant parameters is the first best option. The parameters to which those first best charges are to be differentiated depends on the cost drivers of that cost category. For air pollution, the combination of fuel type and Euro emissions standard could be used as a basis for differentiation. For noise, the noise level of the vehicle could be used and for wear and tear costs the axle load (and the number of axles) is a first best option for differentiation.

For accidents costs, no simple vehicle characteristics can be used for charge differentiation, as many other factors play a key role as well. Therefore, a charge for internalising accident costs would ideally be differentiated to a set of parameters that are a good measure for the accident risk, e.g. various vehicle characteristics[5], experience and driving style of the driver, etc. As this is likely to be too complicated, an alternative first best approach could be to internalise external accident costs via insurance companies.

Congestion costs can be internalised by a differentiated kilometre charge but in some cases an area or cordon charge can also be regarded as (close to) first best, particularly in the case of urban congestion. Such measures can be regarded as second best option for internalising other cost elements.

From the stakeholder consultation:

A mandatory OBU

Some stakeholders are in favour of making an on-board unit (OBU) mandatory for cars. If an OBU would be standard equipment of cars, city authorities could choose a charge per kilometre, which would give the charging system a much better cost-benefit ratio. They are now limited to the solution of number plate recognition. An OBU might also be useful for providing other services to the drivers.

[5] This could for example be based on the Euro NCAP rating.

Table3.6 First-best and second-best/pragmatic internalisation measures

External costs	First best internalisation measure	Second-best / pragmatic urban internalisation measure
Congestion	Kilometre charge differentiated to time and place **Area/cordon charges for congested urban areas**	**Parking fees**
Noise	Differentiated kilometre charges	**Area/cordon charges** **Parking fees**
Air pollution	Differentiated kilometre charges	**Area/cordon charges** **Parking fees**
Climate change	Fuel taxes Emission trading system	**(Differentiated) kilometre charges** **Area/cordon charges** **Parking fees**
Accidents	Differentiated kilometre charges Internalisation via insurance companies	**Area/cordon charges** **Parking fees**
Wear and tear costs	Differentiated kilometre charges	**Area/cordon charges** **Parking fees**

Note: Measures that can be taken at an urban level are printed bold. All other measures are usually taken at a national level, except for emission trading which is taken at the EU level.
Source: Consultants own assessment, based on IMPACT

All the internalisation measures that are listed in Table 3-6 have been implemented in some countries or cities. Emission trading is the only exception, but this has been implemented for aviation and also for electric transport as power production is included in the ETS. In the context of this study, only the measures that can be taken at an urban level are relevant. In the following chapters, the focus will be on congestion charges and parking fees. Both have been implemented in many cities. Selected cases have been analysed and are presented in the next chapters.

Local pricing instruments to internalise external costs can to some extent interfere with other types of internalisation measures. Urban schemes usually focus on specific urban issues like air pollution and congestion within urban areas. Other internalisation policies such a fuel taxes or nationwide road pricing schemes do often not cover urban roads and if they do, they do not consider the much higher external costs on urban roads. Therefore nationwide pricing schemes and urban congestion pricing schemes can be regarded as complementary. Only in the case of a fully differentiated nationwide kilometre charging scheme as was previously discussed in the Netherlands, a true overlap could be expected.

Another link between the urban internalisation schemes and other internalisation measures is harmonisation. When charges are differentiated to certain vehicle characteristics (e.g. Euro emissions standard) the urban scheme could build on labelling schemes that are also used in other policies, such as environmental zoning or vehicle taxation . Such coordination could improve the effectiveness and reduce costs of both policies.

4 Economic instruments and policy measures: existing applications and failed attempts

4.1 Introduction

In this chapter an analysis of existing pricing instruments for internalisation of external costs in an urban context and failed schemes is presented. As mentioned in chapter 2, the study focuses on pricing and charging (urban road pricing and paid parking) as economic instruments, though other policy measures are also addressed.

The analysis is carried out by analysing a number of selected case studies on road pricing and paid parking, in EU27 and in third countries. In addition a case study on a rejected road pricing scheme and a case study on withdrawal of a road pricing scheme after implementation will be discussed. The possible transferability between case studies and towards "newcomers" will be elaborated in chapter 5.

Information has been collected on:

1. The kind of pricing solutions that have been considered and how these instruments have been implemented in an urban context.
2. The actual principles and mechanisms applied within these schemes and systems to set charges and internalise external costs.
3. The effectiveness and efficiency of these applied schemes and other policy measures.

The main observations of the case studies are presented in the next sections.

4.2 Case study selection and methodology

Selected cities – road charging

The report 'Study on Urban Access Restrictions' (ISIS and PWC, 2010)[6] includes an overview of the access restriction schemes (ARS) in operation or planned in urban areas in the EU 27 member states. In some cases, charges are used to restrict the access of motor vehicles to enter the restricted zones, and these are relevant for the selection of the case studies. The primary objectives pursued through these schemes are (i) to reduce traffic congestion, (ii) to improve the environmental conditions, or (iii) other objectives, like raising funds to be invested in enhancing the quality of public transport (ISIS and PWC, 2010). The charges that have the objectives (i) and (ii) can be considered to internalise part of the external costs of the motor vehicles, although this does not answer the question of the relationship between the actual charge and the actual external costs. For the charges with other objectives (iii), a closer consideration is needed. The Norwegian toll ring roads e.g., were designed to generate revenues to finance the infrastructure (Santos and Verhoef, 2011)[7]. While it is clear that construction of new roads can relieve congestion on existing roads, it cannot be considered as internalisation of external congestion costs but only as a possible reducing measure (although one has to take into account a possible rebound effect). The same is true for the

[6] Study on Urban Access Restrictions, ISIS and PWC (TREN/A4/130-2/2009), Final Report, Rome, December 2010.

[7] G. Santos and E.T. Verhoef (2011): Road Congestion Pricing, in: A. de Palma, R. Lindsey, E. Quinet and R. Vickerman (Eds), A Handbook of Transport Economics, Cheltenham: Edward Elgar.

use of the proceeds of the charge for investment in public transport. From the point of view for this study however the purpose of the policy is of less importance, as long as the impact of the charging instrument is directly related to the externalities.

The ARS study (ISIS and PWC, 2010) reports on 417 cities in the EU 27 member states, but only a part of these cities are applying charges according to our definition, the others using other methods for restricting access to certain areas.

A different overview of potential case studies is given by Santos and Verhoef (2011). This source looks at road congestion pricing only (the first of the three primary objectives given in the ARS study), but from a world-wide perspective. Apart from the Norwegian toll rings already mentioned, the authors identify a number of toll highways which are not only designed to generate revenue, but also to relieve congestion. Examples in urban areas (in the broad sense) are the M6 Toll in England (in the West Midlands / Birmingham area), the Highway 407 ETR in Toronto in Canada, and in Australia the City Link in Melbourne and the Westlink M7 in Sydney. In these examples the private sector is providing faster alternatives to the congested public road network.

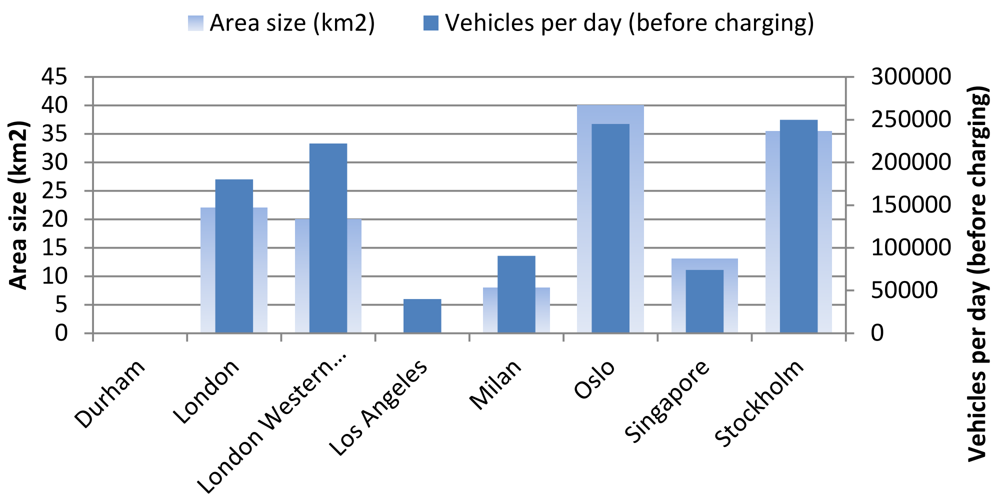
The most important criterion for the selection of case studies has been the availability of data. The data availability has been assessed through a scan of available literature. Other criteria are spread over countries, measures and primary objectives. The selection has been based on the sources cited above. The following case studies have been selected:

In the EU27+Norway:
- Durham (UK)
- London (UK)
- Milano (Italy)
- Oslo (Norway)
- Stockholm (Sweden)

Outside Europe:
- Los Angeles HOT lanes SR-91 (USA)
- Singapore (Singapore)

Figure 4.1 shows figures of the size of the charging area (in square kilometres) and the amount of vehicles entering the charged area (before the charge was introduced). The area size of Los Angeles is unknown; Durham appears insignificant compared to the other cases due to the small area size (one road of a kilometre in length) and the limited amount of cars entering the area (roughly 500 per day).

Figure 4.1: Case studies road charging[8]



Selected cities– paid parking

In cases of paid parking the charge is only for the use of a parking space at the destination. However, this charge influences the complete trip from home to destination, including the use of highways or urban arteries. The difference with road charging is smaller than it appears on first sight. Visitors checking their destination in these cities will make a careful calculation of the parking fee they will have to pay (if informed about this) and balance this with the use of other modes or parking elsewhere (for example Park+Ride). For daily commuters working in paid parking areas and not having a permit for on street parking or a reserved parking space, parking every day near their workplace is very expensive.

Local parking policies and parking management have proven to be effective tools to increase the use of alternative modes and reduce car use, thereby reducing traffic congestion, accidents and pollution (for example CIVITAS demonstration projects, Cost 342[9]).

In (almost) all large and medium sized, but also in many smaller European Cities parking regulation and paid parking in the city centre nowadays is a common feature. There is no comprehensive overview of the number of EU cities having implemented parking regulation, but there are some indications. In a recent survey among 67 small and medium sized cities (25.000 to around 250.000 inhabitants) across Europe 77% of the case cities had implemented a car free area. In more then 90% of the case cities there is parking regulation in the city centre. All larger case cities in the survey had some kind of parking regulation in the city centre.

For the selection of the long list we used the following sources

- Civitas case cities
- The study ‘Europe’s Parking U-Turn: From Accommodation to Regulation’ (2011)[10]
- COST Action 342
- The PROCEED project
- Case cities for which the authors have carried out parking studies or have direct access to relevant studies and contacts

[8] The data used for the figure is mainly converted from other units or is taken from an estimated range. For more detailed figures the authors refer to the case studies in the annexes.
[9] Parking Policies And The Effects On Economy And Mobility, REPORT on COST Action 342, August, 2005.
[10] Europe's Parking U-Turn: From Accommodation to Regulation, by Michael Kodransky and Gabrielle Hermann Spring, 2011.

For a case study to be included, the first criterion is that information about parking measures and their impacts should be available. The second criterion used is whether the parking policies have the same objectives as the internalisation measures described in chapter 3. This is important, as traditionally, many parking policies started with the aim of creating more parking spaces for short terms visitors, at the expense of cars of commuters that are parked all day. Such a policy may not reduce congestion very much, but it does increase the total number of car trips to the city.

From the stakeholder consultation:
Monitoring
The stakeholders agree that monitoring is vital. However the city organisations point out that the cities in some countries have very limited staff available for such tasks, and that monitoring studies are expensive.

The following case studies have been selected:
- Amsterdam (Netherlands)
- Graz (Austria)
- Strasbourg (France)
- Pécs (Hungary)
- Vilnius (Lithuania)

Selected cities – rejected or withdrawal after implementation
The following cases of rejected or withdrawn schemes have been selected, based again on available data:
- the Western Extension Zone of the London congestion charge system,
- the Manchester congestion charge

It is noted that “public acceptance” and " political feasibility" will be the main themes for these cases. No impacts for Manchester can be analysed.

Methodology
The case studies have been subjected to an in-depth literature review. The review took into account all open source information (ARS study, Curacao, COST, PROCEED etc.), a scan of scientific literature and (for most cases) additional information by contacting local authorities. It appeared that information gaps occur on the impacts of the charging and paid parking schemes. In some cases we have confirmation that in fact this information does not exist; notably the environmental impacts of paid parking are not monitored in most case cities.

Each case has been described using a standard format. In **Annex B and C** the detailed case study reports are presented, including a list of literature sources used.

4.3 Main findings case studies: data availability

Although data availability was expected to be sufficient, a number of data gaps has been identified. For each of the cases we briefly present an overview of data availability.

4.3.1 Road charging cases

Durham
In Durham the charging system (implemented in 2002) focusses on accessibility, and not so much on external costs.

Surveys have been conducted in order to measure traffic flows (car, bus and pedestrian) and data on accidents. Furthermore, data were gathered on retail sales and tourists visiting the cathedral.

Not much data on mobility impacts is available about the Durham scheme. No data is available on environmental effects and no clear figures are available on the revenues and costs of the scheme. In terms of acceptance information is available. Nevertheless, Durham is included as an example of a small scheme, which extends the range of possible choices for local authorities. More on this in the recommendations in paragraph 6.4.

London

On 17 February 2003, the London Congestion Charging Scheme (LCCS) was implemented in the city centre of London. The scheme was intended to achieve four priorities, which were to i) reduce congestion; ii) make radical improvements to bus services; iii) improve journey time reliability for car users; and iv) make the distribution of goods and services more efficient.

A western extension was implemented in 2007, but this extension was withdrawn as of January 2011. Several other changes were implemented at the same time (the main change being an increase of the charge).

This case study shows data of both the situation from 2003 to 2007 (without the western extension) and data from the situation from 2007 to 2010 (including the western extension), where possible compared to the situation prior to introduction. No data on the situation since January 2011 is available yet.

Regarding externalities, it is important to remark that in 2008 a Low Emission Zone (LEZ) was introduced in the Greater London area (covering almost 5000 square kilometres, including the area in which the LCCS is applied). This was introduced “to encourage the most polluting diesel vehicles” entering London “to become cleaner”. Aimed at reducing the amounts of particulate matter, the LEZ has an effect on the air quality in the area. Any shown improvement on air quality is therefore not solely contributable to the LCCS.

The London case has been well documented, the availability of data on impacts is good.

Los Angeles HOT lanes

The State Route 91 (SR-91) Express Lanes in Los Angeles, which opened in December 1995, were the first practical example of congestion pricing in the United States and the embryo example of High Occupancy Toll (HOT) lanes. The tolls varied according to a pre-set schedule and by 1998 they had evolved to a highly sophisticated level of variation.

The explicit goal of HOT lanes is to maintain a minimum quality of service on the tolled lanes. Therefore the only external cost really considered is congestion. Figures on emissions have been estimated through modelling. An extensive evaluation of impacts of the SR 91 variable toll express lanes has been carried out in 1998, and an additional study (albeitless extensive) was performed in 2006.

Milano

In January 2008, the so-called Milan Ecopass System (MES) was introduced in the Italian city of Milan. The MES aims at an improvement of negative environmental effects, more specifically air pollution caused by motorized vehicles. This is reflected partially in the fee level which, among other things, is determined by the emissions of the vehicle. The scheme proved to be successful in reducing the amount of polluting vehicles, but less so In reducing congestion. Therefore, as of January 2012, the MES is replaced by the so-called Area C, which consist of a pure congestion charge scheme.

Impacts of the MES system have been monitored and are well documented. No figures on the impacts of the Area C are available yet, due to the recent implementation of this congestion charge (January 2012).

Oslo

The Oslo toll ring (Oslo Package 1) started in 1990. The objective was to finance investments in infrastructure. Oslo Package 2 is a supplement to the existing Oslo package 1 and consists of an increase in the toll. The increase is earmarked for public transport infrastructure investments. In addition, the package includes an increase in the public transport fee, earmarked for rolling- stock investments. The Oslo toll ring Package 3 has been introduced in 2008; the objective is still to raise revenue for investments. But In addition it also raises revenue for public transport operation.

Mobility impacts of the toll ring packages have been monitored and are well documented. Limited information on environmental impacts is available. The Oslo Package 3 has not been evaluated yet.

Stockholm

The Stockholm case is well documented in literature. The primary goal is to reduce congestion in the city centre. Secondary goals are to improve environment and improve public transport. In particular the impacts of road charging in the trial scheme (2006) have extensively been studied. During the permanent system (in place since 2008) a much smaller set of effects is measured, mainly direct traffic effects (volumes, travel times, traffic composition in types of vehicles, etc.).

Impacts have been measured ex post using different techniques (traffic flow measurements, surveys etc.). Since air quality measurements are very sensitive to weather conditions, and vary considerably from day-to-day and year-to-year, the larger part of the environmental evaluation of the trial was model-generated.

The effects consist of the combined effects of charging and improved public transport services. Generally, the larger parts of those effects can be attributed to the charging scheme as such.

Singapore

Road pricing was introduced in Singapore in 1975 in the form of an Area Licensing Scheme (ALS). The scheme was introduced to reduce congestion and optimize road usage. It was explicitly not a measure to raise revenues. Following the success of the ALS, a similar manual pricing system called the Road Pricing Scheme (RPS) was introduced progressively in the 1990s at six locations along congested sections on three expressways to manage the morning peak traffic. In 1998 Singapore introduced electronic road pricing (ERP) to replace the manual road pricing schemes. The ERP system is based on the use of an In-vehicle Unit (IU) or transponder that is fitted on the windscreen of vehicles. To date, more than 99% of the local vehicles are fitted with the IU. There are 6 different types of IU for 6 categories of vehicles.

The primary objective of the ERP is to reduce congestion in the city centre and to optimize the use of the road capacity available. External costs to the environment are not taken into consideration when establishing the ERP charges. Nevertheless, the introduction of the ERP is explicitly part of Singapore’s strategy to reduce emissions from transport and increase the use of public transport.

In general, impacts on mobility are well known. Few data can be found, however, from evaluations of the environmental impact of road pricing in Singapore.

4.3.2 Paid parking cases

Amsterdam

In 2008, the Action Plan “Voorrang voor een Gezonde Stad (VGS, Priority for a Healthy City)” was adopted by the City Council. This plan contained a package of (traffic) measures to improve air quality. The measures were aimed at discouraging car use in the area within the ring road and stimulating the use of cleaner vehicles. The plan aimed to improve air quality through several measures: i) application of an environmental zone (emission requirements for vehicles, including particulate filters) and ii) intensification of the parking regime (higher prices, longer paid parking times, etc.), which was expected to result in a reduction of car use by non-residents.

The Amsterdam business community expected that the parking measures would have negative economic impacts (business leaving the city, less visitors, increasing difficulties to find and retain employees).

The plan was adopted in 2008 and on 1 January 2009 the parking measures were implemented. Extensive evaluations of the impacts of the parking measures have been conducted; in particular environmental impacts and impacts on traffic levels have been studied thoroughly.

Graz

The city of Graz attaches high priority to extensive use of public transport in the city. The transport policy (the concept of “Sanfte Mobilität”, soft mobility) includes many pedestrian zones and the promotion of cycling. The city council of Graz decided not to implement congestion charging; instead, city-wide parking management was introduced to deal with the increasing volume of car traffic in Graz. In 2004 the city implemented a parking fee system with ‘blue zones’ and ‘green zones’. The blue zones are areas in and around the inner city with short stay parking regulation. The green zones allow to park for longer stays.

The city of Graz has implemented a lower parking tariff for cars with low emissions (including hybrid, electric and bio fuel cars). By doing this, the city aims to improve air quality, reduce noise levels and raise awareness.

No explicit evaluation of the impact of paid parking on modal shift is available. Some information is known on the impact of the parking measure ‘lower parking tariff for cars with low emissions’, in terms of reduction of emissions.

Strasbourg

The city of Strasbourg has the following policy goals: residential parking prioritisation, public transport promotion and quality of life improvements. Different policy measures were introduced (e.g. provision of high quality public transport, promotion of cycling and improvement of walking facilities, and reduction of car use) including paid parking (since approximately 1990). Different parking tariffs are implemented, with inner city on-street parking being most expensive and peripheral off-street parking least expensive. Strasbourg earmarks the revenues from parking fees for sustainable transport goals (public transport projects, walking and cycling facilities).

No explicit relation with recovering (part) of the external costs caused by car transport exists. In terms of data availability, no evaluations exist on the impact of paid parking on the modal split and associated external costs. The evolution of the modal spit is known, this is however caused by a combination of measures. In general in France, few evaluations are conducted on environmental impacts of measures[11].

Pécs

The City of Pécs has formulated the following overall policy objectives: i) improving air quality, ii) improving environmental living conditions and iii) reducing the use of fossil energy and noise. The sensitive heritage and the rapidly increasing traffic within the city made the city decide to introduce paid parking and car access restrictions. A car-free zone was introduced together with a zone-modal parking system (differentiated prices) with limited parking time.

The policy goals of these measures are i) decrease the number of cars parking in the city centre by 20% and ii) decrease air and noise (– 3dB(A)) pollution.

The impacts of the paid parking scheme and car access restrictions have been evaluated in 2006. The impacts covered are traffic intensities, average parking time, air and noise pollution.

Vilnius

In the Vilnius Strategic Plan 2010-2020 some parking measures are defined. One of these measures is the reduction of the number of parking spaces in the old town of Vilnius and at the same time the creation of parking lots (multi storey buildings) on the edges of the old town. Furthermore, the parking fee in the old town will be increased in order to limit the general traffic.

No overall analysis of the evolution of modal split, air pollution, congestion etc. is available for Vilnius. Likewise, no specific evaluation of the impact of parking measures could be found.

From the stakeholder consultation:

Paid parking

Paid parking in cities is most often a part of an integrated strategy. For many cities, parking charges are the first step to internalisation of external costs. Cities want to have the freedom to choose their own system, not an abstract formula they have to follow. Their first concern is the rotation of parking in urban space. Planning parking outside the city centres is becoming the new phase in parking policy. There are large differences in practical approach, as illustrated in the workshop by Brussels and London. Brussels is creating a parking agency, to harmonise parking policy as part of the overall mobility policy. In London, on the other hand, the city has no parking policy, as this is left to the 33 London boroughs who define their policy in conjunction with their land use planning.

4.3.3 Summary

The following table presents an overview of some of the important characteristics of the road charging cases, based on above brief descriptions.

[11] Source: contacts with research institute Certu, Lyon.

Table 4.1 Overview of the general characteristics of the road charging cases

City	Year of implemen-tation	Restriction by charge on		Primary objective			Impact data available			
		priv. cars	freight vehic.	cong. (i)	env. (ii)	other (iii)	mobility	env.	economy	social
Durham	2002	X	X	X			L	-	-	L
London	2003	X	X	X			H	H	H	H
Los Angeles	1995	X		X			M	M	M	L
Milano	2008	X			X		M	M	M	M
Oslo	1990	X				X	M	L	M	M
Stockholm	2008	X	X	X			M	M	M	M
Singapore	1975	X		X			H	L	M	M

Legend: - = no data available, L = limited data, M = moderate, H = extensive data

The table shows that the availability of impact data is marked 'moderate' for most cases. Positive exception is London for which the data set is impressive. For the city of Durham limited impact data exists.

The parking cases are summarised in the following table.

Table 4.2 Overview of the general characteristics of the paid parking cases

City	Year of implemen-tation	Primary objective			Impact data available			
		cong. (i)	env. (ii)	other (iii)	mobility	env.	economy	social
Amsterdam	1990	x	x		H	H	M	M
Graz	2004	x	x		L	M	-	-
Strasbourg	+/- 1990				L	-	-	L
Pécs	?	x	x		M	M	-	-
Vilnius	?				-	-	-	-

Legend: - = no data available, L = limited data, M = moderate, H = extensive data

The information base for the parking cases is less positive. For most cases data on impacts are non existing or limited. The positive exception is the city of Amsterdam for which several well documented evaluation studies are available.

These findings are in line with other research done on parking. A recent study on the impacts of 176 parking measures concludes that particular gaps exist in the evaluation studies that link parking to congestion, CO_2 emissions and sustainable transport. There is a lack of evidence to demonstrate that parking limitations and charging reduce congestion, although it is a logical to suppose that they should do so given the evidence of their impact on car use[12].

[12] D Palmer and C Ferris (TRL), Parking Measures and Policies Research Review, May 2010.

4.4 Main findings case studies: principles and mechanisms to set the charges

With regard to the pricing instruments in the case studies the focus of the this study is to identify what principles of 'payment' or 'charging' for externalities have been applied. Here, two main issues are examined:

- *What kind of external costs were to be (partly) recovered*?

The road charging case studies showed that the primary externality addressed is congestion. In particular Singapore and Los Angeles (SR-91 HOT lanes) are most advanced, since the charge is depending on the time of the day (higher in rush hours), sometimes more than 20 different levels of charging exist. The environment is explicitly addressed in one case only, namely in Milan.

Concerning the paid parking cases, congestion and environmental objectives are mentioned.

- *(How) has the level of the charge been calculated and are these charges related to the external costs caused?*

Information on how the charges have been determined is limited. The limited information shows that for a number of cases trials have been held. Both the Stockholm and Oslo case are clear examples. In Stockholm a separate trial case has been in operation in order to test the system and gather information on the impacts. Based on the trial the charge was set. In Oslo a gradual increase of the charging area and charge itself has been applied, also based on experiences. The paid parking cases are all examples of charges set through trials and modifications are done regularly.

The level of the external costs of urban mobility, if at all calculated, has in no case study been used as input to determine the level of charges.

4.5 Main findings: failed attempts

Next to the list of (successfully) implemented road charging schemes, there are also a few schemes that were rejected before or withdrawn after implementation. This section describes one case of each of these situations: the rejected charging scheme of Manchester and the implemented but later withdrawn Western Extension of the London Congestion Charging Scheme.

Manchester

Aimed at reducing the extensive congestion in the Greater Manchester area, a cordon based charging scheme was designed to be introduced in 2013. In short, the Manchester Congestion Charging (MCC) scheme was designed with the following characteristics:

- Cars travelling towards the city between 7am and 9am would be charged £2 when crossing the outer ring road and £1 when crossing the inner ring road.
- Cars would be charged £1 when leaving the city and crossing either of the ring roads between 4pm and 6.30pm.
- A maximum charge of £10 per vehicle per day, and 20% discount for low income families would be in place.
- Taxis, private hire cars, motorcycles and scooters would be fully exempted from the charge.

- The UK Department for Transport agreed that resources from the Transport Innovation Fund would be available of up to £2.7 billion[13].
- Part of the revenues of the scheme were to be invested in public transport improvements.

In July 2008, it was decided that a public vote would be used to decide whether or not to implement the scheme. In December that year, 78% of the city's residents voted against the implementation of the scheme. Reasons as to why the scheme gained so little support are not straightforward, but several elements point towards the perception of the (in)effectiveness of the proposed congestion charge: people for instance felt that there were few alternatives to using the car, and an active "no" campaign was organised by a local business man. For more on the importance of perceptions: see the paragraph on this below.

London Western Extension

In February 2003 the London Congestion Charging Scheme was implemented in the central area of London (the so-called Central Zone). In 2004, due to the success of the scheme, the Mayor of London asked the competent authority (Transport for London) to develop proposals for possible extensions of the scheme. In February 2007, the scheme was extended with an area west of the city centre: the so-called Western Extension. The western area was chosen for three main reasons:

- The area experienced high levels of traffic throughout the working day
- Suitable diversion routes around the area existed leaving options for traffic wanting to avoid the charging zone
- The area is well-served by public transport

The successor of the Mayor of London made clear his commitment to listening to the views of Londoners about the future of the Western Extension. By means of a public consultation, the Mayor asked Londoners, businesses and stakeholders for their opinion on the future of the extension[14]. The majority of the public and business who responded supported the removal of the Western Extension[15]. Views from stakeholders were mixed, with more supporting either keeping or changing the extension than removing it[16]. As a consequence of these outcomes, the Mayor decided to officially remove the extension, and as of January 2011 the London Congestion Charging Scheme is back to the original area as in February 2003.

General discussion on acceptance of road charging

Several studies have been performed into the social acceptance of road charges. Brundell-Freij and Jonsson (2009)[17] have looked into the attitude of people being affected by the Stockholm congestion charge, and provide an overview of research in this area. They find from literature that overall attitudes towards road charging are mainly negative, but there are factors that positively influence the level of acceptance.[18].

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13 Source: Study on access restrictions, PWC, ISIS, 2009. Part of this funding would be a long-term loan, to be paid back in 30 years time.

14 Transport for London, 2008, Non-statutory consultation on the future of the Western Extension of the Congestion Charging Zone, Report to the Mayor, November 2008

15 The report does not provide exact reasons as to why these parties voted in favor of removing the Western Extension.

16 For an extensive review of the stakeholder consultation, the reader is referred to the report of Accent, who performed the consultation on behalf of the Mayor of London: http://www.tfl.gov.uk/assets/downloads/Annex-A-Accent-Report-on-the-Public-Consultation.pdf

17 Brundell-Freij, K., Jonsson, L., 2009, Accepting charging – a matter of trusting the effects?, ETC 2009, Leiden

18 As described in CURACAO (2008): acceptability is related to attitudes towards anticipated introduction of a policy, while acceptance relates to the same type of attitudes once the policy is implemented.

An important factor is *familiarity*: after introduction, people tend to have a more positive attitude towards charging schemes (i.e.: find it more acceptable) than before introduction. Also referring to the Stockholm scheme is Jonas Eliasson (a key figure in designing and evaluating the Stockholm congestion charge), underlining the importance of familiarity (Eliasson and Jonsson, 2009). Eliasson and Jonsson furthermore conclude that the *perceived* effects of the charges and the general attitudes to environmental issues are important factors in the acceptance of a road charging scheme.

From the stakeholder consultation:

Effects outside the road charging zone

Some stakeholders are worried about an increase in congestion outside the charging zone. London indicated that thorough investigation shows that no negative social effects are found outside the charging zone and only a slight increase in traffic growth. But it was noted that good alternatives were provided in the form of improved public transport.

4.6 Conclusions

Based on the overview of case study material collected, the following conclusions may be drawn:

- The road charging cases are generally well documented, though impacts on mobility, emissions, economy and social aspects have not always been studied. Interestingly, once the system is in place, the monitoring and evaluation efforts are less than during the initial phase (examples of Stockholm and Los Angeles).
- Impacts of paid parking measures are less well described. Parking is mostly part of an integrated urban mobility policy often including measures on enhancing public transport. Evaluation studies on impacts of paid parking only are scarce, the city of Amsterdam is a positive example, having an extensive list of evaluations.
- The principle of internalisation of external costs (polluter or user pays principle) has not been the driving force of the road charging and paid parking schemes. In some cases the goal of the charging schemes has been to generate revenues for investment in road infrastructure and public transport. The level of the external costs of urban mobility, if at all calculated, has in no case study been used as input to determine the level of charges.
- Several studies were made of the social acceptance of road charges. It is concluded that overall attitudes towards road charging are mainly negative. However, there are factors that positively influence the level of acceptance. A main factor is *familiarity*: after introduction, people tend to have a more positive attitude towards charging schemes than before.

5 Assessment of mobility, environmental and socio-economic impacts of economic instruments

5.1 Introduction

In this chapter the mobility, environmental and socio-economic impacts of economic instruments for urban transport in the EU are discussed. As in the previous chapters, two economic instruments are considered: urban road charging schemes and parking pricing measures. Two main sources of information for this impact analysis are considered: a brief review of the literature and a thorough assessment of the case studies introduced in the previous chapter.

The results of the impact analysis for urban road charging schemes and parking pricing measures are presented in section 5.2 and section 5.3. The conclusions of this chapter are presented in section 5.4.

5.2 Urban road charging schemes

In this section the mobility, environmental and socio-economic impacts of urban road charging schemes are discussed. In section 5.2.1 the potential impacts of urban road charging schemes are discussed. Next, a brief literature review of the impacts of this policy instrument is presented (section 5.2.2), followed by an analysis of the case studies from the previous chapter (section 5.2.3). Finally, based on this an estimate of the impacts of urban road pricing schemes is given in section 5.2.4.

5.2.1 Potential impacts of road charging systems

Urban road charging schemes may result in various mobility, environmental and congestion impacts. The main mobility impacts[19] are (see also Figure 5.2):

- *Change in size and composition of urban traffic volumes;* due to the implementation of road user charges people may decide to reduce the use of the vehicles that are charged in urban areas, e.g. by using non-charged vehicles, using another mode, travelling to another destination or not travelling at all. If road pricing schemes differentiate between different kinds of cars (e.g. low-emission cars and other cars), the measure may also result in a different composition of car traffic flows in urban areas (a shift to low-emission cars). Because of the latter impact, urban road charges could be used to foster the use of electric cars.

- *Change in timing of trips;* if urban road charges are differentiated according to time (e.g. peak / off-peak) they may also stimulate travellers to reconsider the timing of their trips. People may choose to depart earlier or later to avoid highly charged periods. This may results in a more equal spread of urban traffic flows over the day.

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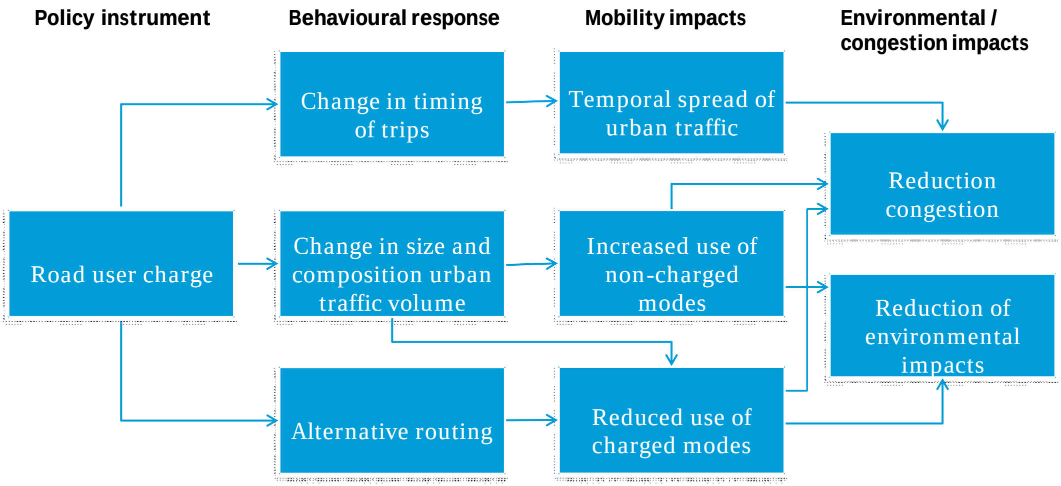
[19] Urban road charges may also stimulate people to take up carpooling. However, we expect this impact to be small and therefore it is not discussed in more detail in this study.

- *Alternative routing;* particularly transiting travellers may decide to avoid the charging area by choosing an alternative route to avoid the charge. Such a detour will probably increase their total number of kilometres travelled. This may be regarded as a rebound effect of urban road charging schemes[20].

Figure 5.2 Potential mobility, environmental and congestions impacts of urban road pricing schemes



As shown in Figure 5.2 the mobility impacts may result in a reduction of various environmental impacts[21]:

- Air pollutant emissions will decline due to a reduction of car use. The increased use of non-charged modes[22] may have a negative impact on the reduction of air pollutant emissions (e.g. in case additional buses have to be deployed, or trams and trains with their upstream emissions or an increased use of motorised two-wheelers which are exempted in most schemes), but this impact is expected to be smaller than the positive impacts of the reduced car use. In case the road charging scheme is differentiated according to emission values of the vehicle, an additional reduction of air pollutant emissions will be realized due to the shift to low emission vehicles. Due to changes in the geographical pattern of traffic flows resulting from alternative routing of (transiting) travellers, the air quality in urban areas outside the charging zone may deteriorate. This should be carefully considered when designing the urban road charging scheme.

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[20] Theoretically the reduction in urban congestion levels may have a traffic generating impact, which could also be considered a rebound effect of urban road charging schemes. However, this effect will only take place if the valuation of the marginal time savings due to the lower congestion levels are larger than the charge levels.

[21] The authors would like to point out that these impacts are theoretical (they do not follow specifically from the case studies), and no probabilities are indicated.

[22] In general, public transport modes are exempted from urban road charges. In this way a modal shift from the car to public transport modes will be stimulated which may have positive environmental or accessibility impacts. However, from a economic efficiency perspective all modes – including the public ones - should be charged their marginal costs (see section 3.3). If the marginal external costs of public transport modes are not internalised by other pollicy instruments yet, introducing road charges for these modes would result in a more effecient allocation of transport (but not necessarily a shift of transport from the car to public transport).

- The net impact of road user charges on CO_2 emissions is less clear. On the one hand, CO_2 emissions in the charging zone will decrease due to a reduction in total vehicle kilometres travelled, but on the other hand CO_2 emissions outside the charging zone will probably increase (e.g. by people travelling to other cities, transit travellers choosing alternative routes). Since CO_2 emissions have a global impact (in contrast to air pollutant emissions, which only have a local impact) the net CO_2 impact of urban road pricing schemes should be taken into account. For that reason urban road pricing schemes are particularly appropriate in improving inner city air quality; to a lesser extent in decarbonising transport.
- Due to a reduction in traffic volumes, noise emissions may decrease. However, this reduction may be partly undone if the number of buses, trams or motorcycles (which produce higher noise levels than passenger cars) increases due to a shift from the car to these modes. Additionally, noise emissions outside the charged urban areas may increase due to alternative routing by transiting travellers.

An even more important impact of urban road charging schemes than the one of the environment is the reduction of congestion levels (leading to an improved accessibility of the city (centre)[23]). Due to the decrease of overall traffic volumes congestion levels in the charged zone will decline. This impact will be higher if the road charges are differentiated according to time (e.g. peak / off-peak) resulting in a more equal spread of traffic flows over the day.

Finally, some potential socio-economic impacts of urban road pricing schemes can be identified:

- *Less traffic accidents*; due to a reduction in the total number of vehicle kilometres, traffic safety will probably improve in the charged zone (although part of the positive impacts may be undone by increasing average speed levels). However, traffic safety may deteriorate due to an increased number of motorised two-wheelers and in other parts of the city may (slightly) deteriorate due to increased traffic levels.
- *Revenues of urban road charges;* the implementation of urban road pricing schemes may generate considerable revenues for the local government.
- *Implementation and operating costs;* the implementation of an urban road charging scheme results in significant investment costs. And the operational costs (including costs of perceiving the payments, monitoring and enforcement) can also be significant. On the longer term the implementation costs of these kinds of schemes may fall due to reductions in the ICT costs (through the learning effects and economies of scale).
- *Impacts on the urban economy;* on the one hand the introduction of an urban road charging scheme may reduce the number of people visiting the inner city, which will have a negative impact on the urban economy; on the other hand the improved accessibility and quality of life in the city may attract visitors / companies and hence may stimulate the urban economy. Additionally, the improved accessibility and quality of life may attract more tourists, particularly because they often use public transport which is in most schemes exempted from the road charges.
- *Improvement of the quality of life in the cities;* a reduction in traffic and hence improved air quality and traffic safety may improve the quality of life in the charged zone. However, if the urban economy is significantly harmed by the urban road charging scheme, the quality of life in the city centre may deteriorate on the long term. Additionally, in other parts of the city quality of life may deteriorate due to increased traffic levels.

[23] The positive impact on the accessibilty of the city (centre) may (partly) be undone by increased traffic levels on roads just outside the charging zone (due to alternative routing). Careful planning of the scheme is needed to avoid such rebound effects.

- *Distributional impacts;* the implementation of road user charges may affect population groups to varying degrees (depending on their mobility patterns, but also on factors as income levels and their valuation of time), resulting in changes in equity between groups.

5.2.2 *Literature*

In this section we present the main results of the literature review on the impacts of urban road pricing schemes. Three types of impacts are distinguished: mobility, environmental and socio-economic impacts.

The literature review covers both meta-studies on the impacts of urban road charging schemes and studies investigating impacts of individual schemes. We review three meta-studies, i.e. CURACAO (2005); ISIS and PWC (2010); PRoGRESS (2004). However, the first two are mainly based on the same case studies (e.g. London, Stockholm, Milan, Singapore) as the ones considered in detail in the present study. For these studies, we therefore only discuss the general conclusions here. The case study specific results are discussed in section 5.2.3. PRoGRESS (2004) presents the results for eight case studies (Bristol, Copenhagen, Edinburgh, Genoa, Gothenburg, Helsinki, Rome, Trondheim) not covered by this study. In these case studies urban road charging schemes actually implemented, pilot projects and planned schemes are discussed. The impacts presented by this study are based on observed and modelling results. We do not discuss the results of the PRoGRESS case studies extensively here, but only formulate some general conclusions based on these results.

Mobility impacts

Based on the literature reviewed, urban road charging schemes are considered effective instruments to reduce traffic in the charged zone. For example, CURACAO (2005) concludes that urban road charging schemes aiming to reduce traffic are effective in reducing the amount of traffic entering the charged zone (for the cases reviewed they found reduction percentages of 14% to 23%). Schemes aiming to generate revenues (like the Norwegian toll schemes), however, have much smaller impacts in terms of traffic reduction (if this would not be the case, they would not generate the revenues). ISIS and PWC (2009) also concludes that urban road pricing schemes have beneficial impacts in terms of traffic reduction. However, the authors of this study also mention that the availability of data on the impacts of road user charging schemes is limited and in general of episodic nature. Like CURACAO (2005) and ISIS and PWC (2009), Progress (2004) states that road pricing schemes result in a reduction of private traffic within the charged zone. The size of this impact differs widely between the various case studies however (from 5% to 19%), depending heavily on the design of the scheme and the type of complementary instruments implemented. The dependency of the impacts of urban road pricing schemes on their design and the implementation of complementary instruments – which is also emphasized by CURACAO (2005) and ISIS and PWC (2009) – is also found by Grontmij (2007). Depending on its design, a road charging scheme in the Amsterdam area is (based on ex-ante model exercises) expected to reduce the total transport demand in the charged zone by 4% to 11%. Finally, in text box 5.1, elasticity values estimated for the road charging schemes in Singapore[24] and Norway are presented. These elasticities also show that road charging results in a reduction of total traffic demand.

[24] Notice that the elasticities for Singapore refer to the successor of the scheme discussed in more detail in section 5.2.3.

Box 5.1: Road charging elasticities in Singapore and Norway

In Singapore, a system of Electronic Road Pricing (ERP) was introduced in 1998. The system allows for a variation of charges over time. Every three months the ERP charges are calibrated to keep traffic flows at optimum levels. This variation provides interesting data for the calculation of elasticity values as done by Olszewski and Xie (2005) (presented in Table 5.). These elasticity values mean for cars that a charge increase by 10 percent leads to a decrease in mobility of about 1.2 percent (on average during the day). Interestingly, the demand elasticity is the highest for cars and in the afternoon peak (17:30-19:00), which is positive from a policy perspective as the problem of congestion is the most pressing in the peak periods. On the other hand, the number of kilometres driven by trucks and buses seems to be rather price insensitive. Yap (2005) notes that since the implementation of ERP there has been a gradual increase in the demand elasticities, suggesting that motorists seem to become more willing to change their travel patterns and behaviour when they are confronted with a higher ERP charge.

Table 5.1.1 Elasticity values for different vehicle categories and time periods in Singapore

Elasticity for various vehicle categories during AM peak hours

Vehicle category	Restricted Zone	Expressways
Cars	−0.106	−0.195
Motorcycles	−0.040	−0.134
Taxis	−0.015	−0.112
LGVs	−0.023	−0.044
HGVs and buses	−0.007	−0.109
All vehicles	−0.069	−0.151

Elasticity of traffic entering RZ by time interval

Time period	Cars	Other vehicles	All vehicles
7:30–9:30	−0.106	−0.019	−0.069
9:30–15:00	−0.082	−0.080	−0.083
15:30–17:30	−0.123	−0.151	−0.143
17:30–19:00	−0.324	−0.189	−0.265
7:30–19:00	−0.123	−0.106	−0.118

Source: Olszewski and Xie (2005). RZ = Restricted Zone

Olszewski and Xie (2005) also compared elasticity values for Singapore with those for cities in Norway, of which the results are shown in Table 5.2.1. These elasticity values are in the range of –0.03 to –0.45. At least part of the difference can be explained by the different characteristics of the road charging schemes. The authors note that the Norwegian and Singapore case studies suggest that when cordon pricing is applied, elasticity values turn out to be lower than when tolls are applied at one point (e.g. on an expressway). This can be explained by the absence of alternative ways to enter the city in the case of cordon pricing.

Table 5.2.1 Comparison of toll elasticities in Norway and Singapore

Location	Elasticity range	Remarks	Source
Oslo Toll Ring, Norway	−0.03 to −0.04	Cars	Ramjerdi (1994)
	−0.22	Cars, substitution	Jones and Hervik (1992)
Alesund, Norway (point toll)	−0.45	effects considered	
Trondheim Toll Ring, Norway	−0.30	Cars, AM peak	Polak and Meland (1994)
	−0.10	Cars, all day	
Singapore Restricted Zone (ERP, cordon)	−0.106	Cars, AM peak	Olszewski and Xie (2002)
	−0.069	All vehicles, AM peak	
Singapore expressways (ERP, point toll)	−0.195 to −0.216	Cars, AM peak	
	−0.151 to −0.215	All vehicles, AM peak	

Source: Olszewski and Xie (2005)

Furthermore, more recently the elasticities of travel demand and users attitudes towards tolls have been studied in 19 Norwegian toll road projects, including the Oslo toll roads (Odecka and Brathena, 2007). A mean short-run demand elasticity of −0.45 and a mean long-run elasticity of −0.82 were found. The fact that the long-run elasticity is higher than the short-run elasticity can be explained by the fact that in the long-run there are more substitution possibilities, e.g. reducing the commuting distance by accepting a new job.

Next to the impact of total transport volumes in the charged zone, the various studies also have investigated other mobility impacts. For example, all studies found positive impacts on the modal shift from the car to public transport and slow modes. However, the size of this shift depends heavily on the availability and quality of the public transport infrastructure. Again, this stresses the importance of complementing measures aimed to improve public transport facilities. The impacts on congestion are investigated as well by various studies. According to CURACAO (2005) the variability in the impacts on congestion and travel speeds is rather large. Depending on the design of the instrument the impacts on congestion levels could be significant (e.g. a scheme differentiated according to time will be significantly more effective in reducing congestion in this respect)., PRoGRESS (2004) finds congestion reductions ranging from 15% to 30%. Grontmij (2007) finds significant reductions in congestions levels, resulting in travel time savings for households and business located in Amsterdam.

Environmental impacts

All studies reviewed show that urban road charging schemes reduced the environmental impact of urban transport. As mentioned by ISIS and PWC (2009), the schemes differentiated according to environmental characteristics of the vehicle (e.g. Euro emission standards) are particularly effective in terms of environmental objectives; on top of the incentive to travel less by car in the charged zone, these schemes provide incentives to use low-emission cars. Since the various studies do not provide additional quantitative information on environmental impacts of urban road charging schemes, compared to the case studies discussed in section 5.2.3, we do not discuss these studies in any more detail here.

Socio-economic impacts

The socio-economic impacts of urban road user charging schemes are important with respect to political commitment and social acceptability (CURACAO, 2006). The evidence on these impacts is, however, limited. Both CURACAO (2006) and PRoGRESS (2004) conclude, based on the case study evidence available, that the impacts of road user charging on the urban economy are likely to be small . PRoGRESS (2004) even presents results for Edinburgh showing (small) positive impacts of road pricing on consumer spending and number of visitors to the city centre.

Distributional impacts are also an important issue in the political debate. According to CURACAO (2006), inequities are more likely to arise from factors like location, demography and transport needs than from factors related to income. Potential inequities can be reduced by modifying the scheme design, revising charge levels and exemptions, and using the revenues to provide compensating policies.

5.2.3 Case studies

In this section the main results of the impacts of urban road charging schemes from the relevant case studies as presented in the previous chapter are discussed. In order to be able to draw some general conclusions on the impacts of road charging schemes, we have to make the case studies comparable. In this section we describe the methodology that is applied for this purpose and then discuss the main mobility, environmental and socio-economic impacts.

Methodology

In order to draw general conclusions on the impacts of road pricing schemes, we have to make the case studies comparable in terms of mobility impacts, i.e. express the same types of results in the same units. This is done in the following steps:

Step 1: Construct a uniform price

The height of the urban road charges in the case studies are expressed in different currencies and in price levels of different years. To facilitate comparison, the height of the charge has been made comparable between countries by correcting for:

- Differences in purchasing power across countries (PPP, Eurostat),
- Inflation (HICP, Eurostat).

Step 2: Correct for autonomous trends

The impact of urban road charging systems on mobility is usually presented as the difference between measurements *ex ante* and *ex post*. However, a correct measure of the impact is the difference between the actual impact and the baseline scenario which includes an autonomous trend in mobility (What if the measure would not have been taken?).

The mobility effects (number of vehicles entering the charging zone and number of vehicle kilometres) have been corrected for the autonomous trends in mobility which follow from the TREMOVE 3.3.2 model. This trend has been calculated by selecting the model parameters that represent the situation as well as possible (e.g. country, metropolitan / urban area, network type, vehicle type).

Step 3: Correct for the impact of other policy measures

Analysing the impact of a policy instrument in a real-life situation is difficult, since other policy instruments and external factors may have influenced the outcome at the same time. For example, together with the introduction of an urban road charging scheme, the local public transport infrastructure is often improved as well. It is obvious that at least part of the resulting modal shift impacts (from the car to public transport) is due to this improvement of public transport, but it is very difficult to isolate these effects. Therefore we will not correct for these kind of 'interaction effects' of various policy measures in quantitative terms, but discuss them only in qualitative terms.

Step 4: Construct an indicator of the 'impact per euro of charge'

The impact of a price incentive on mobility is usually expressed as a price elasticity. However, when the charge is introduced for the first time a price elasticity cannot be calculated (although we have attempted to calculate a demand elasticity on the macro level in Box 5.2[25]). Instead, we decided to calculate 'the absolute effect per euro'. This is the effect per euro charged.

Information on the environmental and socio-economic impacts from the case studies is assessed qualitatively. In the case of environmental impacts, we discuss similarities and differences that may allow us to draw some qualitative conclusions about the local environmental impacts of the different schemes. Regarding socio-economic impacts, the common themes that are identified in section 5.2.1 (e.g. impacts on the urban economy) are assessed by discussing evidence from the case studies.

Mobility impacts

The urban road charging schemes result in various types of mobility impacts, as was explained in section 5.2.1 Impacts on the number of vehicles entering a charging zone and impacts on the number of vehicle kilometres driven inside the charging zone are discussed. Where possible, a distinction is made between the short and long term impacts. Also, specific attention is given to modal shift impacts and impacts on congestion.

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[25] Calculation of variable cost elasticities for the individual cases in a reliable way was not possible due to a lack of reliable case specific data on variables like the average trip length or trip costs.

Number of vehicles entering the charging zone

The short term changes in the total number of vehicles entering the charging zone are reported for the various case studies in Table 5.1. We did not include Los Angeles (which is also one of the case studies, see chapter 4) in this comparison because the structure and objectives of this scheme differs widely from those of the other schemes and hence a direct comparison is not possible[26]. Therefore we will only use the results from the Los Angeles case study to enhance or illustrate findings found in the comparison of the other case studies.

Table 5.1 Short term changes in number of vehicles entering the charging zones

Case study	Year of introduction	Measurement period	Uniform price (€$_{2010}$, PPP adjusted)	Reported change in no. of vehicles	Corrected change in no. of vehicles	Change in no. of vehicles per € of charge
Durham	2002	2001-2003	3.24 per area visit	–65%	–66%	–20%
London	2003	2002-2003	7.81 per day	–14%	–15%	–2%
London western extension	2007	2006-2007	10.74 per day	–13%	–14%	–1%
Singapore* (ALS)	1975	1975-1976	5.68 per day	–44%	–45%	–8%
Milano	2008	2007-2008	4.48 per day**	–21%	–21%	–5%
Oslo	1990	1990-1991	1.66 per area visit	–5%	–7%	–4%
Stockholm	2006	Jan-Jul 2006	2.70 per day***	–22%	–23%	–8%

* In 1998, the area licensing scheme (ALS) in Singapore was changed into an electronic road pricing scheme (ERP). This allowed the charges to be varied over time and by place; they are calibrated every three months to keep traffic flows at optimum levels. This allows for the calculation of elasticity values (see section 5.2.2), but not for inclusion in this table, so only the earlier system is included.

** In Milan the charge level ranges from € 2 to € 10 per day, depending on the Euro emission standard of the car. Based on the tickets sold we estimated the average charge level in 2008 at €4.40 per day. Corrected for inflation and PPP, a uniform price of € 4.48 per day is estimated.

*** In contrast to most of the other case studies, a cordon pricing scheme in which road users are charged when they enter and exit the charging zone is implemented in Stockholm. To make this charge comparable to the area charging schemes, we multiply the average charge for Stockholm by 2. Additionally, Stockholm uses three charge levels, for off-peak, shoulder and peak period respectively. Here we used an average charge level (of 28 SEK per vehicle per day).

[26] In Los Angeles there are more than 20 different charge levels, depending on the day, time and travelling direction. Furthermore, the toll lanes were created to provide additional capacity, which have had a positive impact on traffic volumes (of which 59% was induced demand). On the other hand, the opening of the toll lanes reduced peak hour congestion for all travellers on the corridor. These characteristics of the Los Angeles case do not allow for a comparison of Los Angeles with the other cases of urban road charging schemes found.

A first finding from Table 5.1 is that the charges of the road charging schemes differ widely, ranging from €1.66 per visit to the charging area in Oslo to about € 10.74 in London (western extension; although this is per day, where the former is per visit). These rather large differences may be the result of different types of objectives (e.g. in Oslo the main objective of the urban road charging scheme was to gather revenues, while the London Congestion charge mainly aimed at reducing congestion levels), different targets to be met by the scheme, or simply due to differences in local circumstances (e.g. political and social acceptance). However, notice that the differences in the prices do not reflect differences in local external cost values, as the charge levels are not based on the level of the external costs of urban mobility.

A second finding from Table 5.1 is that in the short term all schemes result in significant reductions in the number of vehicles entering the charging zone. However, the results differ widely between the various case studies, which is particularly clear when the impacts per euro of charge (last column) are compared. The western extension of the London congestion charge had the lowest traffic impact with –1 % per euro. The highest impact was observed in Durham (–20% per euro) followed by Singapore (–8% per euro).

The rather large reduction in the number of vehicles in the Durban charging zone could be explained by the rather limited geographical scope of the scheme (just one road), which provides many opportunities to avoid entering the charging zone by car (by taking another route or parking just outside the charging zone and entering by foot). With respect to Singapore, the large reduction in vehicles entering the charging zone may be partly explained by the fact that the introduction of the road charging scheme is supported by some other (financial) policies, including the imposition of a new registration tax for passenger cars and of parking surcharges.

The more limited effectiveness of the London congestion charging compared to the schemes implemented in Milan, Oslo and Stockholm may be explained by other (unknown) case specific issues (e.g. public transport quality, cultural differences, income distribution). Income distribution matters as the sensitivity to a charge generally differs with income. While the price of the charge is PPP-adjusted (i.e. corrected for differences in purchasing power across countries), the existence of a group of very wealthy workers and visitors in a city makes the charge less effective if they are the ones mainly paying the charge. Also employers paying the charge for their employees could be an explanation.

Box 5.2: Demand elasticity

Calculation of an average demand elasticity with respect to the variable costs of car travel for the fairly comparable cases in Europe (London (2x), Milan, Oslo and Stockholm) would allow for a comparison to the elasticities found in the literature. Due to a lack of data on specific case on trip length, trip costs etc, this was done at an aggregated level with some assumptions. Durham and Singapore were not included because they are less comparable: Durham because the restricted zone is so small and many substitution possibilities exist, Singapore because of its different socio-economic characteristics and different time period (1975).

The 'average' road charge (we assume an area charge here, since this instrument was applied in most case studies) in these 5 cases was found to be €5.50 and the average total mobility impact in terms of vehicle entries was -16%.

In order to calculate price elasticities an average trip price needs to be established. We assume the following variables costs (based on TREMOVE 3.2.2 for 2010):

€0.11 repair costs/km

€0.095 fuel costs/km

This results in the following estimates for urban travel demand elasticities for 2010:

Table 2: Estimates of demand elasticities in selected case studies

Return trip length in an urban environment (km)	25	40	55
Average variable cost/trip	5.1	8.2	11.3
Average variable cost increase (%)	107%	67%	49%
Elasticity	-0.2	-0.2	-0.3

This is roughly comparable to the elasticity range we have obtained from the literature: -0.03 to -0.45 (see section 5.2.2). It is not clear whether the elasticities from the literature are also variable cost elasticities (as we have calculated). If in our case fixed costs such as depreciation and ownership taxes had been included, the price elasticities would have been higher, as the same mobility impact would have occurred with a smaller price increase. Including a fixed cost of €0.30 per km, the elasticity value for a return trip of 40 km would become -0.59.

Short vs. long term impacts

In the case studies, the shortest measurement period was chosen as in this case the influence of other external factors is as limited as possible. However, we are also interested in the long term impact as there may be a rebound effect[27]. The most important one may be in the long term the relocation of origin or destination. Another is the fact that people who previously commuted to work by public transport notice the reduction in congestion and may decide to start commuting by car. The latter effect is expected to be relatively small, since the charge for the use of the infrastructure will strongly influence their choice.

[27] In theory the rebound effect can be dealt with through the charge level: there is an optimal charge level at which the net impact on vehicle kilometers is maximal, but this optimal charge level depends heavily on all kinds of local factors (including time valuation of local travelers). For more on this the reader is referred to the IMPACT Study (CE Delft et al, 2008).

Table 5.2 Distribution of traffic impacts (expressed in entries) over time in Milan

	Chargeable	Chargeable (corrected)	Non-chargeable	Non-chargeable (corrected)	Total	Total (corrected)
T+1 (2008)	–57%	–57%	+6%	+6%	–21%	–21%
T+2 (2009)	–68%	–68%	+20%	+20%	–17%	–17%
T+3 (Jan-Jun 2010)	–70%	–70%	+23%	+22%	–16%	–16%

NB: Corrected means that traffic impacts are corrected for autonomous traffic growth (+0.2% per year)

In the case of Milan (Table 5.2) the downward trend in traffic of chargeable vehicles strongly persisted after the first year as did the upward trend in traffic of non-chargeable vehicles. This is perhaps mainly explained by the fact that motorised two-wheelers form an important part of the traffic flows and these are non-chargeable. Another factor may be the normal fleet renewal over time. Therefore, some of this shift from chargeable to non-chargeable vehicles over time is due to autonomous fleet renewal (every year, part of the vehicle fleet is renewed) so not all of it can be attributed to the Ecopass charge. For total traffic, the initial decrease is somewhat offset in the two following years. An explanation for this might be that once individuals and business have renewed their car or truck, they again make more entries (as entries are free of charge for new, clean vehicles), or acquired a motorised two-wheeler.

Table 5.3 Distribution of traffic impacts (expressed in entries) over time in central London[28]

	Total	Total (corrected)
T+1 (2003)	–14%	–15%
T+5 (2007)	–16%	–21%

NB: Corrected means that traffic impacts are corrected for autonomous traffic growth (+1.2% per year)

In London (Table .3) the total entries have gone down between 2003 and 2007, so the total traffic impact is higher after 5 years than after 1 year (especially when correcting for autonomous traffic growth).

For Singapore, it was also noted that while car ownership and employment in the city grew, by 1988 the traffic entering the restricted zone was still 31% below the 1975 level. While there may have been some rebound effect, much of the initial impact (–44% reduction in total traffic) is still present 13 years later.

Vehicle kilometres

For three of the case studies (London, Milan and Stockholm) data on the total number of vehicles kilometres in the charging zone are available. For the short term these results are presented in Table 5.4. For all case studies, the relative reduction in number of vehicle kilometres within the charging zone is lower than the relative reduction in number of vehicles entering the charging zone. However, looking at only the kilometres made within an area does not provide enough information to draw conclusions on the overall impacts of the system. This would require the total amount of kilometres made per trip of the vehicles entering the charged area; these figures are not available for any of the cases.

[28] For the London case, the distinction between non-chargeable and chargeable is not of interest for the actual impact on mobility, since non-chargeable vehicles in this case are for instance taxis and Blue Badge holders (disabled people). The non-chargeable vehicles therefor do not differ in their contribution to any of the impacts (congestion, pollution, etc.).

Like the changes in the number of vehicles entering the charging zone, the short term results with respect to the number of vehicle kilometres differ significantly between the case studies. In terms of changes per euro of the charge, the lowest impact has been observed for the London western extension (–1% per €), while Stockholm showed the largest impact (–6%).

Table 5.4 Short term changes in total number of vehicle kilometres in the charging zones

Case study	Year of introduction	Measurement period	Uniform price (€$_{2010}$, PPP adjusted)	Reported change in total veh. km	Corrected change in total veh. km	Change in total veh. km per € of charge
London	2003	2002-2003	7.81 per day	–12%	–13%	–2%
London western extension	2007	2006-2007	10.74 per day	–10%	–11%	–1%
Milan	2008	2007-2008	4.48 per area visit	–17%	–17%	–4%
Stockholm	2006	Jan-Jul 2006	2.70 per area visit*	–14%	–15%	–6%

* See table 5.1 for further explanation on the way the uniform price for Stockholm is estimated.

Short vs. long term impacts

With respect to the distinction between the short and the long term impacts on vehicle kilometres driven inside a restricted area, only the central London charge provides sufficient data (see Table 5.5).

Table 5.5 Distribution of traffic impacts (expressed in vehicle kilometres) over time (central London)

	Total	Total (corrected)
T+1 (2003)	–12%	–13%
T+4 (2006)	–14%	–20%

NB: Corrected means that traffic impacts are corrected for autonomous traffic growth (+1.2% per year)

It follows from that total entries have gone down between 2003 and 2007, so the total traffic impact is stronger after five years than after one year (especially when correcting for autonomous traffic growth).

Modal shift impacts

One possible impact of road charging is modal shift: a change in the shares of different transport modes in total traffic. For two of our cases, London and Milan, we have sufficiently detailed information, on the number of vehicle entries. This is only a proxy of the modal shift as we do not know how many people changed to public transport. We start with an analysis of the vehicle entries, by comparing the impacts on chargeable, non-chargeable and total entries. The results are presented in Table 5.6.

On the matter of **transferability**, some remarks on both cases:

- For London, the distinction between chargeable and non-chargeable vehicles is different from those in Milan (see footnote on this with Table 5.3). Furthermore, residents get a 90% reduction, but this group is not specifically taken into account here, since it is unknown what proportion this group is.

- For Milan, an important element is the share of mopeds and motorcycles (which are non-chargeable). Although absolute figures are missing, the assumption is that of the 58% of non-chargeable vehicles in Milan, a significant share of this will be from this specific group.

Table 5.6 Calculation of the impact of modal shift on total entries for London (western extension) and Milan[29]

		Milan (2008)	London (western extension, 2007)
Chargeable (cars, vans, lorries)	% of total traffic (before) **(a)**	42%	72%
	% change in entries **(b)**	–57%	–18%
	% of total traffic (after)	23%	67%
Non-chargeable (buses, taxis, motorcycles, in Milan: clean vehicles)	% of total traffic (before)	58%	28%
	% change in entries	+6%	+3%
	% of total traffic (after)	77%	33%
Total	% change in entries as result of reduced chargeable traffic **(c)** Where **c** = **a * b**	–24%	–13%
	% change in entries of all traffic **(d)**	–21%	–12%
	% change in total entries that shifted from chargeable to non-chargeable (**d - c**)	3%	0.8%

In Milan, modal shift following the introduction of the Ecopass system was quite large. What makes Milan special is that the charge is differentiated by Euro class and a shift from a polluting lorry to a less polluting lorry is a way of avoiding the charge. Non-chargeable vehicles constituted the majority of entries (58%) before the introduction. The percentage change in entries of non-chargeable vehicles after introduction was substantial (6%) and closer inspection of the data reveals that goods vehicles show the highest modal shift from chargeable to non-chargeable vehicles. Unfortunately there is no information available on the impacts on the use of public transport. However, the data shown in Table 5.6 suggest that significant modal shift is likely to have happened.

In London, there are also significant modal shift impacts. With the Western extension in London there was about 8% increase in bus passenger-kilometres, but no significant change in other public transport modes (the underground and the national rail). The modal shift is also visible form the data in Table 5.6. The 18% decrease in chargeable entries is accompanied by a 3% increase in non-chargeable entries.

For Durham, it was noted that the number of pedestrians increased by about 10% on average, going from 14.000 – 14.500 a day up to 15.000 – 16.500. For Stockholm, no significant increase was observed in cycling, carpooling or telecommuting. Public transportation use increased by 6-9% though this increase could not be all attributed to congestion. For Singapore, data on the overall car share for commuters show that between 1975 and 1983 the car share for commuter's had dropped from 56 to 23%, whilst the use of public transport for the journey to (in the AM peak) work in the RZ,

[29] No corrections for autonomous growth; one year period only

on the other hand, rose sharply from 33% before the ALS to about 70% by 1983. This was stimulated by the fact that the quality and availability of public transport increased enormously.

Impacts on congestion

For London, data on congestion are expressed in an excess travel rate, which is the difference between the travel rate during uncongested hours and those during charging hours. Calculating congestion figures this way, the transport authority TfL finds a reduction of around 30% in congestion in the year after implementation of the congestion charge in the central area (2.3 minutes per kilometre in 2002 compared to 1.6 minutes per kilometre in 2003). However, between 2003 and 2007, congestion has increased slightly, and is currently around pre-charging levels. In case of the western extension, the introduction realised a decrease of around 20% in excess travel time (from around 2.5 minutes per kilometre in 2006 to 2 in 2007). There is an increase in congestion visible, however.

In Oslo, there has been a slight reduction in travel times during morning rush hours, but no significant change in the afternoon. Increased road capacity has thus counterbalanced the growth in traffic by a small positive margin. In Stockholm, travel times have been significantly reduced as a consequence of reduced demand. These reductions have particularly been large on the access (approach) roads to and from the inner City. Queuing times on these roads have fallen by one third for inbound traffic during the morning peak period and by half for outbound traffic during the afternoon / evening peak.

For Milan the only available information relates to public transport; the overall average speed of public transport services within the time of operation of the charging system (7.30 – 19.30) increased by 8.1%. With respect to Singapore, Wilson (1988) found that while the ALS reduced peak hour traffic by 65%, more travellers (44.1%) initially saw longer travel time and fewer (36.1%) saw a reduction of travel time, as slower (and now more crowded) buses substituted faster cars. Investments in grade-separated alternative modes (in Singapore Mass Rapid Transit (MRT) and Light Rail Transit (LRT)) have influenced the effects of the road charge.

To conclude, the charges have caused a decrease in congestion levels for all cases. Due to matters of transferability, it is hard to further draw common conclusions.

Environmental impacts

Table5.7 shows the reported impacts on emissions in each case study. As explained in the methodology section, it very important to determine the environmental impact against a baseline scenario. According to TREMOVE (3.3.2), the emission factor for NO_x has decreased by 5.5% on average in the UK between 2002 and 2003. So when the emission reduction for NO_x is reported to have been 8% between 2002 and 2003, this 5% ‘autonomous’ decrease should be taken into account as otherwise the impact from the congestion charge in London is overstated. Unfortunately, as air pollutant emissions are so dependent on local circumstances, this correction would never be perfect. Secondly, it is not always clear whether the reported impact on emissions is set against a baseline scenario or not. Thirdly, the impact on PM_{10} emissions in Milan is not expressed in a percentage reduction but rather in the number of days that the threshold is exceeded. These factors make a comparison of the case studies difficult and we therefore only present the reported impacts on emissions in the case studies in Table5.7. For some case studies no information is available.

Table 5.7 Reported impact on emissions

Case study	Reported impact on emissions
Durham	N/a
London	8% reduction in NO_x, 6% reduction in PM_{10}
London western extension	1.48% reduction in NO_x, 1.1% reduction PM_{10} and 1.5% reduction in $PM_{2.5}$
Singapore (ALS)	N/a
Milan	CO_2 emissions have dropped by 11%. In 2010, the EU PM_{10} threshold of 50 µg/m^3 was exceeded on 86 days, compared to 137 days in 2007
Oslo	It was noted that air pollution levels do not seem to be negatively affected by road investments
Stockholm	Based on ARTEMIS (model): CO_2 –13%, PM_{10} –13%, NO_x –8.5%

What could be taken from Table 5.7 is that in Milan and Stockholm, CO_2 emissions have decreased by 11% and 13% respectively, which is quite substantial. The impacts on PM and NO_x emissions differ per case. In the case of the western extension in London they have decreased only marginally, whereas the reduction in vehicle-kilometres driven inside the restricted zone was quite substantial (–10%). This can probably be explained by be relatively high pollutant emissions of some of the non-chargeable vehicles (e.g. buses).

Socio-economic impacts

The socio-economic impacts as presented in the literature in section 5.2.2 such as equity / distributional considerations, accessibility of goods and services, impact on retail business in the city centre, labour force participation, social inclusion and influences on business supply chains are not always reported in the evaluations of the urban road charging systems.

Less traffic accidents

CEDR (2009) noted that with respect to the central London congestion charge, it was estimated that around 40 to 70 additional collisions between cars are saved each year due to the charge. However, an increase in pedestrian mobility has at the same time resulted in an increase in pedestrian accidents. For Stockholm, the same study notes that there are two impacts at the same time: a reduction in traffic and a rise in speeds. On balance, the number of personal injury accidents has decreased by 5 to 10% in the charging area. At third of this decrease concerns pedestrians and cyclists.

In Durham, 78% of the people interviewed after the introduction of the charge felt that Durham had become a safer place for pedestrians, which was a 10% increase from general figures on safety before implementation. The decreased vehicle traffic within the central RZ in Singapore was found to have increased perception of pedestrian safety by reducing the conflicts and delays at street crossings.

The AMMA in Milan reports a decline in both the number of accidents (–10%) and in the number of accidents in which people were injured (–13%).

Revenues and implementation / operating costs

About 40 per cent of the revenue from road user charging in Oslo must be spent on public transport investments. From 1990 to 2001, the Oslo Package 1 (funding from user charging and the state budget) financed investments for a total of NOK 11 billion (about € 1.4 billion). The operating costs of the scheme have stayed at 10- 11% of the operating revenues for the last 10 years. Having close to 93 million registered trips through the ring in 2006, this makes the operating cost per trip to be NOK 1.40 (€0.20).

For Stockholm, the overall initial cost were approximately SEK 1900 million (roughly € 190 million). Figures on the yearly operating costs are estimated by the Swedish Road Administration, and are thought to be around SEK 220 million (€22 million) p.a. including re-investments in the technical charging system[30]. Income from the congestion tax is estimated to be around SEK 550 million p.a. (€55 million) after deduction of operating costs. This means that the operating costs take up 30% of total operating income.

In the first year of operations (2008), the MES in Milan had an overall revenue of little over €12 million. The operational costs for the same year were €6.5 million, making the net revenue little below 6M€. These revenues were invested in public transport improvements. The operating costs therefore take up around 55% of total operating income.

The investment cost of the ERP in Singapore was SDG $200 million, of which 50% has been used for installation of IUs that have been provided for free to some 680.000 vehicle owners at the introduction of the ERP system in 1998. The initial revenues collected were some SGD $70 million, around 30% lower than the revenues collected under the ALS. In 2008, gross revenues from the ERP charges were some SGD $125 million and net revenues were SGD $100 million. The average cost of maintaining the ERP system over the years has been estimated at some 20% to 30% of revenue collected. As the operation and maintenance costs have grown at the same pace as the revenues, this share of 20-30 % has remained constant over the years. Revenue collected goes to the Government Consolidated Fund, but it is maintained that ERP is a traffic management tool and not for revenue collection. Although no clear earmarking takes place, the public authorities stress that net revenues of ERP are returned to vehicle owners through tax rebates on vehicle ownership and heavy investment in the public transport and highway systems.

When the Western Extension was still in place, the financial data on the charging scheme was combined for both areas (the original central area and the western extension). It was therefore not possible to differentiate which revenues can be accrued to which part of the scheme. The table below shows the costs and revenues of the total scheme for the financial year 2007/2008, which had an overall increase in net revenue of about £55 million compared to the year 2006/2007. All net revenues have been allocated to support the Mayor’s Transport Strategy (which is mandatory by law). The majority of the revenues were applied to bus network improvements (£112 million), roads

[30] As given by Eliasson (2009): “A cost–benefit analysis of the Stockholm congestion charging system”. Exact figures on the operating costs were not found by the authors.

and bridges (£13 million) and also spent on road safety, environment, walking and cycling and borough plans (local transport improvements).

Table 5.8: Outturn figures London central area and western extension

Overall outturn figures 2007/2008, complete scheme (in £m)	
Costs	
Scheme operational, publicity and enforcement costs	91
Other costs	40
Total costs:	**131**
Revenues	
Standard daily vehicle charges (£8)	146
Fleet vehicle daily charges (£7)	37
Resident vehicles (£4 per week)	12
Enforcement income received	73
Total revenues:	**268**
Net revenues:	**137**

The following table provides a more recent picture of the revenues and costs of the central zone, showing figures for both 2010 and 2011.

Central charging area	**2011 £m**	**2010 £m**
Income	286	312
Toll facilities and traffic management	102	144
Administration, support services and depreciation	10	10
Total revenues	**174**	**158**

It follows that in London, the operating costs take up between 50 and 60% of the total revenues (with an important year-on-year difference), and that in the year 2007/08 almost 40% of the revenues where due to enforcement income, despite the increase in the charge[31].

It would appear that the cheapest road charging system (expressed as a percentage of operating income) is operated in Oslo (10-11%) and Milan has the most expensive system (55% of revenues). However, when comparing these percentages, it should be borne in mind that cost definitions differ between countries, certain costs may be included in one scheme and not in another. The figures might look different if they could be standardised, which sadly is not the case. In all cities, revenues from the system are used to invest in infrastructure and public transport services, which increases public acceptance.

Impacts on the urban economy

For both London charges, research into the effects in the charging zone on local businesses (e.g. retail sales) appears to show no significant changes. Transport for London indicates that these effects are particularly hard to separate from other economic impacts (such as cyclical patterns and local, national and global economic trends).

[31] The penalty charge consisted of a £60 fine, rising to £120 if delayed (in 2007/2008; the charge at the time was £8). Source: TfL Annual reports

In Singapore, post-ALS implementation surveys found that the ALS apparently did not adversely affect labour availability (as also the quality and availability of public transport increased enormously). Also, it appears that the ALS did not, by itself, initiate changes in business conditions or location patterns. Overall, the business community responded positively to the ALS.

In Stockholm, the trial was too short to have significant influence on land use, real estate prices and regional economy. During implementation of the system, no monitoring of the impacts mentioned is performed. Surveys of business leaders suggested that charges are likely to be a minor factor in influencing these dimensions. Also, no identifiable impacts on retail business or household purchasing power were identified. The trial showed that consumers overall did not shop less neither outside or inside the charging zone.

Improvement of the quality of life in the cities

All in all, not much is known about the improvement of the quality of life in cities that have implemented a road charging system. CEDR (2009) notes that during the Stockholm trial, changes in traffic volumes were not large enough to lower perceived noise levels to a clearly noticeable degree. In Oslo, noise nuisance was reduced where new roads were built as tunnels.

Distributional impacts

Equity / distributional impacts are important factors in political discussions surrounding the (possible) introduction of a road charging scheme. Political and public acceptability of these kinds of schemes depends heavily on their distributional effects. Lump sum payments for certain populations segments are sometimes used to compensate for these distributional effects to gain public and/or public support.

The majority of Londoners (>90%) did not feel they had been affected to any significant extent by the scheme in the central area. For the western extension the surveys show little evidence of signs of social exclusion (in terms of access to goods and services) as a result of the charging policy, mainly due to the level of availability and use of alternative transport modes. In the latter case, 16% of Londoners indicated that they thought they had benefited from the scheme and also around 16% indicated that they felt they had lost.

Equity discussions on the Oslo toll ring are primarily related to the high number of road users which do not pay. All trips that are fully within the toll ring and fully outside it, avoid the fee. Less than 30% of the trips in the area pay toll; the others benefit without contributing.

In Stockholm, equity implications have been assessed by looking at the direct road user effects: changes in travel time and increases in travel costs. It is concluded that all groups studied experience an economic loss on average. Statistically, one was “hit hardest” by the congestion tax if one was an affluent, employed male living in a household with two adults and two children in the inner city or Lidingö.

5.2.4 Synthesis

Congestion charging schemes that have been implemented and analysed above differ widely regarding scope, technology and impacts. Despite these differences, there are some general conclusions that can be drawn from the assessment of existing schemes. Local circumstances will have an effect on the impacts, but the overall conclusions on impacts are transferable to other situations and are expected to be valid for new schemes as well.

Most importantly; for all cases the charge had an impact on the number of entries in the charged area, which has decreased. Similar effects have occurred for congestion figures, which have decreased in all cases. Furthermore, the higher the fee, the higher the impacts of the systems. Little information on impacts on environmental effects is available and this information is not straightforward as they intertwine with the effects of other (environmental) measures.

Combining the different types of socio-economic impacts presented above, it can be concluded that no serious socio-economic impacts in terms of losses for retail businesses or losses of job opportunities have been reported in the case studies. Accidents are reduced significantly and the operating costs differ considerably between cities (ranging from 10-55% of operating revenues, although direct costs comparisons cannot be made). Cities tend to use at least part of the revenues for infrastructure investments and improvement of public transport services. Equity considerations are reported, but it remains a political discussion how to weigh the impacts on different groups.

5.3 Parking pricing instruments

In this section we discuss the mobility, environmental and socio-economic impacts of parking pricing instruments. Two types of instruments are considered: increases of charge levels (parking fees) and differentiation of those levels according to environmental characteristics of the car (e.g. air pollutant emission figures). In section 5.3.2 we first discuss the potential impacts of parking charges. Next, we present the results of a brief literature review of the impacts of parking policies in section 5.3.3. In section 5.3.4 the various impacts of the parking charges implemented in the case studies are discussed. Finally, based on the results from the previous sections we estimate the impacts of parking charges in section 5.3.5.

5.3.1 Introduction on parking policies

Parking policies are a common feature in most major European cities, but the literature on parking policies however is less extensive than on road pricing. A reason for this might be that parking policies are very local and generally not supported by national policies or national research institutions.

Parking policies are very much area based; they have their major impact on the area that is covered: less cars, less parking spaces, less traffic looking for a free space, less environmental impact of cars in that specific area. To a lesser extent the impact will be on the general amount of car traffic or traffic on the roads in and out the area. The cities in the stakeholder consultation noted that the turnover of parking spaces is also very important to them; they should not be occupied by one vehicle for the whole day.

Parking policies extend to three highly separated fields:

1. The roads that are open for traffic and under control of a local authority. The parking space on them can be governed by paid parking and this forms the central theme of this study.
2. The parking spaces on private ground, only accessible with permission of the owner and outside the direct control of the local government. By putting limits on these spaces in the construction permits the local government helps create a more sustainable city. This part of the parking policy is not covered in this study.
3. The parking spaces open for the general public but outside the direct control of a local government. These parking places are mostly in car parks and they allow to create cities with no parked cars on the streets; they form an active part of most parking policies. The general

impact on the environment is limited and therefore these policies fall outside the scope of this study.

Concentrating on the first type of parking policy (on-street paid parking) another distinction needs to be made. Many cities distinguish between residents (and to a lesser extent commuter traffic) and visitors. In many cases residents get an annual permit for on-street parking which is much cheaper than what non-residents have to pay for parking in the same space. When discussing the effects on mobility this distinction is relevant.

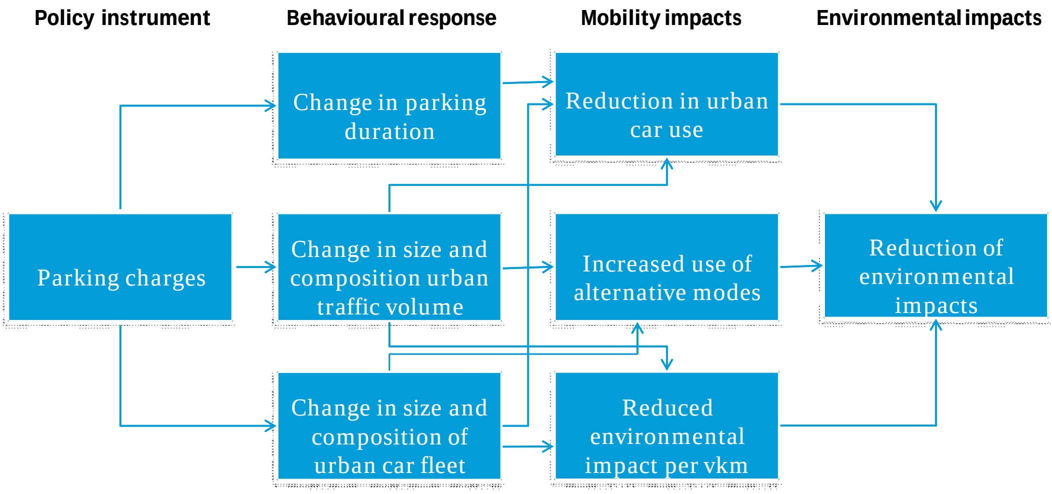
5.3.2 Potential impacts of parking charges

Policies with respect to parking charges may result in several mobility and environmental impacts. In this study we distinguish the following impacts (see also Figure 5.3):

- *Change in size and composition of the car fleet;* an increase of parking fees may result in an increase of the total cost of ownership of a car and hence in a reduction of the number of vehicles. Differentiating the parking charges according to the environmental characteristics of the car may stimulate consumers to buy a more environmentally friendly car. These are both long-term effects, which will be mainly affect car users who park regularly in the area (or areas) concerned (parking licensees). In some areas however the effect of parking policy on car ownership is very direct. For instance in the city of Amsterdam there is a maximum on the number of permits for residents. Many applying for a permit are on a waiting list and are effectively banned from buying a car (the nearest parking place that can be used without a permit is miles away). Car ownership in these areas is extremely low: only 30% of the households has a car (DIVV, 2011)
- *Change in size and composition of urban traffic volumes*[32]*;* policies with respect to parking charges may stimulate people to change their car use, e.g. by using public transport or a bike instead of their car, parking outside the parking policy zone, travelling to another city, not travelling at all. In case of an increase of the parking charges a reduction of car kilometres to and in the parking policy zone will result, while in case of a differentiation of the parking charges a change in the composition of the car kilometres may result (shift to 'cleaner kilometres'). Additionally, an increase in parking charges may result in extra kilometres travelled by public transport and cycling. Finally, an increase of parking charges may lower the occupancy rate of parking spaces, which in turn may reduce the amount of traffic by cars searching for a parking space.
- *Change in parking duration;* increases in parking fees may result in a reduction of parking duration. In this way the supply of available parking spaces will increase which may attract additional cars, provided the local authorities do not use the space for other purposes. If they don't, this may be regarded as a rebound effect of higher parking charges. But if the space is available at a higher fee, it may also discourage extra cars.

[32] This entails cars travelling within a city, as well as to that city.

Figure 5.3: Potential mobility and environmental impacts of parking policies



The size of the mobility impacts of parking pricing measures depend on various factors (Booz, Allen and Hamilton, 2006) , including:

- Current pricing levels and changes in the price level. It has been shown that increasing an already high price of parking by a certain percentage will have more effect than increasing a relatively low price by the same percentage.
- The attractiveness of travel and parking alternatives. Four variables apart from pricing itself are:
  - Proportion of commuters whose employers pay for parking
  - Availability of public transport
  - Availability and quality of cycling and pedestrian infrastructure
  - Availability of uncontrolled parking supplies (e.g. neighbourhood streets, vacant lots, etc) to where car users may divert under pricing strategies.

As shown in Figure 5.3 the mobility impacts[33] will results in a reduction of the environmental impacts. Different environmental impacts are:

- A decrease of air pollutant emissions due to a reduction of car use and a shift to cleaner cars (reduced environmental impact per vehicle km). The increased use of public transport may have a negative impact on the reduction of air pollutant emissions (in case additional buses have to be deployed; or trams, trains etc. which may have upstream emission effects), but as for road user charging schemes this effect is expected to be much smaller than the positive effects of the other two mobility impacts.
- A decrease of CO_2 emissions due to a reduction of car use and a shift to more fuel efficient cars (in case parking charges are differentiated according to CO_2 emission figures of cars). However, as mentioned in section 5.2.1, CO_2 emissions have a global impact and therefore the impact of

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[33] The impact of “Reduction in urban car use” also has the effect of creating more space for other elements such as green areas (grass, trees, etc.). This can also be a goal of a parking policy, but this is not explicitly taken into account in the policy instrument of “Parking charges” in this case.

parking charges on CO_2 emissions should be considered at a broader scale, also taking additional CO_2 emissions due to extra traffic in other parts of the city or in other cities into account. For that reason the contribution of parking charges to the decarbonisation of transport is significantly lower than its contribution to the improvement of the inner city air quality.
- A change in noise emissions; a reduction of traffic volumes may result in lower noise emission levels. However, this reduction may be partly undone if the number of buses or trams and of motorised two-wheelers (which produce higher noise levels than passenger cars) increases due to the shift to public transport.

Next to mobility and environmental impacts, parking pricing policies may also have socio-economic impacts.

- *Lower congestion levels and improved accessibility of the city (centre)*; the reduction in traffic volume due to parking pricing measures may result in lower congestion levels and improved accessibility of the area because of the removal of less necessary car traffic (mostly commuting). Furthermore, more space can be created without further need to invest in road infrastructure. A differentiation of parking charges to environmental characteristics of the car will probably have no impact on congestion levels and accessibility of the city centre.
- *Less traffic accidents*; the reduction in the total number of vehicle kilometres will probably improve the traffic safety in the parking policy zone. However, in the areas bordering the parking policy zone traffic safety may deteriorate due to increased traffic volumes and unclear traffic situations as a consequence of parked cars.
- *Revenues from parking charges*; an increase in parking charges may increase parking revenues. However, due to behavioural effects (reduced demand for parking spaces, shorter parking duration), the revenue will not increase at the same rate. In the case of differentiated parking charges, the impact on revenues depends on the actual design of the measure. Is the measure is designed in a revenue neutral way or not?
- *Implementation and operating costs*; parking measures will have implementation costs (e.g. adjustments of ticket machines) and may result in higher operating costs (e.g. higher monitoring / inspection costs). On the other hand; cities might profit from their parking policy. These revenues acquired can for instance be used for improving the quality of biking or public transport. These kind of indirect (positive) effects are not covered in this study.
- *Impacts on the urban economy*; a possible decrease in the number of visitors to the inner city may have adverse impacts on the urban economy. On the contrary, better accessibility of the city centre (including additional free parking spaces) may boost the urban economy. The value of private parking space could increase, thereby creating or stimulation a market for private parking.
- *Improvement of the quality of life in the cities*; a reduction in traffic and hence improved air quality and traffic safety may improve the quality of life in parking policy zones (also see remark on this in the footnote on the mobility impacts in figure 5.3).

5.3.3 Literature

In this section we present the main results of the literature review of the impacts of parking pricing measures. Three types of impacts are distinguished: mobility, environmental and socio-economic impacts.

Mobility impacts

The mobility impacts of parking pricing measures[34] are often expressed in terms of parking price elasticities, i.e. the ratio between the percentage of change in some mobility or parking demand parameter and the percentage increase in parking charges[35]. No specific parking price elasticities are available with respect to car ownership. However, in the literature some fixed cost elasticities of car ownership are available (see Table 5.9), which could be used as a proxy for parking price elasticities of car ownership[36]. These elasticities imply that an increase in the fixed cost car costs due to a price increase of parking licenses of 10% results in a decrease of the number of cars owned by parking licensees of about 1%. These elasticities could also be used to estimate the impact of a differentiation of parking charges on the composition of the car fleet. This was done by CE Delft (2010), which provides an ex-ante evaluation study of a revenue neutral differentiation of parking charges to air pollutant emissions of cars. The analysis carried out in this study shows a limited shift of parking licensees to 'clean cars' (e.g. cars with a particulate filter) . About 1% of the licensees decide (on the long term) to choose for a clean car[37].

Table 5.9 Overview fixes cost elasticities of car ownership

Study	Elasticity	Description
De Jong et al. (1990)	–0.13	Estimated by using a theoretical model
Boose and Van Wee (1996)	–0.1	Estimated by using a theoretical model

The impact of parking pricing measures on the amount and type of car use in parking policy zones can be expressed by two types of elasticities (see Table **5.10**): parking price elasticities of the number of vehicle kilometres in the parking zone[38] and parking price elasticities of the number of car trips in the parking zone. In Table **5.10** we also present parking price elasticities of the demand for parking places. These elasticities are closely related to the two types of parking price elasticities mentioned above. However, there is one crucial difference between these elasticities: an increase of parking charges may stimulate people to park outside the parking zone in which case the demand for parking places in the parking zones decreases, but the number of vehicles kilometres will probably not decrease (or at a lower rate).

[34] It is pointed out that there are different ways of paying for parking (for instance licenses, meters, etc.)

[35] It should be noted that the elasticity of a visitor is likely to differ from that of a residential license holder, assuming that the cost of temporary parking will be significantly higher then that of a permit. This is not taken into account for the elasticities mentioned here.

[36] Costs of parking licences could be considered fixed annual costs of car ownership. Note that parking pricing measures may particularly stimulate parking licensees to give up their car or to buy another (more environmentally friendly) type of car.

[37] In the researched parking charging schemes three categories of cars are distinguished: normal cars, clean cars (petrol cars manufactured after 1990 and diesel Euro 4 with particulate filter or Euro 5 cars) and very clean cars (electric, natural gas).

[38] Notice that these elasticities show the net impact of parking charges on the number of vehicle kilometres travelled in the charging zone, i.e. next to the reduction in vehicle kilometres due to a fall in car traffic in the charging zone also the additional vehicles kilometres due to cars searching for a 'free' parking space are taken into account.

Table 5.10 Overview of parking price elasticities

Study	Elasticity	Description
Parking price elasticity of the number of vehicle kilometres		
Delcan et al. (1999)	–0.15	Estimated by expert guess by the Canadian National Roundtable on the Environment and the Economy (NRTEE)
TRACE (1999)	–0.07	Estimated by using a theoretical model; weighted average for various travel motives.
Parking price elasticity of the number of car trips		
Vaca & Kuzmyak (2005)	–0.1 to –0.3	Based on a literature review
Booze et al. (2003)	–0.011	Based on empirical research of parking/transport data for Canberra
Hensher & King (2001)	–0.015 to –0.541	Based on empirical research of parking/transport data for Sydney
TRACES (1999)	–0.16	Estimated by using a theoretical model; weighted average for various travel motives.
Parking price elasticity of the demand for parking places		
Vaca & Kuzmyak (2005)	–0.1 to –0.6 (–0.3[a])	Based on a literature review
Kelly & Clinch (2005)	–0.29	Based on empirical research of parking data for Dublin
Kelly & Clinch (2003)	–0.11	Parking price elasticity of. parking frequency; based on empirical research of parking data for Dublin
Shoup (1994)	–0.15	Parking price elasticity of commuters' demand for parking places. Based on various empirical studies.
Feeney (1998)	–0.32 or lower	Parking price elasticity of commuters' demand for parking places. Based on survey in Washington DC.
Kulash (1974)	–0.20	Parking price elasticity of demand for off-street parking places; Empirical study carried out in San Francisco.

[a] The figure between brackets is most frequently found in the literature

Table 5.10 shows that most parking price elasticities are in the range of –0.1 to --0.3, indicating that an increase in the parking charges by 10% results in 1-3% less car kilometres in the parking zone. Although not mentioned in Table 5.10 the value of parking elasticities depends on the purpose of the car trip. For example, TRACE (1999) shows that parking elasticities with respect to shopping trips are higher than with respect to commuter trips, which might be explained by the fact that there are more options to avoid parking for shopping trips than commuter trips (e.g. by visiting other shopping areas / malls, combining shopping trips, etc.). TRACE also mentions that elasticity values increase if the quality and availability of public transport increases or the trip length decreases (i.e. short car trips are more price sensitive than long car trips).

As mentioned in section 5.2.1, parking pricing measures may also affect the average parking duration of a car. This is illustrated by Clinch & Kelly (2003), who find an elasticity of parking frequency which is smaller (–0.11) than the elasticity of total parking duration (total time parking spaces are occupied).

Finally, some studies provide estimates of the impacts of parking pricing measures on the use of alternative modes. These impacts are often expressed in terms of cross elasticities, i.e. the percentage change in the use of an alternative mode as a function of the percentage increase in parking charges. TRACE (1999) finds cross elasticities with respect to public transport use and cycling / walking which are in the order of +0.02. This implies that the use of public transport and slow modes is rather insensitive to changes in parking charges. Hensher and King (2001) present comparable elasticity values with respect to public transport use for areas in Sydney which are not popular places to park a car. However, for popular parking areas a cross elasticity with respect to public transport use of +0.29 is found. This indicates that increasing parking charges in inner cities may result in significant increases of public transport use, while increasing parking charges in other parts of the city (for which the accessibility by public transport is poorer) will not affect public transport significantly.

Environmental impacts

The environmental impacts of parking pricing measures are assessed by various studies. CROW (2011) provides an ex-ante assessment of different kinds of parking measures in three Dutch cities. Among other measures, this study estimated the mobility and environmental impacts of both a flat increase of parking fees (not differentiated by emission class of the vehicle) by 50% and a revenue neutral differentiation of the parking fees (the differentiation was based on fuel type and emission class of the car). Both measures were applied to on-street parking and parking licenses. The flat increase of parking charges resulted in a decrease of PM_{10} and NO_x emissions in the parking zone of 1–4%. These emission reductions were mainly caused by a decrease in vehicle kilometres (ca. 4–11%) of passenger cars initially parking on-street. The emission reductions in the case of a differentiated parking charge are significantly higher, ranging from 1– 6%. The reduction in vehicle kilometres (2–5%) is smaller than for a flat parking charge increase, but thanks to the shift of vehicle kilometres to ‘cleaner vehicles’ the reduction of air pollutant emissions is larger than for a flat parking charge increase.

In CE Delft (2007 and 2011) ex-ante environmental impact analyses of environmentally differentiated parking charges are carried out. CE Delft (2007) finds a reduction of PM_{10} and NO_x emissions in the whole city (both inside and outside the parking policy zone) of ca. 1% and 0.2% (no emission reduction for the parking zone is given). CE Delft (2011) estimates a reduction of PM_{10} and NO_x emissions in the parking zone of 1–2% and 0.5–1% respectively. These emission reductions are significantly lower than the ones estimated by CROW (2011), which is due to different designs of the parking pricing measure in these studies[39].

Socio-economic impacts

As mentioned in section 5.3.2, parking charges may result in several socio-economic impacts. In the literature the largest attention is paid to the impact of parking charging measures on the local economy. Based on a review of several national and local studies, COST (2005) concludes that there is little evidence to support the hypothesis that parking regulation adversely effects and area’s economic viability. Although in the short term parking regulation can harm the local economy, in the longer term (but within 12 months) the economy recovers to the same level as before any change was introduced. This low sensitivity of local economies to parking regulation is due to the fact that visitors select their destination mainly based on its quality and its attractiveness and the parking situation has only a minor factor (see Goudappel Coffeng, 2004). However, this does not imply that

[39] The effectiveness of differentiated parking charges depends heavily on the way the charges are differentiated. The larger the difference in tariff levels for clean cars and other cars, the more effective the measure will be.

parking charges will never harm the local economy. Particularly, the economy of (smaller) cities with centres which don't have unique qualities and which face strong competition of neighbouring cities, may be vulnerable to parking regulation (Booz, Allen, Hamilton, 2006; COST, 2005).

With respect to the investment and operational costs of raising parking charges, CROW (2011) mentions that these costs are negligible, particularly if compared to the additional revenues collected by the local government. Introducing parking fees may require rather large investments, but cost estimates are not available in the literature. However, it may be expected that these costs will be recovered by the revenues collected by the local governments. In case of implementation of differentiated parking charges, significant costs of replacing (old) car park ticket machines may occur. CROW (2011) roughly estimates the investment costs of these machines at € 10,000 per machine. The number of machines needed is a function of the design of the parking lot or garage, or if it is on-street. Additionally, the costs of monitoring and enforcing the parking fees may slightly increase. On the other hand, parking fee revenues will probably not increase if differentiated fees are implemented; revenues may even decrease if a large shift to cleaner cars is realized. To implement this measure in a revenue neutral way, an (ex-ante) increase of fee levels is probably needed.

Finally, no empirical evidence is found in the literature with respect to the impact of parking charges on congestion levels or traffic safety.

5.3.4 Case studies

In this section we discuss the main impacts of parking pricing measures from the case studies. As mentioned in chapter 2, detailed evaluation studies on the impacts of paid parking schemes are scarce. Actually, only for the Amsterdam scheme reliable quantitative estimates on the impacts of parking measures are available. Therefore, the quantitative impact assessment of the parking charges will be mainly based on the results observed in the Amsterdam case. This quantitative assessment will be supplemented by more qualitative results from the other case studies.

Mobility impacts

The case studies on paid parking show that parking pricing measures may result in significant reductions in the total number of vehicle kilometres in the city. According to Ecorys (2010) the increase of parking charges by on average 27% in Amsterdam resulted in a decrease of vehicle kilometres of at least 3.8%. This suggests a parking elasticity of at least –0.14, which is in the range of elasticity values found in the literature (see section 5.3.3). For the parking pricing measures in Strasbourg and Pécs evidence of a reduction in vehicle kilometres exist. In Strasbourg a policy package (described below) resulted in a decrease of vehicles entering the city of 28% over a period of 18 years. In Pécs the introduction of a zone-modal parking system with an increase of the average level of parking fees (and the introduction of limited parking time) shows a 20% decrease in the number of cars using parking facilities in the inner city.

For Strasbourg some evidence on the impact of parking pricing measures on the urban modal shift is also available. The share of cars in total urban transport declined by 6% (from 52% to 46%) in the period 1997-2009, due to the implementation of a set of transport measures, including extension of the tram network, improvement of the bus network, realisation of P+R facilities and city centre parking garages, creation of pedestrian zones, improvement of cycling and walking facilities and parking pricing measures. Both the shares of public transport and slow modes (walking and cycling) increased in this period. Although it is not clear which part of this modal shift can be attributed to paid parking , it is likely that this policy significantly contributed to the modal shift realised. For Graz some evidence is available as well on a modal shift from the car to public transport and the bike which is at least partly explained by parking pricing measures. The enlargement of the paid parking zone in Graz in 2004 contributed to a modal shift of 2% from the car to public transport and the bike in the period 2004-2008.

Finally, the Pécs case study shows that parking pricing measures also result in lower average parking times. These reduced by 20–30% due to the introduction of paid parking fees.

Environmental impacts

For Amsterdam the impact of increased parking charges on NO_2 and PM_{10} concentrations is estimated by Ecorys (2010). Based on the assumption that the total NO_2 and PM_{10} emissions of passenger transport in the city decreased by the same percentage as the number of vehicle kilometres (at least 3.8%), concentrations on road-level are estimated for the whole city. It is calculated that the NO_2 and PM_{10} concentrations decrease on average by 0.2 to 0.3 mg/m^3 and 0.0 to 0.1 mg/m^3, respectively.

For Strasbourg and Pécs no data on environmental impacts of the parking pricing measures are available. However, It may be expected that the reductions in vehicle kilometres due to parking measures may also result in lower emissions.

Finally, the introduction of differentiated parking charges in Graz (parking charges for low emission cars are lower than for other cars) resulted in reductions of both air pollutant emissions (NO_x and PM) and CO_2 emissions. This could probably be explained by a shift to smaller and cleaner cars. Unfortunately, it was not possible to calculate the relative emission reductions.

Socio-economic impacts

Only for Amsterdam evidence on the socio-economic impacts of parking pricing measures are available. Ecorys (2010) indicates that the parking measures had no substantial negative impacts on the social and recreational activities of the residents in the paid parking zone. However, a significant number of inhabitants (particularly elderly and people with lower incomes) of this area indicated that the measure had a negative impact on their social visits, they were visited less frequently or at other times.

5.3.5 Synthesis

Parking pricing measures may result in several mobility impacts. The literature review and the case studies show that paid parking measures result in a decrease in the number of vehicle kilometres and the number of car trips in the paid parking zone. The size of this impact can be summarized by a parking price elasticity of -0.1 to –0.3, indicating that an increase of the parking charges with 10% may result in a reduction of vehicle kilometres of 1% to 3% (depending on the policy and the amount of visitors). Part of this effect is realised by a shift from cars to public transport and slow modes (walking, cycling). No data were found for the impact of paid parking on the number of vehicle kilometres outside paid parking zones.

The reduction in vehicle kilometres and the modal shift to public transport and slow modes results in improvements of the air quality in the paid parking zones. The size of this impact depends heavily on the design of the parking measures. However, from the literature it is known that in general differentiated parking charges (based on air pollutant emission figures of the car) are more effective in terms of air pollutant reduction than increases of flat parking fees. The assessment also shows that the parking pricing measures result in a decrease of the CO_2 emissions in the paid parking zone. However, as mentioned in 5.3.2, CO_2 emissions have a global impact and therefore the impact of parking charges on CO_2 emissions should be considered at a larger scale, also taking additional CO_2 emissions due to extra traffic in other parts of the city or in other cities into account. Unfortunately no empirical evidence on the latter impacts is available.

Finally, the socio-economic impacts of parking pricing measures have been assessed. The available empirical evidence shows that the impacts on local urban economies is probably small. The case study for Amsterdam shows that these measures also have little impact on the social and recreational activities of the residents in the paid parking zone, although they receive on average less social visits.

These conclusions on the impacts of parking pricing measures are transferable to other situations and new schemes, although the precise impacts can differ and depend on many local circumstances like demographic and socio-economic characteristics and the availability, price and quality of alternative transport options.

6 Conclusions and recommendations

The conclusions of this study are divided into three parts: conclusions on the impacts of pricing measures in an urban context (6.1), lessons for practical implementation (6.2) and the comparison with the IMPACT handbook (6.3). Paragraph 6.4 provides recommendations for both cities considering to implements a pricing scheme and for the European Commission.

6.1 Impacts of pricing measures

The analysis of the case studies shows that the charge levels are set in rather pragmatic way and were never explicitly based on external cost estimates. The general theoretical pricing principles (e.g. marginal social cost pricing, Baumol, Ramsey etc.) have not been used to set charging levels for road charging and paid parking. Internalisation of external costs caused by urban transport, i.c. paying for the negative impacts caused through the use of transport, has not been an explicit goal for cities and regions.

It is noted that the theoretical approach of internalisation certainly has its value, but that in the development of a scheme much wider and also more pragmatic arguments play a role. Based on the case studies and the available literature, this does not seem to be a problem in developing a pricing scheme; the goals as set by cities when designing a scheme seem to be reached by the pragmatic approach. Internalisation policies on urban roads are currently not subject to EU Directives.

The case studies allow for a comparison of impacts of urban road charging schemes and paid parking schemes, corrected for autonomous growth of traffic and impacts of other policy measures. The mobility impacts are rather well documented, environmental impacts are not always reported, and information on socio-economic impacts (accidents, urban economy etc.) is scarce.

The cases on road user charges show that the charge level differs widely. Typically the charge for cordon charging[40] ranges between about € 2 per area visit to maximum € 10.7 per day with most of the cases in between the range change € 2 to € 8 per day (all price level 2010 and PPP adjusted). The mobility impacts have been expressed in change of number of vehicles. It is concluded that the charging schemes do pay off, since a decrease in number of vehicles occurs. The higher the charge, the higher the impacts, ranging from 7% decrease in number of vehicles for the lowest charge (around € 2 per day) to 45% decrease in number of vehicles for higher charge levels (around € 7 per day).

Concerning the case studies on paid parking, it is concluded that detailed evaluation studies of the impacts of paid parking are lacking, with the exception of the city of Amsterdam. The size of this impact can be summarized by a parking price elasticity of -0.1 to -0.3. Part of this effect is realised by a shift from cars to public transport and slow modes (walking, cycling). No data were found for the impact of paid parking on the number of vehicle kilometres outside paid parking zones.

[40] Paid for entering an area, as opposed to distance-based charging where the actual distance is taken into account for the height of the charge.

Despite the lack of extensive evaluation studies, the available evaluations show that parking policy on the whole can be very effective in reducing the external costs of cars in specific areas. Parking is little studied and relatively little professionally discussed (related to the impact), but widely used across the world.

Both for congestion charging schemes and parking pricing policies the conclusions and estimated impacts are transferable to other situations and new schemes. However, the precise impacts also depend to some extent on local circumstances like demographic and socio-economic factors and the availability, price and quality of alternatives for private car transport.

6.2 Lessons for practical implementation of measures

In implementing an urban road charging scheme several lessons emerge from the case studies, the literature survey and the stakeholder consultation. Most prominently, setting an appropriate configuration of the charge scheme (level and structure) is difficult and no one-size-fits all solution seems to exists, due to local (amongst other things) geographical, historical and political circumstances. This lack of one-on-one transferability is recognized by both cities and stakeholder organisations, making it difficult to indicate general success and fail factors. However, within this limitation both urban road charging and parking policies in practice prove to be self-financing schemes, that are capable of reducing substantial negative externalities of urban mobility.

Reasons for implementing a pricing scheme differ amongst cities, but both stakeholder organisations and cities see congestion and air pollution as the most important negative externalities of urban mobility.

Earmarking the revenues from a scheme for transport is regarded as promising, helping to raise the public acceptance of a scheme. Using the revenues to improve public transport seems favourable; this creates alternatives for using the car, and by doing so creates public acceptance.

Some individual road charging and paid parking cases also show other interesting aspects which could be marked as best practices. In Singapore the on board units for the electronic road charging system have been made available for free. In Pécs the public acceptance of a paid parking scheme is high, because of the centre being a sensitive cultural heritage, which similarly counts for the road charge in Durham's old city centre.

Setting an appropriate charge level can be facilitated through a (temporary) trial case to test the impacts, as shown in the Stockholm case. Organising a trial case also has the advantage to facilitate the acceptability of the charging scheme. If the scheme shows positive results, in particular less cars on the road, less congestion and less noise, this will improve the general attitude of citizens towards the scheme.

A success factor that stands out is the importance of monitoring and enforcement; both are considered critical in ensuring an effective scheme and creating sufficient public acceptance. Informing the public and incorporating the pricing scheme in integrated urban mobility solutions are regarded as promising policies towards the successful implementation of a scheme. Interestingly, the majority of the consulted cities for this study indicate that the general public has not been consulted ex ante by means of a public consultation, a survey or otherwise.

6.3 Comparison of the results with the IMPACT study

If a comparison is made on the charge levels that are applied with the cost estimates that were presented in chapter 3, they seem on a aggregated level reasonably consistent. The charge levels of congestion charges are in the range of € 1,7 per entry to € 10.7 per day. In chapter 3, we have seen that the external congestion costs are usually the dominant costs in urban areas. These costs are not internalised by any other measure and are in the range of 10 cents to 2 Euro per vehicle-kilometre. This means that even in the case of relatively low driving distances in the charging area (like 5 to 15 km), the charged level of several Euro per entry is in a reasonable range when compared to the congestion costs.

To assess in more detail whether the charge levels reflect well the marginal external costs in each of the cases, congestion cost estimates for the charging areas of these cases would be required. As it lacks such estimates, this comparison can not be made. However, at a more aggregated level we can conclude that the charge levels are within reasonable ranges when compared with the typical estimates for congestion costs in urban areas.

The IMPACT handbook concluded that congestion costs depend strongly on local circumstances and should be estimated on a case by case basis. The case studies show that also for the charging schemes that have been implemented, the levels differ widely and are decided case by case. Although this is not done on the basis of estimates of the congestion or other external costs, these existing schemes are rather effective in reducing the external effects. From a theoretical perspective one could question whether higher or lower charges would be beneficial. However, it should be noted that such a theoretical approach is very complicated and still relatively uncertain.

Recommendations on the IMPACT handbook on external costs

The methodological overview and recommendations as well as the external cost values provided in the IMPACT handbook could be updated and further developed with regard to cost estimates in urban areas. Particularly the definitions of rural, urban and metropolitan areas could be specified. Also a full set of cost estimates or each EU Member State and differentiated to road type and vehicle type would be useful. Furthermore, a complete overview of road infrastructure cost estimates in urban areas is currently missing. However, as noted above, urban pricing schemes are generally not explicitly based on external cost estimates, so in that respect the update of the handbook is not a necessity for further development of urban congestion pricing and parking fees.

To the extent this is feasible, it is recommended to base charges/taxes on the best available external cost estimates and to use these estimates in ex ante/ex post evaluations. Cities that have further information on the (future) use of external costs estimates for pricing schemes are recommended to share this information with the European Commission as this may help to improve the data basis on external costs and internalisation in urban areas.

6.4 Recommendations

Cities: clear policy goals, measures and revenue spending

First of all, for any city investigating implementing road charging or paid parking, it is important to clearly define the policy goals. Reducing the negative externalities from urban transport is probably one of the major goals to keep the cities accessible, attractive and liveable. Urban congestion is seen as an important externality, together with air pollution.

Several policy measures can be used to reduce congestion, in most cases a combination of measures is seen; road charging in combination with public transport quality enhancement, or access restriction measures in the city in combination with an increase of parking fees. Incorporating a pricing scheme into integrated urban mobility solutions is deemed favourable not only by cities but also by stakeholder organisations.

If road charging or a parking policy is implemented, it is important to communicate how the revenues are spent. We have observed that cities differ on how revenues are spent: on public transport, on infrastructure or as general public expenditure on the other. Using the revenues for public transport has the advantage of creating alternatives for car usage, thereby increasing the public acceptability of the scheme itself. Raising public awareness and acceptance are considered important for the success of a pricing scheme. Clear communication on how revenues are addressed is therefor essential for public acceptability.

Cities: importance of road charging trial case and monitoring

The conclusions of this study showed that the direct transferability of pricing schemes between cities should be treated with care. However, we have seen evidence of the fact that (at least) the level of mobility impacts vary with different pricing strategies within the urban road charging schemes. A charge of less than € 1 per day (PPP adjusted) will not yield significant results[41], a charge of around € 7 per day leads to substantial decrease of number of vehicles in the charging zone (up to 45% decrease).

Implementing a road charging scheme in a city remains a tailor made solution. It is recommended to test a foreseen scheme through a well-communicated trial case period, in order to judge if the anticipated results occur. If not, the structure of the charge or the level of the charge can still be adjusted to achieve the policy goals. The trial phase can also greatly contribute to the acceptability of the scheme; if indeed the number of cars decreases, and one can actually see this on the streets, the public will probably be more favourable towards the charging scheme.

In order to determine whether a scheme (be it road user charging or paid parking policy) has any effect, monitoring is essential. The cities of London (road user charge) and Amsterdam (paid parking policy) are good examples of how to (extensively) monitor the effects of a scheme; Singapore focusses its monitoring on traffic efficiency and not on environmental effects. Depending on the goals of the scheme and the available resources, a city can choose to what extend it wants to monitor the impacts before and during the implementation. Apart from creating acceptability (before introduction), monitoring also allows for the ability to determine whether the scheme helps achieving policy goals (during implementation), thereby increasing acceptance.

An additional advantage of trials and monitoring, is that the data acquired allows for the sharing of experiences and lessons learned; what worked for which circumstances, what was the effect of a certain change, etc.? When more and more cities implements trials and monitor the effects of schemes, the transferability of the different schemes will increase, allowing cities to build on the experience others have had.

[41] Due to this euro not being able to cover the implementation costs of a scheme. With information technology progressing, the costs of implementation will drop, making it potentially possible in the future to have a costs recovering scheme with a one euro charge.

Role of the European Commission

First of all, the role of the EC could be focused on supporting or stimulating the development of smart charging, e.g. by gathering and dissemination of best practices. Coordination with the work done in the field of inter-urban pricing is required, with a view to achieving synergies and mutual learning, as exemplified by the case of the Impact Handbook. Although difficult due to the limited transferability, the stimulation of well designed and implemented pricing schemes can also be performed through 1) research and 2) overlapping EU policies:

1. Research on parking is limited, whereas almost every European city uses parking to internalise external costs. The link of both parking policies and urban road charging schemes with for instance spatial planning has not been studied in much detail, while the need for integrated urban planning is stipulated by all stakeholders. European studies into these elements of internalisation of external costs could provide useful insights for both local, regional and national governments, as well as for the Commission herself.
2. EU policies such as the Intelligent Transport Systems (ITS) action plan and the Action Plan on Urban Mobility, and actions related to Cohesion Policy show a clear overlap with the internalisation of external costs of urban mobility such as congestion, pollution and maintenance of infrastructure. The Common Strategic Framework addresses this issue and proposes specific key actions to Member States and Regions for projects that will be carried out between 2014 and 2020**.** This allows for EU funding of both research and specific elements of both road user charges and parking policies (such as the stimulation of the use of intelligent digital systems).

At this moment there is no need for existing stakeholders to have any EC legal requirements with regard to the design of internalisation measures. Also from the perspective of subsidiarity this seems not desirable for stakeholders.

Possible future role of the EC

Overall we can discern 4 levels of policy interventions for the EC:

1. Increased/adapted regulatory measures (harmonisation: technology, charging regimes)
2. Increased coordination (between different cities, between related types of policy interventions)
3. Improved communication / additional promotion of best practices (attract more cities)
4. Do nothing, continue current policy

Given the apparent positive results of our study (cities implementing pricing schemes have observed substantial reduction of mobility related externalities) and the viewpoints of the stakeholders that have reacted within the framework of this study, we conclude that the first policy action for the EC can be positioned on the second and third level.

However, assuming that the number of cities implementing pricing schemes is likely to increase we expect that there might be a need for a more regulatory role (level 1) for the EC. Without trying to be exhaustive, we could expect regulation in areas like the harmonisation of charging/payment technologies and/or charging regimes (for instance charging based on GPS or license plate registration and differentiated in time and place, payment by cell phone or credit card, etc.), to prevent a patchwork of technologies and/or regimes across Europe. However, these steps will become relevant only if a substantial larger amount of cities have introduced similar pricing schemes.

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Annex A: Summary of valuation methodology per cost category from IMPACT

Summary of valuation methodology per cost category (from IMPACT handbook)

Cost component	Cost elements	Critical valuation issues	Cost function	Data needs	Main cost drivers
Congestion costs (road)	• Time and operating costs • Add. safety and environmental costs	• Speed-flow relations • Valuation of economically relevant value of time (reliability)	• Increasing marginal cost in relation to traffic amount, depending on time of the day/week/year and region	• Speed-flow data • Level of traffic and capacity per road segment	• Type of Infrastructure • Traffic and capacity levels, mainly depending on: time of the day, location
Scarcity costs (scheduled transport)	• Delay costs • Opportunity costs • Loss of time for other traffic users	• Valuation approach as such (opportunity costs, willingness to pay, enlargement costs, optimisation model)	• Increasing marginal cost in relation to traffic amount, depending on time of the day/week/year and region	• Level of traffic, slot capacity per Infrastructure segment	• Type of Infrastructure • Traffic and capacity levels, mainly depending on: time of the day, location
Accident costs	• Medical costs • Production losses • Loss of human life	• Valuation of human life • Externality of self accidents in individual transport • Allocation of accidents (causer/victim related)	• Only limited correlation between traffic amount and accidents; other factors (such as individual risk factors and type of Infrastructure)	• Accident database • Definition of fatalities and heavy/slight injuries very important	• Type of Infrastructure • Traffic volume • Vehicle speed • Driver characteristics (e.g. age, medical conditions, etc.) • Others
Air Pollution	• Health costs • Years of human life lost • Crop losses	• Valuation of life years lost • Market prices for crops	• Correlation with traffic amount, level of emission and location	• Emission and exposure data (exp. PM, NO_x, SO_2, VOC)	• Population and settlement density • Sensitivity of area • Level of emissions,

	• Building damages • Costs for nature and biosphere	• Valuation of building damages • Valuation of long term risks in biosphere			dep.on: • Type and condition of vehicle • Trip length (cold start emissions) • Type of Infrastructure • Location • Speed characteristics •
Noise costs	• Rent losses • Annoyance costs • Health costs	• Valuation of annoyances	• Declining marginal cost curve in relation to traffic amount	• Noise exposure data (persons)	• Population and settlement density • Day/Night • Noise emissions level, depending on: • Type of Infrastructure • Type and condition of vehicle
Climate change	• Prevention costs to reduce risk of climate change • Damage costs of increasing temperature	• Long term risks of climate change	• Proportional to traffic amount and fuel used (marginal cost close to average cost)	• Emission levels	• Level of emissions, depending on: • Type of vehicle and add. equipment (e.g. air conditioning) • Speed characteristics • Driving style • Fuel use and fuel type
Up- and downstream processes	• Costs of the whole energy cycle (environmental and risk effects of energy supply)	• Valuation of long term energy risks, such as climate change and nuclear risk	• Rather proportional correlation with traffic amount and (marginal cost close to average costs)	• Data on energy processes and electricity mix	• Level of indirect energy need • Electricity mix (level of non renewables)

Annex B: Case studies urban road charging

CASE STUDY DURHAM

General background

In October 2002, Durham City Council introduced a charge for vehicles entering the historic centre of the town of Durham; the Durham Road User Charge Zone. Although the charge only applies to a single road, it is the first road pricing scheme to be implemented in the United Kingdom. The toll consist of a £2 charge for vehicles using Saddler Street and the Market Place between 10am and 4pm, Monday to Saturday. Saddler Street is a narrow road, and is the only public access to the historic centre which lies on a peninsula (surrounded by the River Wear) an contains a cathedral and a castle (which have designated World Heritage Status), several colleges, businesses and private residences. The primary objectives of the measure were to[42]:

- Improve pedestrian safety
- Improve access for the disabled
- Enhance the World Heritage Site
- Preserve the viability of the peninsula as a working part of the city centre.

The toll is charged on exiting the area on, and is monitored by Closed Circuit Television (CCTV) using Automatic Number Plate Recognition (ANPR).Payments can be made up to 6pm the next day at the National Car Parks Parking Shop. Several exemptions exist, for instance for public utility vehicles on emergency duty, the Dean and Chapter of Durham Cathedral and residents of the peninsula. High frequency users can acquire a transponder, so the system can automatically detect them and lower the bollard. The penalty for non-payment is £30, and vehicles can be tracked through the Driver and Vehicle Licensing Agency (DVLA). In addition to the charging system, aiming to decrease the traffic flow into the city centre and its sights, the previously underused bus service into the area (The Cathedral Bus) was extended and enhanced.

The red line in the figure below shows Saddler Street, which can only be exited and exited from the north side (shown at the top of the map; the black stripes are footpaths). The total length of the charged zone is roughly one kilometre.

[42] Durham County Council, 2003, pp.3

External costs

The charging system is (as described in the previous paragraph) predominantly aimed at mobility and conservation of touristic nature. The focus of the scheme is therefor mainly on accessibility, and not so much on external costs. Surveys have been conducted in order to measure traffic flows (car, bus and pedestrian) and data on accidents. Furthermore, data was gathered on retail sales and tourists visiting the cathedral.

Impacts

Mobility

Not much data is available on the Durham scheme. Data on vehicles entering and exiting the area has been gathered by a private company, both before (in 2001) and after the system was introduced (2003). The following conclusions can be drawn from data acquired up to July 2003 (9 months after the introduction of the charge):

- The number of vehicles entering the area in the first eleven months (October 2002 till August 2003) was 5732 per month on average. This is a daily average of 239 vehicles[43].
- The amount of cars entering the area has sharply decreased (figures from the City Council monitor show a range of almost 50 to 85%), but exact and elaborate figures are not provided[44].
- The number of pedestrians increased by about 10% on average, going from 14.000 – 14.500 a day up to 15.000 – 16.500[45].
- On average, there are little over 3 collision per month with the bollard (that regulates the cars going into and out of the area) over the period of October 2002 up to August 2003. Numbers on accidents involving pedestrians are not available[46].

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[43] Durham County Council, 2003, pp. 9
[44] Durham County Council, 2003, Chart 3
[45] Durham County Council, 2003, Chart 13
[46] Durham County Council, 2003, Chart 16, and pp. 14

Environment

No data is available on environmental effects of the charging scheme.

Economy

No clear figures are available on exact revenues and costs of the scheme[47]. Revenues made from the charging has been used to support the extend and enhance the bus line to the city centre[48].

Social

A year before introduction of the scheme, roughly 50% of people living in Durham felt that the access charge would be a good idea. This number has grown to 70% after introduction of the scheme. There has been a reduction of 25% in the number of people who feel that the scheme was and those who still think it is a bad idea. 78% of the people interviewed after introduction felt that Durham has become a safer place for pedestrians, which is a 10% increase from the figures before implementation.

Comparability and transferability

Context data

- *Time of implementation:* October 2002
- *GDP/capita[49] (Durham County 2005):* 24% below EU 27 average
- *Population size (Durham County):* 87.100[50]
- *Car ownership:* 71.9%

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[49] Source: County Durham Statistical Profile, 2008, pp. 12
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CASE STUDY LONDON

General background

On February 17 2003, the London Congestion Charging Scheme (LCCS) was implemented in the city centre of London. The scheme was intended to achieve four of the Mayor of London his transport priorities, which were to[51]:

- Reduce congestion;
- Make radical improvements to bus services;
- Improve journey time reliability for car users; and
- Make the distribution of goods and services more efficient.

Before implementing the LCCS, a study was performed to assess different possibilities of introducing a road user charge[52]. The options considered covered various geographical areas (from Greater London to Central London) and included a range of technologies (from paper permits to full electronic road pricing). From this assessment followed a preferred option, which consisted of an area license scheme, enforced by digital camera's and number plate recognition[53].

When introduced in 2003, the so-called Charging Zone (CZ) encompassed an area of approximately 22 square kilometres, and was expended with the Western Extension in 2007, to an area of approximately 42 square kilometres. The scheme is an area licensing scheme: users pay a daily charge to enter or be within the charging zone, after which they can enter and exit the area as often as they want during the charging period. The charge was set at £5 per day in 2003 and raised to £8 in July 2005. Both discount rates (for instance 90% discount for residents of the area) as well exemptions to the charge exist (a list of vehicles is exempted, amongst which two-wheeled vehicles, taxis, public transport vehicles and vehicles used by disabled people). Registration is performed by means of camera's using Automatic Number Plate Recognition (ANPR). The time-window for the charge initially was from 7.00 till 18.30 on weekdays, and was changed to 7.00 till 18.00 on weekdays in February 2007 (together with the introduction of the western extension). Payments can be made on several possible ways, including online and via SMS, and have to be paid the day of entrance at the latest (fines are applied for failing to do so). As of 2011, automatic payment is possible, requiring registration.

Following a public consultation in which 67% of the 280.000 respondents indicated they wanted the extended levy zone to be removed[54], the in May 2008 newly elected Mayor, removed the western extension as of January 2011. Additionally, the Mayor implemented several changes to the original charging area (the main change being an increase of the area charge to £10 per day). This case study shows, where possible, data of both the situation from 2003 up to 2007 (without the western extension) as well as data from the situation from 2007 up to 2010 (including the western extension), where possible compared to the situation prior to introduction. Unfortunately no data on the situation as of January 2011 is available yet.

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[51] Taken from CURACAO (2009), pp. 21

[52] Road Charging Options for London: A Technical Assessment (2000), author unknown

[53] Apart from looking at road user charges, the report also looks at a workplace parking levy: a charge on employers for providing parking for their staff and visitors. This has not been implemented in London, but as of the 1st of April 2012, the City of Nottingham is the first city in the UK to make use of such a levy. http://www.telegraph.co.uk/motoring/news/9179055/Tax-on-workplace-car-parks-begins-in-Nottingham.html

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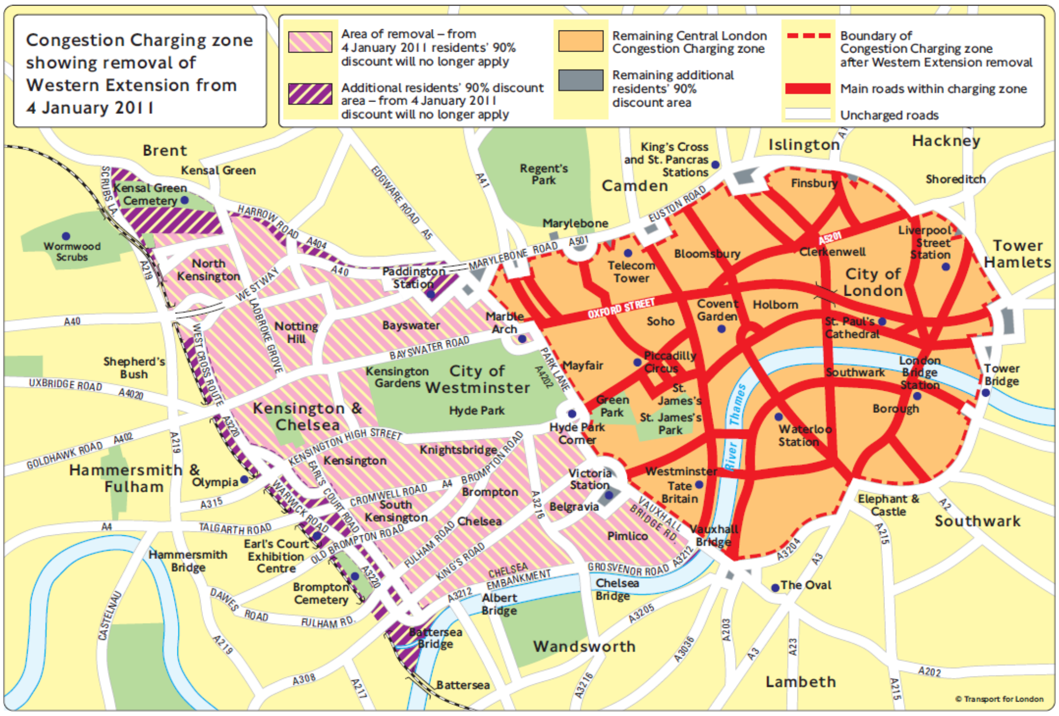

External costs

An important remark on the subject of externalities, is the fact that in 2008 the Low Emission Zone (LEZ) was introduced in the Greater London area (covering almost 5000 square kilometres, including the area in which the LCCS is applied). This was introduced "to encourage the most polluting diesel vehicles" entering London "to become cleaner"[55]. Aimed at reducing the amounts of particulate matter, the LEZ has an effect on the air quality in the area. Any shown improvement on air quality is therefore not solely contributable to the LCCS.

Transport for London (TfL; the local governmental body responsible for most aspects of the transport system of Greater London) set up an extensive programme of impacts monitoring. The monitoring is aimed at gaining understanding and appreciation of the direct and indirect effects of the LCCS, and consist of monitoring the range of traffic and other transport, and of social, economic and environmental impacts of congestion charging[56]. Managed by a team of TfL staff, the data is largely gathered by independent contractors.

Data on traffic flows and types is gathered by the Closed Circuit Television (CCTV) which is linked to the automatic number plate technology in order to acquire vehicle registration data upon entry of the area. A database stores the data until payments are performed.

Impacts

Mobility

Mobility data as provided by the TfL, in their annual reports on the LCCS. Their latest report at the time of writing was the sixth, published in the summer of 2008 and using data up to the end of 2007. More recent data is unfortunately not publicly available yet. Data on congestion is expressed

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[55] Transport for London, About the LEZ, http://www.tfl.gov.uk/roadusers/lez/, visited on December 15 2011.

[56] Transport for London (2008), pp.10

in an excess travel rate (expressed as minutes per kilometre - the inverse of speed), which is the difference between the travel rate during uncongested hours and those during charging hours.

Central charging area data[57] (mainly compared with data from the spring of 2002, roughly a year before the LCCS was implemented):

- Overall, there was a decrease in chargeable vehicles from the moment of implementation, but figures have been stable since: from roughly 180.000 cars and minicabs on average for charging hours flow (7.00-18.00) before implementation, to around 120.000 after the system was taken into usage.
- Non-chargeable vehicles either shown a slight annual increase (bicycles: an annual increase of about 7-8%, leading to a 66% increase from 2002 (15.000) till 2007 (25.000), buses: changing figures, but an increase of 31% from 2002 (14.000) up to 2007 (18.000)) or no real changes (taxis and powered two-wheelers).
- There have been only minor changes in the amounts of vehicle kilometres driven in the central charging area. The only significant increase can be seen in vehicle kilometres made by lorries (9%) and bicycles (17%).
- A baseline figure for a hypothetical uncongested travel rate is set at around 1.8 minutes per kilometre, on top of which congestion delays are added, which then act as the comparable data (the before mentioned excess travel rate).
- Calculating congestion figures this way, the TfL finds a reduction of around 30% in congestion for the year after implementation (2.3 minutes per kilometre in 2002 compared to 1.6 minutes per kilometre in 2003). Up till 2007, congestion has increased slightly, and is currently around the levels of post charging.
- Given that traffic volumes have been reduced consistently, it is concluded that it must be the case that the increased congestion from summer 2007 reflects removal of effective road network capacity, on a temporary (e.g. road works) or more permanent basis.
- Figures on the amount of collisions, the severity and the involvement of pedestrians do not show any significant changes over time attributable to the introduction of the charging area. Absolute figures are differentiated in many forms, and there are several disturbances in the data that make it hard to compare subsequent years with each other (for instance different forms of data gathering by the supplying institution, the London Accidents Analysis Unit).
- The number of bus passengers in the central charging area saw an increase of around 15.000 the year of introduction (2003: from roughly 88.000 to 103.000 passengers) in the morning peak period (7.00 – 10.00). The years after this, this figure has remained stable at around 110.000 passengers during the morning peak. In 2007 the number was 113.000 passengers. Average bus speeds have continued to decline since 2003, with an overall reduction of 14 per cent. Buses in the central area are on average 8 per cent slower than before charging was introduced, which is related to the increased congestion figures.
- Figures on the usage of other public transport modes (the underground and the national rail) show no significant changes due to the congestion charge.

Western Extension data[58] (mainly compared with data on the area from the year before the extension was implemented, 2006):

- 195.000 vehicles per weekday entered the area in 2007, a reduction of 14% compared to 05/06. Non-chargeable increases varied between 0% (taxis) and 12% (bicycles).
- The daily driven vehicle kilometres driven within the area during charging hours decreased by roughly 10% in 2007 compared to 2006: from 1.02 million vehicle kilometres in 2007 compared to 1.12 million in 2006.

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[57] Ibid, pp. 39-51
[58] Ibid, pp. 16-38

- Overall, more non-chargeable vehicles enter the area than expected, mainly vehicles with residents' discount.
- Traffic on boundary routes has been stable, and there have been overall reductions to traffic across an area around the extension zone
- The introduction of the extension realised a decrease of around 20% in excess travel time (from around 2.5 minutes per kilometre in 2006 to 2 in 2007). Similar as with the central area congestion, there is however an increase in congestion visible, but since the data only shows figures up to the first quarter of 2008, no real conclusions can be drawn yet.
- Figures on the amount of collisions, the severity and the involvement of pedestrians do not show any significant changes over time attributable to the extension of the charging area. Absolute figures are differentiated in many forms, and there are several disturbances in the data that make it hard to compare subsequent years with each other (for instance different forms of data gathering by the supplying institution, the London Accidents Analysis Unit).
- The figures on bus patronage show an overall increase in bus usage, comparing the years 2004/2005 and 2007/2008 (24 hour average day):
    - The amount of passenger journeys increased by 23.000, from 291.000 to 314.000
    - The amount of passenger kilometres increased by 82.000: from 1,032 million to 1,114 million
    - The amount of bus kilometres operated increased by almost 5.000: from 45.300 to 50.200
    - The average passengers per bus shows a decrease of half a passenger on average: from 22.7 to 22.2.
- The average bus speed in the extension area showed no real change compared to the year before introduction (2006): roughly 10.6 kilometres per hour. This is suspected to be due to the congestion effects in the area.
- Figures on the usage of other public transport modes (the underground and the national rail) show no significant changes due to the extension of the congestion area.

Environment

Data on air quality indicators are very much differentiated (showing multiple measuring points and mainly graphs instead of absolute figures), making it hard to draw general conclusions or to provide absolute figures. Overall percentages are however provided, which show the following[59]:

Central charging area (2003 compared to 2002)**:**
- 16% emissions abatement for CO_2
- 8% emissions abatement for NO_x
- 6% reduction in PM_{10} emissions

Due to increasing congestion, new vehicles (with higher Euro emissions standards) and traffic volume changes, these numbers will probably have been reduced in intensity over subsequent years.

Western extension (2007 compared to 2006):
- Negligible emissions abatement for CO_2
- 1.48% emissions abatement for NO_x
- 1.1% and 1.5% emissions reduction for PM_{10} and $PM_{2.5}$ respectively

[59] Percentages provided by Transport for London (2008) and PWC, ISIS (2009). A request for figures has been sent to TfL on December 19th.

Economy

When the Western Extension was still in place, the financial data on the charging scheme was combined for both areas (the original central area and the western extension). It was therefore not possible to differentiate which revenues can be accrued to which part of the scheme. The table below shows the costs and revenues of the total scheme for the financial year 2007/2008, which had an overall increase in net revenue of about £55 million compared to the year 2006/2007. All net revenues have been allocated to support the Mayor's Transport Strategy (which is mandatory by law). The majority of the revenues were applied for bus network improvements (£112 million), roads and bridges (£13 million) and furthermore spent on road safety, environment, walking and cycling and borough plans (local transport improvements).

Overall outturn figures 2007/2008 in £m, complete scheme	
Costs	
Scheme operational, publicity and enforcement costs	91
Other costs: TfL staff; traffic management; TfL central costs	40
Total costs:	**131**
Revenues	
Standard daily vehicle charges (£8)	146
Fleet vehicle daily charges (£7)	37
Resident vehicles (£4 per week)	12
Enforcement income received	73
Total revenues:	**268**
Net revenues:	**137**

The following table provides a more recent picture of the revenues and costs of the central zone, showing figures for both 2010 and 2011.

Central charging area	**2011 £m**	**2010 £m**
Income	286	312
Toll facilities and traffic management	102	144
Administration, support services and depreciation	10	10
Total revenues	**174**	**158**

Research into the effects of the charging zone on local businesses appears to show no significant changes; not for the initial area, nor for the extension. Transport for London does indicate that these effects are particularly hard to separate from common economic impacts (such as cyclical patterns and local, national and global economic trends).

Social

Research into the social effects of the LCCS has mainly been performed for the western extension, not so much for the original charging area. The first specific insights into social effects are provided in the fifth annual monitor of the LCCS (TfL, 2007), but this is mainly the pre-introduction research for the western extension. Findings on the introduction of the **original charging area** are the following (Transport for London, 2007, pp. 223-224):

- The majority of Londoners (>90%) did not feel they had been effected to any significant extend by the scheme.
- Residents of the area itself tended to recognize the benefits of the scheme.

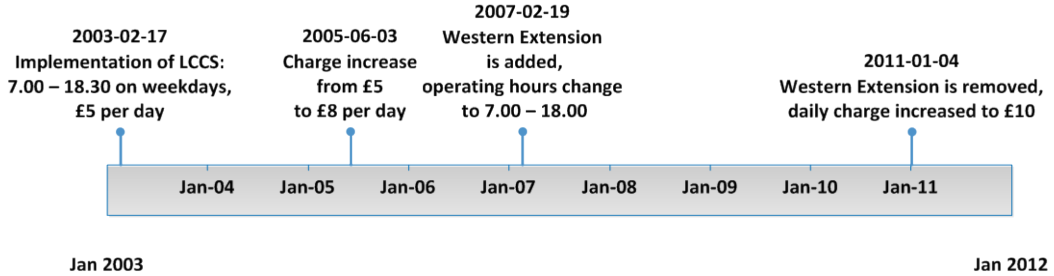
- Transport effects that respondents felt most negative about where mainly unrelated to the scheme, parking being a key concern.
- In depth discussions with frequent users of the charging area showed that they generally felt that the scheme had been more successful than they had expected in reducing congestion, and that their journeys had become more reliable.

Main conclusions, combining surveys performed before and after the introduction of the **western extension**, are the following (Transport for London 2008, PWC, ISIS 2009):
- One of the main findings is that there has been a reduction of the amount of trips into the charging area, particularly for leisure and social purposes.
- The surveys show little evidence for signs of social exclusion (in terms of access to goods and services) as a result of the charging policy, mainly due to the level of availability and use of alternative transport modes.
- 16% of Londoners indicated that they thought they had benefited from the scheme, and about one in six (also around 16%) indicated that they felt they had lost.

Comparability and transferability

Several elements of the LCCS are worth mentioning:
- Several through going roads exist, which are uncharged, and show stable figures concerning the amount of traffic using them.
- Large amounts of data are acquired, for instance also on effects in surrounding areas. Although not all very straightforward and/or scientifically usable, this does provide some interesting insights in the London case.
- As mentioned in the text, in 2008 the Low Emission Zone has been introduced. This is suspected to have an effect on the measured air quality of the charging area as well.
- As of January 2011, the Western Extension has been removed, meaning that the charging area is as it was at the original time of introduction in 2003.

Context data:
- *Time of implementation*:



- *GDP of Inner London area (2008)*[60]: € 267 billion
- *Car ownership:* 0.33 per inhabitant
- *Population size*[61]*:* 3.06 million inhabitants (Inner London area)
- *Modal split*[62]*:*
  - Walking: 31.4%
  - Cycling: 2.0%

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[60] Source: Eurostat," Regional gross domestic product (million EUR), by NUTS 2 regions", http://epp.eurostat.ec.europa.eu/tgm/table.do?tab=table&init=1&language=en&pcode=tgs00003&plugin=1
[61] Office for National Statistics, 2009 Midyear estimate
[62] Source: PWC, ISIS 2009, pp. 320. Unclear whether these figures are pre-implementation or after introduction of the scheme.

- Bus: 14.3%
- Light rail: 0.5%
- Metro: 7.2%
- Commuter rail: 4.8%
- Car (incl. passengers): 37.9%
- Motorcycle/scooter: 0.6%

Sources used:

CURACAO (2009), “Deliverable D3: Case Study Results Report”, Coordination of Urban Road User Charging and Organizational Issues, University of Leeds for the EC Curacao Project, U.K., 2009.

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CASE STUDY LOS ANGELES

General background[63]

High Occupancy Toll (HOT) lanes in the United States are lanes where tolls are applied on low occupancy vehicles wanting to use lanes which are free to use for high occupancy vehicles (HOV). High occupancy is usually defined as vehicles with two or more occupants. The State Route 91 (SR-91) Express Lanes in Los Angeles, which opened in December 1995, were the first practical example of congestion pricing in the United States and the embryo example of HOT lanes. The tolls varied according to a pre-set schedule and by 1998 they had evolved to a highly sophisticated level of variation.

The SR-91 Express Lanes extend 16 km between the Orange/Riverside county line and the Costa Mesa Freeway (SR-55) interchange in eastern Anaheim. In July 2003 a toll policy for the SR-91 Express Lanes based on the concept of congestion management was implemented. Tolls are set to optimize traffic flows.

On May 19, 2003, the Orange Country Transportation Authority adopted the “Three Ride Free” policy. This innovative policy encourages carpooling by allowing a group of three or more commuters per vehicle to travel the 91 Express Lanes for free during most hours, except when traveling Eastbound, Monday through Friday between the hours of 4:00 p.m. and 6:00 p.m. At these times, carpools of three or more can still save money by earning a 50 per cent discount on the posted toll.

As of 2008, there are over **20 different charges** according to day of the week, time of the day and travelling direction. Being an innovative policy, the case has been subject to extensive analysis. Studies range from assessment of changes in travel behaviour among different socioeconomic groups as a result of the implementation of the express lanes, social benefit–cost analysis for the SR-91 and comparison of the regressive impacts of the SR-91 tolls with those from the Orange County’s local option transportation sales tax. As of 2008, there are an additional seven HOT lane projects in operation in the United States.

Tolls Effective October 1, 2011:

[63] Based on Santos and Verhoef (2010)

Toll Schedule – Effective October 1, 2011 – **Eastbound** – SR-55 to Riverside Co. Line

	Sun	M	Tu	W	Th	F	Sat
Midnight	$1.30	$1.30	$1.30	$1.30	$1.30	$1.30	$1.30
1:00 am	$1.30	$1.30	$1.30	$1.30	$1.30	$1.30	$1.30
2:00 am	$1.30	$1.30	$1.30	$1.30	$1.30	$1.30	$1.30
3:00 am	$1.30	$1.30	$1.30	$1.30	$1.30	$1.30	$1.30
4:00 am	$1.30	$1.30	$1.30	$1.30	$1.30	$1.30	$1.30
5:00 am	$1.30	$1.30	$1.30	$1.30	$1.30	$1.30	$1.30
6:00 am	$1.30	$2.10	$2.10	$2.10	$2.10	$2.10	$1.30
7:00 am	$1.30	$2.10	$2.10	$2.10	$2.10	$2.10	$1.30
8:00 am	$1.65	$2.10	$2.10	$2.10	$2.10	$2.10	$2.10
9:00 am	$1.65	$2.10	$2.10	$2.10	$2.10	$2.10	$2.10
10:00 am	$2.55	$2.10	$2.10	$2.10	$2.10	$2.10	$2.55
11:00 am	$2.55	$2.10	$2.10	$2.10	$2.10	$2.10	$2.55
Noon	$3.05	$2.10	$2.10	$2.10	$2.10	$3.15	$3.05
1:00 pm	$3.05	$2.90	$2.90	$2.90	$3.15	$4.85	$3.05
2:00 pm	$3.05	$4.15	$4.15	$4.15	$4.25	$3.10	$3.05
3:00 pm	$2.55	$4.45	$3.70	$3.95	$5.45	$9.75	$3.05
4:00 pm	$2.55	$4.55	$5.80	$7.30	$8.95	$8.85	$3.05
5:00 pm	$2.55	$4.85	$6.25	$7.50	$8.80	$7.00	$3.05
6:00 pm	$2.55	$4.45	$3.60	$3.60	$4.40	$5.35	$2.55
7:00 pm	$2.55	$3.15	$3.15	$3.15	$4.55	$5.00	$2.10
8:00 pm	$2.55	$2.10	$2.10	$2.10	$2.90	$4.55	$2.10
9:00 pm	$2.10	$2.10	$2.10	$2.10	$2.10	$2.90	$2.10
10:00 pm	$1.30	$1.30	$1.30	$1.30	$1.30	$2.10	$1.30
11:00 pm	$1.30	$1.30	$1.30	$1.30	$1.30	$1.30	$1.30

Toll Schedule – Effective October 1, 2011 – **Westbound** – Riverside Co. Line to SR-55

	Sun	M	Tu	W	Th	F	Sat
Midnight	$1.30	$1.30	$1.30	$1.30	$1.30	$1.30	$1.30
1:00 am	$1.30	$1.30	$1.30	$1.30	$1.30	$1.30	$1.30
2:00 am	$1.30	$1.30	$1.30	$1.30	$1.30	$1.30	$1.30
3:00 am	$1.30	$1.30	$1.30	$1.30	$1.30	$1.30	$1.30
4:00 am	$1.30	$2.45	$2.45	$2.45	$2.45	$2.45	$1.30
5:00 am	$1.30	$4.00	$4.00	$4.00	$4.00	$3.85	$1.30
6:00 am	$1.30	$4.15	$4.15	$4.15	$4.15	$4.00	$1.30
7:00 am	$1.30	$4.60	$4.60	$4.60	$4.60	$4.45	$1.75
8:00 am	$1.75	$4.15	$4.15	$4.15	$4.15	$4.00	$2.10
9:00 am	$1.75	$3.30	$3.30	$3.30	$3.30	$3.30	$2.55
10:00 am	$2.55	$2.10	$2.10	$2.10	$2.10	$2.10	$2.55
11:00 am	$2.55	$2.10	$2.10	$2.10	$2.10	$2.10	$2.95
Noon	$2.55	$2.10	$2.10	$2.10	$2.10	$2.10	$2.95
1:00 pm	$2.95	$2.10	$2.10	$2.10	$2.10	$2.10	$2.95
2:00 pm	$2.95	$2.10	$2.10	$2.10	$2.10	$2.10	$2.95
3:00 pm	$2.95	$2.10	$2.10	$2.10	$2.10	$2.55	$2.95
4:00 pm	$3.10	$2.10	$2.10	$2.10	$2.10	$2.55	$3.10
5:00 pm	$3.10	$2.10	$2.10	$2.10	$2.10	$2.55	$3.10
6:00 pm	$3.10	$2.10	$2.10	$2.10	$2.10	$3.05	$2.55
7:00 pm	$2.55	$1.30	$1.30	$1.30	$1.30	$2.10	$2.10
8:00 pm	$2.55	$1.30	$1.30	$1.30	$1.30	$1.30	$1.30
9:00 pm	$2.55	$1.30	$1.30	$1.30	$1.30	$1.30	$1.30
10:00 pm	$1.30	$1.30	$1.30	$1.30	$1.30	$1.30	$1.30
11:00 pm	$1.30	$1.30	$1.30	$1.30	$1.30	$1.30	$1.30

Source: http://www.octa.net/91_schedules.aspx

External costs

The explicit goal of HOT lanes is to maintain a minimum quality of service on the tolled lanes. Therefore the only external cost really considered is congestion. Figures on emissions have been estimated through modelling.

Impacts

Mobility

An extensive evaluation of the impacts of the SR 91 variable toll express lanes has been carried out in 1998[64]. The study investigated a four year period, collecting 18 months of baseline data against which to compare 18 month post-opening data. This evaluation focussed on travel impacts.

The express lanes attracted and maintained a substantial share of east-west traffic using the riverside freeway corridor. The total average daily weekday traffic (ADT) on the express lanes approached 37.000 vehicles per day and average weekend ADT reached 17.000 vehicles per day. The total ADT following the capacity increase resulting from the opening of 91 express lanes increased 14 per cent in the first year. Based on travel surveys, 21 per cent of total increase in ADT represent travellers who previously diverted to arterial routes that returned to SR-91 due to improved traffic conditions, 20 per cent represents secular growth trends and 59 per cent represents induced demand. It is unclear if autonomous traffic growth has been included in the impact analysis.

The increased capacity substantially reduced peak hour congestion on the riverside freeway, giving short-term travel time benefits to all commuters in the corridor. The typical PM peak trip delay on

64 ARDFA, "Evaluating the impacts of the SR 91 Variable Toll express Lanes Facility", 1998

the uncontrolled freeway lanes fell from 30 to 40 minutes to less than 10 minutes per trip. Twelve moths later the PM peak trip increased by approximately 5 minutes to the 12-13 minutes range.

More recent information on the number of trips on SR 91[65]:

- Fiscal year 2009- 2010: 12.7 million trips and 2.9 million trips from carpoolers in HOV3+ lane
- Fiscal year 2008- 2009: 12.1 million trips and 2.8 million trips from carpoolers in HOV3+ lane

No case specific **price elasticity** (on road usage related to the price of the usage) is known for the HOT lane SR 91. Several studies have investigated the sensitivity of vehicle travel to road tolls. These indicate a price elasticity of **–0.1 to –0.4** for urban highways (i.e., a 10% increase in toll rates reduces vehicle use by 1-4%)[66]

Environment

The environmental impacts of the HOT lane SR-91 have not been measured as such. An estimation of the impacts, through modelling the mobility impacts and associated emissions, is provided in a PhD dissertation from 2000[67]. The results are mentioned below.

The major sources of emissions taken into account are reactive organic gases (ROG), nitrogen oxides (NOx) and carbon monoxide (CO). During congested periods when vehicles must accelerate and decelerate within a low range of speeds, per kilometre emissions are high. The vehicle emissions are estimated using the EMFAC2000 model.

In year 1, the baseline “no action” case produces 0,83 metric-tons of ROG per peak period. The “convert to toll lane” case produces 0,74 metric-tons of ROG, a reduction of 0,89 metric-tons of ROG emissions per perk period. In terms of NOx and CO, also less metric-tons of emissions are produced; for NOx 0,065 metric tons and for CO 8,5 metric-tons.

During a 10-year period the eliminated ROG emissions are 2.673 metric-tons, eliminated CO emissions are 24.699 metric-tons and NOx reduction is modest at 271 metric tons (the later is for a 20 year period available only).

In an additional study performed in 2006[68], emission rates for four types of pollutant species (HC, CO, NO_x and PM_{10}) were estimated on the tolled express lanes. Using the California EMFAC model the researchers estimated emissions for the afternoon period (2.30-7.30 p.m.) in the heavy traffic direction (eastbound). Apart from PM_{10} emissions which remained stable and equal to the base-scenario (consisting of two normal lanes instead of express lanes), all of the emissions increased over the estimated period (2000-2005). The researchers explain these increases to the increased speed of the express lanes, compared to the congested free lanes[69].

Economy

Toll revenue for the fiscal year 2009-2010 is $ 43,0 million USD (increase of 4.4 per cent compared to 2008-2009) over the previous year.

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65 Annual report OCTA 2010

66 Source: Victory Transport Policy Institute, http://www.vtpi.org/tdm/tdm35.htm

67 Eugene J. Kim (2000), HOT lanes, A comparative evaluation of Costs, Benefits and Performance, University of California (a PhD dissertation)

68 Sullivan and Burris (2006), Benefit-Cost Analysis of Variable Pricing Projects: SR-91 Express Lanes, JOURNAL OF TRANSPORTATION ENGINEERING, March 2006

69 Ibid, pp195.

Social

Equity: An evaluation of the SR-91 express lanes (Sullivan, 2000) found a “moderate” income effect, with the percentage of trips on the express lanes for the lowest and highest income groups (20 per cent and 50 per cent) staying the same over the 3-year evaluation period. Evaluators also found that the use of express lanes increased over time for both those who carpooled and solo drivers across all incomes. Low-income and moderate-income travellers appeared to be more selective and used the tolled route for less than half of their trips. When prices rose, people in the lowest income group did not reduce their travel, but people of moderate income did. This suggests that people with lower incomes have less flexibility in the time they travel (Kuehn, 2008), or that low-income individuals have very high values for reliable travel when they need it[70].

Comparability and transferability

The modal split in the SR-91 catchment area has not been traced. It is expected that the public transport share is modest, and road transport is the dominant mode. The study performed in 2006 indicates that despite the existence of a commuter rail line and an express bus line on the SR-91 corridor, the total public transit ridership in the corridor amounts to less than 1% of the highway traffic. The evaluation studies do not show further information on a potential modal shift due to the SR-91 express lane.

Sources used:

ARDFA, “Evaluating the impacts of the SR 91 Variable Toll express Lanes Facility”, 1998

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Victory Transport Policy Institute, http://www.vtpi.org/tdm/tdm35.htm

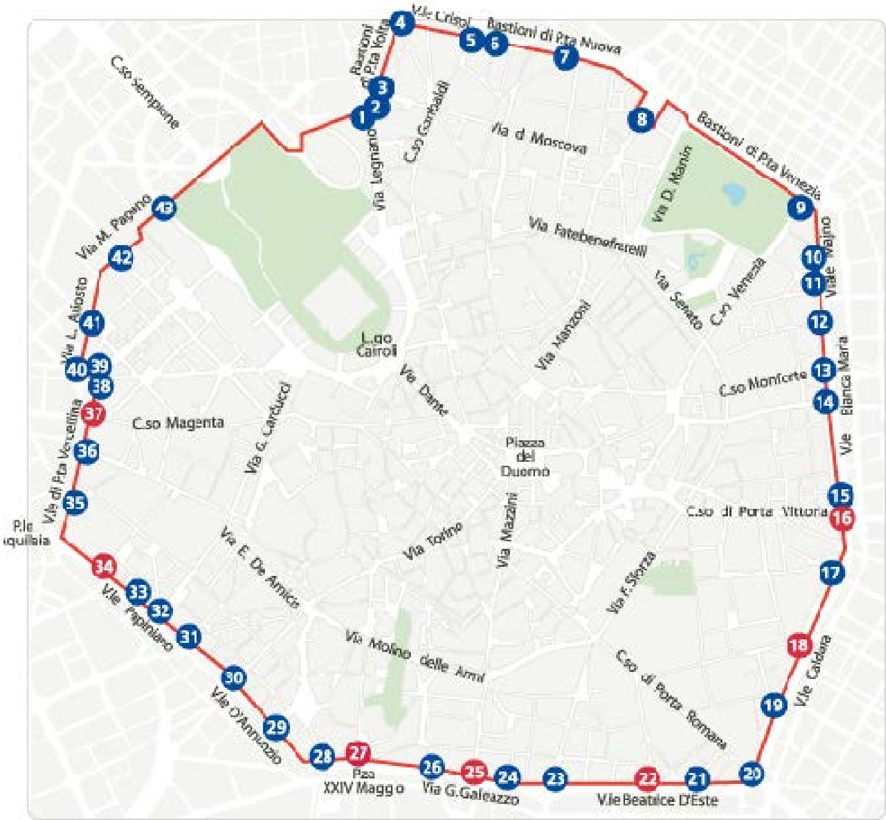
70 US Department of Transportation, Federal Highway Administration, Office of Transportation Management Federal Highway Administration, “Income-Based Equity Impacts of Congestion Pricing” A primer, 2008

CASE STUDY MILANO

General background

In January 2008, the so-called Milan Ecopass System (MES) was introduced in the Italian city of Milan. This urban road pricing system encompasses an area of roughly 8 square kilometres in the city centre of Milan, for which vehicles pay a fee upon entering the area. Milan has, what are considered to be, very high levels of air pollution[71]. These levels are due to the high reliance on car usage and adverse geographical and climatic conditions of the region surrounding Milan. The system aims to reduce this air pollution; counteracting congestion is considered a secondary objective.

The figure below shows the MES area and the entrance gates, the red gates being entrances for public transport vehicles (source: http://www.comune.milano.it/):



The fee is imposed only on cars and certain freight vehicles, differentiating the charge according to the 5 Euro emission standards and ranging from € 2 up to €10 per entrance. Discounts are available for frequent users and inhabitants of the area, and no differentiation is made in time; the system is in operation on weekdays between 7.30 and 19.30. The revenues of the system are said to be invested in sustainable traffic and a sustainable environment[72].

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[71] For instance the EU set limit of 50 µg/m3 PM10 was exceeded during 125 days in the period 2002-2007, with an average value of 51.2 µg/m3. Taken from Rotaris *et al* (2009), pp. 5.

[72] CURACAO (2007), "Deliverable D3: Case Study Results Report", Coordination of Urban Road User Charging and Organizational Issues, University of Leeds for the EC Curacao Project, U.K., 2007, pp.108.

The MES proved successful in the reduction of polluting vehicles, but after several years of implementation, congestion levels began to rise (albeit with cleaner vehicles). A referendum was held in June 2011 in which 79.12% Milan voters expressed their agreement to a scheme charging all vehicles to enter the city centre a fee. Therefore, as of January 16 2012, the MES has been replaced by the so-called Area C scheme. This scheme, operating between 7.30am and 7.30pm in the city centre, is a pure congestion scheme. All vehicles entering the zone (which is identical to the former MES area) have to purchase a € 5 ticket. Residences have 40 free daily entrances per year, and a € 2 discount from the 41st entrance onwards. Special terms are also applied to duty vehicles. Bicycles, scooters, electric cars, vehicles displaying blue badges for disabled people as well as hybrid, methane powered, lpg and biofuel cars (up to 31 December 2012) will be exempted from the charge. Euro 0 petrol vehicles and diesel fuelled vehicles Euro 1, 2 and 3 no longer have access to the city centre. The project is an 18 month pilot..

The new scheme has four objectives, underlining the overall aim of improving the living conditions of those who live, work, study in and visit the city of Milan[73]:

- decrease road traffic in the city centre;
- improve public transport networks;
- raise funds for soft mobility infrastructures (cycle lanes, pedestrian zones, 30kph zones);
- improve the quality of life by reducing the number of accidents, uncontrolled parking, noise and air pollution.

External costs

As mentioned before, the MES aimed at an improvement of negative environmental effects, more specifically air pollution caused by motorized vehicles. This is reflected partially in the height of the fee which, amongst other things, was determined by the emissions a vehicle emits (using the 5 Euro standards). Certain vehicles were exempted of the fee, also determined by the Euro standards based on emissions. Discounts existed for residents of the designated toll area and frequent users. No differentiation was made between off-peak and peak hours; the system registered (by means of automatic-number-plate-registration technology, ANPR) who enters the area on weekdays between 7.30 and 19.30.

The scheme as of 2012 does not make such elaborate differentiations. As mentioned, all vehicles (except for some) pay the same charge. Highly pollutant vehicles are banned from the city centre, and the system does differentiate between day and night, but not between on and off-peak hours.

Impacts

Mobility:

Danieles *et al* (2011) draw four overall conclusions on the matter of mobility as a consequence of the MES:

- Initially, the total number of vehicles entering the designated area decreased (before MES: 90,580 vehicles entering the area daily, 2008: 71,729), but as of 2009 they seem to increase (76,114). The expected initial positive effects on both the environment and congestion were visible, but the shown increase in vehicles might have put a halt to at least the effect on congestion.

[73] Source: Eltis, 2012, news item on website (viewed on 10-02-2012): http://www.eltis.org/index.php?ID1=5&id=60&news_id=3110

- The vehicles entering the area are becoming “cleaner” (shown in vehicles with a higher Euro standard as well as zero emission and alternative fuel vehicles), and thereby the environmental goals closer. As an overall figure, the percentage of vehicles belonging to the tolled classes (of all vehicles entering the area) is presented: 47% in 2007, 23% in 2008 and 16% in 2009.
- The amount of paying vehicles declined, from 16,332 in 2008, to 11,569 in 2010.
- Within the vehicles that pay for entrance, the percentage of freight vehicles increased from 25,6% in 2007 up to 32,4% in 2010.

The AMMA (2010, pp.45) reports a decline in both the amount of accidents and the amount of accidents in which people got injured:

- In 2007, 1.345 accidents occurred, of which 853 with injured people
- In 2008, 1.164 accidents occurred, of which 750 with injured people
- In 2009, 1.204 accidents occurred, of which 738 with injured people

A survey conducted by PWC and ISIS on behalf of DG MOVE (DG MOVE, 2010) provides some figures on traffic percentages and public transport for the first year of operations:

- Within the MES area, a traffic reduction (both private and commercial) of 17.1% was measured, and 8.4% outside the area.
- The overall average speed of public transport services within the time of operation of the system (7.30 – 19.30) increased by 8.1%

The Area C scheme has only recently been implemented, but showed its success in decreasing the number of cars in the city centre within the first twelve hours of operation: from 122.000 to 77.000 cars[74]

Environment:

The MES has had a significant positive impact on the environment, which clearly shows in the measurements of emissions:

- *PM_{10}*: In 2010, the threshold of 50 µg/m3 (as set by the EU) was exceeded on 86 days, compared to 137 days in 2007 (the year before the introduction of the MES). This is however still significantly beyond the recommendation of 35 µg/m3, as set in the European Directive 2008/50/CE.
- *$PM_{2.5}$*: The average 2010 value for these particulates was 25.1 µg/m3, slightly above the set standard of 25 µg/m3 (EU Directive 2008/50/CE).
- *NO_2:* The yearly average for 2009 was 61 µg/m3, little above the 42 µg/m3 threshold recommended by the EU (Directive 2008/50/CE).
- *O_3:* The so-called alarm threshold as set by the EU (240 µg/m3 average hourly) was not exceeded in 2010. The information threshold (180 µg/m3 average hourly) was exceeded 13 days, which is equal to the amount of days it was exceeded in 2002.
- *CO_2*: These emissions have dropped by 11% overall as a result of the MES.

Economy

In the first year of operations (2008), the MES had an overall revenue of little over 12 million euros. The operational costs for the same year were 6.5 M€, making the net revenue little below 6M€. These revenues were invested in public transport improvements. Regarding the overall costs and

[74] Source: Treehugger, online news item (viewed on 10-02-2012): http://www.treehugger.com/cars/congestion-charge-drops-traffic-37-italy.html

benefits, Danielis *et al.* (2011) provide an overview of the first three years of operations of the scheme (pp8):

	2008	2009	2010
All transport users	1.5	5.5	6.0
- passengers	5.7	8.9	9.6
- freight	-4.2	-3.4	-3.6
Social costs savings	5.8	7.0	7.2
Public finances	0.5	-1.7	-0.9
Private parking	-1	-0.8	-0.7
Total net benefits	6.9	10.1	11.6

This shows that the gains are increasing, but diminishing over time. Furthermore, the net costs for freight transport shows that the scheme penalizes freight and favours passenger transport.

Social

PWC and ISIS carried out a survey amongst 600 Milan residents after the first year of operations, showing the following results (PWC, ISIS, 2009):

- 74% of the interviewees consider the MES totally useless in reducing air pollution.
- Over 60% would be in favour of a referendum about the real benefit of city access charge
- 77% of residents interviewed thinks that alternatives measures should be considered for air pollution abatement
- 68% of the interviewees approves the proposal of Mr. Filippo Penati (President of Milan Province) to increase the highway tolls for drivers heading towards Milan with 20 eurocents, and use these incomes for improvements in PT improvements (mainly metro and trains).

Comparability and transferability

Several characteristics of the Milan Ecopass System are worth mentioning specifically. Milan has one of the highest car concentration of all cities in the world, and one of the highest concentration particle matters of large European cities (3rd). The latter is not only due to the former, but is strongly influenced by the geographical and climatic conditions of the city: there is little wind in the Pianura Padana valley (in which Milan lies), and the Northern Alps are a physical barrier for the air to clear from pollutant emissions.

Context data[75]

- *Time of implementation (MES/Area C)*: January 2008/January 2012
- *GDP/capita Lombardy region (2008)*[76]: €328222 million / 9.5 million inhabitants = €34,550 / inhabitant
- *Car/vehicle ownership*: 0.6/0.74 per inhabitant
- *Population size (2010)*:
  - Milan city: 1.9 million
  - Milan metropolis : 3.7 million
  - Lombardy region: 9.5 million
- *Modal split*[77]:

[75] Main sources: Danieles *et al* (2009) and monthly reports from the Agenzia Milanese Mobilita Ambiente (AMMA), as cited by Danelies *et al* (2009); AMMA (2010) and AMMA (2010b)

[76] Source: Eurostat," Regional gross domestic product (million EUR), by NUTS 2 regions", http://epp.eurostat.ec.europa.eu/tgm/table.do?tab=table&init=1&language=en&pcode=tgs00003&plugin=1

[77] Figures on Milan urban area, taken from Agenzia Mobilità Ambiente Territorio (AMAT), report from 2009. Unclear whether figures are predated to the MRS or not.

- Train 7.9%
- Metro 13.2%
- Tram, bus 13.7%
- Other 1.0%
- Taxi 0.4%
- Cars 33.5%
- Motorcycles 4.4.%
- Bicycles 3.0%
- Auto pax 7.3%
- Walking 15.7%

Sources used:

AMAT (2009), "VALUTAZIONE AMBIENTALE STRATEGICA", pp. 14
http://www.comune.milano.it/dseserver/WebCity/documenti.nsf/0/c54f2196adf9678cc12575ca003a5b4c/$FILE/All_Valutazioni_trasportistiche.pdf

AMMA (2010) "Monitoraggio Ecopass, Gennaio-Dicembre 2009, Indicatori sintetici (marzo 2010)" http://www.milanosimuove.it/

AMMA (2010b) "Monitoraggio Ecopass, Gennaio-Giungo 2010, Indicatori sintetici (luglio 2010)" http://www.milanosimuove.it/

CURACAO (2007), "Deliverable D3: Case Study Results Report", Coordination of Urban Road User Charging and Organizational Issues, University of Leeds for the EC Curacao Project, U.K., 2007.

Danieles *et al* (2011), "An economic, environmental and transport evaluation of the Ecopass scheme in Milan: three years later", working paper n. 1103.

DG MOVE (2010), "Study on Urban Access Restriction"

Eurostat, "Regional gross domestic product (million EUR), by NUTS 2 regions", viewed on 07/12/2011

Rotaris *et al* (2009), "The urban road pricing scheme to curb pollution in Milan: a preliminary assessment", working paper n.122.

CASE STUDY OSLO

General background

The Oslo toll ring (Oslo package 1) started in 1990. It was initially planned as an ordinary toll road to finance tunnels under the city centre. However, before it was established, the municipality of Oslo joined forces with the neighbouring county, Akershus, and opted for a package to finance several other projects as well. Later in the process, it was also decided to earmark 20 per cent of the revenue for public transport infrastructure investments. The **objective** of Oslo package 1 is to **finance investments** in infrastructure. This includes both road infrastructure and, to an increasing extent, PT infrastructure investments.

Oslo package 2 is a supplement to the existing Oslo package 1 and consists of an increase in the toll of approximately €0.25 per trip making the single fare NOK 15 (approx. €1.9). The increase is earmarked for public transport infrastructure investments. In addition, the package includes an increase in the public transport fare of approximately €0.10 per trip, earmarked for rolling- stock investments. The co-financing plan for Oslo package 2 also involved extraordinary national funding and public-private partnership funds from the redevelopment of the old Oslo airport. The objectives are still the same – to raise revenue to be used for infrastructure investments.

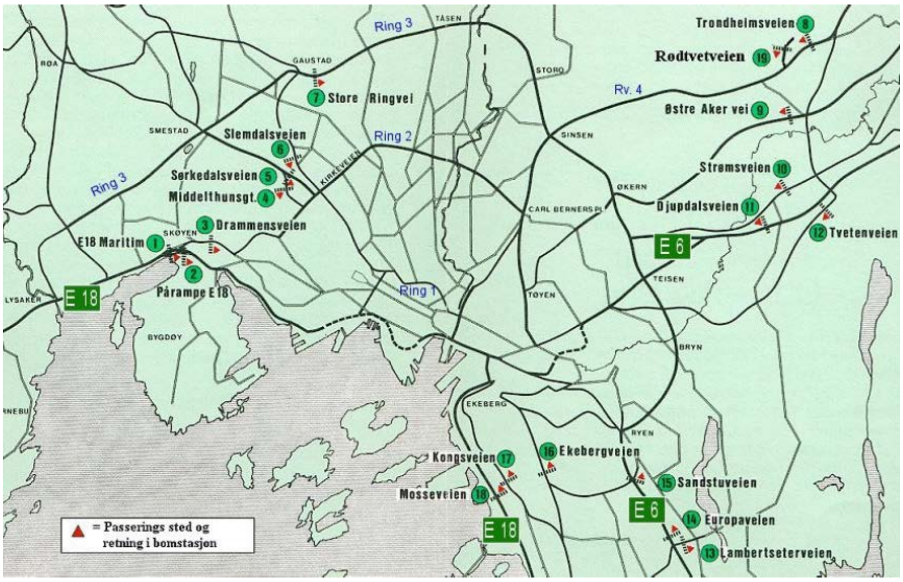

Figure 1: The Oslo toll ring with three sub-rings

The Oslo toll ring was due to end in 2007. As the end of the toll ring came closer, two alternatives were examined. Either the toll ring could be removed, as happened in Trondheim at the end of 2005, or a new toll scheme, “Oslo package 3” could be introduced. The politicians opted for the latter. In the new Oslo Package 3, the objective is still to **raise revenue for investments**. In addition the latest initiative also raises revenue for public transport operation.

External costs considered

The primary goal of the Oslo toll ring packages is to raise funds for investment in road and public transport infrastructure, as well as financing operations of public transport (package 3). The pricing objective is also reflected in the fee structure. There is no differentiation between peak and off-peak. Furthermore, the fee is also collected at weekends and nights.

No reference is made to internalisation of external costs (e.g. congestion, environment).

Impacts

Mobility

Studies of the traffic impacts of the toll ring indicate about 5 % traffic reduction the first year. In 2003 245.000 cars passed the toll ring (one way) in Oslo[78]. Nowadays **220.000 vehicles** pass the toll ring on an average day. It is unclear if the 5% traffic reduction could be fully dedicated to the toll implementation and if autonomous traffic growth has been included.

Mobility impacts have been evaluated in 2004, the following has been concluded (see also CURACAO):

- A fully connected metro system and road lanes reserved for buses have been important and effective measures for public transport.
- During the period 1990-2002 traffic growth has been slightly lower than the national average, in spite of strong growth in traditional drivers of mobility like population, employment and income. Thus, it is hard to claim that major road investments have induced new traffic in general in the region.
- There is a slight reduction in travel times during morning rush hours, but no significant change in the afternoon. Increased road capacity has thus counterbalanced the growth in traffic with a small positive margin.
- Delays vary by corridor, western and southern corridor being the worst. Road sections 10-15 km from the city centre have the largest delays. Freighters regard road accessibility to be improved.
- Oslo Packages 1 and 2 are generally considered to be success stories, but many important transport projects will not be financed by 2008. Furthermore dismantling the Oslo Toll Ring is in the short term calculated to increase road traffic by 8-10 %. The Oslo package 1 led to an immediate effect of 3-5% reduced traffic due to the toll[79].

The Oslo Package 3 has not been evaluated yet. The ex ante calculated effects for car traffic are some growth in speed and shorter rush (not permanent), for public transport less growth than for cars (more permanent) and for public transport market shares an increase of 1-2% point at the toll ring[80].

The elasticities of travel demand and users attitudes towards tolls has been studied in 19 Norwegian toll road projects, including the Oslo toll roads. A mean short-run **demand elasticity** at −0.45 and a mean long-run elasticity at −0.82 has been found. Further, elasticities seem to vary with the characteristics of projects, e.g. road type, project location, etc.[81]

Environment

On local environmental problems is concluded for Package 1 and 2 that “Air pollution levels do not seem to be negatively affected by road investments. Noise nuisance is reduced where new roads are built as tunnels. Measures to improve local environment, like traffic management, reinforce environmental effects.”[82] Overall, the effects of the Oslo packages on the local environment have

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78 Lian, Jon Inge, Impact of main road investments in Bergen and Oslo, TØI report 770/2005

79 Lian, Jon Inge, Impact of main road investments in Bergen and Oslo, TØI report 770/2005

80 Professor Dr Ing Arvid Strand, presentation, ”How Oslo is about to fail”: the case of Oslo, presentation, Institute of Transport Economics – undated

81 James Odecka, Svein Bråthena, “Travel demand elasticities and users attitudes: A case study of Norwegian toll projects”, Department of Economics, Molde University College / Norwegian Public Roads Administration, 28 August 2007.

82 Lian, Jon Inge, Evaluation of Trunk Road Investments in Oslo), TØI rapport 714/2004

been positive. This is not due to traffic reduction effects from the toll ring, but through the investments in road infrastructure. The investments have made the increase in traffic occur on the main roads rather than local roads.

Concerning global emissions, there has been a discussion to what degree improved road infrastructure induces more traffic. This may have adverse effects on the global emissions. No strong support for induced traffic from the packages is found[83].

The Oslo Package 3 has not been evaluated yet. The ex ante anticipated effects for the local environment are effects along the new tunnel lanes, some new problematic (longer) distances and still traffic growth in the inner part of Oslo. In terms of GHG emissions, the effects will be small.

Economy[84]

Since 1990, the Oslo Packages have financed parts of the road and public transport investments in the Oslo region. Package 2 has been dedicated to investments in public transport. The Government was to finance 45 per cent of the investments in Oslo Package 1.

About 40 per cent of the revenue from road user charging should be spent on public transport investments. From 1990-2001 Oslo Package 1 (funding from user charging and the state budget) financed investments for a total of 11 billion NOK (about 1.4 billion Euro).

The total operating income of the Oslo toll ring was 1,248 mill NOK (156 M€). The operating cost of the Oslo toll ring was 134 mill NOK (16.8 M€). The operating costs have stayed at 10- 11% of the operating income for the last 10 years. Having close to 93 million registered trips through the ring in 2006, this makes the operating cost per trip to be 1.4NOK (0.2€).

Social

Equity discussions for the Oslo toll ring are primarily related to the high number of road users which no not pay. All trips within the toll ring and outside the toll ring avoid the fee. Less than 30% of the trips in the area pay toll. The rest benefit without contributing.

Each year since opening a survey of attitudes towards the toll ring has been carried out among the citizens in Oslo and Akershus. The sample is randomly selected among the population, with roughly 1000 interviews carried out each time by telephone. There is no overwhelming public support for the packages. Acceptance has, however, increased over time since each scheme was introduced.

Comparability and transferability

Context data[85]:

City Dimension:

- Just over 1 million people currently live in the two counties of Oslo and Akershus, which cover a total of 5,400 square kilometres.
- Population (2010): 586,860
- Area: 4269 km2
- Population density: 159.6 inhab./km2
- Cars per 1000 inhabitants: 368.6

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83 Ibid

84 CURACAO (2007), “Deliverable D3: Case Study Results Report”, Coordination of Urban Road User Charging and Organizational Issues, University of Leeds for the EC Curacao Project, U.K., 2007.

85 Source: Study on urban access restrictions, PWC, ISIS, 2009

- Proportion of households with the use of a car (2001): 51%

Modal split

- Cars 48.7% :
- Motorcycles 30.5%
- Public transport NA
- Bicycles 1.0%
- Walking 19.8%

Source: Study on urban access restrictions, 2009

Sources used:

CURACAO (2007), “Deliverable D3: Case Study Results Report”, Coordination of Urban Road User Charging and Organizational Issues, University of Leeds for the EC Curacao Project, U.K., 2007.

Lian, Jon Inge, “Delvis brukerbetalt utbygging av transportsystemet i Oslo og Akershus - Evaluering av Oslopakke 1 og 2” (Title: Evaluation of Trunk Road Investments in Oslo), TØI rapport 714/2004

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Study on urban access restrictions, PWC, ISIS, 2009

CASE STUDY SINGAPORE

General background

Road pricing up to 1998 – ALS and RPS

Road pricing was introduced in Singapore in 1975 in the form of an Area Licensing Scheme (ALS). The scheme was introduced to reduce congestion and optimize road usage. It was explicitly not a measure to raise revenues. It was introduced as part of a comprehensive package of measures to manage mobility. Other measures implemented at around the same time included the raising of customs duties and imposition of a new tax (Additional Registration Fee or ARF) on new motor vehicles in 1972, the subsequent increase in ARF in 1974 and 1975, and the imposition of a parking surcharge in 1975[86].

Under the ALS, an imaginary cordon around a Restricted Zone (RZ) that comprised mainly the Central Business District (CBD), demarcated by overhead gantries at the entry points into the RZ Drivers had to purchase a daily or monthly ALS licence to enter the RZ. This area has gradually extended over the years. ALS licences were paper licenses that had to be displayed in the windscreens. They could be purchased from various ALS booths, post offices, various petrol stations and designated retail stores. There were various licence categories for various types of vehicle users. Initially, several car categories got exempted from the scheme, but by 1994 all vehicles (except emergency vehicles) had to have a licence. For cars there were two categories of licences; “whole-day licences” and "part-day licences". The licence fees (in Singapore dollars) were S$3 and S$2 respectively. Compliance was manually enforced by police personnel stationed at each of the entry points, noting vehicle licence numbers of vehicles without licences that were than fined later.

When first operational, the ALS restricted access to RZ from 7.30am - 9.30am daily, except on Sundays and public holidays. Over the years, restricted access hours have been changed several times. From 1994 onwards until 1998, when the ALS was replaced by a new electronic system, the ALS was extended to the whole day to even out traffic flow between 7:30 am and 6:30 pm to achieve a better utilisation of the RZ road network throughout the day. On a secondary note, the whole day ALS also prepared the motorists for more extensive use of road pricing in the years that follow[87].

Following the success of the ALS, a similar manual pricing system called the Road Pricing Scheme (RPS) was introduced progressively in the 1990s to six locations along congested sections on three expressways to manage the morning peak hour traffic from 7:30am to 9:30am on Mondays to Fridays. It was meant as a pilot scheme to familiarize Singaporeans with linear passage congestion tolls to control congestion points on an expressway (as opposed to the area congestion tolls imposed by the ALS[88]) and the RPS used the same principles as the ALS. The RPS required motorists who passed through the two gantries, to display a specific licence. Like ALS it was abolished after 1998 when it was replaced by the electronic road pricing scheme.

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[86] Kian Keong (2002) Road pricing Singapore’s experience. Essay for IMPRINT-EUROPE Thematic Network: “Implementing Reform on Transport Pricing: Constraints and solutions: learning from best practice”, Brussels, 23rd - 24th October 2002

[87] Yap, J. (2005) Implementing Road and Congestion Pricing- Lessons from Singapore. Presentation at the CEMT conference Sustainable Urban Travel Policies in Japan and other Asia-Pacific countries, 2-3 March 2005, Tokyo.

[88] Goh, M. (2002) Congestion Management and Electronic Road Pricing in Singapore. Journal of Transport Geography, Vol. 10, pp. 29-38

Road pricing since 1998 – ERP

In 1998 Singapore introduced electronic road pricing (ERP) to replace the manual road pricing schemes. The ERP system is based on the use of an In-vehicle Unit (IU) or transponder that is fitted on the windscreen of vehicles. The IU communicates with ERP control points, using a dedicated short-range radio communication system. The control points were placed at the same locations as the ALS and RPS overhead gantries and over the years the number of gantries has expanded to include a wider restricted area and more stretches of expressways.

When on the road, a pre-paid smart card (so-called CashCards) needs to be inserted into the IU. As vehicles pass overhead gantries the charge is deducted automatically from the CashCard. The ERP control point are equipped with vehicle detectors and an enforcement camera system that are connected and transmit data to a central control centre. Vehicles without a IU or a malfunctioning IU, or vehicles without a (sufficiently charged) CashCard are registered and invoiced by mail, including an additional charge (S$10) for administration costs in case the balance on the CashCard is too low, or a fine (S$50) in case the IU or the card were not in place.

To date, more than 99% of the local vehicles[89] are fitted with IU[90]. There are 6 different types of IU for 6 categories of vehicles, namely for motorcycles, passenger cars, taxis, freight vehicles (<16 metric ton) and buses(< 30 seats), freight vehicles (>16 metric ton) and buses(>30 seats), and emergency vehicles.

The charges at the central area cordon apply on working days during most of the daytime hours: 7:30 AM–7:00 PM, with a free entry period from 10:00 AM to 12:00 noon. On other roads charges apply only during the morning peak period (7:30 AM–9:30AM). When entering or exiting the RZ of passing two gantries along a stretch of expressway, the road users are charged. Also, in 2008 the pricing strategy was revised to deal with intra-city traffic, as up to then the pricing schemes did not impose any charges on vehicles travelling solely within the city roads. The CBD area was divided into 2 parts with a new pricing line. Traffic crossing either way was subjected to ERP charges.

External costs considered

The primary objective of the ERP is to reduce congestion in the city centre and to optimize the use of the road capacity available.

External cost to the environment are not taken into consideration when establishing the ERP charges. Nevertheless, the introduction of ERP is explicitly part of Singapore's strategy to reduce emissions from transport and enhance the use of public transport.

In order to reduce congestion a pricing method is used, in which ERP charges are set for 30 minute intervals and where the rate increases in steps every 30 minute up to the moment peak traffic is expected (rush hour) and decreasing it after the peak. To discourage motorists from speeding up or slowing down to avoid paying higher ERP charges, graduated ERP rates have been introduced for the first five minutes of the time slot with a higher rate. If the next period has a lower ERP rate, the new rate is introduced for the last five minutes. This applies to cases where the change in the rate is at least S$0.50, depending on vehicle type. For car drivers, the graduated ERP rate applies where the change in rate is at least S$1.

[89] Foreign vehicles driving into Singapore can either pay a fixed fee (SDG$5 daily) if you use ERP-priced roads during ERP operating hours, or have to rent an IU and buy a special rechargeable smart card (Autopass Card)

[90] Yap, J. (2005) idem.

Currently ERP charges for passenger cars vary during the day from S$0.75 - 3.00.

The ERP charges are calibrated to keep traffic flow at optimum levels. It was established that the optimal average speed for expressways should be between 45-65 km/h and between 20-30 km/h for arterial roads. At these speeds there a balance is achieved where there is neither congestion, nor underutilisation of the road capacity.

The charges are set based on traffic conditions and are sensitive to both location and time. To further emphasise the link between road pricing and congestion, the rates for different types of vehicles are set to be approximately proportional to their passenger car equivalent (PCE) values (Menon, 2000).

Probe vehicles equipped with GPS are used to determine the prevailing speeds[91] along the charged roads at half-hour intervals. When prevailing speeds are either too much below or above the calculated optimal speed levels, the charges will be adjusted, respectively, upward or downward. Every three months the ERP charges are reviewed to see if charges for particular intervals and/or locations need adjustment. This way, the charge adapts more accurately in sync with traffic so as to influence demand levels in the direction the policy desires (Ryan et al., 2007).

Impacts

Mobility

From the first introduction of ALS in Singapore in 1975, both the road charges and the system have changed several times, all providing data on the impacts of pricing on mobility.

ALS

With the introduction of ALS, traffic entering the RZ declined from 74,000 to 41,200 (44% reduction), with car entries declining by 73% (from 42,800 to 11,400). Although car ownership and employment in the city grew rapidly, by 1988 the traffic entering the RZ was still 31 % below the 1975 level.

The drop in traffic in the RZ was caused by traffic diverging to other routes, especially by traffic had no destination in the city but had merely been using the city roads as a bypass, and by travelling at different times or with different modes.

Data on the overall car share for commuters show that between 1975 and 1983 the car share for commuter's had dropped from 56 to 23%, whilst the use of public transport for the journey to (in the AM peak) work in the RZ, on the other hand, rose sharply from 33% before the ALS to about 70% by 1983.

When charging exemptions for car pooling where lifted, pricing was extended from the AM period to the PM peak period in 1989, traffic entering the RZ during the PM peak declined by 54% and traffic entering the RZ in the AM peak declined by 14 %.

[91] Since July 2008, the 85th percentile speed measurement method is being applied to determine whether ERP rate changes are necessary, instead of average (mean) speeds, starting from the city centre to the rest of the gantries on the outskirts. With the revised speed method, 85 per cent of motorists will experience speeds above the threshold.

ERP

Traffic volume in the RZ had reduced by about 10-15% during the ERP operation hours, despite the fat that ERP charges have been generally lower than with ALS. This reduction is mainly caused by the fact that with ERP it was no longer possible have multiple entries on a single payment[92]. As a result the number of multiple trips made into the RZ, estimated to constitute some 24 % of traffic entering the RZ at the time, decline heavily. Speeds were between 25-35 kph and increased during the ERP hours. Traffic on the expressways declined with similar rates and as traffic diminished, speeds increased from 35 to 55 kph.

The table below shows elasticity values obtained for different locations and vehicle types from traffic counts before and after rate revisions. It shows that passenger cars show higher elasticity than the other vehicle types. Also, expressway and arterial road traffic shows higher elasticity than traffic entering the central RZ. Yap (2005) also notes that since the implementation of ERP, there is a gradual increase in the elasticity for ERP for both the city roads and the expressways with the latter increasing at a faster rate. This suggest that motorists seem to have become more conscious of the change in ERP prices over the years and are today more willing to change their travel patterns and behaviour when they are confronted with a higher ERP charge.

Elasticity for various vehicle categories during AM peak hours

Vehicle category	Restricted Zone	Expressways
Cars	−0.106	−0.195
Motorcycles	−0.040	−0.134
Taxis	−0.015	−0.112
LGVs	−0.023	−0.044
HGVs and buses	−0.007	−0.109
All vehicles	−0.069	−0.151

Source: Olszewski, P. and L. Xie (2005)

The table below shows that elasticity for cars and other vehicles entering the RZ increase after morning rush hours until late afternoon. In the evening peak traffic flows show the highest demand sensitivity, with elasticity of 0.32 for cars.

Elasticity of traffic entering RZ by time interval

Time period	Cars	Other vehicles	All vehicles
7:30–9:30	−0.106	−0.019	−0.069
9:30–15:00	−0.082	−0.080	−0.083
15:30–17:30	−0.123	−0.151	−0.143
17:30–19:00	−0.324	−0.189	−0.265
7:30–19:00	−0.123	−0.106	−0.118

Source: Olszewski, P. and L. Xie (2005)

Environment

Little data can be presented from evaluations of the environmental impact of road pricing in Singapore. It is clear that the dominating effect in the city is less car traffic and less congestion leading to reduced emissions of NOx, PM, CO and CO2.

The decreased vehicle traffic within the central RZ was found to have increased perception of pedestrian safety by reducing the conflicts and delays at street crossings

[92] In the ALS system one could enter the RZ an unlimited times per day once one had paid the entry charge.

Economy
The investment cost of the ERP was S$200 million, for which 50% has been used for installation of IUs that have been provided for free to some 680.000 vehicles owners at the introduction of the ERP system in 1998.

The initial revenues collected were some S$70 million, around 30% lower than the revenues collected under the ALS. Currently, cross revenues from the ERP charges were some S$125 million (in 2008) and net revenues were S$100 million. The average cost of maintaining the ERP system over the years has been estimated at some 20% to 30% of revenue collected. As the operation and maintenance costs have grown in a same pace as the revenues, this 20-30 % share has remained equal over the years.

Revenue collected goes to Government Consolidated Fund, but it is maintained that ERP is a traffic management tool and not for revenue collection. Although no clear earmarking takes place, the public authorities stress that net revenues of ERP are returned to vehicle owners through tax rebates on vehicle ownership and heavy investment from general fund in transit and highway systems.

An objective assessment of business impacts based on long-term economic data has not carried out. Stakeholder surveys to derive impacts of the ALS on certain dimensions of business productivity have been carried out. Post-ALS implementation surveys also found that the ALS apparently did not adversely affect labour availability (as also the quality and availability of public transport increased enormously). Overall, it appears that the ALS did not, by itself, initiate changes in business conditions or location patterns. Overall, the business community responded positively to the ALS, probably believing that the combined package of actions by the government was necessary and beneficial in the long run[93].

Social
Wilson (1988) found that while the ALS reduced peak hour traffic by 65%, and bus ridership increased from 35.9 to 43.9%; more travellers (44.1%) initially saw longer travel time and fewer (36.1%) saw a reduction as slower (and now more crowded) buses substituted for faster cars. While congestion management as in Singapore may lower welfare for some users, investing in grade-separated alternative modes (in Singapore Mass Rapid Transit (MRT) and Light Rail Transit (LRT)) has mitigated the effects of the road charge. Goh (2002) highlights the success of the Singapore road-pricing scheme as being dependent on the provision of sufficient alternatives, and also the education and involvement of those affected.

Labour mobility into the city did not diminish with pricing, since many commuters were already using public transport, and pricing improved public transport services because of reduced congestion[94]. Also, road pricing had did not really have an impact of migration of businesses from the centre. The relatively small size of this particular urban area might help explain this.

Concerning **public acceptance**, congestion pricing had been operational in Singapore for the past two decades before ERP. Nevertheless, a mass publicity campaign was undertaken to inform and

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93 http://ops.fhwa.dot.gov/publications/fhwahop08047/02summ.htm

94 CURACAO (2007), “Deliverable D3: Case Study Results Report”, Coordination of Urban Road User Charging and Organizational Issues, University of Leeds for the EC Curacao Project, U.K., 2007.

US Department of transportation, Federal Highway Administration, Tolling and pricing programme, “Lessons Learned From International Experience in Congestion Pricing”, http://ops.fhwa.dot.gov/publications/fhwahop08047/02summ.htm educate motorists on the ERP scheme. The ERP was clearly introduced as part of an overall strategy to reduced congestion, reduce environmental pressure from transport and to increase the quality and use of public transport. Moreover, car ownership tax was reduced and IU were installed for free at the start of the ERP scheme. This helped increase acceptability.

Comparability and transferability

Context data[95]:

City Dimension

- Urban area population : 4.4 mil
- Urban Area: 699 km2
- Population Density: 6222 inhabit./km2
- Cars per inhabitants: 117 (cars/1000 inhabit.)
- Car density: 626 (cars/km2)
- Number of private cars: 438,000
- Total number of vehicles: 917,000
- Daily Modal Split for Public Transport: 51%
- Modal Split for Public Transport for Work Trips: 59%
- Bus Population: 3,100 buses; 3.1 million trips per day
- MRT & LRT: 139 km; 89 stations with 1million trips per day

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95 Source: Study on urban access restrictions, PWC, ISIS, 2009

CASE STUDY STOCKHOLM

General background

The **goals** of cordon pricing in Stockholm are *reducing congestion, improving the environment and generating revenues* for transportation improvements. In order to achieve political consensus and public support, it was agreed that a six-month trial project would be implemented and decision about permanent program would be made after evaluating the experience of the trial application and holding a referendum. The stated goals were to reduce congestion and enhance public transportation to increase accessibility, and improve the environment. A full-scale six-month trial was operated from January through July of 2006 and detailed evaluation was carried out.

A referendum was held in September 2006 in which 51 per cent supported making the pricing program permanent and 45 per cent opposed it. The decision was made to reintroduce central area pricing on a permanent basis starting in mid-2007.

The congestion charge in Stockholm has been defined as a tax. This means that it is the state that collects the congestion charges, since local government bodies can only collect taxes from their own citizens. The National Road Administration is responsible for collecting the charges and administering the system, while the city of Stockholm is responsible for monitoring the impacts of the scheme. It is a cordon toll system surrounding the entire Stockholm city with a total area of roughly 35.5 km2. The population of the city area is 756,000 out of the total county population of 1.8 million. The charges are effective weekdays from 6:30AM to 6:30PM and the price is set at 10, 15 and 20 SEK (1, 1.5 and 2 Euro) for off-peak, shoulder and peak period, respectively.

6:30-7:00	10 kr
7:00-7:30	15 kr
7:30-8:30	20 kr
8:30-9:00	15 kr
9:00-15:30	10 kr
15:30-16:00	15 kr
16:00-17:30	20 kr
17:30-18:00	15 kr
18:00-18:30	10 kr

The charges are collected when entering or exiting the zone at 18 barrier free “control points” encircling the city centre. The daily maximum charge, for multiple crossings was set at 60 SEK. Taxis, hybrid cars, buses, foreign cars, handicap tagged cars, diplomats and police and emergency vehicles (a total of 30%) were exempted from charges. Vehicles traveling through the priced zone without stopping are also exempted. Enforcement is undertaken by Automatic Number Plate recognition (ANPR)**.**

Net revenues from the congestion tax are earmarked for new road construction in and around Stockholm. Public transport improvements (new bus lines, additional capacity on commuter trains and metro, more park+ride facilities) were introduced before the scheme was implemented.

External costs

The primary goal of the Stockholm congestion tax is to **reduce congestion** in the city centre. Secondary goals are to improve environment and enhance public transport.

It is noted that designing the charging scheme is a very difficult task, depending among others on the topography of the city. It is unclear if in Stockholm a transport model has been used to determine the tax level; in any case the difficulty in setting the right tariff levels has been overcome by means of running the trial. The congestion tax has three bands, depending on the time of the day, which makes it a variable pricing scheme to some extent

There is no direct correlation between the level of the congestion tax and the level of congestion cost (e.g. valuing the time lost); congestion costs are not explicitly internalised.

Impacts

The trial in 2006 was subject to an extensive evaluation[96] in a multitude of dimensions. During the permanent system *a much smaller set of effects is measured*, namely mainly direct traffic effects (volumes, travel times, traffic composition in types of vehicles, etc.). Therefore, most results available refer to the evaluation of the trial. For some effects information from the permanent system is known, this is indicated in the next sections. The effects consist of the combined effects of charging and increased public transport services. Generally, the larger parts of those effects can be attributed to the charging scheme as such, though it is noted that several other significant changes took place over the 18 months between the measurement periods, such as the increases in fuel prices[97]

Impacts have been ex post measured using different techniques (traffic flow measurements, surveys etc.). Since air quality measurements are very sensitive to weather conditions, and do vary considerably from day-to-day and year-to-year, the larger part of the environmental evaluation of the trial was model-generated (with ARTEMIS model Assessment and Reliability of Transport Emission Models and Inventory Systems).

Most of the impact analysis that is reported here is taken from the extensive evaluation of the trial, supplemented with data from CURACAO and other literature sources.

Mobility

The overall **reduction in traffic** crossing the congestion-charge cordon during the congestion charge period (06.30–18.29 weekdays), was 22 % during the trial. This corresponds to nearly **100,000 passages** (in- and outbound traffic) over the charge cordon. The **demand elasticity** varies from -0,27 to - 0,41. The reduction was lower during the morning peak period (16%) and higher during the afternoon/evening peak (24%). The reduction stabilized quickly after the introduction of charges, and resettled at almost original levels as soon as the trial ended.

[96] Facts and results from the Stockholm Trials, Final version – December 2006

[97] Ibid

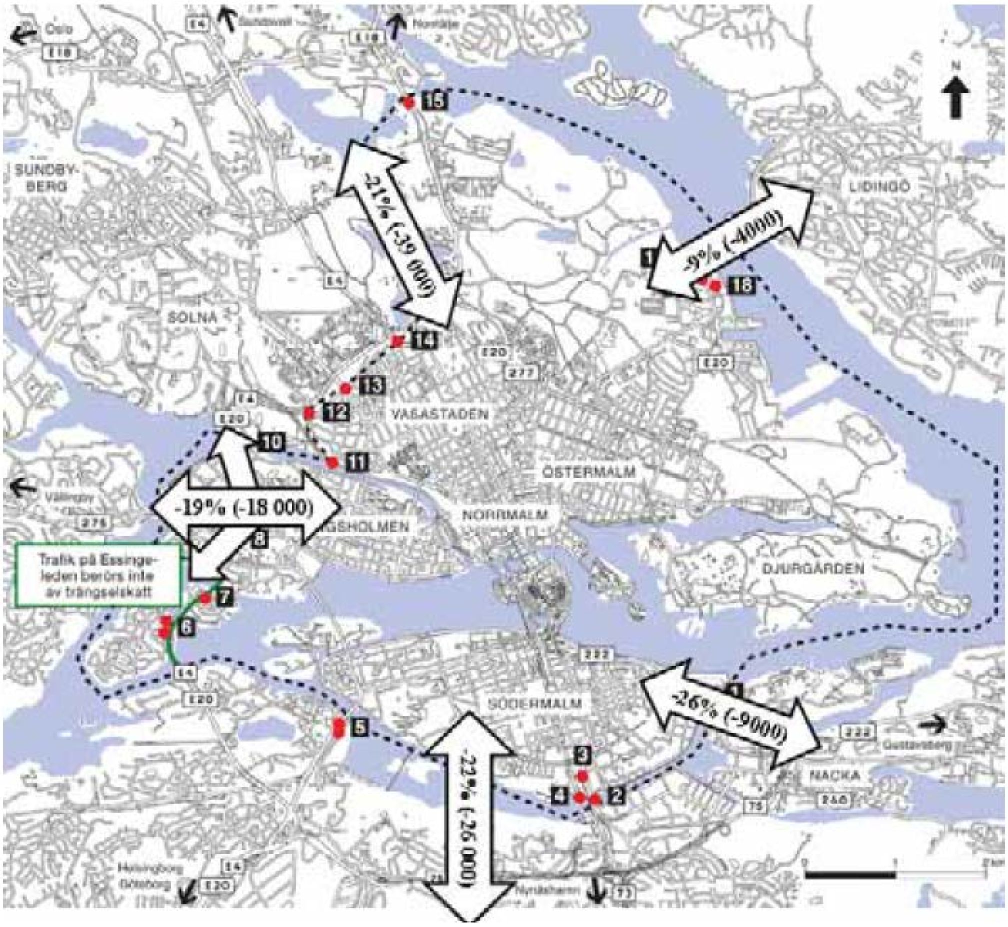

Figure 1: Percentage change in traffic flows in and out of the congestion-charge zone during the charge period

The total reduction of vehicle kilometres travelled (VKT) within the charging zone, is less than the reduction in number of passages over the cordon. Based on samples of link volumes, it was estimated during the trial that the effect on daily total VKT within the charging zone was approximately 14%[98], and that the corresponding figure for the region as a whole was 2%.

Commuters tend to reschedule, but trip purposes are strongly diverse, with about 40% non-commuting trips and many occasional users. No significant increase was observed in cycling, carpooling or telecommuting. Public transportation use increased by 6-9% though this increase could not be all attributed to congestion charging.

As a consequence of reduced demand, **travel times** are significantly reduced. These reductions are particularly large on the access (approach) roads to and from the inner City. Queuing times on these roads have fallen by one third for inbound traffic during the morning peak period and by half for outbound traffic during the afternoon/evening peak.

98 Volume of VKT could not be found.

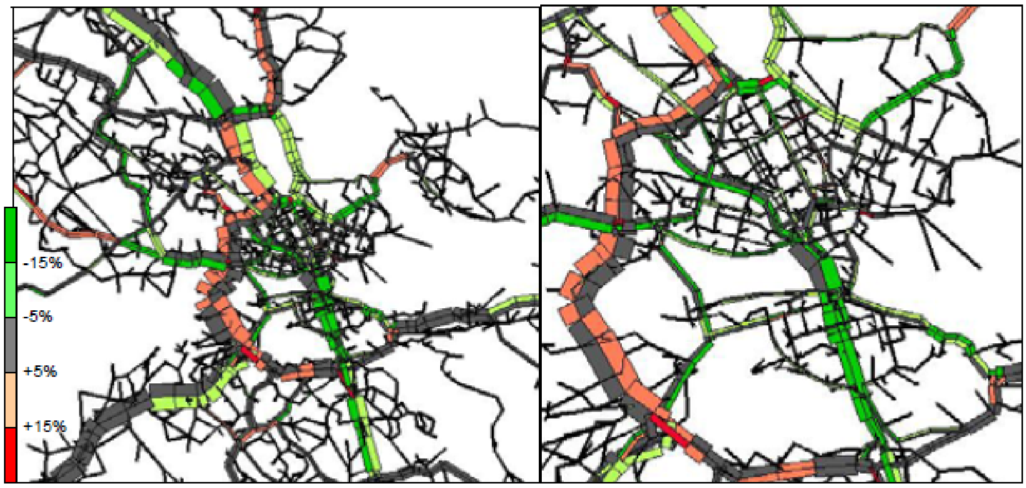

Figure 2 Change in travel times (morning rush hour) April 2005 compared to April 2006[99]

Recent data show that the *permanent charging program*, reintroduced in 2007 August, appears to have reduced traffic by 18 per cent. The proportion of exempted "green" cars has risen to 9%. Access to the city has again improved considerably with a reduction in travel times on city streets and approach roads.

Environment

In the inner city of Stockholm, the dominating effect is less car traffic. In combination with less stop and go traffic, emissions within the charging area decreased significantly. CO and CO2 decreased with around 14% whereas about 9% decrease in NOx and 13% decrease in particulates is encountered.

Furthermore, emissions declined in the whole municipality and even in the Greater Stockholm area emissions declined. There was no measurable change in noise impacts.

Tabl1 1. Effects on road transport emissions (various pollutants) from the Stockholm congestion charging trial[100]

Reduction	Inner city		Stockholm municipality		Greater Stockholm*	
Pollutant	**1000 kg/yr**	**percent**	**1000 kg/yr**	**percent**	**1000 kg/yr**	**percent**
NOx	45	-8.5 %	47	-2.7 %	55	-1.3 %
CO	670	-14 %	710	-5.1 %	770	-2.9 %
PM10 total	21	-13 %	23	-3.4 %	30	-1.5 %
PM10 from road surface	19	-3.3 %	21	-3.3 %	28	-1.5 %
PM10 from fuel and combustion	1.8	-12 %	1.8	-4.4 %	2.1	- 2.4%
VOC Volatile Organic Compounds	110	-14 %	120	-5.2 %	130	-2.9 %
Benzene	6	-14 %	3.6	-5.3 %	3.8	-3.0 %
CO2	36000	-13 %	38000	-5.4 %	41000	-2.7 %

99 City of Stockholm (2006). Facts and Results From the Stockholm Trials. First version - June 2006. Congestion Charge Secretariat, Stockholm, Sweden,

100 Source: Stockholm Trial – Effects on air quality and health. City of Stockholm, Environment and health administration

*) 35*35 km around Stockholm inner city.

Car accidents with injured people decreased by 5% to 10% within the zone[101].

The cost benefit analysis carried out of the trial shows different figures for emissions[102]. The decline in traffic as a consequence of congestion charging is estimated to reduce emissions of greenhouse gases from traffic in Stockholm County by 2.7% (42.5 ktons). This estimation is based on the matrix calibration against link counts.

Other emissions are estimated to decrease between 1.4% and 2.8% in the county. In the densely populated city centre, the decrease is estimated to be between 10% and 14%. The estimated effect for the county comes from the matrix calibration based on link counts. The estimated effect on the city centre comes from a statistical method (developed and applied by Pontus Matstoms at VTI), where links were sampled randomly and the vehicle kilometres travelled were calculated based on counts from these links.

Economy

It is recognized that many of the economic productivity and business impacts take time to show up. The trial was too short to have significant influence on land use, real estate prices and regional economy. Surveys of business leaders suggested that charges are likely to be a minor factor in influencing these dimensions. Also, no identifiable impacts on retail business or household purchasing power were identified.

In advance the trial was heavily criticized that it would change consumers shopping patterns. However, the trial showed that consumers overall did not shop less neither outside or inside the charging zone. Overall no effect on the household purchasing power has been observed. Regional economic calculations show that the congestion tax amounts to 1% of the total disposable income in the Stockholm County per year. Consequently, the tax is assessed not to affect purchasing power and private consumption[103].

The Swedish Road Administration has estimated that the tested system can be run on an operating cost of around SEK 220 million (€22 million) p.a including re-investments. Income from the congestion tax is estimated at around SEK 550 million (€55 million) p.a. after deductions for operating costs.

Social

Equity implications have been assessed looking at the direct road-user effects – changes in travel time and increases in travel costs. It is concluded that all studied groups experience an economic loss (on average). Examining the level of loss for different groups on average, it was concluded that:

- Residents of the inner city and Lidingö lost about twice as much as residents of other areas
- Households with high discretionary income paid nearly three times as much as households with low discretionary income
- Employed people paid about three times as much congestion tax as non-employed
- Men lost nearly twice as much as women

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101 Urban road charge in European cities: A possible means towards a new culture for urban mobility? Report of the Joint Expert Group on Transport and Environment on urban road pricing1 schemes in European cities of the EU Commission

102 Eliasson J.,(2006) “Cost benefit analysis of the Stockholm Congestion Charging System”, Congestion Charge Secretariat, City of Stockholm.

103 Source: CURACAO

- Households with children paid more congestion tax and households with two adults pay more congestion tax (per person)

Statistically, one was thus “hardest hit” by the congestion tax if one was an affluent, employed male living in a household with two adults and children in the inner city or Lidingö[104].

Concerning **public acceptance**, congestion pricing has been on the political and planning agenda in Stockholm for over twenty years. During this time numerous feasibility studies were carried out and pricing proposals were modified and abandoned. Finally, the government succeeded in implementing the current program on a trial basis in 2006 and then on a permanent basis in 2007. The intervening period saw much public consultation, education and outreach effort. This period also saw worsening congestion, environmental degradation and transportation funding prospects. Furthermore, the success of the London pricing project, implemented in 2003, probably acted as a major catalyst in bringing together officials with diverse political leanings to try out pricing on a trial basis in 2006.

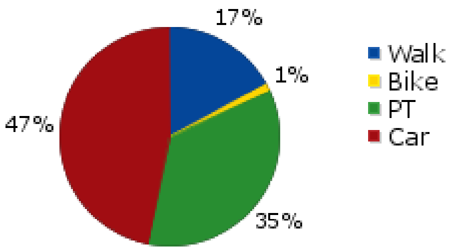
Public acceptability has been measured before and throughout the trial period. The pattern of response is quite similar to what is known from London and the Norwegian cities). Attitudes to the Stockholm Trial have become more positive during this time.

Comparability and transferability

Context data[105]:

City Dimension
- Urban area population 2,019 (1000 inhabit.)
- Urban Area: 6,488 km2
- Population Density: 311 inhabit./km2
- Cars per inhabitants: 403 (cars/1000 inhabit.)
- Car density: 121 (cars/km2)
- Number of private cars: 783,417

Modal split:



Source: EPOMM, Stockholm city council (Miljöavgiftskansliet), 2006

[104] Taking into account direct road-user effects: travel time, congestion tax and adaptation costs
[105] Source: Study on urban access restrictions, PWC, ISIS, 2009

Sources used:

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Annex C: Case studies paid parking

CASE STUDY AMSTERDAM

General background

Amsterdam is the largest city of the Netherlands with 783.364 inhabitants. Starting in the eighties in the city centre by now in most of the area within the ring road there is paid parking.

Impact rate increase 1993-1998

In the period 1996-1997 in Amsterdam in the so-called A and B increased the parking area. In the city centre (zone A) in 1994-95 the hourly rate was 1.82 euros. This hourly rate was raised in two steps: in 1996 to 1.93 euros and 2.16 euros in 1997. In the adjacent districts Oud-West and Oost district (zone B) in 1994-95 the hourly rate was 0.91 euros. This hourly rate in zone B was increased in two steps to 1.25 euros in 1997.

The impacts of the increase of the paid parking area and the fares in the years 1993-1998 were studied in 2001.[106]

In the districts Oud-West and Oost (zone B) the increased rates seemed to have no impact on the numbers of cars of visitors. In the Inner City there was a short term decrease of the number of visitors. This decrease seemed to be temporary.

In general there has been a shift from the car to the bicycle. At longer distances the share of public transport has grown. The parking policy in Amsterdam was an important factor for both developments. There was not only a general decrease in car traffic. Due to the fact that more free parking places were available there was also an additional decrease in car traffic searching for a parking place.

2008 Action Plan

On June 26th, 2008, the Action Plan “Voorrang voor een Gezonde Stad (VGS)” was adopted by the City Council. This plan contained a package of (traffic) measures to improve air quality. The measures were aimed at discouraging car use in the area within the ring road and stimulating the use of cleaner vehicles.

The plan aimed to improve air quality through several measures:

- It was expected that through the application of an environmental zone (emission requirements for traffic) and implementation of source measures (such as particulate filters) half of the target for air quality would be achieved.
- The other half had to be achieved through an intensification of the parking regime, which was expected to result in a reduction of car use by non-residents

Starting point for the measures in the Action Plan was the need to change the behaviour of car users and to stimulate them to purchase cleaner vehicles. Furthermore, the plan aimed to reduce car use and increase the use of alternative transport options.

At forehand it was expected by the Amsterdam business community that the parking measures would have negative economic impacts (Business leaving the city, less visitors, increasing

[106] Parkeren is manoeuvreren, gemeente Amsterdam, Dienst Infrastructuur, Verkeer en Vervoer, 2001.

difficulties to find and retain employees). An ex ante assessment [107] concluded that probably a short term negative local economic impact could be expected in the period following the introduction of the measure, but that this negative economic impact would be only temporarily. These conclusions were based on the study of impacts of similar pricing measures in several Dutch and European Cities as well as in Amsterdam itself in the preceding years.

The plan was adopted in 2008 and per 1 January 2009 the parking measures were implemented. (see figures 1 and 2 of this case study for parking tariffs in 2008 and 2009). This meant an increase of the parking tariffs with on the average 27% and extension of the paid parking time in certain parts. The plan VGS aimed at a reduction of car kilometres in the area within the Ring Road of 1.8 per cent due to the increased parking tariffs, and an additional decrease of 0.36 per cent due to the extension of the parking time, which results in a total reduction of 2,16 per cent car kilometres in the area within the ring road. According to the calculation method of the VGS plan, a decrease in the number of kilometres in the city centre by 15% would lead to a emission reduction by 1.5 micrograms per cubic meter. In line with this calculation method was the assumption that a reduction in car kilometres of 2.16% would result in a reduction of 0.2 micrograms PM10 and NOx per M3. Hereby a linear relationship between a decrease in car kilometres and a decrease in emissions was assumed.

These measures were implemented in combination with two other measures, e.g.:

- Introduction of 10-cents parking zones in a few shopping streets in the neighbourhoods around the city centre. In these zone the maximum parking time is one hour and the tariff is 10-cents. The aim of this measure was to prevent a decline of the number of shop visitors in these streets.
- Introduction of a discount parking tickets for visitors of elderly residents. Elderly residents can purchases tickets against a substantial reduced rate with which their visitors can park for free. With this measure the municipality aimed to prevent negative social impacts i.e. a decrease of social visits caused by the increase of parking tariffs and paid parking times.

External costs

The external costs of air pollution and congestion in the city centre were reduced through the reduction of the number of non residents travelling by car.

Impacts

To determine the impacts of the measures Ecorys has made a comparison between the situation in 2008 and the situation after the introduction of the measures in 2009[108]. Because an integral zero-measurement of the number of parkings in 2008 was missing, the comparison was made by using several available sources. The most important source for determining the impact on traffic and parking was the turnover of the parking meters and "Parkeer en Bel" parking (paying by mobile phone) in 2008 and 2009. In order to isolate the impact of the parking measures from the impact of the economic recession), an analysis was made of the impact of substantial increases of parking tariffs a few years before the recession in the cities of Utrecht and The Hague.

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[107] Ecorys (2007), Economische Effecten Actieplan "Voorrang voor een gezonde stad", Client: Municipality of Amsterdam

[108] Ecorys (2010), Effect evaluatie verhoging parkeertarieven Amsterdam, projectbureau "Voorrang voor een gezonde stad", Client: Municipalty of Amsterdam

The impact on parking and car traffic

The increase of parking rates and the extension of the paid parking time had a positive impact on the reduction of car use in Amsterdam. The number of parkings and car kilometres in the city centre was reduced with 6.8% compared to 2008 (The total number of car kilometres in 2009 were daily 1.850.000.) At least 3.8% of the decline in the number of parkings and car kilometres in the city centre can be related to the parking measures.

The impact on air quality

The parking measures contributed to the reduction of nitrogen dioxide (NO_2) and fine dust particles (PM_{10}) in Amsterdam. The reduction in 2009, compared to 2008, on the main roads is between -0.2 and -0.3 mg / m³ for NO_2 with a maximum value of approximately -0.5 mg / m³. The results for PM_{10} on the investigated routes varied from 0.0 to -0.1 mg / m³.

The social impacts

A survey carried out under 600 residents showed that the parking measures had no substantial negative impacts on the social and recreational activities of the residents in the area within the ring road. More than one third of the respondents though indicated that the measures had a negative impact on their social visits, which came less frequent or at other times.

Comparability and transferability

Figures of Amsterdam	
Population size	783.364 inhabitants (april 2011)
Size of the city (km2)	219 km2
Population density	3577 inhabitants /km2
Local GDP / capita	
Modal split	38% cars, 20% walking, 20% public transport and 22% cycling (2008)

Sources

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Figure 1: Parking tariffs Amsterdam 2008

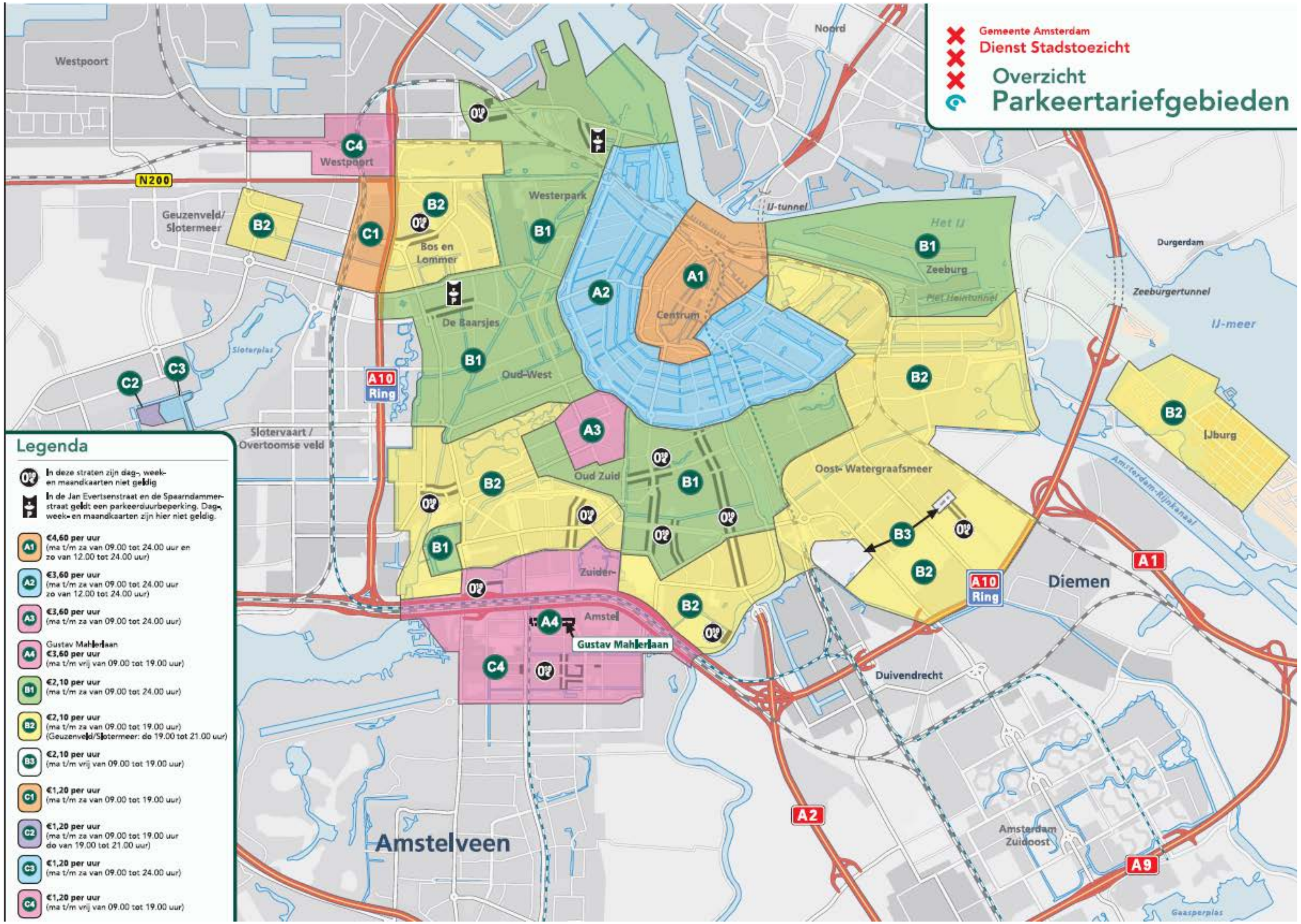
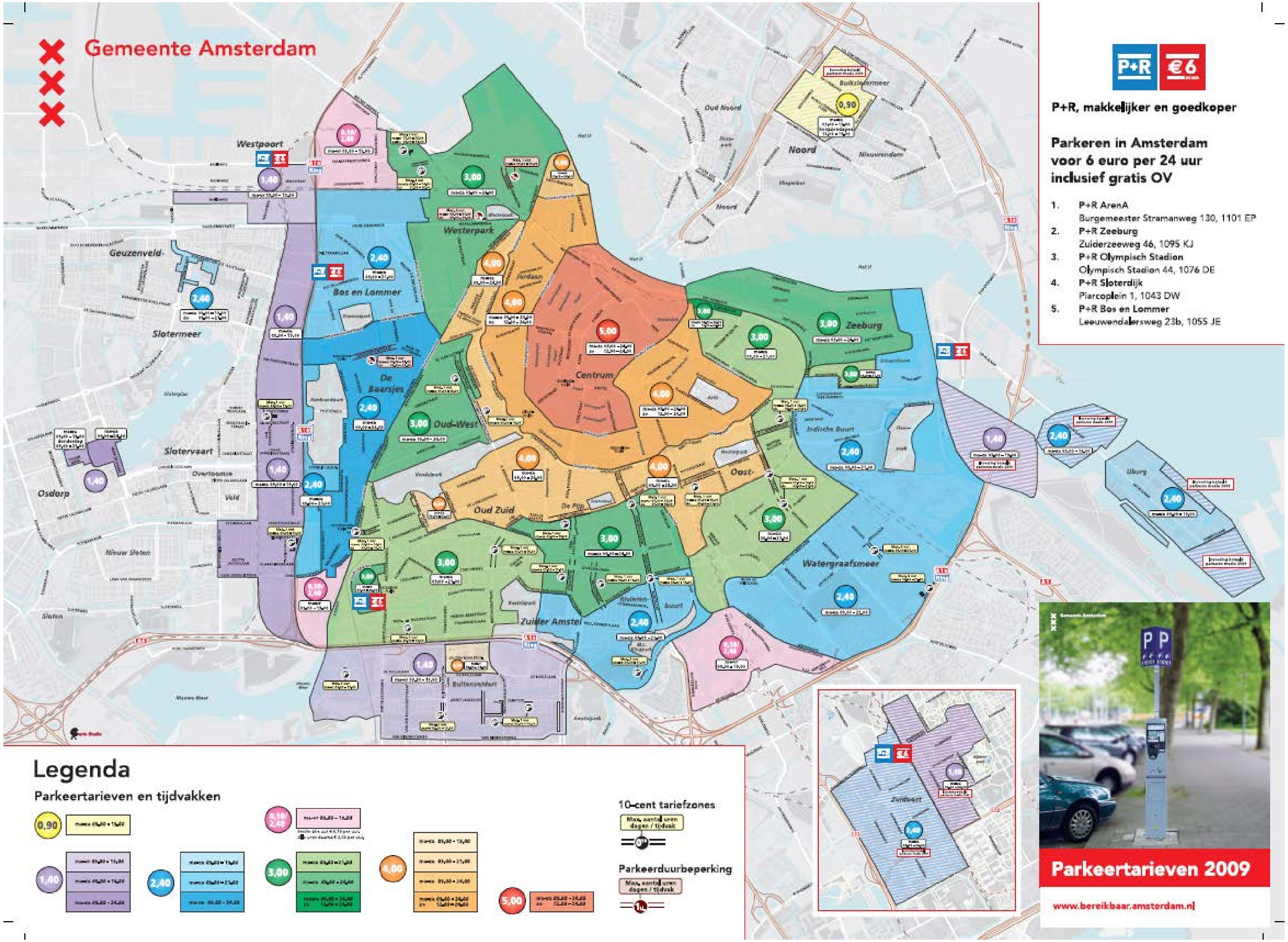


Figure 2: Parking tariffs Amsterdam 2009

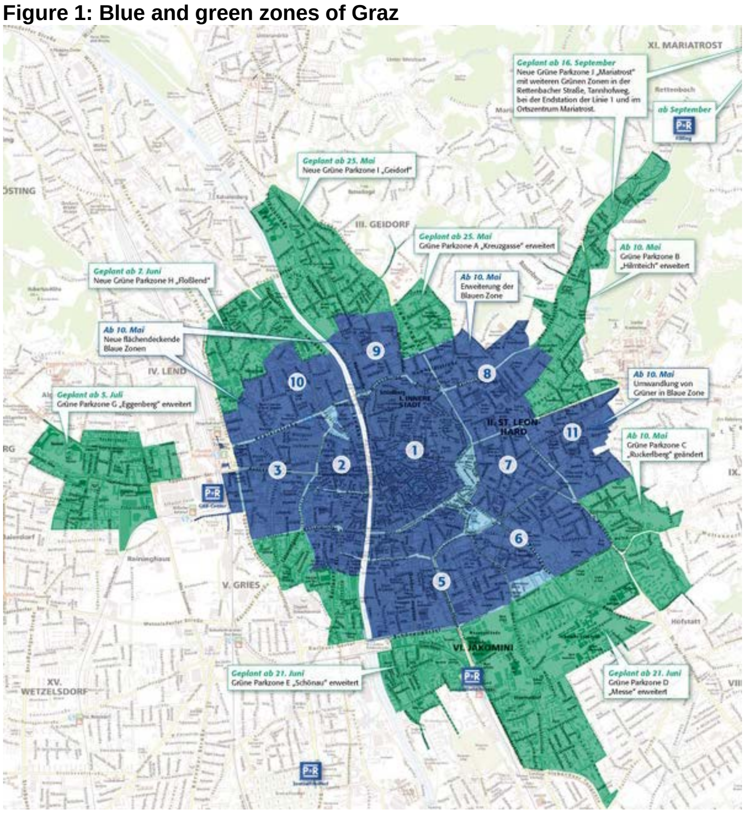


CASE STUDY GRAZ

General background

Graz is the capital city of the province of Styria and is with its 250,000 inhabitants the second largest city in Austria. The city covers an area of approximately 127 km2 and it has a historically old city centre with rather narrow streets. The centre is a car-free pedestrian area and outside the centre the whole inner-city is a “blue zone” where parking is only allowed for max. 3 hours (€ 0,60 per 30 minutes). Furthermore, some “green zones” are defined were a parking fee has to be paid, but were not time restrictions are set. The blue and green zones are shown in figure 1 below.

Figure 1: Blue and green zones of Graz



Due to the geographic and therefore weather situations within the city, Graz has problems with air-quality and particulate matter. An increase of the use of public transport is therefore essential for the health of the inhabitants. Besides that, Graz faces an increase in car use due to the movement of people from the city centre to the outskirts. By providing good public transport facilities and supporting the use of cleaner vehicles, the city tries to weaken this trend.

The city of Graz attaches high priority to extensive use of public transport in the city. The transport policy (“Sanfte Mobilitat” concept) includes many pedestrian zones and promotion of cycling. The objectives of the transport policy defined by the city are:

- Making Graz a city of short distances;
- Balancing the distribution of transport modes;
- Ensuring socially and environmentally compatible traffic;
- Creating good accessibility for all destinations using all modes;
- Ensuring grass-roots planning, public participation and public awareness.

The use of information technology measures should make public transport a more user friendly and attractive alternative for the car.

Further extensions of parking zones

The city council of Graz decided not to implement congestion charging; another solution to deal with the increasing volume of traffic in Graz has been implemented namely a comprehensive, city-wide parking management. In 2004 the city implemented a parking fee system with 'blue zones' and 'green zones'. The blue zones are areas in and around the inner city with short term parking regulation (with a maximum of 3 hours). The green zones allow to park for longer terms.

Low emission vehicles

The city of Graz has implemented a lower parking tariff for cars with low emissions (including hybrid, electric and bio fuel cars). By doing this, the city aims to improve air quality, reduce noise levels and raise awareness. The measure was implemented together with a necessary tariff increase. For all ordinary vehicles the parking fee increased from € 1,00 to € 1,20 per hour, but for the low emission vehicles the tariff was reduced to € 0,80 per hour.
The objectives of this measure was to:

- Develop and implement a new parking model system, acceptable for citizens and technically and organisationally feasible;
- Increase the number of smaller an/of low emission vehicles in the city centre, with reduced emission, noise levels and energy consumption as a result.

The owners of low emission cars could get an environmental token ("Umweltjeton") and a special sticker in case they registered themselves at the city council with a car registration certificate that proves that their car meets the emission requirements. The ticket machines recognize these tokens and as a result deliver a lower tariff for these cars. The sticker is an official document, filled out by the city council, and includes the car number, type, colour and an official seal of the city of Graz.

The requirements for a car to be qualified as being a 'low emission car' are the following:

- Petrol powered vehicles have to achieve the Euro IV norm and emit less than 140 gr CO2 per kilometre;
- Diesel powered vehicles have to achieve the Euro IV norm and emit less than 130 gr CO2 per kilometre;
- Diesel powered vehicle have to be equipped with particle filters;
- Gas powered vehicles have to achieve the Euro IV norm and emit les than 140 gr CO2 per kilometre.

External costs

The main objective of the parking measures as described above is to reduce the air pollution in the city of Graz, because the city suffers from severe air pollution problems. Therefore the city increased the parking fees and extended the zones in general for all vehicles, except the fees for the low emission cars. The primary goals of this measure is to promote the use of clean vehicles and reduce the number of polluting vehicles in the centre. Secondary goals are reduction of noise pollution and energy consumption.
With this system, the city (partly) covers the external costs caused by air polluting vehicles, since these vehicles have to pay a higher parking fee than the clean vehicles.

Furthermore, the city uses all the additional revenues of the parking management system for the improvement of public transport. This earmarking of revenues leads to further promotion of sustainable urban transport.

Impacts

Modal split

In 2008 the modal shift of Graz was 48% car (35% driver, 13% passenger), 25% walking, 18% public transport and 15% cycling. Between 2004 and 2008 around 2% of the travellers shifted from the car to the bike or public transport. [109]

Emissions

According to the Trendsetter Evaluation report, the parking measure 'lower parking tariff for cars with low emissions' resulted in a reduction of 435 tons CO_2, 1.7 tons NO_x and 0.124 tons particulate matter per year.

Social acceptability

A study of the University of Dresden[110] (2000) with 536 respondents showed that the problem perception of the inhabitants of Graz is relatively high. A significant part (indicated with %) of the respondents perceive traffic congestion (92%), limited parking space (86%) and air pollution from motor vehicles (84%) as being significant problems. Though the policies to reduce these problems are rather unpopular. There is little support for measures like access restriction (37%), reducing parking space (25%), increasing parking cost (17%) and distance based pricing (11%). Only measures like the improvement of public transport: improve public transport (90%) and realising park & ride locations (87%) are relatively popular. This indicates that all kind of measures that restrict or limit the behaviour of car drivers or measures that increase the costs for car drivers have low social acceptance.

A small survey in Graz (N=77) indicated that the differentiated tariff measure with advantages for car owners with low emission cars is accepted by 61% of the respondents. In addition to that, 30% of the respondents think that car users will be influenced by the parking measures and buy cleaner vehicles or park outside the city.

Comparability and transferability

Figures of Graz	
Population size	261 540 inhabitants (2011)
Size of the city (km2)	127.6 km2
Population density	2050 inhabitants /km2
Local GDP / capita	€ 39 100 (2008)
Modal split	48% car (35% driver, 13% passenger), 25% walking, 18% public transport and 15% cycling (2008)

[109] The total travel volumes of Graz are unknown.
[110] Schlag, B. and J. Schade (2000). Public acceptability of traffic demand management in Europe.

Sources

CIVITAS, *Graz Trendsetter City: Lower parking tariffs for low-emission cars*, Factsheet (www.civitas-initivative.org)

CIVITAS, City-to-city-exchange: Access Restrictions, *Parking Management in Graz*, (www.civitas-initivative.org)

Schlag, B. and J. Schade (2000), *Public acceptability of traffic demand management in Europe*, Traffic and Transport Psychology, Dresden University of Technology, Germany.

Trendsetter Evaluation Report (2006), *Graz Local activities*, Trendsetter Report No 2005:15, Trendsetter External Deliverable No 4.4b.

TEMS, The EPOMM Modal Split Tool, City of Graz, 2008.

PROCEED, (http://www.proceedproject.net/)

CASE STUDY PECS

General background

Pécs is with its 158 thousand inhabitants the fifth largest city of Hungary. The city has a cultural centre with sensitive cultural heritage, indicated by the UNESCO World Heritage title for the Christian burial chambers which the city received in 2000. During the transition period, the demand for private parking places and public transport increased significantly as well as the number of private cars, number of students and tourists. The monitoring of air quality and the environment has been a central issue in Pécs.

The City of Pécs has a number of overall objectives:
- Improving air quality
- Improving environmental living circumstances
- Reducing the use of fossil energy and noise

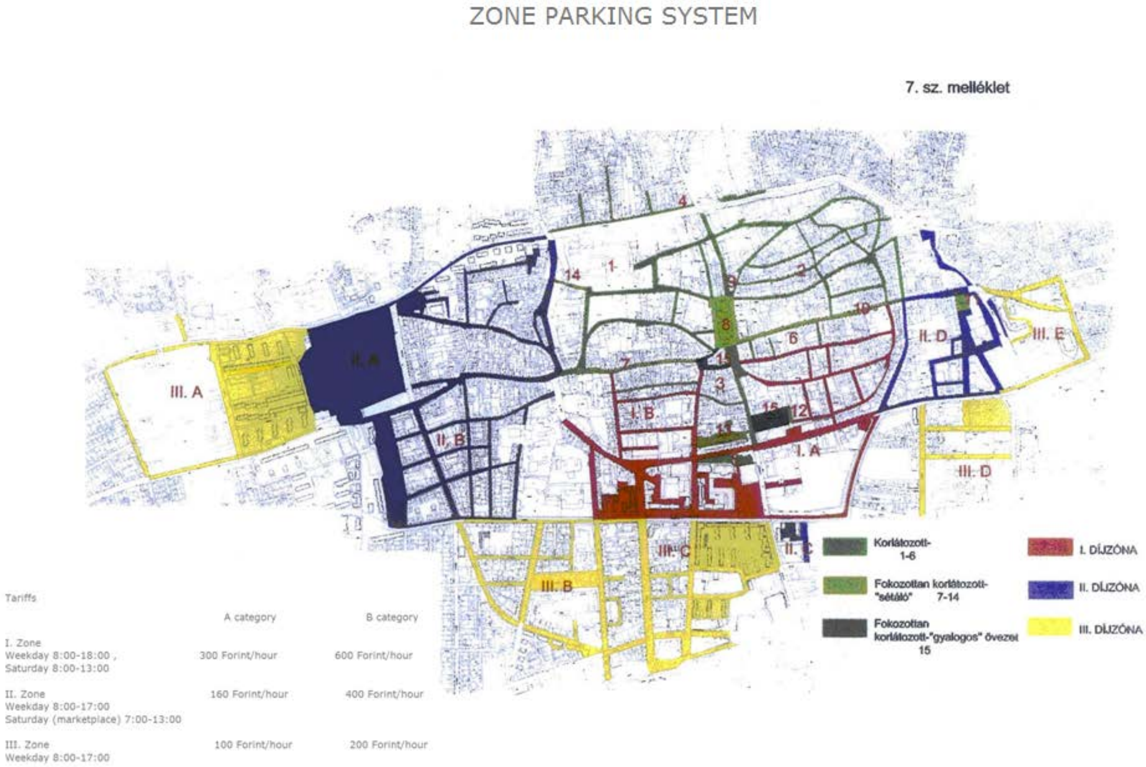
The sensitive heritage and the rapidly increasing traffic within the city made the city decide to introduce parking and access restrictions. A car-free zone was introduced together with a zone-modal parking system (differentiated prices) with limited parking time. The parking fees are much higher than before.

Policy goals of these measures:
- Decrease the number of cars parking in the city centre by 20%
- Decrease air and noise (- 3dB(A)) pollution

Car-free zone in the city centre
The objective of this measure was to reduce the volume of traffic in the city centre and decrease the number of private cars visiting the cultural heritage of the city. Measures take to achieve this objective:
- Establishing a car-free zone in the World Heritage area
- Creating a limited access zone inside the city walls
- Establishing a zone-model parking system outside the city walls (as explained below)
- Creating a bicycle route in the city centre

Zone-model parking system
Together with the car-free zone, the implementation of the zone-model parking system had the goal to reduce the number of cars in the city centre and reduce emissions and noise.
The city is divided into four zones:
- Red zone: core of the inner city, expensive parking with limited parking time
- Blue zone: adjacent to the red zone, moderately priced parking
- Yellow zone: for the distant parts of the city centre, rather low parking fees
- Green zone: outside the city centre, free parking

Figure 1: Parking zones and tariffs of Pécs



The extra revenues earned from the new parking system are partly spent on modernisation of the public transport fleet.

The two measures were implemented parallel. During 6 months the whole city was equipped with all necessary infrastructure required for the zone system. In the city information boards have been placed to inform the citizens about the new system. The municipality also started a media campaign to persuade the citizens about the positive effects of the zone system. Between 6 and 24 months the municipality have been increased the number of parking spaces outside the city and the green areas in the city centre. After two years prices and time limits in the system have been changed and P+R parking facilities have been established.

External costs

Before these measures, parking was free in the whole city centre and no income was generated from parking. The fact that no parking fees existed, led to congestion (the city centre was always full of cars looking for a parking place), emissions and other kind of pollutants.

Impacts

The two measures together resulted in some notable outcomes in terms of traffic reduction, reduction in air and noise pollution. Emissions caused by motor vehicles were reduced by 20-80% (depending on the location of the zone, the numbers of cars visiting the **city centre** has reduced by 600-800 units daily, around 80% of this traffic has been diverted around the centre, the real reduction is 250 cars per day). The number of heavy goods vehicles in the city centre went down by 95% (due to some parts of the town being restricted for traffic).

The average parking time went down with 20-30 % and in general the car use in the city and the use of parking facilities reduced. Furthermore, a reduction of air and noise pollution of 3 per cent is noticed in the city centre. In terms of indirect effects, the living and working environment improved as well as the conditions for the preservation and protection of the UNESCO World Heritage sites. The argument that the city needed to save the UNESCO World Heritage sites from emissions, made it easier to reach public acceptance for expensive parking in the city centre.

The number of daily bus tickets sold in Pécs has been increased from 2.821.000 (2001) to 2.953.400 in 2003, the monthly bus tickets sold from 762.400 (2001) to 860.600 (2003).

Comparability and transferability

Figures of Pécs	
Population size	158.000 inhabitants (2010)
Size of the city (km2)	162 km2
Population density	975 inhabitants /km2
Local GDP / capita	
Modal split	76% cars, 23% walking, 41% public transport and 1% cycling (2010)

Sources

TEMS, The EPOMM Modal Split Tool, City of Pécs (2010).

CIVITAS; Trendsetter, Evaluation report – Pécs local activities (2006),(www.trendsetter-europe.org)

CASE STUDY STRASBOURG

General background

Strasbourg is a city in the northeast of France with approximately 270,000 inhabitants. Strasbourg has developed an extensive public transport system, including the longest network of tram tracks and 500km of cycling infrastructure. The city experiments since the early 1990's with policies that should reduce car use. In addition, Strasbourg promotes sustainable urban travel and intermodality, and claims to be the most cyclable city of France.

The city of Strasbourg aims for the following policy goals: residential parking prioritization, public transit promotion and quality of life improvements. The policy goals are based on six areas of action:

1. Implementation of a new tramway system as the backbone of public transport;
2. Connection of the tramway and the bus network;
3. Promotion of cycling and improvement of the walking facilities;
4. Reduction of the car use;
5. Renovation of urban spaces in accordance with the public transport system;
6. Public participations and information of local residents.

By facilitating multiple P+R locations, public transport improvements and bicycle routes and furthermore restrict the number of on-street parking places (and make these the most expensive parking places), the city aims to shift the modal share to a more sustainable and clean mix of urban transport.

Tram

Between 1994 – 1997 the tram is introduced in the city and the streets were facilitated with enlarged sidewalks and zebra crossings. Together with these developments, the on-street parking places were replaced by off-street parking lots (underground) and as a result there became more space for bicycle lanes and pedestrian zones integrated with tram facilities. In addition, several bicycle parking places were realised near tram stations.

Tariff zones

Nowadays, the city has 7,850 on-street paid parking places, 10,300 parking places in 16 semi-public parking garages and 4,400 P&R parking places. Different parking tariffs are implemented, with inner city on-street parking as being most expensive and peripheral off-street parking least expensive:

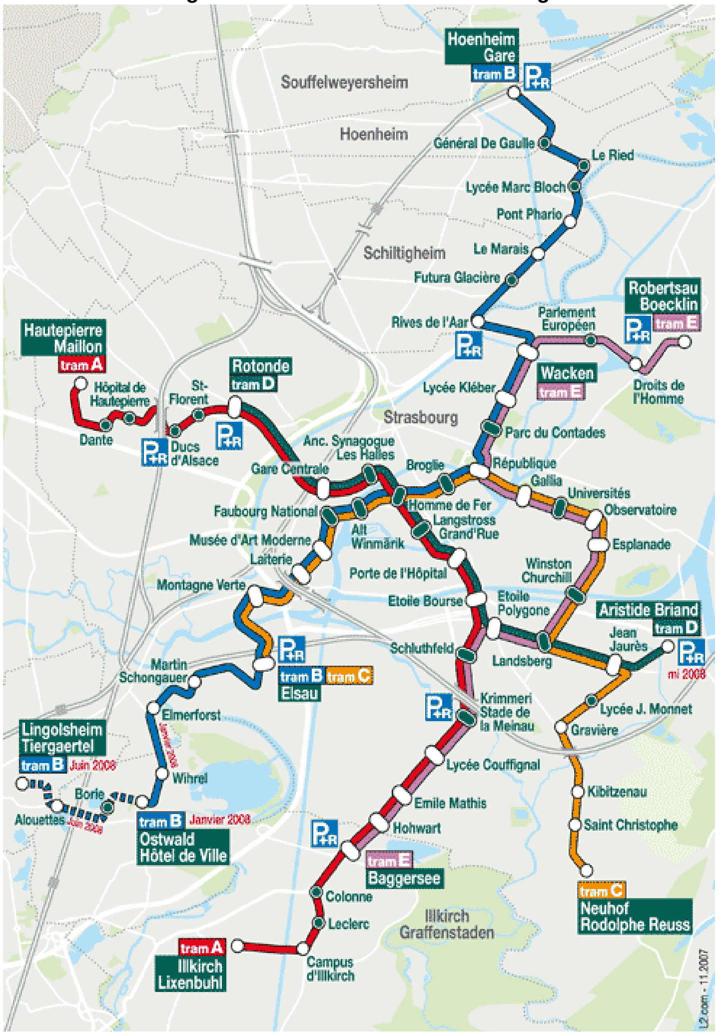
- Red zone: € 1.60 / hour on-street
€ 1.00 - € 1.60 / hour off-street
- Orange zone: € 1.30 / hour on-street
€ 1.20 / hour off-street (some garages first 30 minutes for free)
- Green zone: € 0.50 / hour on-street
€ 2.70 - € 3.00 / day P+R (incl. a round-trip tram ticket for up to 7 people)
- Monthly public transport pass allows free access to P&R.

The large blue zones around the city are parking free zones, though a parking disc needs to be displayed and the parking time is limited to 90 minutes.

P+R locations

The realisation of P+R locations at the end of or next to tram lines made it possible for urban traffic to park the car at the outskirts of the city for a relatively low price and travel further to the city centre by public transport (as can be seen in figure 1 below). The measure should further reduce the number of private cars in the city centre. The stimulate this public transit, the parking ticket of P+R locations includes a round-trip tram ticket for the tram for up to seven people. Parking a car for the whole day at a P&R location is as expensive as two hours of parking in the city centre.

Figure 1: Park and Ride in Strasbourg



Earmarking parking revenues

Strasbourg earmarks the revenues from parking fees for sustainable transport goals (transit projects, walking and cycling facilities). While doing this, the public sees were the parking revenues are spent on and this contributes to the social acceptance of the parking charges.

External costs considered

The external costs accompanied with congestion are (partly) recovered by the increasing parking tariffs towards the inner city (the red zone versus the orange and green zones) and making on-street parking more expensive than off-street parking.

The most important cause of air pollution in Strasbourg is the road transport and particularly car transport. Through a shift in modal share to a more sustainable mix of urban transport (less private car usage and more public transport and walking / cycling) the external costs of air pollution and emissions are reduced.

Impacts

Modal shift

Several impacts of the transport and parking policy of Strasbourg can be noticed. For example, the model shift in1997 was 52% car, 31% walking, 10% public transport and 7% bicycle. Through the city's efforts on parking policy, promoting public transport and cycling and P+R facilities, the modal shift has changed within 12 years to a more sustainable direction. In 2009, the modal share in Strasbourg was 46% cars, 33.4% walking, 12.5% public transport and 8.2% cycling. This makes Strasbourg the first city in France where less than 50% of the travellers use the private car to move.[111]

Private car usage

Especially the realisation of P+R facilities has contributed significantly to the increase of use of public transport and the resulting decrease of car usage in Strasbourg. P&R surveys have shown that 90% of the P+R users are former car drivers who never or rarely used public transits. Since most of the P+R facilities are located at the end of tramlines, 4% of the total number of tramway users travels from the P+R locations.

The realisation of several facilities like P+R locations at the end of tram lines, off street parking garages under pedestrian zed streets, enlargement of the tram network and the paid parking zones in the inner city, all together led to a 28% decrease of vehicles entering the city within 18 years.[112]

By removing the on-street parking spaces, the streets of the inner city became more suitable for walking, cycling and public transport transits.

Social acceptance

The earmarking of the parking fee revenues results in more public support for the parking measures, since the public can see that the earnings are used to improve public transport, transits, cycling and walking facilities.

Comparability and transferability

Figures of Strasbourg	
Population size	272 123 inhabitants (2007)
Size of the city (km2)	78.3 km2
Population density	3475 inhabitants /km2
Local GDP / capita	€ 26,500 (2007) (for province of Alsace)
Modal split	46% cars, 33.4% walking, 12.5% public transport and 8.2% cycling (2009)

[111] The total travel volumes of Strasbourg are unknown.
[112] Kodransky and Hermann (2011)

Sources

Kodransky, M. and G. Hermann (2011), *Europe's Parking U-Turn: From Accommodation to Regulation*, Policy papers on parking, IDTP.

European Academy of the Urban Environment, *Strasbourg: The tram as a key element of urban transport policy*, Extract from the database 'SURBAN - Good practice in urban development', sponsored by: European Commission, DG XI and Land of Berlin.

CIVITAS, Forum City Description Strasbourg (www.www.civitas-initiative.org)

www.strassbourg.eu

CASE STUDY VILNIUS

General background

Vilnius is the capital city of Lithuania and is with almost 560,000 inhabitants also the largest city. The transport modes available in Vilnius are walking, cycling, (trolley)buses, trains, (minibus) taxis and cars. The modal split in Vilnius was 45% public transport, 23% cars, 32% walking & cycling in 2007. From 1981 on, the car ownership and car use has increased rapidly and the use of public transport went down.

The city's transport policy is defined in the City Master Plan and City Strategic Plan. In several 'Special Plans' the specific measures are described with the main objective to develop a modern, efficient, fast, comfortable and safe public transport system.

Since the Vilnius aims to follow the main principles of sustainable development, the city tries to stimulate the use of public transport. Furthermore, the city focuses on an environmentally friendly public transport fleet and therefore started to replace the old buses for new buses that run on compressed natural gas.

In the Vilnius Strategic Plan 2010-2020 some parking measures are defined. One of these measures is the reduction of the number of parking spots in the old town of Vilnius and at the same time realising parking lots (multi storey buildings) on the edges of the old town. Furthermore, the parking fee in the old town will be increased in order to limit the general traffic. This development goes together with the design of a public transportation system for the old town.

OPTIPARK Market validation trial

The OPTIPARK project aimed to enhance mobility and optimise parking resources through development of innovative parking tools across Europe. Vilnius was one of the cities that introduced an OPTIPARK pilot project (the market validation trial).

With the OPTIPARK project the city of Vilnius (2005-2007) tried to launch underused parking resources into the market. While improving offers and services to the customers about available parking places, also traffic flows can be redirected to the less congested areas of Vilnius. Therefore the project plaid an essential role in demonstration of the potential of innovative parking tools.

The trial focused on the provision of improved information and reservation services for car users, which enabled them to look for a parking space and reserve it in advance. Car users can register themselves through an online application and they receive a login and password. This enables them to login at the reservation system and reserve a parking space. The system provides information about the availability of parking spaces and parking tariff (from 1lt -3 lt, about € 0,30 – € 0,90 an hour) for a particular time and date. The reservation can be modified until 2 hours before the reservation time.

External costs

The external costs of air pollution and congestion in the old town are reduced through the redirection of traffic flows to car parks on the edges of the old town, using parking tariffs as an instrument.

Impacts

No overall analysis of the evolution of modal split, air pollution, congestion etc. is available for Vilnius. In addition, no specific evaluation of the impact of parking measures could be detected.

Comparability and transferability

Figures of Vilnius	
Population size	554.400 inhabitants (2011)
Size of the city (km2)	400 km2
Population density	1386 inhabitants /km2
Local GDP / capita	
Modal split	38% cars, 36% walking, 25% public transport and 1% cycling (2010)
Land use patterns	Buildings 29.1%, 68.8% green, waters 2.1%

Sources

Vilnius City Municipality Government Administration (2010), Vilnius City Strategic Plan 2010-2020.

CIVITAS, CIVITAS forum city descriptions (2010), (http://www.civitas.eu/index.php?id=117&city_id=141)

TEMS, The EPOMM Modal Split Tool, City of Vilnius, 2010.

OPTIPARK, Implementation of the Vilnius Market Validation Plan, 2007

European Metropolitan Transport Authorities (EMTA) barometer of public transport in the European metropolitan areas, 2004

Website municipality of Vilnius, (http://www.vilnius.lt)

PROCEED, (http://www.proceedproject.net/)

Annex D: Stakeholder consultation

D.1 Objectives and set up of the consultation

A consultation was organised as part of the study in order to enhance the analysis with additional information from a number of relevant cities and organisations. The objectives of this consultation were to collect information and facts from these cities and organisations on:

- the negative externalities of mobility in an urban context (congestion, air pollution, climate change, noise, accidents and the tear and wear of infrastructure);
- the most promising policy instruments to reduce externalities, and to learn of possible alternative measures;
- the lessons learnt in the implementation of the policy measures to reduce externalities, in particular concerning road pricing and paid parking, and on the key success and failure factors;
- the monitoring and enforcement practices and on the acceptability of the measures;
- the possible role of stakeholder organisations and the role of the EU.

The consultation was organised in two parts, an on-line survey and a workshop.

The on-line survey

The invitation to participate in the on-line survey was sent to a selected number of cities and organisations. There was a separate questionnaire for both categories. The respondents were asked to submit their answers between 18 February and 9 March 2012, extended later to 23 March 2012.

Seventeen cities were invited to respond to the questionnaire and 11 cities responded.

The questionnaire for the stakeholder organisations was sent to 42 organisations, and 10 responded. Most of them are European; some 30% represent one Member State only.

See annex E for the questionnaires and a list of the participating cities and stakeholders. Annex F provides a summary of the questionnaire results.

The workshop

The half-day workshop was held on 21 May 2012 in Brussels, in the premises of the European Commission. Representatives of two cities and 12 European or international organisations (some of which also represent cities and regions) participated. They are shown in the following table.

Cities and European or international organisations participating in the workshop held on 21 May 2012 in Brussels

Cities	Organisations
Brussels (BE)	ACEA, European Automobile Manufacturer´s Association
London (GB)	CEMR, Council of European Municipalities and Regions
	CLECAT, European Ass. for forwarding transport logistics & customs services
	ECF, European Cyclist Federation
	EIA, European Intermodal Association
	EPOMM, European Platform on Mobility Management
	Eurocities

	FIA, Federation Internationale de l'Automobile IRU, International Road Transport Union Polis UITP, International Association of Public Transport

The structure of this Annex

This Annex follows the objectives of the consultation. Each section combines the results of both parts of the consultation, the on-line survey and the workshop.

Section D.2 describes the practice that was found in the consultation: the negative externalities identified and the measures implemented. Section D.3 presents the most promising policies and the lessons learnt, as indicated by the cities and stakeholder organisations. Section D.4 relates the monitoring and enforcement issues and the acceptability, as reported in the consultation. Section D.5 discusses the possible role of the stakeholder organisations, and the role of the EU, as seen by the consultation respondents.

D.2 In practice: the externalities identified and the measures implemented

Of the cities which responded to the on-line survey, 50% have road charging systems in place or planned and 100% employ a form of parking charges. In the larger part of the responding cities the general public was not consulted prior to implementation by means of a public consultation, a survey or otherwise. However, the cities seem to agree that raising awareness is important to improve public understanding and acceptance.

For both groups of respondents to the survey, cities and stakeholder organisations, congestion is the most important negative externality to address, closely followed by air pollution. For other externalities, opinions differ. The stakeholder organisations rate climate change as more important than cities, they are more decisive on the relevance of accidents and noise, and rate tear and wear of higher importance than most respondent cities.

The cities in the survey consider congestion to be the most important of the negative externalities (60% indicated this as most important), followed by air pollution (70% indicated this as very important). Climate change received mixed ratings, being perceived as most important by 20%, but as least important by 30%. Accidents and noise were deemed rather important, whilst tear and wear is less important to a large part of the respondents. Other reasons given by the cities for charging car use and parking include the effects on human health, the degradation of public space, people's mental and somatic health, oil leakages, damages in cultural structures, the decreasing accessibility for businesses and economic traffic. External costs are monitored for congestion, climate change, and noise, and in a few cases for other external costs.

Of the cities in the survey 40% state that in principle all road users should pay for congestion and environmental damage through road charging; 30% does not agree and another 30 % cannot give an answer.

Two thirds of the stakeholder organisations responding to the survey indicate that congestion is most or very important, and only 10% that this is least important. The same percentages apply to the negative externality of air pollution. Slightly less, but still important is climate change. Noise and tear and wear of infrastructure all rate equally as rather important. Other negative externalities that are rated very important by the stakeholder organisations, include: lack of physical activity, urban sprawl, ineffective use of resources (urban space, energy, etc.) and separation effects caused by rail and road infrastructure, loss in eco-systems due to areas ‘sealed’ by transport infrastructure, and loss of the ecological functions of the soil like the absorption of rainfall, the production of biomass and CO_2 storage.

Positive effects

It is noteworthy in the survey, that the stakeholder organisations stress the importance of positive effects of car usage, whereas cities comment foremost on the negative effects and externalities. Some stakeholder organisations stated it was important to bring out the positive effects of car use, and that the use of incentives rather than restrictive (punitive) measures would be more effective. This was elaborated in the workshop by the association of car manufacturers, who noted that the study disregards other modes than the car and that in the political discussion on urban access restrictions too little attention is paid to the social and economic effects of car use and its positive side. In the same way, the federation of cyclists pointed to the external benefits of walking and cycling in the workshop. See section D.3.5 for a further discussion.

D.3 The most promising policies and the lessons learnt

D.3.1 Success factors for implementation

Road charging

The comment that earmarking the revenues from a charging system for improvements of the transport modes are helping public acceptance and therefore are an important success factor, was made in the on-line survey as well as in the workshop. See section D.3.3 on this issue.

The stakeholder organisations indicated in the survey that success lies in the combination of integrated urban mobility solutions and informing the public about these. The implementation should provide choice, flexibility and seamless connectivity and take into account costs, comfort and safety.

All cities in the survey indicated that financial aspects (cost efficiency, allocation of revenues, fee level) are crucial for the successful implementation of road charging instruments. The majority of the cities mentioned that raising awareness on the problems of external costs is most relevant. Other factors, such as carrying out a detailed impact assessment and implementation studies or studying the examples of other cities, all scored equally high (over 56%). To the question if the public has been consulted before introduction, 56% of the responding cities answered that no consultation was carried out, 20% held a referendum, and 33% a survey. They used a combination of awareness measures (89%), fiscal incentives (29%) and other measures to enhance acceptance by the public. The latter included providing information on re-investment of the revenues. On the question if all users should pay for congestion and environmental damage through a charge, the responding cities are divided. A large part agrees, but there are also many cities that disagree.

Parking

The organisations representing the cities indicated in the workshop that the cities use an integrated strategy, of which parking and charging are only a part[113]. For many cities, parking charges are the first step to internalisation of external costs. Cities want to have the freedom to choose their own system, not an abstract formula they have to follow. Their first concern is the rotation of parking in urban space. Planning parking outside the city centres is becoming the new phase in parking policy.

Differences in practical approach were illustrated in the workshop by Brussels and London. Brussels is creating a parking agency, to harmonise parking policy as part of the overall mobility policy. In London, on the other hand, the city has no parking policy, as this is left to the 33 London boroughs who define their policy in conjunction with their land use planning.

The cities responding to the survey saw the legal aspects, concerning the competence in the matter of the cities and the use of the revenues, as being crucial for the implementation of paid parking. The financial aspects were given slightly less importance.

D.3.2 Other important aspects of implementation

Road charging

In the on-line survey, the other important aspects mentioned by the cities were:

- *Financial aspects*
  These include cost efficiency, the allocation of the revenues (for road improvements or public transport), the fee level ("to provoke modal shift"), abolishment of the fixed taxes for cars (which are independent of the distance driven), compliance costs for operators, and the net profit.
- *Legal aspects*
  These include privacy and non-discrimination, clear legal rules on the use of streets, clear determination of the vehicles to be included and excluded, and proper legal embedding of the charges versus the taxes.
- *Technical aspects*
  Mentioned here were the collection of data, a proper calculation of distance driven, and a collection system without flaws.
- *Monitoring and enforcement*
  Although these aspects were seen as less important, they include a good equilibrium between the revenues and the costs of enforcement (road side equipment, mobile teams etc.), a clear and reliable identification of the vehicles breaking the rules and prompt penalties.
- *Communication and information aspects*
  These include transparent communication concerning the bills and the use of the revenues, customer reviews, information of the public on the consequences of pollution and on other relevant impacts. In general, a wide ranging consultation and information campaign with citizens, before, during and after implementation of a scheme is deemed essential.
- Other aspects mentioned were political will and cooperation with and involvement of the business community.

[113] In a study performed by Polis in 2008/2009 (Cré and Sharkie, 2009, *Flow? Destination!*), it is pointed out that in the best case a parking plan is an intergrated part of a Sustainable Urban Transport Plan. The report furthermore concludes that in practice cities learn by doing when it comes to parking policies, and often move from an initial parking regulation and control, to a point where parking policies are used to manage and boost urban development.

In the workshop the representatives of the automobile associations were worried that car use and congestion would increase outside the charging area. Congestion often happens outside the city, and the road charging may improve conditions for city dwellers while at the same time complicating life for those who live far away and need the car for their mobility needs. The association of the cities and the representatives of London explained that traffic growth outside the Congestion Charge area was +2%, so the congestion outside the area did not increase significantly. The effects outside this area were thoroughly investigated and no negative social impacts were found. It should be remembered that there was already good public transport in place. This has been further improved, including in the evenings when there is no Congestion Charge, to offer good alternatives. The introduction of the London Congestion Charge was possible because the business community saw the advantages: to keep London moving. The business community in Brussels is also calling for road pricing schemes. These are now being prepared, but can only start when the new RER/GEN train system is in place. Not only will the car commuters pay the charge, but also the local inhabitants. The long term goal is for –20% car kilometres in 2020. Public transport and public space have to be improved, walking has to be made more attractive. It was noted that apart from the cities who favour road charging, there are also those who oppose it, like e.g. the Austrian capital Vienna. These cities want to reduce the emissions at the source, but that is largely outside their competence.

The representatives of the freight hauliers pointed out in the workshop that the interests of freight transport and goods delivery should not be forgotten. E.g., good locations for loading and unloading should be provided. They also noted that different cities are using different systems, which is a nightmare for hauliers who drive in several cities. Interoperability should be a requirement.

In Brussels a road charging system is still under development. The important choices, as indicated in the workshop, were:

- Charging only the commuters or the inhabitants as well? Both groups will be charged, as they both produce the negative effects.
- How large should the area be? The whole area of the Brussels Capital Region was chosen, as a push towards the outlying areas was unwanted.
- What technology should be chosen? The choice is very limited. The ideal solution would be an on-board unit (OBU) which would allow to charge per kilometre. But the car industry cannot provide this and the investment is too large for the city.

The representatives of the automobile associations in the workshop pointed out that if people would pay according to use, like in the case of a fuel tax, acceptance would be high. All users should be included, and trials and an awareness campaign are needed. The representatives of the cities cited the example of Stockholm, where the road charge is a tax. As the tax office just implements taxes that have been decided by the political bodies, an awareness campaign was not deemed necessary. In London, a public consultation is mandatory for every change in the law. It is thought important to build confidence in the scheme, why it exists, and why charging is at the level it is. A lot of studies are done in London to explain the effects of different charging levels.

The representatives of automobile associations and freight hauliers in the workshop said that when new charges are introduced existing charges need to be lowered in order to keep the same tax burden. CO_2 taxes, e.g., are already included in energy taxes and people should not be paying twice. The representative of Brussels mentioned studies of the EU which indicate that the current taxes do not cover all environmental costs.

Parking

An important legal aspect of parking charges is mentioned by the cities in the survey. Most respondents indicate that local or regional competence to charge is very important; the competence should be clear, including the use of the revenues. Paid parking instruments should be part of an integrated mobility plan that includes other measures and offers alternatives. Moreover, enforcement (by the local police) is crucial, as is the availability of parking space.

D.3.3 Options for using the revenues of the pricing policies

In response to the survey question how revenues should be spent, 80% of the responding cities indicate improvements in public transport and 60% indicate general public expenditure as well. Other suggestions are investment in infrastructure for walking and cycling, a charging scheme for trucks based on GPS, support of electrical vehicles, promotion of alternative fuels, and stimulation of mobility management schemes. A plea for an integrated plan, without stand alone solutions, is made as well. The cities agree that a clear communication on how revenues are spent is essential for public acceptance.

The stakeholder organisations responding to the survey disagree on how the revenues from the charging schemes should be spent. Public transport is supported by a large majority of stakeholders (67%), but the option to improve road-related infrastructure (e.g. city tunnels, noise barriers) receives support from 35%. Besides, a minority chooses to invest in other mobility modes (walking and cycling), or suggests to support public transport operating costs. Some contributors ask to earmark the money for greening road transport at the source. The organisations agree, however, that it helps increasing public acceptance when it is communicated clearly how revenues are spent.

In the workshop there was a lot of support for spending revenues on public transport improvements, as it was found important that alternative are offered. In London, an already extensive public transport system has been further expanded with proceeds from the charging scheme.

D.3.4 The question of transferability

The responding cities in the survey are reluctant to indicate which aspects of their implementation can be seen as examples of best practice, to be implemented elsewhere. This is because all cases are seen as very different. Aspects mentioned are the small amount of experience, situational differences, differences in local knowledge, and differences in political will, or even the historical situation.

D.3.5 Alternatives to reducing negative external effects

According to the survey answers from the stakeholder organisations, the most adequate policy instruments to address all negative externalities are, in order of effectiveness:

- improvements in public transport,
- land use planning,
- walking and cycling improvements.

ITS instruments are seen as effective as well, but not for all externalities. The above instruments primarily address congestion, accidents, climate change and air pollution.

An average effectiveness is attributed to:

- paid parking,
- urban congestion charging,
- green zones.

The first two mainly address congestion, the last one air pollution.

An effectiveness below average is attributed to:
- other restricted zones,
- road taxes.

These are only thought to reduce congestion and to some extent to pollution.

Another rating can be made from the survey answers from the stakeholder organisations on the effectiveness of instruments for each negative externality separately. This gives the following rating per externality, with the policy instruments shown in order of effectiveness:

- Congestion: ITS, public transport, land use planning.
- Air pollution: public transport, land use planning, walking and cycling.
- Climate change: public transport, ITS, land use planning, walking and cycling.
- Accidents: public transport, ITS, land use planning.
- Noise: land use planning, walking and cycling, ITS.
- Tear and wear of infrastructure: walking and cycling, public transport, land use planning.

Some stakeholder organisations pointed out that some negative externalities are already (partly) being paid by the users in the form of time loss, or general tax for tear and wear of infrastructure.

Other suggestions made are a more efficient freight distribution system, reduced health insurance costs for active commuters, promotion of low or zero-emission vehicles by the European Commission, and alternative modes of transport.

Almost 40% of responding organisations mention a best practice of implementation of instruments aimed at reducing externalities of urban mobility. Examples included a scheme of tax reduction in the case of not using the car to work [114], the European Commission's emission regulation for passenger cars (Euro 1 to 6), a real time traffic information platform, and integrated land use and public transport scheme.

The cities at the workshop mentioned that they have looked extensively at alternatives for the road charging schemes. For London, a report describes all the alternatives that were considered before the Congestion Charge was implemented. A lot of information was collected before the system was put in place and this continues, see the case study of London in Annex B. Brussels has looked at parking fees, at free public transport for certain groups, at the RER/GEN train network, at a fee for parking in private buildings, but the effects were never sufficient. Therefore, a combination of all of these measures is being sought.

D.3.6 Success and fail factors for implementation of pricing schemes

The survey indicates that the stakeholders have mixed opinions on the critical success and fail factors for the introduction and implementation of charging instruments in urban mobility. According to some, a financial risk is that the charging system will only lead to increasing costs for the

[114] I.e.; advantages for not using the car, The employee receives an allowance; the employer benefits from lower absenteeism, better accessibility, healthy image, and authorities have lower tax losses.

operators and users. The inability to explain to the public the necessity of charging instruments were also mentioned as possible fail factors. Between them, the organisations have very different perceptions of the fail factors for operating road charging schemes.

In the workshop the automobile associations indicated that in the case of Milan a confusing name was used for the system and that it was not well explained. They also pointed out that 37% of traffic accidents happen in urban areas. If motorised two-wheelers are excepted from the charge, an increase in use may lead to more accidents.

In the view of the freight transport operators in the workshop, Milan is a case where at first electric cars were promoted. But when this became a success, a congestion charge was implemented. Users were punished twice: first for investing in a clean vehicle and second to pay a charge on top of that. This was apparently not understood by the public.

D.4 Monitoring, enforcement and acceptability

Monitoring and enforcement are seen as critical to operate an effective paid parking scheme or road charging scheme by the stakeholder organisations in the on-line survey. The cities report that the results and effectiveness of the implemented schemes are being monitored for paid parking schemes (at least in terms of financial revenues, less in mobility impacts), but less so for road charging schemes. Approximately 35% of the cities are monitoring the results of their road charging scheme, and 60% of the paid parking measures. The specific results of the monitoring, however, are not readily available. The respondents indicate that these figures vary over time. Enforcement ensures higher rates of compliance. However, a ‘one size fits all’ approach would not work, and the consistency of the enforcement is considered vital to ensure public acceptability. An impact assessment beforehand is recommendable in addition to regular reporting.

Of the cities responding in the survey, 25% indicate not having a system in place to identify users, but the vast majority does. This is being done by means of a camera system, a number plate identification system, monitoring by mobile teams, taxes related to the residence register, or (parking) tickets.

A minority of the respondents have taken technical measures to minimise costs and optimise cost recovery. They mention mobility studies on parking demand, changing the contractor, or upgrading the camera system. The majority (89%) have not taken any measures.

Whereas the cities in the survey indicate that monitoring is not one of the most important factors for success when implementing a paid parking or road charging scheme, the stakeholder organisations do not agree. For them, monitoring and enforcement are critical success factors. This is remarkable, because overall it will be the (local or regional) authorities that will be responsible for the monitoring measures. In the workshop, however, all participants agreed that monitoring is vital. But the city organisations pointed out that the cities in some countries have very limited staff available for such tasks, and that monitoring studies are expensive.

Finally, it proved very difficult for cities to provide information regarding the impacts of the road charging or paid parking schemes on mobility, environment, and economy. It is not clear whether this is because the information is not (yet) available, or not available on such a detailed scale, or that the information is considered too sensitive to be public. Another explanation for the lack of detailed information may be that cities considered the information too technical, expanding thereby the span of the consultation. In the workshop some organisations pointed out that a broad range of indicators should be monitored; not just vehicle kilometres, but also passenger kilometres.

Acceptability

The most important factor for the acceptability of road charges mentioned in the workshop was the earmarking of the revenues for transport and the transparency of the spending. This sets the charges out from normal taxes, which feed the general public budget. This is confirmed by the survey respondents.

The survey respondents are divided on the question if all road users should pay for congestion and environmental damage through road charges. More than 40% think they should and 35% think there should be exceptions.

D.5 The possible role of the stakeholders and of the EU

There is large support for a role by the European Commission, in the on-line survey as well as in the workshop, but this role is perceived in different ways. All survey respondents agree that the EC should facilitate the exchange of best practices, and there is a vast majority in favour of guidelines and a legal framework providing standards for vehicle identification (70% in both cases). Other legal measures (providing standards for road signs or minimum access criteria) are less popular and there is hardly any support for a legal framework providing minimum access criteria. Such views were also expressed during the workshop, where the organisations of cities confirmed that the role of the EU would have to remain limited. The cities and their organisations stressed their need for flexibility in the workshop. This flexibility is essential in the local political discussions that precede the adoption of a road charging scheme. In the workshop an EU website was suggested for charging schemes, by extending the existing website for low emission zones.[115]

The need for fair, transparent and non-discriminatory measures was expressed in the survey as well as in the workshop. Suggestions in the survey include a regulatory framework for standard emissions, support for a demonstration programme, setting maximum levels for environmental impacts (along with local government) or even banning conventionally-fuelled cars in cities. The stakeholders in the survey agree largely on the role other parties than the EC should have, such as local authorities, users/citizens, public transport operators and organising authorities, national authorities, local economic actors and retail organisations. Roles that are mentioned are for instances that of initiative, co-operation or even investments on pricing policies.

Providing financial support was viewed positively by two thirds of the survey respondents.

In the survey, only 50% of the respondents were in favour of a handbook. In the workshop it was noticed that road charging is already part of a number of initiatives supported by the EC. There are guidelines on the ELTIS site for Sustainable Urban Mobility Plans. There is also an EC expert group working on urban ITS. Besides, there is a tool already developed for Union of Railways (UIC) and also within the IMPRINT project an external cost tool was developed. Recently, an update of the 2008 handbook was made by CE Delft, INFRAS and Fraunhofer-ISO, commissioned by UIC.

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[115] LEEZEN website: http://www.lowemissionzones.eu/leezen/

However, none of the urban schemes in the present report were based on external cost considerations.

Although all survey respondents indicate that there is a role for the EU, the stakeholder organisations feel more strongly about this. The cities responding tend to be more considerate to the repartition of mandates, and seem to attach more importance to the principle of subsidiarity in general. The subsidiarity principle could limit the EC in its attempts to harmonise and provide guidelines for actions undertaken by Member States and regional and local authorities.

The stakeholder organisations see a slightly wider role for the EC, and appreciate further going measures, e.g. in the field of legal frameworks. Local authorities stress the relevance of the proportionality of measures, which should be taken care of at the appropriate level.

Suggestions in the survey include making OBUs in private cars mandatory, and improving cross border enforcement. This was repeated in the workshop where the cities indicated that if an OBU would be standard equipment of cars, city authorities could choose a tax per kilometre, which would give the charging system a much better cost-benefit ratio. They are now limited to the second best solution of number plate recognition. The automobile associations added that an OBU might also be useful for other services to the drivers. Workshop participants also suggested that a link should be made with the EC policy on EETS. It should allow working towards a single bill for all charges. Cross-border issues, including billing, were mentioned as a problem by several parties in the workshop.

In the survey the stakeholder organisations indicate mixed views regarding their own role. They do agree on a role of informing and to raising awareness. Some point out that they can assist in setting up a legal framework. According to the workshop, the organisations of cities might help to set up collaborations between cities that could lead to joint procurement. This collaboration could also serve the objective of interoperability, which is very much needed, according to the representatives of freight hauliers.

In the workshop the question was discussed if the EC's role should be different for parking and for road use charges. Most participants saw no EC role in the case of parking policy, which is already well established and used by all cities. However, common elements, also exist. The possibility of one bill was mentioned in this section and the possibility of paying all charges by mobile telephone was also mentioned.

Annex E: Questionnaires and participants

Participating cities and stakeholders:

Stakeholders:

European Cyclists Federation (ECF)
Federation International de l'Automobile (FIA)
International Association of Public Transport (UITP)
Community of European Railway and Infrastructure Companies (CER)
International Road Transport Union (IRU)
Lithuanian National Road Carriers' Association (LINAVA)
Bundesverband Deutcher Omnibusunternehmer e.V. (BDO)
Linja-autoliitto
European Association for forwarding transport logistics & customs services (CLECAT)
Allgemeiner Deutscher Automobil-Club e.V. (ADAC)
[European Automobile Manufacturers' Associoation (ACEA) sent a separate contribution and held a presentation at the workshop in Brussels]

Cities:

Brussels
Florence
Zurich
Warsaw
Madrid
Malmö
München
Barcelona
Roma
London
Oslo

Questionnaire for stakeholders:

Urban Aspects of Internalisation of External Costs

*** 1. How relevant do you rate the following negative externalities of urban mobility? (Please indicate the level of importance according to scale)**

	1 least important	2 slightly important	3 rather important	4 very important	5 most important	N/A
Congestion						
Air Pollution						
Climate Change						
Accidents						
Noise						
Tear and wear of infrastructure						
Please indicate which other negative externalities of urban mobility you deem relevant						

*** 2. What instruments do you consider useful to address negative externalities? (Please indicate on a scale from 1 to 5; 1 being not relevant, 5 being most useful, see below for a description of the instruments)**

	Congestion	Air pollution	Climate change	Accidents	Noise	Tear and wear of infrastructure
Urban road charging						
Urban congestion charging						
Paid parking						
Green Zones						
Other restricted zones						
Intelligent Transport Solutions						
Road taxes						
Improvements in Public Transport						
Land-use planning						
Walking and cycling promotion instruments						

Description of instruments:

Urban road charging: distance-based, time-based or event- based (e.g. crossing a particular part of the network) road charging systems

Urban congestion charging: charging system where the level of the road charge is based on the level of congestion

Paid parking: paying for the use of space in a particular urban area, the charge often differs per time of the day or specific area and therefore varies with the time of the day

Green Zones: areas where the most polluting vehicles are restricted from entering, also referred to as 'Low Emission Zones' (LEZs).

Other restricted zones: restriction schemes (bans) focussed on reducing congestion and increasing the overall liveability of cities, not targeted to emission standards

Intelligent Transport Solutions: better utilisation of the existing infrastructure by means of using intelligent transport systems (e.g. traffic management systems).

Road taxes: increase the taxes on vehicle use (e.g. fuel tax) or vehicle ownership.

Walking and cycling promotion instruments: improvements of infrastructure, safety measures, information and awareness campaigns

Improvements in Public Transport: enhanced accessibility, connectivity, better information, infrastructural improvements etc,.

Land-use planning: control of the use of land and design of the urban environment, including urban mobility networks, to guide and ensure an urban development in which there is less need for car use.

* **3. What other related instruments are useful to contribute successfully to minimise the negative externalities of urban mobility?**

* 4. **Do you consider monitoring and enforcement practices relevant for the implementation of instruments aimed at reducing externalities of urban mobility?**

- ☐ No
- ☐ Yes, please specify which practices

* 5. **Do you have knowledge of a best practice of implementation of instruments aimed at reducing externalities of urban mobility?**

- ☐ No
- ☐ Yes, please specify which practices

* 6. **Which are in your view critical success or fail factors for the introduction and implementation of instruments aimed at reducing the negative externalities of urban mobility? *If possible, please consider aspects such as* communication and information, legal, financial and technical aspects, and aspects related to monitoring and enforcement.**

* 7. **When addressing the externalities of urban mobility, do you see a role for your own organisation?**

- ☐ No
- ☐ Yes, please specify

* 8. **When addressing the externalities of urban mobility, do you see a role for the European Commission? *If yes, please specify below:***

- ☐ Promotion of best practice
- ☐ Guidelines
- ☐ Handbook, toolkit
- ☐ Financial support
- ☐ Facilitate legal framework by providing standards for vehicle identification
- ☐ Facilitate legal framework by providing minimum access criteria
- ☐ Facilitate legal framework by providing standards for road signs
- ☐ Other interventions at EU level, such as

- ☐ No

* 9. Do you see any role for other parties that are essential for successful implementation?

- No
- Yes, please specify

* 10. In principle, do you or your organisation think all road users should pay for congestion and environmental damage through road tolls?

- No
- Yes
- I cannot say

* 11. How should the money thus collected be spent? (multiple answers possible)

- To improve road-related infrastructure (e.g. city tunnels, noise barriers)
- To invest in public transport (e.g. rail and urban transport)
- As general public expenditure
- Other, please specify
- I cannot say

* 12. You have reached the last question. In order to get a good understanding of specific information, this survey is not anonymous. Therefore, we ask you to fill in your personal details below:

Name organisation

Department

Name contact person

Email address

Telephone number

Other relevant contact details

Questionnaire for cities:

Cities on Urban Aspects of Internalisation of External Costs

*** 1. Has your city/ region considered a system to internalise the external costs of urban transport in the form of road charging measures?**

- ☐ Yes, such instruments are in operation
- ☐ Yes, such instruments are foreseen to be implemented
- ☐ No, no such instruments are implemented nor foreseen
- ☐ If yes, please give a brief description of the instruments

*** 2. Has your city/ region considered a system to internalise the external costs of urban transport in the form of paid parking measures?**

- ☐ Yes, such measures are in operation
- ☐ Yes, such measures are foreseen to be implemented
- ☐ No, no such measures are implemented nor foreseen
- ☐ If yes, please give a brief description of the measures

If no instruments have been implemented nor forseen for road charging or paid parking, please go to question 17:[In principle, do you or your organisation think all road users should pay for congestion...]

3. Which factors are in your opinion crucial for successful introduction of road charging measures? (multiple answers possible)

- ☐ Raising awareness of external costs problems
- ☐ Carrying out detailed impact assessment and implementation studies
- ☐ The example from other cities
- ☐ Consultation with citizens

4. Have citizens been consulted about the measures?

- ☐ No, no consultation was held
- ☐ Yes, by means of survey
- ☐ Yes, by means of a referendum, please specify the results

5. Which measures have you used to improve public understanding/acceptability?

Measures related to awareness and information, such as

Fiscal measures, such as

Other measures, such as

6. Which factors are in your opinion crucial for successful implementation of road charging measures? (multiple answers possible)

Legal aspects, such as

Technical aspects, such as

Financial aspects such as

Aspects relating to monitoring and enforcement such as

Communication and information aspects such as

Other aspects, such as

7. Which factors are in your opinion crucial for successful implementation of paid parking measures? (multiple answers possible)

Legal aspects, such as

Technical aspects, such as

Financial aspects such as

Aspects relating to monitoring and enforcement such as

Communication and information aspects such as

Other aspects, such as

8. What technical measures have you taken to identify users and to collect money?

- [ ] None
- [ ] Please give a description of the system

9. What technical measures have you taken to minimise costs and optimise cost recovery

- [ ] None
- [ ] Measures such as (please specify your answer):

10. Do you think that the aspects of successful implementation in your city could be divulged in order to turn into a best practice to be implemented elsewhere?

Yes, please explain why

No, please explain why not

11. Can you indicate which of the following negative externalities of urban transport have been considered when deciding to implement the instruments? On a scale from 1 to 5 (1 being of least importance, 5 being of most importance):

	1 least important	2 slightly important	3 rather important	4 very important	5 most important	N/A
Congestion	○	○	○	○	○	○
Air Pollution	○	○	○	○	○	○
Climate Change	○	○	○	○	○	○
Accidents	○	○	○	○	○	○
Noise	○	○	○	○	○	○
Tear and wear of infrastructure	○	○	○	○	○	○
Please indicate which other negative externalities of urban mobility you deem relevant	○	○	○	○	○	○

12. Whether you apply charging schemes or not, do you measure the extent of these external costs in your city?

	Congestion	Air Pollution	Climate change	Accidents	Noise	Tear and wear of infrastructure
No						
Yes, please indicate which negative externality and how it is measured (multiple answers possible)						

13. Do you monitor the results of the road charging scheme?

☐ Yes

☐ No, please specify why not (and please proceed to question 15)

14. Could you please indicate the results of the road charging scheme on mobility, environment, and economy?

	Change (in %)	Source	N/A
Mobility: number of vehicles entering the charged zone			
Mobility: number of vehicles kilometres entering the charged zone			
Mobility: change in average speed			
Environment: CO2 emissions			
Environment: CO emissions			
Environment: Noxemissions			
Environment: PM10, PM2,5emissions			
Economy: investment cost			
Economy: operational costs			
Economy: revenues from charges			
Reduction of accidents			
Quality of street surface			
Other, please specify			

15. Do you monitor the results of the paid parking scheme?

- Yes
- No, please specify why not (and please proceed to question 17)

16. Could you please indicate the results of the paid parking scheme on mobility, environment, and economy?

	Change (in %)	Source	N/A
Mobility: number of vehicles entering the charged zone			
Mobility: number of vehicles kilometres entering the charged zone			
Mobility: change in average speed			
Environment: CO2 emissions			
Environment: CO emissions			
Environment: Noxemissions			
Environment: PM10, PM2,5emissions			
Economy: investment cost			
Economy: operational costs			
Economy: revenues from charges			
Other, please specify			

* 17. What instruments do you consider useful to address negative externalities? (Please indicate on a scale from 1 to 5; 1 being not relevant, 5 being most useful, see below for a description of the instruments)

	Congestion	Air pollution	Climate change	Accidents	Noise	Tear and wear of infrastructure
Urban road charging						
Urban congestion charging						
Paid parking						
Green Zones						
Other restricted zones						
Intelligent Transport Solutions						
Road taxes						
Improvements in Public Transport						
Land-use planning						
Walking and cycling promotion instruments						
Other, please specify						

Description of instruments:

(See stakeholder questionnaire)

* 18. In principle, do you or your organisation think all road users should pay for congestion and environmental damage through road tolls?

- Yes
- No
- I cannot say

* 19. **How is the money thus collected spent? (Or how should it be spent in a hypothetical case?)**

- To improve road-related infrastructure (e.g. city tunnels, noise barriers)
- To invest in public transport (e.g. rail and urban transport)
- As general public expenditure
- I cannot say
- Other, please specify

* 20. **What other related instruments are in place or planned that contribute successfully to minimise the negative impacts of urban mobility? Please specify.**

* 21. **When addressing the externalities of urban mobility, do you see a role for the European Commission? If yes, please specify below:**

- Promotion of best practice
- Guidelines
- Handbook, toolkit
- Financial support
- Facilitate legal framework by providing standards for vehicle identification
- Facilitate legal framework by providing minimum access criteria
- Facilitate legal framework by providing standards for road signs
- Other interventions at EU level, such as
- No

* 22. **Do you see any role for other parties that are essential for successful implementation?**

- No
- Yes, please specify

* 23. **You have reached the last question. In order to get a good understanding of specific information, this survey is not anonymous. Therefore, we ask you to fill in your personal details below:**

Name city / region

Department

Name contact person

Email address

Telephone number

Other relevant contact details

Annex F: Summary of questionnaire results

Summary of answers given by stakeholders:

Urban Aspects of Internalisation of External Costs

stakeholders

1.1. How relevant do you rate the following negative externalities of urban mobility? (Please indicate the level of importance according to scale)

- Congestion

(Each respondent could choose only ONE response per sub-question.)

Response	Total	% of responses	%
1 least important	1		10 %
2 slightly important	0		0 %
3 rather important	2		20 %
4 very important	6		60 %
5 most important	1		10 %
- N/A	0		0 %
Average: 3,60 — Median: 4			
Total respondents: 10 Skipped question: 0		**0% 20% 40% 60% 80%**	

1.2. How relevant do you rate the following negative externalities of urban mobility? (Please indicate the level of importance according to scale)

- Air Pollution

(Each respondent could choose only ONE response per sub-question.)

Response	Total	% of responses	%
1 least important	0		0 %
2 slightly important	1		10 %
3 rather important	2		20 %
4 very important	6		60 %
5 most important	1		10 %
- N/A	0		0 %
Average: 3,70 — Median: 4			
Total respondents: 10 Skipped question: 0		**0% 20% 40% 60% 80%**	

1.3. How relevant do you rate the following negative externalities of urban mobility? (Please indicate the level of importance according to scale)

- Climate Change

(Each respondent could choose only ONE response per sub-question.)

Response	Total	% of responses	%
1 least important	1		10 %
2 slightly important	2		20 %
3 rather important	2		20 %
4 very important	5		50 %
5 most important	0		0 %
- N/A	0		0 %
Average: 3,10 — Median: 3			
Total respondents: 10 Skipped question: 0		**0% 20% 40% 60% 80%**	

1.4. How relevant do you rate the following negative externalities of urban mobility? (Please indicate the level of importance according to scale)

- Accidents

(Each respondent could choose only ONE response per sub-question.)

Response	Total	% of responses	%
1 least important	1		10 %
2 slightly important	1		10 %
3 rather important	1		10 %
4 very important	4		40 %
5 most important	3		30 %
- N/A	0		0 %
Average: 3,70 — Median: 4			
	Total respondents: 10 **Skipped question: 0**	**0% 20% 40% 60% 80%**	

1.5. How relevant do you rate the following negative externalities of urban mobility? (Please indicate the level of importance according to scale)

- Noise

(Each respondent could choose only ONE response per sub-question.)

Response	Total	% of responses	%
1 least important	0		0 %
2 slightly important	2		20 %
3 rather important	5		50 %
4 very important	3		30 %
5 most important	0		0 %
- N/A	0		0 %
Average: 3,10 — Median: 3			
	Total respondents: 10 **Skipped question: 0**	**0% 20% 40% 60% 80%**	

1.6. How relevant do you rate the following negative externalities of urban mobility? (Please indicate the level of importance according to scale)

- Tear and wear of infrastructure

(Each respondent could choose only ONE response per sub-question.)

Response	Total	% of responses	%
1 least important	1		10 %
2 slightly important	2		20 %
3 rather important	4		40 %
4 very important	3		30 %
5 most important	0		0 %
- N/A	0		0 %
Average: 2,90 — Median: 3			
Total respondents: 10 **Skipped question: 0**		**0% 20% 40% 60% 80%**	

1.7. How relevant do you rate the following negative externalities of urban mobility? (Please indicate the level of importance according to scale)

- Please indicate which other negative externalities of urban mobility you deem relevant

(Each respondent could choose only ONE response per sub-question.)

Response	Total	% of responses	%
1 least important	0		0 %
2 slightly important	0		0 %
3 rather important	0		0 %
4 very important urban effects , up- and downstream processes - Ineffective use of resources (urban space, energy, etc.)	3		60 %
5 most important Physical activity, Separation effects caused by rail/road infrastructure ; scarcity problems ; ecosystem loss due to 'sealed' areas of transport infrastructure ; loss of the ecological functions of soil such as absorption of rainfall, production of biomass, and CO2 storage	1		20 %
- N/A	1		20 %
Average: 4,25 — Median: 4			
Total respondents: 5 **Skipped question: 5**		**0% 20% 40% 60% 80%**	

2.1. What instruments do you consider useful to address negative externalities? (Please indicate on a scale from 1 to 5; 1 being not relevant, 5 being most useful, see below for a description of the instruments)

- Urban road charging

(Each respondent could enter MULTIPLE responses.)

Response	Total	% of responses	%
1 Congestion	10		100 %
2 Air pollution	10		100 %
3 Climate change	10		100 %
4 Accidents	10		100 %
5 Noise	10		100 %
6 Tear and wear of infrastructure	10		100 %
Total respondents: 10 **Skipped question: 0**		**0% 20% 40% 60% 80%**	

2.2. What instruments do you consider useful to address negative externalities? (Please indicate on a scale from 1 to 5; 1 being not relevant, 5 being most useful, see below for a description of the instruments)

- Urban congestion charging

(Each respondent could enter MULTIPLE responses.)

Response	Total	% of responses	%
1 Congestion	10		100 %
2 Air pollution	10		100 %
3 Climate change	10		100 %
4 Accidents	10		100 %
5 Noise	10		100 %
6 Tear and wear of infrastructure	10		100 %
Total respondents: 10 **Skipped question: 0**		**0% 20% 40% 60% 80%**	

2.3. What instruments do you consider useful to address negative externalities? (Please indicate on a scale from 1 to 5; 1 being not relevant, 5 being most useful, see below for a description of the instruments)

- Paid parking

(Each respondent could enter MULTIPLE responses.)

Response	Total	% of responses	%
1 Congestion	10		100 %
2 Air pollution	10		100 %
3 Climate change	10		100 %
4 Accidents	10		100 %
5 Noise	10		100 %
6 Tear and wear of infrastructure	10		100 %
Total respondents: 10 Skipped question: 0		**0% 20% 40% 60% 80%**	

2.4. What instruments do you consider useful to address negative externalities? (Please indicate on a scale from 1 to 5; 1 being not relevant, 5 being most useful, see below for a description of the instruments)

- Green Zones

(Each respondent could enter MULTIPLE responses.)

Response	Total	% of responses	%
1 Congestion	10		100 %
2 Air pollution	10		100 %
3 Climate change	10		100 %
4 Accidents	10		100 %
5 Noise	10		100 %
6 Tear and wear of infrastructure	10		100 %
Total respondents: 10 Skipped question: 0		**0% 20% 40% 60% 80%**	

2.5. What instruments do you consider useful to address negative externalities? (Please indicate on a scale from 1 to 5; 1 being not relevant, 5 being most useful, see below for a description of the instruments)

- Other restricted zones

(Each respondent could enter MULTIPLE responses.)

Response	Total	% of responses	%
1 Congestion	10		100 %
2 Air pollution	10		100 %
3 Climate change	10		100 %
4 Accidents	10		100 %
5 Noise	10		100 %
6 Tear and wear of infrastructure	10		100 %
Total respondents: 10 Skipped question: 0		**0% 20% 40% 60% 80%**	

2.6. What instruments do you consider useful to address negative externalities? (Please indicate on a scale from 1 to 5; 1 being not relevant, 5 being most useful, see below for a description of the instruments)

- Intelligent Transport Solutions

(Each respondent could enter MULTIPLE responses.)

Response	Total	% of responses	%
1 Congestion	10		100 %
2 Air pollution	10		100 %
3 Climate change	10		100 %
4 Accidents	10		100 %
5 Noise	10		100 %
6 Tear and wear of infrastructure	10		100 %
Total respondents: 10 Skipped question: 0		**0% 20% 40% 60% 80%**	

2.7. What instruments do you consider useful to address negative externalities? (Please indicate on a scale from 1 to 5; 1 being not relevant, 5 being most useful, see below for a description of the instruments)

- Road taxes

(Each respondent could enter MULTIPLE responses.)

Response	Total	% of responses	%
1 Congestion	10		100 %
2 Air pollution	10		100 %
3 Climate change	10		100 %
4 Accidents	10		100 %
5 Noise	10		100 %
6 Tear and wear of infrastructure	10		100 %
Total respondents: 10 Skipped question: 0		**0% 20% 40% 60% 80%**	

2.8. What instruments do you consider useful to address negative externalities? (Please indicate on a scale from 1 to 5; 1 being not relevant, 5 being most useful, see below for a description of the instruments)

- Improvements in Public Transport

(Each respondent could enter MULTIPLE responses.)

Response	Total	% of responses	%
1 Congestion	10		100 %
2 Air pollution	10		100 %
3 Climate change	10		100 %
4 Accidents	10		100 %
5 Noise	10		100 %
6 Tear and wear of infrastructure	10		100 %
Total respondents: 10 Skipped question: 0		**0% 20% 40% 60% 80%**	

2.9. What instruments do you consider useful to address negative externalities? (Please indicate on a scale from 1 to 5; 1 being not relevant, 5 being most useful, see below for a description of the instruments)

- Land-use planning

(Each respondent could enter MULTIPLE responses.)

Response	Total	% of responses	%
1 Congestion	10		100 %
2 Air pollution	10		100 %
3 Climate change	10		100 %
4 Accidents	10		100 %
5 Noise	10		100 %
6 Tear and wear of infrastructure	10		100 %
Total respondents: 10 Skipped question: 0		**0% 20% 40% 60% 80%**	

2.10. What instruments do you consider useful to address negative externalities? (Please indicate on a scale from 1 to 5; 1 being not relevant, 5 being most useful, see below for a description of the instruments)

- Walking and cycling promotion instruments

(Each respondent could enter MULTIPLE responses.)

Response	Total	% of responses	%
1 Congestion	10		100 %
2 Air pollution	10		100 %
3 Climate change	10		100 %
4 Accidents	10		100 %
5 Noise	10		100 %
6 Tear and wear of infrastructure	10		100 %
Total respondents: 10 Skipped question: 0		**0% 20% 40% 60% 80%**	

3. What other related instruments are useful to contribute successfully to minimise the negative externalities of urban mobility?

(Each respondent could write a single open-ended response of maximum 2000 characters.)

Response	Total	% of total respondents	%

- While most modes of transport have only negative externalities, this is not the case of active modes of transport, which have some clear positive externalities. The most important of these positive externalities relate to health. Cycling health benefits are externalities because active modes of transport users have lower costs to the society: these lower costs are due to their reduced premature mortality (Macdonald B. (2007) “Valuing the benefits of cycling”; Rutter, H., (2006) ‘Mortality Benefits of Cycling in London’; Saelensminde K. (2004) “Walking- and cycling track networks in Norwegian cities”; WHO (2007) “Economic assessment of transport infrastructure and policies”); to their lower costs to social security (Macdonald, 2007); and to their higher productivity (through lower absenteeism and lower tax losses, Macdonald, 2007; “Reduced sickness absence in cyclists”, TNO, 2009). These positive externalities are very important. The overall external benefit of cycling is estimated at 1.22 DKK/km and represents 159% of all the main negative car externalities combined (air and noise pollution, climate, road crashes and deterioration, congestion). The benefits from avoided external costs when transferring one road user from car to bicycle is 1.95 DKK/km in the off-peak hours, and 3.20 DKK/km in peak hours (‘Economic Evaluation of cycle projects’, Copenhagen, 2009, using the figures of the Danish Ministry of Transportation’s official unit price catalogue). Information and awareness-raising are welcome, but they are likely to increase cycling externalities! Maximizing positive externalities makes sense but to ensure we use transport in the optimal and most sustainable way it is important to internalize externalities, positive and negative. Allowing employers to pay a tax-free distance-based allowance, linked to the actual distance cycled by their employees, is one example for this. Reduced health insurance costs for active commuters is another example.
- Governance on a larger scale of territory, not limited to the traditionally defined urban areas. Considering the development of meta-cities, interregional mobility can now be considered as part of the urbanised area. Measures taken at city-centre-level (e.g. road pricing) risk to simply shift the problem in those (urban) areas not interested by the measure itself “Mobility management” and “smart working” schemes can be promoted providing incentives to those companies, which are more active on promoting changes in employees’ behavioural change (tax rebate; mobility facilities; flexible working hours; etc.). Introduce an early assessment of the expected impact of a new urban infrastructure on mobility, on the model of the environment assessments. Promoting the planning of a more efficient distribution of goods in urban areas (city logistics; low carbon fleets), with enormous benefit potential for improving air quality and decreasing congestion. A clear biofuel-Strategy of the European Union and ensure a consumer-oriented roll-out in each EU member state Promotion of green-procurement schemes: if local authorities use clean propulsion systems for their fleets, they can help to build up a critical mass to bring forward the infrastructure for clean vehicles (e.g. natural gas filling stations in a city, battery charging stations for electric vehicles) and help raise awareness on alternative, CO2-reducing and low emission energy in transport Promoting low and ultra-low carbon technologies in urban transport by facilitating the realization of a network of EV-eBike-eScooters as well as the relative infrastructure network Creating smarter a connection between roads and public transport (e.g. park-and-ride), favouring commuters’ travel and accessibility to cities Promoting ecodriving skills, particularly for professional drivers (e.g. taxi; public transport; delivery services)
- Workplace parking levy - Promotion of low/zero-emission vehicles - Efficient urban freight distribution Note: the item "improvement in public transport" should also include priority (e.g. bus lanes)
- Full charging to all modes of external costs A level playing field for all modes Dedicated infrastrucuture for clearner modes (bus lanes, cycle lanes, pedestrian routes etc.)
- Incentives should be provided to promote the use of collective passenger transport, in particular by bus, coach and taxi such as dedicated priority lanes, access to infrastructure of other modes and inclusion in multimodal journey planners. - Measures to improve the access of urban freight delivery vehicles such clearly defined loading and unloading times, access to dedicated parking areas for loading and unloading, clear sign posting and enforcement of parking policies. - Encourage stakeholder dialogue to facilitate solutions to the different problems relating to urban mobility.
- Development of bypasses.
- state subsidy programmes
- Public transport should always be the priority, all possible means to increase the use of public transport should be used: bus lanes (BRT), priority in traffic lights etc.
- [org] would welcome incentives, rather than only considering restrictive measures. Examples for such matters would be tax exemptions for greener vehicles, or for using infrastructure at non-peak hours, car-sharing, etc. Delivery times for HGV could be opened up to avoid delivery during peak hours especially in the morning. We would also like to stress that improving urban mobility necessarily needs to tackle individual passenger transport, and not only goods transport. Labelling could prove a viable tool in order to promote the exchange of best practices in the field of fight against congestion. However a labelling scheme has to find objective criteria on how to charge users. As far as professional ‘freight transport’ driving is concerned, eco-driving could be promoted through subsidised training programmes. In the future, one could also imagine an ‘eco-driving module’ in the training and education schemes of professional drivers

	0%	20%	40%	60%	80%

4. Do you consider monitoring and enforcement practices relevant for the implementation of instruments aimed at reducing externalities of urban mobility?

(Each respondent could choose MULTIPLE responses.)

Response	Total	% of responses	%
1 No	1		10 %
2 Yes, please specify which practices	9		90 %
- Definition of methodologies for the assessment of environmental efficiency including before/after analysis, in order to measure the results of imposed limitations using an objective method, and informing the citizens of the outcomes. - Monitoring is critical in understanding impact of measures. Enforcement ensures higher rates of compliance. Monitoring and enforcement practices should be the most applicable to the instruments adopted (i.e. a “one size fit all” approach would not work). - With any charging schemes, or restrictions on mobility, consistency of application is vital to ensure public acceptability - proper enforcement of access for buses, coaches and trucks, including of dedicated parking areas and times.			
Total respondents: 10 **Skipped question: 0**		**0% 20% 40% 60% 80%**	

5. Do you have knowledge of a best practice of implementation of instruments aimed at reducing externalities of urban mobility?

(Each respondent could choose MULTIPLE responses.)

Response	Total	% of responses	%
1 No	5		50 %
2 Yes, please specify which practices	5		50 %
The NL and Belgium have ‘tax-free mileage allowance’ schemes, a win-win-win instrument: the employee is healthier, receives an allowance, the employer has lower absenteeism, better accessibility, healthy image, and authorities have lower tax losses. European Union emission regulations for passenger cars (Euro 1 to 6) Real time traffic information platform (ACI Luce Verde: http://regionelazio.luceverde.it/ ; RACC Info transit: http://infotransit.racc.es/) 1. Instruments need to be tailored to the desired effect; 2. Need of balanced combination of instruments aiming at integrating land use and public transport, increasing the use of PT and other sustainable modes, managing travel demand. see: http://www.busandcoach.travel/download/en_smart_movepractical_solutions_final.pdf and http://www.busandcoach.travel/en/best_practices/industry_initiatives.htm			

Response	Total	% of responses	%
Total respondents: 10 **Skipped question: 0**		**0% 20% 40% 60% 80%**	

6. Which are in your view critical success or fail factors for the introduction and implementation of instruments aimed at reducing the negative externalities of urban mobility? If possible, please consider aspects such as communication and information, legal, financial and technical aspects, and aspects related to monitoring and enforcement.

(Each respondent could write a single open-ended response of maximum 2000 characters.)

Response	Total	% of total respondents	%
Open answer	10		100 %

Have a clear view on the global cost of the trip: the costs should not be spread across too many different charges, taxes, etc. so that it is not too difficult for the road user to put a price tag on his/her trip. • Link sustainable travel and active travel: active travel is a more promising message to the public than the environment. Evidence shows that promoting environmental reasons is most often no sufficient reason to motivate people to change their behavior (Bonsall, 2009). • Consider sustainable travel together with active travel in relation to journey type. While the short trips - those that are most likely to be replaced by active modes- represent an important share of total trips (about 30% for trips less than 3 km), in particular in urban settings, these short trips are also grossly inefficient and have much higher (air pollution and climate change) externalities, as during the first three kilometers exhaust emissions are more than 50 times higher per kilometer (Loukopoulos and Gärling, 2005, 'Are car users too lazy to walk?', De Nazelle et al., 2010, 'Short trips: An opportunity for reducing mobile-source emissions?'). In this context, replacing motorized trips by active modes trips will make an even greater difference. Also, considering it might be technically difficult to put different costs on externalities created over different length of trips, diminishing the number of short trips will also make it possible to internalize externalities more accurately. • Make travel costs variable whenever possible. Insurance premiums, when paid on a yearly (or time) basis, do not give any price signal as regards external costs of vehicle use. Pay-as-you-drive vehicle insurance motivates road users to consider other means of transport. • Favoring policy instruments that can limit the rebound effect, like non-price levers around network use: dedicated bicycle lanes or parking policies.

Motorists are consumers and any forced attempt to shift from private to collective transport will not be accepted by users: on the contrary, they are ready to switch from one to another mode of transport if they can experience a benefit in terms of cost, comfort and safety. The challenge for urban mobility is to create integrated mobility solutions that will provide people with choice, flexibility and seamless connectivity. When introducing new measures which limit individual mobility, consultation processes, dissemination strategies, and users' participation are essential factors: it would be important to engage not only the usual stakeholders (associations and organisations) but also the wider public (citizens) through a consultation process, indicating vision/policy/benefit and keep open channels for feedback (on-line/ e-mail). E 10 introduction in Germany and in Finland is an example that the implementation of new ecologic measures and instruments will not prove successful if they are not introduced in a consumer-oriented way. This case shows that consumer information is a key factor of success. Specific transport policies may increase social exclusion. For this reason urban transport policies aimed at reducing negative externalities should also consider equity audits: audits should assess equity effects to assist policymakers in understanding how measures (are likely to) affect different social groups, and determine how best to pre-empt, correct, or mitigate adverse social effects associated with such charges.

- Adopt a flexible approach for the internalization option to be taken

- Make decisions at the level of the whole urban mobility system

- Coordination of local and regional authorities' mobility policies at the scale of the metropolitan area.

- Earmark revenue from any internalization scheme to support modes with less negative externalities and more positive externalities (typically public transport) - Anticipate extra demand for public transport linked to implementation of internalization scheme - Link the level of contribution required in internalization scheme to the quality of the alternative offered by public transport - Get support from all relevant stakeholders

- Measure impacts accurately on the basis of passenger x km or trips - From a technical perspective, standards for e.g. emissions need to be best practice but realistic – an overly strict standard may result in a reduction in economic activity.

Good communicaiton of the impact. Explanation of the wider benefits. Ensure benefits are clearly attainable by users (e.g. cheaper buses) so that it is not just seen as an additional tax. Earmark revenue to support those modes you wish to encourage more.

- The subsidiarity principle which could limit the European Commission in its attempts to harmonise and provide guidelines for actions undertaken by Member States, local, regional and municipal authorities. - Incentives to accelerate the uptake of the cleanest and most efficient technologies by commercial transport operators. - Incentives to encourage the use of collective passenger transport. - Guarantees to transport operatorsfor required investments, opportunities arising from them and legal certainty for a reasonable period of time in order to allow return on investments for road transport operators. - Targetting of the right road users, including the private car. - Putting into place and implementation of a clear policy to prioritise collective passenger transport with the aim of doublinfg its use by 2025. - A compatible mix of measures aimed at solving problems.

Response	Total	% of total respondents	%
- Most critical success factor is finacial aspect			
Total respondents: 10 **Skipped question: 0**		**0% 20% 40% 60% 80%**	

7. When addressing the externalities of urban mobility, do you see a role for your own organisation?

(Each respondent could choose MULTIPLE responses.)

Response	Total	% of responses	%
1 No	4		40 %
2 Yes, please specify	6		60 %
We want to make sure all externalities of all modes of transport are internalized, not just the so-called "main (negative) externalities" that are usually considered, but also the positive externalities of active modes of transport. Educate and inform motorists on sustainable mobility promoting benchmarking activities on the safety and quality of mobility promote users' acceptance on ITS for urban mobility develop and promote ecodriving programmes promote Mobility Management 1. Raise awareness of external benefits of public transport 2. Support exchange of best practice 3. Inform decision on adequate internalization option As a dedicated stakeholder to provide input on possible solutions to the urban mobility of people and goods Our organization has an impact in solving legal aspect The subsidiarity principle, according to which the MS are responsible for urban development and mobility, may become a fail factor. Member States may be reluctant to implement EU rules in form of a Regulation. Measures need to be applied on an equal basis taking into account private and commercial vehicles.			
Total respondents: 10 **Skipped question: 0**		**0% 20% 40% 60% 80%**	

8. When addressing the externalities of urban mobility, do you see a role for the European Commission? If yes, please specify below:

(Each respondent could choose MULTIPLE responses.)

Response	Total	% of responses	%
1 Promotion of best practice	10		100 %
2 Guidelines	8		80 %
3 Handbook, toolkit	8		80 %
4 Financial support	7		70 %
5 Facilitate legal framework by providing standards for vehicle identification	3		30 %
6 Facilitate legal framework by providing minimum access criteria	1		10 %
7 Facilitate legal framework by providing standards for road signs	3		30 %
8 Other interventions at EU level, such as	4		40 %
• regulatory framework (standard emissions EU driving cycle) support demonstration programme • Maximum acceptable levels of externalities from urban transport could be determined at EU level for selected externalities (e.g. environmental impact), bearing in mind that in most cases they are better determined at the local level. • Setting of wider strategic goals , e.g. banning conventionaly-fuelled cars in cities by 2050, fully internalising all external costs • Ensuring the harmonisation of the different measures taken by Member States and municipal authorities and ensuring their fairness, transparency and non-discriminatory character. Measures should be proportional to the objectives to be achieved.			
9 No	0		0 %
Total respondents: 10 **Skipped question: 0**		**0% 20% 40% 60% 80%**	

9. Do you see any role for other parties that are essential for successful implementation?

(Each respondent could choose MULTIPLE responses.)

Response	Total	% of responses	%
1 No	2		20 %
2 Yes, please specify	8		80 %
• Local authorities have an important role to play in effectively implementing the internalization of transport externalities. • Involvement of users is essential: many of our future challenges are shaped by people's values, behaviour and preferences. It is essential to promote ways to influence mass behaviour and social norms in positive ways to promote low-carbon, healthier lifes • Mayors and local authorities (initiative), public transport operators and organizing authorities, national authorities (legal framework), local economic actors, citizens • Ensure support and buy-in from local authorities, transport operators, and governments • Member States, municipalities, public transport authorities, retail organisations, the ITS Community • National governments and institutions • Civil society organisations, CoR, EESC, local and regional organisations/authorities			
Total respondents: 10 **Skipped question: 0**		**0% 20% 40% 60% 80%**	

10. In principle, do you or your organisation think all road users should pay for congestion and environmental damage through road tolls?

(Each respondent could choose MULTIPLE responses.)

Response	Total	% of responses	%
1 No	4		40 %
2 Yes	4		40 %
3 I cannot say	2		20 %
Total respondents: 10 **Skipped question: 0**		**0% 20% 40% 60% 80%**	

11. How should the money thus collected be spent? (multiple answers possible)

(Each respondent could choose MULTIPLE responses.)

Response	Total	% of responses	%
1 To improve road-related infrastructure (e.g. city tunnels, noise barriers)	3		30 %
2 To invest in public transport (e.g. rail and urban transport)	6		60 %
3 As general public expenditure	0		0 %
4 Other, please specify	5		50 %
• To invest in mobility with positive externalities, i.e. active modes of transport –walking and cycling- • To support (part of) public transport operating costs 2. To invest in infrastructure for other sustainable modes (walking, cycling) • To earmark to road related projects aimed at greening road transport at-source. No cross-subsidising to rail. • for investing and improving public transport infrastructure			
5 I cannot say	0		0 %
Total respondents: 10 **Skipped question: 0**		**0% 20% 40% 60% 80%**	

12. You have reached the last question. In order to get a good understanding of specific information, this survey is not anonymous. Therefore, we ask you to fill in your personal details below:

(Each respondent could write multiple open-ended responses of maximum 255 characters.)

Response	Total	% of responses	%
Name organisation	10		100 %
Department	5		50 %
Name contact person	9		90 %
Email address	10		100 %
Telephone number	10		100 %
Other relevant contact details	3		30 %
Total respondents: 10 **Skipped question: 0**		**0% 20% 40% 60% 80%**	

Summary of responses given by cities:

Cities on Urban Aspects of Internalisation of External Costs

1. Has your city/ region considered a system to internalise the external costs of urban transport in the form of road charging measures?

(Each respondent could choose MULTIPLE responses.)

Response	Total	% of responses	%
1 Yes, such instruments are in operation	2		18 %
2 Yes, such instruments are foreseen to be implemented	4		36 %
3 No, no such instruments are implemented nor foreseen	5		45 %
4 If yes, please give a brief description of the instruments	4		36 %
• road charge for business operators • fees on some of motorways or their sections • The measure has yet to be implemented. Political will has been expressed • London's Congestion Charge covers 22km2 of the centre of the city, the heart of business, government and entertainment. The aim of the Charge is to reduce congestion and it operates from Monday to Friday 07:00-18:00. It does not apply at weekends, Bank Holidays , or the days between Christmas Day and New Year's Day, when traffic levels are lighter. The Charge was introduced by Transport for London. (TfL) in February 2003, following extensive public and stakeholder consultation and was extended westward in February 2007. Following public consultation this western extension came to an end in January 2011. Currently the charge for driving into or within the zone is £10 per day. Congestion charging reduced traffic flows into the centre by over 20 per cent and this reduction has been maintained year on year. • London also operates a Low Emission Zone (LEZ) which covers almost all of Greater London, 24 hours a day, every day of the year. The scheme was introduced in 2008 following extensive consultation to improve air quality. The LEZ set minimum standards for particulate matter (PM) emissions from lorries buses and coaches in 2008 and these were tightened to Euro IV for PM in January 2012. Also in January 2012 new Euro 3 for PM standards were introduced for vans and minibuses. Vehicles which meet these standards can drive within Greater London free of charge, while those that do not must pay a very significant daily charge (£200 per day for lorries, buses and coaches and £100 per day for vans			

Response	Total	% of responses	%
and minbuses) or risk a fine. These charges are set at a level to encourage compliance with air quality standards and this approach has been very successful. Compliance levels are very high (over 90 per cent for lorries buses and coaches and 98 per cent for vans and minibuses). The LEZ does not generate net income but is a very effective air quality scheme.			
Total respondents: 11 Skipped question: 0		0% 20% 40% 60% 80%	

2. Has your city/ region considered a system to internalise the external costs of urban transport in the form of paid parking measures?

(Each respondent could choose MULTIPLE responses.)

Response	Total	% of responses	%
1 Yes, such measures are in operation	6		55 %
2 Yes, such measures are foreseen to be implemented	1		9 %
3 No, no such measures are implemented nor foreseen	1		9 %
4 If yes, please give a brief description of the measures	7		64 %
• Parking places are with fees, lower for residents • Parking charge in central areas much higher than in residential areas. • more than 25 tho paid parking places in the city center, growing re city center • We have a policy of on-street paid parking within the urban area. Prices are set to maximize the use of garages rather than on-street parking.javascript:srr(7) • Parkraummanagement, Bewirtschaftung öffentlicher Stellplätze in der Innenstadt • Parking space in city center is regulated, with time restrictions and a tax. Residents can use park in their zones almost for free. • Road parking spaces across London are largely paid parking in some shape or form. However, parking policies are generally the responsibility of London 33 municipal authorities known as Boroughs. TfL is responsible for only 580km of the city's approximately 14,000km of roads. Despite on-going discussions in a number of boroughs, currently none base parking fees on externalities. In the London			

Response	Total	% of responses	%
Borough of Richmond parking charges were based on CO2 emissions until June 2011. TfL currently does not charge for parking on the portion of the road network it is responsible for.			
Total respondents: 11 **Skipped question: 0**		**0% 20% 40% 60% 80%**	

If no instruments have been implemented nor forseen for road charging or paid parking, please go to question 17:[In principle, do you or your organisation think all road users should pay for congestion...]

3. Which factors are in your opinion crucial for successful introduction of road charging measures? (multiple answers possible)

(Each respondent could choose MULTIPLE responses.)

Response	Total	% of responses	%
1 Raising awareness of external costs problems	8		80 %
2 Carrying out detailed impact assessment and implementation studies	6		60 %
3 The example from other cities	5		50 %
4 Consultation with citizens	6		60 %
Total respondents: 10 **Skipped question: 1**		**0% 20% 40% 60% 80%**	

4. Have citizens been consulted about the measures?

(Each respondent could choose MULTIPLE responses.)

Response	Total	% of responses	%
1 No, no consultation was held	6		60 %
2 Yes, by means of survey	3		30 %
3 Yes, by means of a referendum, please specify the results	2		20 %
1. Referendum in the 1990ies. More than 50% yes 2. periodic Warsaw Barometer, open public discussions			

Response	Total	% of responses	%
Total respondents: 10 Skipped question: 1		0% 20% 40% 60% 80%	

5. Which measures have you used to improve public understanding/acceptability?

(Each respondent could write multiple open-ended responses of maximum 255 characters.)

Response	Total	% of responses	%
Measures related to awareness and information, such as	6		75 %
Fiscal measures, such as	2		25 %
Other measures, such as	4		50 %
• Other measures, such as: publicity • Measures related to awareness and information, such as: public meetings • Measures related to awareness and information, such as: news papapers, leaflets • Measures related to awareness and information, such as: information about the advantages such as noise and air pollution reduction • Measures related to awareness and information, such as: Public Transport Days, public consultanties,info in media including local rules, public exhibition of "Strategy of sustainable transport development in Warsaw up to 2015 and beyond" • Fiscal measures, such as: incentives included in parking tarrifs • Other measures, such as: increasing of public transport quality, new modern rolling stock • Measures related to awareness and information, such as: communication campaigns • Measures related to awareness and information, such as: Public information campaigns, TV / radio / internet / social media / print / billboards / extensive stakeholder engagement / direct interaction (e.g. information dispersal by hand at residents meetings for congesting charging and at markets for LEZ) • Fiscal measures, such as: The UK Government's car taxation regime is based on CO2 emissions. Congestion Charging discounts are offered to low emitting vehicles such as Electric vehicles and greener vehicles defined as those meeting a Euro V standard and emitting less that 100g CO2 • Other measures, such as: 100 per cent of net revenues from the Congestion Charge must by law be reinvested in public transport, walking, cycling and related measures. For the LEZ TfL worked extensively with the abatement industry to ensure that PM filters would be available for for all affected vehicle groups so that vehicle operators would not have to replace vehicles. TfL established a certification scheme in the UK to ensure that only appropriate filters were fitted. TfL recognises filters fitted and certified in other			

Response	Total	% of responses	%
EU states to enable easy access for foreign registered operators.			
Total respondents: 8 **Skipped question: 3**		**0% 20% 40% 60% 80%**	

6. Which factors are in your opinion crucial for successful implementation of road charging measures? (multiple answers possible)

(Each respondent could write multiple open-ended responses of maximum 255 characters.)

Response	Total	% of responses	%
Legal aspects, such as	7		88 %
Technical aspects, such as	7		88 %
Financial aspects such as	8		100 %
Aspects relating to monitoring and enforcement such as	6		75 %
Communication and information aspects such as	6		75 %
Other aspects, such as	5		62 %
• Legal aspects, such as: foolproof • Technical aspects, such as: cheap system • Financial aspects such as: makes a diffrence • Communication and information aspects such as: campaign • Other aspects, such as: fairness • Legal aspects, such as: privacy and non-discrimination • Technical aspects, such as: perfect calcul of distance driven • Financial aspects such as: tarifs high enought to provoke modal shift • Aspects relating to monitoring and enforcement such as: good equilibrium between investment and return concerning enforcement (road side equipment, mobil teams etc...) • Communication and information aspects such as: Transparant communication concerning the bills and also on the use of the collected money (someway of earmarking is advised) • Legal aspects, such as: clear lex and norms • Technical aspects, such as: alternatives convenient and easy usable • Financial aspects such as: contributes for fair beahviours • Aspects relating to monitoring and enforcement such as: do cutomers survey and share continuous results • Communication and information aspects such as: let know people about consequences of pollution and traffic • Legal aspects, such as: adaptation of the constitution, until now "free use of streets" • Technical aspects, such as: collection of data • Financial aspects such as: collection of earnings • Other aspects, such as: abolishment of flat taxation of cars • Legal aspects, such as: rule on road charging in cities, clear system of cars excluded of road			

Response	Total	% of responses	%
charging • Financial aspects such as: finances gathered with road charging allocated for road improvements • Aspects relating to monitoring and enforcement such as: clear ad reliable indication of vehicles breaking rules, prompt penalties • Communication and information aspects such as: like mentioned previously • Other aspects, such as: as for towns crucial is to have by-pass roads • Legal aspects, such as: The charge has to be a charge and not a tax, before we can implement it. • Technical aspects, such as: It has to be secure and cost efficient • Financial aspects such as: It has to be cost efficient • Aspects relating to monitoring and enforcement such as: It has to be reliable and without glitches • Communication and information aspects such as: It has to be clear how the net profit is used (to improve sustainable modes of transport) • Other aspects, such as: Fysical aspects, such as actual problems that need to be solved (congestion, NOx levels, etc) • Legal aspects, such as: A robust legal base (in London's case set out in the Greater London Authority Act 1999). • Technical aspects, such as: Expertise and experience / skills base to establish such a scheme, plus infrastructure (both road and public transport alternatives) that would make such a scheme practical, workable and publicly-acceptable. • Financial aspects such as: Rigorous analysis of costs and any expected income and analysis of routes to, and costs of compliance for operators. • Aspects relating to monitoring and enforcement such as: A strong evidence base in terms of traffic levels and environmental factors. Initially at least it is important to produce detailed impact assessments to monitor the effectiveness and wider influences of a scheme, particularly larger ones. Such analysis, when monitored over time allows a scheme to be modified to maximise its effectiveness and minimise any negative consequences. Effective enforcement is an important determinant to overall acceptance of a scheme. This is particularly relevant in the case of foreign registered vehicles where there is often a perception that evasion is widespread. Indeed bilateral arrangements covering road traffic enforcement between member states have proved difficult resulting in many offences going unpunished. TfL welcomes measures at an EU level to ensure equal compliance and enforcement of road traffic rules on all drivers, irrespective of their home member state. Whilst TfL welcomes Directive 2011/82/EU facilitating the cross-border exchange of information on road safety-related traffic offences as an important first step, when the Directive is reviewed in 2016 TfL			

Response	Total	% of responses	%
hopes the range of offences will be extended to include, amongst others, non-payment of road user charges and compliance with low emission / green zones. • Communication and information aspects such as: Wide ranging consultation and information campaigns with citizens, before, during and after implementation of a scheme. Prior communication is critical where the scheme is dependant on prior action by citizens e.g. fitting abatement equipment or buying a new/er vehicle to succeed. Post scheme communication is particularly important so that citizens are informed where any revenue raised from a scheme is spent. In the case of London 100 per cent of net revenues from the Congestion Charge are re-invested back into public transport, walking, cycling and other transport services. A pro-active information campaign aims at highlighting improvements to these services that result from this additional investment. This is particularly important in the early years after the introduction of a scheme. The LEZ does not raise net revenue but it is important to communicate the positive environmental benefits of the scheme. • Other aspects, such as: • Political will: in London's case the power to introduce the charge is vested in a directly-elected Mayor. • Engagement and support of (at least a part of) the business community • Implementation in the context of an integrated transport plan, which, inter alia offers alternatives to car travel in the charging area • Technical aspects, such as: in the city center improvment of public transport			
Total respondents: 8 **Skipped question: 3**		**0% 20% 40% 60% 80%**	

7. Which factors are in your opinion crucial for successful implementation of paid parking measures? (multiple answers possible)

(Each respondent could write multiple open-ended responses of maximum 255 characters.)

Response	Total	% of responses	%
Legal aspects, such as	4		50 %
Technical aspects, such as	6		75 %
Financial aspects such as	5		62 %
Aspects relating to monitoring and enforcement such as	5		62 %
Communication and information aspects such as	4		50 %
Other aspects, such as	5		62 %
• Other aspects, such as: avalibility of space • Legal aspects, such as: Is this regional or local competence • Technical aspects, such as: Agree with local municipalities on number of parkings spaces • Financial aspects such as: agreement on repartition earnings between region and local municipalities • Aspects relating to monitoring and enforcement such as: effective enforcement by the police forces • Communication and information aspects such as: make people understand that parkingspace is very expensive for the society and community • Other aspects, such as: courage to reduce number of parking spaces • Legal aspects, such as: lex to support less car owned • Technical aspects, such as: shuttle with parking places and integration with public transport • Financial aspects such as: mix prices with parking and public transport • Technical aspects, such as: introduction or adaptation of parkingmeters • Aspects relating to monitoring and enforcement such as: inspectation and punishment • Other aspects, such as: development of an attractive public transport as an alternative to the car • Legal aspects, such as: common rules for classic and alternative fueled/driven vehicles • Technical aspects, such as: paid parking capacities differenciated in any city zone • Financial aspects such as: different fee in any city zone, also in time o'clock • Aspects relating to monitoring and enforcement such as: more effective enforcement system (now it is working with inspectors walking around streets • Communication and information aspects such as:			

Response	Total	% of responses	%
like mentioned previously • Other aspects, such as: more underground parking slots out of the city centre, gratis • Technical aspects, such as: easy to pay • Financial aspects such as: net profit • Aspects relating to monitoring and enforcement such as: it should not be worth it to take a chance not paying for parking • Financial aspects such as: ausreichende Finanzmittel für eine rasche Einführung in zusammenhängenden Gebieten • Aspects relating to monitoring and enforcement such as: regelmäßige Kontrollen • Communication and information aspects such as: intensive und frühzeitige Information der Bürgerinnen und Bürger, Beteiligung der Stadtteilparlamente			
Total respondents: 8 **Skipped question: 3**		**0% 20% 40% 60% 80%**	

8. What technical measures have you taken to identify users and to collect money?

(Each respondent could choose MULTIPLE responses.)

Response	Total	% of responses	%
1 None	2		22 %
2 Please give a description of the system	7		78 %
• car and taxometer • Capsch identification system and e-toll system on motorways; penalties for illegal parking are collected by circulating inspectors • Parkscheinautomaten • Car taxes and residence register. • Both the congestion charging scheme and the Low Emission Zone are enforced by means of a camera network and automatic number plate recognition software which gives TfL a record of vehicles driving in the relevant zones each day. For congestion charging vehicles seen driving in the zone have until the next day to pay their charge. Charges can be paid on line, via a call centre, using mobile phones or in a network of local shops. Since January 2012 vehicle drivers have been able to open an account with TfL to enable their congestion charge to be paid automatically each month from a nominated account. Should a charge not be paid for a vehicle, the license plate is sent to the licensing authority in the UK who return the keeper details and a penalty charge is issued. Foreign registered vehicles are also expected to pay the charge. For the Low Emission Zone, TfL maintains a database showing the age and weight of all UK vehicles. Those vehicles that are retrofitted with a filter are certified by the UK			

Response	Total	% of responses	%
vehicle certification agency and this information is automatically passed to TfL. TfL is then able to determine which vehicles meet the LEZ emissions standard and which do not. Vehicles not meeting the required air quality standard and not paying a daily charge are issued a penalty in the same way as those not paying a congestion charge. Foreign registered diesel vehicles subject to the LEZ must be registered with TfL to demonstrate that they meet the required standard. TfL employs a dedicated foreign enforcement agency which will issue a Penalty Charge Notice where possible to foreign registered operators not complying with the relevant scheme.			
Total respondents: 9 **Skipped question: 2**		0% 20% 40% 60% 80%	

9. What technical measures have you taken to minimise costs and optimise cost recovery

(Each respondent could choose MULTIPLE responses.)

Response	Total	% of responses	%
1 None	5		56 %
2 Measures such as (please specify your answer):	4		44 %
• foolproof system • Mobility studies (parking demand, etc.) • Since Congestion Charging began TfL has changed its contractor leading to significant savings. Other measures such as upgraded cameras have improved reliability and driven down costs.			
Total respondents: 9 **Skipped question: 2**		**0% 20% 40% 60% 80%**	

10. Do you think that the aspects of successful implementation in your city could be divulged in order to turn into a best practice to be implemented elsewhere?

(Each respondent could write multiple open-ended responses of maximum 255 characters.)

Response	Total	% of responses	%
Yes, please explain why: • people are oriented to foreign patterns • hohe Akzeptanz des Parkraummanagement; Konzept wurde bereits häufig in- und ausländischen Experten und Kommunalvertretern vorgestellt • Whilst the central London Congestion Charge and Low Emission Zone have been successful, this is due to a range of factors, some of which include: • Political commitment • Adequate public transport alternatives for congestion charging • Adequate retrofit solutions for LEZ • Effective research and clear policy objectives • Extensive public consultation and stakeholder engagement • Strong project management • Effective contract management • Effective traffic management • Strong public information campaign • Ongoing customer and impacts monitoring, stakeholder engagement and scheme improvements TfL has always been happy to share its experience of the Congestion Charge and Low Emission Zone with other cities. However, it is important to note that a road user charge is only one of many mobility policies a city or regional authority is able to use. It is not the only solution and ultimately it is for individual cities and their	3		33 %

Response	Total	% of responses	%
democratically elected leaders to decide on the best policy options.			
No, please explain why not: • specific circusntances • the measures are only in preparation with the aid of consultants • we are still doing "standard" measures with soft results • gains from the parking taxation are not implemented to internalise external costs • if it would be expensive and influence on indidual financial condition • The policy is not that innovative and the high compliance with paid parking comes down to cultural aspects (high trust in government)	7		78 %
Total respondents: 9 **Skipped question: 2**		**0% 20% 40% 60% 80%**	

11.1. Can you indicate which of the following negative externalities of urban transport have been considered when deciding to implement the instruments? On a scale from 1 to 5 (1 being of least importance, 5 being of most importance):

- Congestion

(Each respondent could choose only ONE response per sub-question.)

Response	Total	% of responses	%
1 least important	1		9 %
2 slightly important	1		9 %
3 rather important	1		9 %
4 very important	1		9 %
5 most important	7		64 %
- N/A	0		0 %
Average: 4,09 — Median: 5			
Total respondents: 11 **Skipped question: 0**		**0% 20% 40% 60% 80%**	

11.2. Can you indicate which of the following negative externalities of urban transport have been considered when deciding to implement the instruments? On a scale from 1 to 5 (1 being of least importance, 5 being of most importance):

- Air Pollution

(Each respondent could choose only ONE response per sub-question.)

Response	Total	% of responses	%
1 least important	0		0 %
2 slightly important	0		0 %
3 rather important	3		27 %
4 very important	5		45 %
5 most important	3		27 %
- N/A	0		0 %
Average: 4 — Median: 4			
Total respondents: 11 Skipped question: 0		**0% 20% 40% 60% 80%**	

11.3. Can you indicate which of the following negative externalities of urban transport have been considered when deciding to implement the instruments? On a scale from 1 to 5 (1 being of least importance, 5 being of most importance):

- Climate Change

(Each respondent could choose only ONE response per sub-question.)

Response	Total	% of responses	%
1 least important	3		30 %
2 slightly important	2		20 %
3 rather important	2		20 %
4 very important	2		20 %
5 most important	1		10 %
- N/A	0		0 %
Average: 2,60 — Median: 2			
Total respondents: 10 Skipped question: 1		**0% 20% 40% 60% 80%**	

11.4. Can you indicate which of the following negative externalities of urban transport have been considered when deciding to implement the instruments? On a scale from 1 to 5 (1 being of least importance, 5 being of most importance):

- Accidents

(Each respondent could choose only ONE response per sub-question.)

Response	Total	% of responses	%
1 least important	3		27 %
2 slightly important	3		27 %
3 rather important	3		27 %
4 very important	1		9 %
5 most important	1		9 %
- N/A	0		0 %
Average: 2,45 — Median: 2			
Total respondents: 11 Skipped question: 0		**0% 20% 40% 60% 80%**	

11.5. Can you indicate which of the following negative externalities of urban transport have been considered when deciding to implement the instruments? On a scale from 1 to 5 (1 being of least importance, 5 being of most importance):

- Noise

(Each respondent could choose only ONE response per sub-question.)

Response	Total	% of responses	%
1 least important	2		18 %
2 slightly important	2		18 %
3 rather important	5		45 %
4 very important	2		18 %
5 most important	0		0 %
- N/A	0		0 %
Average: 2,64 — Median: 3			
Total respondents: 11 Skipped question: 0		**0% 20% 40% 60% 80%**	

11.6. Can you indicate which of the following negative externalities of urban transport have been considered when deciding to implement the instruments? On a scale from 1 to 5 (1 being of least importance, 5 being of most importance):

- Tear and wear of infrastructure

(Each respondent could choose only ONE response per sub-question.)

Response	Total	% of responses	%
1 least important	0		0 %
2 slightly important	5		45 %
3 rather important	3		27 %
4 very important	2		18 %
5 most important	0		0 %
- N/A	1		9 %
Average: 2,70 — Median: 2			
Total respondents: 11 **Skipped question: 0**		**0% 20% 40% 60% 80%**	

11.7. Can you indicate which of the following negative externalities of urban transport have been considered when deciding to implement the instruments? On a scale from 1 to 5 (1 being of least importance, 5 being of most importance):

- Please indicate which other negative externalities of urban mobility you deem relevant

(Each respondent could choose only ONE response per sub-question.)

- effect on human health: very important
- degradation of the public space: rather important
- people's mental and somatic health, operation oil leakages,damages in cultural structures etc: most important
- Erreichbarkeit für den Wirtschaftsverkehr: rather important
- Land use planning: most important

Response	Total	% of responses	%
1 least important	0		0 %
2 slightly important	0		0 %
3 rather important	2		29 %
4 very important	1		14 %
5 most important	2		29 %
- N/A	2		29 %
Average: 4 — Median: 3,50			

Response	Total	% of responses	%
Total respondents: 7 Skipped question: 4		0% 20% 40% 60% 80%	

12.1. Whether you apply charging schemes or not, do you measure the extent of these external costs in your city?

- No

(Each respondent could enter MULTIPLE responses.)

Response	Total	% of responses	%
1 Congestion	3		75 %
2 Air Pollution	3		75 %
3 Climate change	3		75 %
4 Accidents	2		50 %
5 Noise	2		50 %
6 Tear and wear of infrastructure	2		50 %
Total respondents: 4 Skipped question: 7		0% 20% 40% 60% 80%	

12.2. Whether you apply charging schemes or not, do you measure the extent of these external costs in your city?

- Yes, please indicate which negative externality and how it is measured (multiple answers possible)

(Each respondent could enter MULTIPLE responses.)

Response	Total	% of responses	%
1 Congestion	5		71 %
2 Air Pollution	6		86 %
3 Climate change	5		71 %
4 Accidents	7		100 %
5 Noise	7		100 %
6 Tear and wear of infrastructure	6		86 %
Total respondents: 7 Skipped question: 4		0% 20% 40% 60% 80%	

13. Do you monitor the results of the road charging scheme?

(Each respondent could choose MULTIPLE responses.)

Response	Total	% of responses	%
1 Yes	3		33 %
2 No, please specify why not (and please proceed to question 15): too much hassle; not yet started	6		67 %
Total respondents: 9 **Skipped question: 4**		**0% 20% 40% 60% 80%**	

14.1. Could you please indicate the results of the road charging scheme on mobility, environment, and economy?

- Mobility: number of vehicles entering the charged zone

(Each respondent could enter MULTIPLE responses.)

Response	Total	% of responses	%
1 Change (in %)	2		50 %
2 Source	0		0 %
- N/A	2		50 %
Total respondents: 4 **Skipped question: 7**		**0% 20% 40% 60% 80%**	

14.2. Could you please indicate the results of the road charging scheme on mobility, environment, and economy?

- Mobility: number of vehicles kilometres entering the charged zone

(Each respondent could enter MULTIPLE responses.)

Response	Total	% of responses	%
1 Change (in %)	2		50 %
2 Source	0		0 %
- N/A	2		50 %
Total respondents: 4 **Skipped question: 7**		**0% 20% 40% 60% 80%**	

14.3. Could you please indicate the results of the road charging scheme on mobility, environment, and economy?

- Mobility: change in average speed

(Each respondent could enter MULTIPLE responses.)

Response	Total	% of responses	%
1 Change (in %)	0		0 %
2 Source	0		0 %
- N/A	4		100 %
Total respondents: 4 Skipped question: 7		0% 20% 40% 60% 80%	

14.4. Could you please indicate the results of the road charging scheme on mobility, environment, and economy?

- Environment: CO2 emissions

(Each respondent could enter MULTIPLE responses.)

Response	Total	% of responses	%
1 Change (in %)	1		25 %
2 Source	0		0 %
- N/A	3		75 %
Total respondents: 4 Skipped question: 7		0% 20% 40% 60% 80%	

14.5. Could you please indicate the results of the road charging scheme on mobility, environment, and economy?

- Environment: CO emissions

(Each respondent could enter MULTIPLE responses.)

Response	Total	% of responses	%
1 Change (in %)	1		25 %
2 Source	0		0 %
- N/A	3		75 %
Total respondents: 4 Skipped question: 7		0% 20% 40% 60% 80%	

14.6. Could you please indicate the results of the road charging scheme on mobility, environment, and economy?

- Environment: Noxemissions

(Each respondent could enter MULTIPLE responses.)

Response	Total	% of responses	%
1 Change (in %)	0		0 %
2 Source	0		0 %
- N/A	3		100 %
Total respondents: 3 Skipped question: 8		0% 20% 40% 60% 80%	

14.7. Could you please indicate the results of the road charging scheme on mobility, environment, and economy?

- Environment: PM10, PM2,5emissions

(Each respondent could enter MULTIPLE responses.)

Response	Total	% of responses	%
1 Change (in %)	1		25 %
2 Source	0		0 %
- N/A	3		75 %
Total respondents: 4 Skipped question: 7		0% 20% 40% 60% 80%	

14.8. Could you please indicate the results of the road charging scheme on mobility, environment, and economy?

- Economy: investment cost

(Each respondent could enter MULTIPLE responses.)

Response	Total	% of responses	%
1 Change (in %)	0		0 %
2 Source	0		0 %
- N/A	3		100 %
Total respondents: 3 Skipped question: 8		0% 20% 40% 60% 80%	

14.9. Could you please indicate the results of the road charging scheme on mobility, environment, and economy?

- Economy: operational costs

(Each respondent could enter MULTIPLE responses.)

Response	Total	% of responses	%
1 Change (in %)	1		25 %
2 Source	0		0 %
- N/A	3		75 %
Total respondents: 4 **Skipped question: 7**		**0% 20% 40% 60% 80%**	

14.10. Could you please indicate the results of the road charging scheme on mobility, environment, and economy?

- Economy: revenues from charges

(Each respondent could enter MULTIPLE responses.)

Response	Total	% of responses	%
1 Change (in %)	1		33 %
2 Source	0		0 %
- N/A	2		67 %
Total respondents: 3 **Skipped question: 8**		**0% 20% 40% 60% 80%**	

14.11. Could you please indicate the results of the road charging scheme on mobility, environment, and economy?

- Reduction of accidents

(Each respondent could enter MULTIPLE responses.)

Response	Total	% of responses	%
1 Change (in %)	1		25 %
2 Source	0		0 %
- N/A	3		75 %
Total respondents: 4 **Skipped question: 7**		**0% 20% 40% 60% 80%**	

14.12. Could you please indicate the results of the road charging scheme on mobility, environment, and economy?

- Quality of street surface

(Each respondent could enter MULTIPLE responses.)

Response	Total	% of responses	%
1 Change (in %)	1		25 %
2 Source	0		0 %
- N/A	3		75 %
Total respondents: 4 **Skipped question: 7**		**0% 20% 40% 60% 80%**	

14.13. Could you please indicate the results of the road charging scheme on mobility, environment, and economy?

- Other, please specify

(Each respondent could enter MULTIPLE responses.)

Response	Total	% of responses	%
1 Change (in %)	0		0 %
2 Source	0		0 %
- N/A	1		100 %
Total respondents: 1 **Skipped question: 10**		**0% 20% 40% 60% 80%**	

15. Do you monitor the results of the paid parking scheme?

(Each respondent could choose MULTIPLE responses.)

Response	Total	% of responses	%
1 Yes	6		55 %
2 No, please specify why not (and please proceed to question 17) • not started yet • It is not readily possible to construct this table since it is not timebound – the extent of the impacts has varied both with time and with the evolution of the scheme.	5		45 %
Total respondents: 11 **Skipped question: 10**		**0% 20% 40% 60% 80%**	

16.1. Could you please indicate the results of the paid parking scheme on mobility, environment, and economy?

- Mobility: number of vehicles entering the charged zone

(Each respondent could enter MULTIPLE responses.)

Response	Total	% of responses	%
1 Change (in %)	2		50 %
2 Source	0		0 %
- N/A	2		50 %
Total respondents: 4 Skipped question: 7		0% 20% 40% 60% 80%	

16.2. Could you please indicate the results of the paid parking scheme on mobility, environment, and economy?

- Mobility: number of vehicles kilometres entering the charged zone

(Each respondent could enter MULTIPLE responses.)

Response	Total	% of responses	%
1 Change (in %)	0		0 %
2 Source	0		0 %
- N/A	4		100 %
Total respondents: 4 Skipped question: 7		0% 20% 40% 60% 80%	

16.3. Could you please indicate the results of the paid parking scheme on mobility, environment, and economy?

- Mobility: change in average speed

(Each respondent could enter MULTIPLE responses.)

Response	Total	% of responses	%
1 Change (in %)	0		0 %
2 Source	0		0 %
- N/A	4		100 %
Total respondents: 4 Skipped question: 7		0% 20% 40% 60% 80%	

16.4. Could you please indicate the results of the paid parking scheme on mobility, environment, and economy?

- Environment: CO2 emissions

(Each respondent could enter MULTIPLE responses.)

Response	Total	% of responses	%
1 Change (in %)	0		0 %
2 Source	0		0 %
- N/A	4		100 %
Total respondents: 4 **Skipped question: 7**		**0% 20% 40% 60% 80%**	

16.5. Could you please indicate the results of the paid parking scheme on mobility, environment, and economy?

- Environment: CO emissions

(Each respondent could enter MULTIPLE responses.)

Response	Total	% of responses	%
1 Change (in %)	0		0 %
2 Source	0		0 %
- N/A	4		100 %
Total respondents: 4 **Skipped question: 7**		**0% 20% 40% 60% 80%**	

16.6. Could you please indicate the results of the paid parking scheme on mobility, environment, and economy?

- Environment: Noxemissions

(Each respondent could enter MULTIPLE responses.)

Response	Total	% of responses	%
1 Change (in %)	0		0 %
2 Source	0		0 %
- N/A	4		100 %
Total respondents: 4 **Skipped question: 7**		**0% 20% 40% 60% 80%**	

16.7. Could you please indicate the results of the paid parking scheme on mobility, environment, and economy?

- Environment: PM10, PM2,5emissions

(Each respondent could enter MULTIPLE responses.)

Response	Total	% of responses	%
1 Change (in %)	1		25 %
2 Source	0		0 %
- N/A	3		75 %
Total respondents: 4 Skipped question: 7		0% 20% 40% 60% 80%	

16.8. Could you please indicate the results of the paid parking scheme on mobility, environment, and economy?

- Economy: investment cost

(Each respondent could enter MULTIPLE responses.)

Response	Total	% of responses	%
1 Change (in %)	1		25 %
2 Source	0		0 %
- N/A	3		75 %
Total respondents: 4 Skipped question: 7		0% 20% 40% 60% 80%	

16.9. Could you please indicate the results of the paid parking scheme on mobility, environment, and economy?

- Economy: operational costs

(Each respondent could enter MULTIPLE responses.)

Response	Total	% of responses	%
1 Change (in %)	0		0 %
2 Source	0		0 %
- N/A	4		100 %
Total respondents: 4 Skipped question: 7		0% 20% 40% 60% 80%	

16.10. Could you please indicate the results of the paid parking scheme on mobility, environment, and economy?

- Economy: revenues from charges

(Each respondent could enter MULTIPLE responses.)

Response	Total	% of responses	%
1 Change (in %)	1		20 %
2 Source	1		20 %
- N/A	3		60 %
Total respondents: 5 Skipped question: 6		0% 20% 40% 60% 80%	

16.11. Could you please indicate the results of the paid parking scheme on mobility, environment, and economy?

- Other, please specify

(Each respondent could enter MULTIPLE responses.)

Response	Total	% of responses	%
1 Change (in %)	0		0 %
2 Source	0		0 %
- N/A	1		100 %
Total respondents: 1 Skipped question: 10		0% 20% 40% 60% 80%	

17.1. What instruments do you consider useful to address negative externalities? (Please indicate on a scale from 1 to 5; 1 being not relevant, 5 being most useful, see below for a description of the instruments)

- Urban road charging

(Each respondent could enter MULTIPLE responses.)

Response	Total	% of responses	%
1 Congestion	11		100 %
2 Air pollution	11		100 %
3 Climate change	11		100 %
4 Accidents	11		100 %
5 Noise	11		100 %
6 Tear and wear of infrastructure	11		100 %
Total respondents: 11 **Skipped question: 0**		**0% 20% 40% 60% 80%**	

17.2. What instruments do you consider useful to address negative externalities? (Please indicate on a scale from 1 to 5; 1 being not relevant, 5 being most useful, see below for a description of the instruments)

- Urban congestion charging

(Each respondent could enter MULTIPLE responses.)

Response	Total	% of responses	%
1 Congestion	11		100 %
2 Air pollution	11		100 %
3 Climate change	11		100 %
4 Accidents	11		100 %
5 Noise	11		100 %
6 Tear and wear of infrastructure	11		100 %
Total respondents: 11 **Skipped question: 0**		**0% 20% 40% 60% 80%**	

17.3. What instruments do you consider useful to address negative externalities? (Please indicate on a scale from 1 to 5; 1 being not relevant, 5 being most useful, see below for a description of the instruments)

- Paid parking

(Each respondent could enter MULTIPLE responses.)

Response	Total	% of responses	%
1 Congestion	11		100 %
2 Air pollution	11		100 %
3 Climate change	11		100 %
4 Accidents	11		100 %
5 Noise	11		100 %
6 Tear and wear of infrastructure	11		100 %
Total respondents: 11 **Skipped question: 0**		**0% 20% 40% 60% 80%**	

17.4. What instruments do you consider useful to address negative externalities? (Please indicate on a scale from 1 to 5; 1 being not relevant, 5 being most useful, see below for a description of the instruments)

- Green Zones

(Each respondent could enter MULTIPLE responses.)

Response	Total	% of responses	%
1 Congestion	11		100 %
2 Air pollution	11		100 %
3 Climate change	11		100 %
4 Accidents	11		100 %
5 Noise	11		100 %
6 Tear and wear of infrastructure	11		100 %
Total respondents: 11 **Skipped question: 0**		**0% 20% 40% 60% 80%**	

17.5. What instruments do you consider useful to address negative externalities? (Please indicate on a scale from 1 to 5; 1 being not relevant, 5 being most useful, see below for a description of the instruments)

- Other restricted zones

(Each respondent could enter MULTIPLE responses.)

Response	Total	% of responses	%
1 Congestion	11		100 %
2 Air pollution	11		100 %
3 Climate change	11		100 %
4 Accidents	11		100 %
5 Noise	11		100 %
6 Tear and wear of infrastructure	11		100 %
Total respondents: 11 **Skipped question: 0**		**0% 20% 40% 60% 80%**	

17.6. What instruments do you consider useful to address negative externalities? (Please indicate on a scale from 1 to 5; 1 being not relevant, 5 being most useful, see below for a description of the instruments)

- Intelligent Transport Solutions

(Each respondent could enter MULTIPLE responses.)

Response	Total	% of responses	%
1 Congestion	11		100 %
2 Air pollution	11		100 %
3 Climate change	11		100 %
4 Accidents	11		100 %
5 Noise	11		100 %
6 Tear and wear of infrastructure	11		100 %
Total respondents: 11 **Skipped question: 0**		**0% 20% 40% 60% 80%**	

17.7. What instruments do you consider useful to address negative externalities? (Please indicate on a scale from 1 to 5; 1 being not relevant, 5 being most useful, see below for a description of the instruments)

- Road taxes

(Each respondent could enter MULTIPLE responses.)

Response	Total	% of responses	%
1 Congestion	11		100 %
2 Air pollution	11		100 %
3 Climate change	11		100 %
4 Accidents	11		100 %
5 Noise	11		100 %
6 Tear and wear of infrastructure	11		100 %
Total respondents: 11 **Skipped question: 0**		**0% 20% 40% 60% 80%**	

17.8. What instruments do you consider useful to address negative externalities? (Please indicate on a scale from 1 to 5; 1 being not relevant, 5 being most useful, see below for a description of the instruments)

- Improvements in Public Transport

(Each respondent could enter MULTIPLE responses.)

Response	Total	% of responses	%
1 Congestion	11		100 %
2 Air pollution	11		100 %
3 Climate change	11		100 %
4 Accidents	11		100 %
5 Noise	11		100 %
6 Tear and wear of infrastructure	11		100 %
Total respondents: 11 **Skipped question: 0**		**0% 20% 40% 60% 80%**	

17.9. What instruments do you consider useful to address negative externalities? (Please indicate on a scale from 1 to 5; 1 being not relevant, 5 being most useful, see below for a description of the instruments)

- Land-use planning

(Each respondent could enter MULTIPLE responses.)

Response	Total	% of responses	%
1 Congestion	11		100 %
2 Air pollution	11		100 %
3 Climate change	11		100 %
4 Accidents	11		100 %
5 Noise	11		100 %
6 Tear and wear of infrastructure	11		100 %
Total respondents: 11 **Skipped question: 0**		**0% 20% 40% 60% 80%**	

17.10. What instruments do you consider useful to address negative externalities? (Please indicate on a scale from 1 to 5; 1 being not relevant, 5 being most useful, see below for a description of the instruments)

- Walking and cycling promotion instruments

(Each respondent could enter MULTIPLE responses.)

Response	Total	% of responses	%
1 Congestion	11		100 %
2 Air pollution	11		100 %
3 Climate change	11		100 %
4 Accidents	11		100 %
5 Noise	11		100 %
6 Tear and wear of infrastructure	11		100 %
Total respondents: 11 **Skipped question: 0**		**0% 20% 40% 60% 80%**	

17.11. What instruments do you consider useful to address negative externalities? (Please indicate on a scale from 1 to 5; 1 being not relevant, 5 being most useful, see below for a description of the instruments)

- Other, please specify

(Each respondent could enter MULTIPLE responses.)

- speed limitations - zone 30
- Tax on petrol, energy (for the operation of cars)
- by-passes (ring roads)

Response	Total	% of responses	%
1 Congestion	4		100 %
2 Air pollution	4		100 %
3 Climate change	4		100 %
4 Accidents	4		100 %
5 Noise	4		100 %
6 Tear and wear of infrastructure	4		100 %
Total respondents: 4 **Skipped question: 7**		**0% 20% 40% 60% 80%**	

18. In principle, do you or your organisation think all road users should pay for congestion and environmental damage through road tolls?

(Each respondent could choose MULTIPLE responses.)

Response	Total	% of responses	%
1 Yes	5		45 %
2 No	3		27 %
3 I cannot say	3		27 %
Total respondents: 11 **Skipped question: 7**		**0% 20% 40% 60% 80%**	

19. How is the money thus collected spent? (Or how should it be spent in a hypothetical case?)

(Each respondent could choose MULTIPLE responses.)

Response	Total	% of responses	%
1 To improve road-related infrastructure (e.g. city tunnels, noise barriers)	3		27 %
2 To invest in public transport (e.g. rail and urban transport)	8		73 %
3 As general public expenditure	6		55 %
4 I cannot say	0		0 %
5 Other, please specify: • mixture all of the above • Noise protection • Biking and walking • Sustainable modes of transport	4		36 %
Total respondents: 11 **Skipped question: 7**		**0% 20% 40% 60% 80%**	

20. What other related instruments are in place or planned that contribute successfully to minimise the negative impacts of urban mobility? Please specify.

(Each respondent could write a single open-ended response of maximum 2000 characters.)

Response	Total	% of total respondents	%
• Extension public transport network -investment in infrastructure for walking and biking -promotion of walking (walking plan) -charging scheme for trucks based on gps (2014) • implementing bike sharing and car sharing as well as support electrical vehicles • Restrictive parking policy, no construction of new	11		100 %

Response	Total	% of total respondents	%
streets • Directive 2009/33/WE implementation technical improvements in vehicles alternative fuels and populsions adequate choice of vehicle/drive/fuel to parameters of the road emission and energy efficiency baseg eticettes scheme Park/Bike&Ride facilities etc • Mobility management schemes. • vorhanden: Verkehrsentwicklungsplan, Nahverkehrsplan, Stadtentwicklungskonzept, Grundsatzbeschluss Radverkehr geplant: Grundsatzbeschluss Nahmobilität • Public bikes system. Bus lanes. • The Mayor of London's transport strategy is an integrated, multi-modal strategy that sets out transport's contribution to successfully addressing the economic, environmental and social challenges facing London over the next 20 years, including population growth of 1.25 million. It takes a holistic view of the city's transport needs ensuring all modes work together to meet the Capital's urban mobility challenges. One of the key goals of the strategy relates to reducing transport's contribution to climate change, and improving its resilience. It requires a growing share for low carbon modes of public transport, walking and cycling to deliver lower emissions. An uptake of low carbon vehicle technologies and fuels will make significant reductions in CO2 emissions across all modes. A greater public awareness of the environmental impact of travel choices and driving style, together with targeted travel planning and car clubs will further reduce transport-related CO2 emissions and tackle car dependency. Working with the freight industry, the Mayor of London will seek to ensure that freight movement in London is made as efficient as possible, including greater use of rail and water. The strategy also aims to enhance the quality of life for all Londoners with a better journey experience through more attentive staff, better information, newer and cleaner trains and buses (including the New Bus for London), less crowding and smoother flowing traffic, and greater use of the Thames and other waterways. Enhancements to the built and natural environment will improve perceptions of the urban realm, streets and town centres and deliver a step change in the appeal of walking and cycling as healthy, active travel options. • cycling and walking reinforcement			
Total respondents: 11 **Skipped question: 7**		**0% 20% 40% 60% 80%**	

21. When addressing the externalities of urban mobility, do you see a role for the European Commission? If yes, please specify below:

(Each respondent could choose MULTIPLE responses.)

Response	Total	% of responses	%
1 Promotion of best practice	10		91 %
2 Guidelines	7		64 %
3 Handbook, toolkit	5		45 %
4 Financial support	6		55 %
5 Facilitate legal framework by providing standards for vehicle identification	7		64 %
6 Facilitate legal framework by providing minimum access criteria	1		9 %
7 Facilitate legal framework by providing standards for road signs	2		18 %
8 Other interventions at EU level, such as: • making OBU's in private cars obligatory • Cross border enforcement	2		18 %
9 No	0		0 %
Total respondents: 11 **Skipped question: 7**		**0% 20% 40% 60% 80%**	

22. Do you see any role for other parties that are essential for successful implementation?

(Each respondent could choose MULTIPLE responses.)

Response	Total	% of responses	%
1 No	3		27 %
2 Yes, please specify	8		73 %
• the national governement • Benelux: concertation between neigbouring countries and regions • national goverment • European, statal, regional and local government initiatives, active banking financing policiest involvement, common public authority, academia and businesses initiative, financial incentives for users and buyers of vehicles, common "co-operation" of sta • National governments and national traffic authorities • Bundesgesetzgeber • European research institutes, university etc • Members states, regional and city administrations			

Response	Total	% of responses	%
are crucial players. Road user charging is one of many policy tools open to decision makers, what works well in one city may not work well in another. Cities and regional authorities need a flexible range of options. Whilst there is a role for the European Commission in disseminating best practice and guidance on how schemes should be established (who to consult, public information campaigns etc) externality charging is a highly controversial area of public policy. Decisions on legal frameworks, access criteria and charging are best left to local, democratically elected representatives rather than being made at an EU level.			
Total respondents: 11 Skipped question: 7		**0% 20% 40% 60% 80%**	

23. You have reached the last question. In order to get a good understanding of specific information, this survey is not anonymous. Therefore, we ask you to fill in your personal details below:

(Each respondent could write multiple open-ended responses of maximum 255 characters.)

Response	Total	% of responses	%
Name city / region	11		100 %
Department	11		100 %
Name contact person	11		100 %
Email address	11		100 %
Telephone number	9		82 %
Other relevant contact details	2		18 %
Total respondents: 11 Skipped question: 7		**0% 20% 40% 60% 80%**	

Annex G: Relevant literature and links

General literature on pricing schemes

Handbook on estimation of external costs in the transport sector, Internalisation Measures and Policies for All external Cost of Transport (IMPACT)
M. Maibach, C. Schreyer, D. Sutter (INFRAS), H.P. van Essen, B.H. Boon,
R. Smokers, A. Schroten (CE Delft), C. Doll (Fraunhofer Gesellschaft – ISI),
B. Pawlowska, M. Bak (University of Gdansk)
IMPACT handbook and IMPACT Deliverable 3
Delft : CE Delft, 2008
http://ec.europa.eu/transport/sustainable/doc/2008_costs_handbook.pdf

Impacts of the proposal for amending Directive 1999/62/EC on road infrastructure charging: An analysis on selected corridors and main impacts.
P. Christidis, M. Brons
Joint Research Centre – Institute for Prospective Technological Studies.
Luxembourg: Office for Official Publications of the European Communities, 2009.
http://ftp.jrc.es/EURdoc/JRC54766_TN.pdf

Urban road charging

Urban congestion charging: theory, practice and environmental consequences
G. Santos, D. Newbery
Cambridge: University of Cambridge, 2001
http://staff.bath.ac.uk/ecsjgs/Teaching/Introducory%20Microeconomics/Articles/venice.pdf

Do Economists Reach a Conclusion on Road Pricing? The Intellectual History of an Idea.
R. Lindsey
Econ Journal Watch, Volume 3, Number 2, May 2006, pp 292-379.
http://financecommission.dot.gov/Documents/Background%20Documents/Lindsey%20DoEconomists%20ROC%20on%20road%20pricing.pdf

Paid parking

Parking policies and the effects on economy and mobility
Report on COST Action 342
CROW
Ede; 2005
http://www.europeanparking.eu/cms/Media/COST%20Action%20342%20final%20report[1].pdf

Flow? Destination!
Polis-EPA Parking Report: Towards a new deal for urban parking
I. Cré, B. Sharkie
Brussels; 2009
http://www.polisnetwork.eu/uploads/Modules/PublicDocuments/polisepaparkingpaper2011.pdf

Annex H: Relevant IMPACT unit values

Road transport: exemplary unit values per cost component in €ct/vehicle-km for Germany (€2000)

Cost component		***Passenger car***	***Heavy duty vehicle (HDV)***
€ct/vkm		*Unit costs (bandwidths)*	*Unit costs (bandwidths)*
Noise	Urban, day	0.76 (0.76 - 1.85)	7.01 (7.01 - 17.01)
	Urban, night	1.39 (1.39 - 3.37)	12.8 (12.8 - 31)
	Interurban, day	0.12 (0.04 - 0.12)	1.1 (0.39 - 1.1)
	Interurban, night	0.22 (0.08 - 0.22)	2 (0.72 - 2)
Congestion	Urban, peak	30 (5 - 50)	75 (13 - 125)
	Urban, off-peak	0 (-)	0 (-)
	Interurban, peak	10 (0 - 20)	35 (0 - 70)
	Interurban, off-peak	0 (-)	0 (-)
Accidents	Urban	4.12 (0 - 6.47)	10.5 (0 - 13.9)
	Interurban	1.57 (0 - 2.55)	2.7 (0 - 3.5)
Air pollution	Urban, petrol	0.17 (0.17 - 0.24)	(-)
	Urban, diesel	1.53 (1.53 - 2.65)	10.6 (10.6 - 23.4)
	Interurban, petrol	0.09 (0.09 - 0.15)	(-)
	Interurban, diesel	0.89 (0.89 - 1.8)	8.5 (8.5 - 21.4)
Climate change	Urban, petrol	0.67 (0.19 - 1.2)	(-)
	Urban, diesel	0.52 (0.14 - 0.93)	2.6 (0.7 - 4.7)
	Interurban, petrol	0.44 (0.12 - 0.79)	(-)
	Interurban, diesel	0.38 (0.11 - 0.68)	2.2 (0.6 - 4)
Up- and downstream processes	Urban, petrol	0.97 (0.97 - 1.32)	(-)
	Urban, diesel	0.61 (0.61 - 1.05)	3.1 (3.1 - 6.9)
	Interurban, petrol	0.65 (0.65 - 1.12)	(-)
	Interurban, diesel	0.45 (0.45 - 0.92)	2.7 (2.7 - 6.7)
Nature & landscape	Urban	-	0 (0 - 0)
	Interurban	0.4 (0 - 0.4)	1.15 (0 - 1.15)
Soil & water pollution	Urban/Interurban	0.06 (0.06 - 0.06)	1.05 (1.05 - 1.05)
Total			
Urban	Day, peak	36.7 (7.1 - 61.1)	109.8 (35.5 - 192)
	Day, off-peak	6.7 (2.1 - 11.1)	34.8 (22.5 - 67)
	Night, off-peak	7.4 (2.8 - 12.7)	40.6 (28.2 - 80.9)

Explanations by cost category:

Noise costs:	Recommended output values from Table 5, p. 221, car/HGV, urban/suburban. The lower limit of the bandwidth is based on dense traffic situations, while the upper limit is based on thin traffic situations. Unit cost value chosen based on the predominant traffic situation in the respective regional cluster: urban: dense; interurban: thin.
Congestion:	Congestion Urban: Recommended output values Table 7, p.34, small and medium urban areas, urban collectors (2000 values). Congestion Interurban: Recommended output values from Table 7, p.34, rural areas, motorways (2000 values).
Accident costs:	Accidents Urban: Exemplary values for Germany Table 3**,** p. 219, urban roads (2000 values). Accidents Interurban: Exemplary values for Germany from Table 3**,** p. 219, other roads (2000 values).
Air pollution:	Output values from Table 4, p. 220, exemplary for Germany, urban/interurban; for passenger car: medium vehicle (1.4-2 L), EURO 3, for HGV: truck >32 t, EURO-3. Ranges represent different sensitivity analysis carried out in CAFE CBA (e.g. different valuation of value of life years lost).
Climate change:	Exemplary values for Germany Table 6, p. 222, for passenger car: medium vehicle (1.4-2 L), EURO-3, for HDV: truck >32 t, EURO 3, based on valuation for 2010. Note that climate cost increase over time.
Up- and downstream:	Air pollution and climate change costs of well-to-tank emissions. Exemplary values for Germany from **Error! Reference source not found.**, p. **Error! Bookmark not defined.**. Passenger car: medium vehicle (1.4-2 L), EURO 3, for HGV: truck >32 t, EURO-3. Ranges represent different sensitivity analysis carried out in CAFE CBA (e.g. different valuation of value of life years lost).
Nature&Landscape:	Source: INFRAS/IWW, 2004. No external costs in urban and built-up areas. Ranges Interurban: Min: short run marginal costs, Max: long run marginal costs.
Soil&water:	Recommended values from **Error! Reference source not found.**, p. **Error! Bookmark not defined.**, values for Switzerland (2000 values).
Total	Total sum for passenger cars presented for petrol cars. Bandwidths are calculated by adding up the bandwidths of each cost category.

Table 3 Unit values for external accident costs **for different network types in (€ct/vkm) for passenger cars, motor cycles and heavy duty vehicles (€2000)**

	Passenger cars			Motor cycles			HDV		
	Urban roads	Motorways	Other roads	Urban roads	Motorways	Other roads	Urban roads	Motorways	Other roads
	€ct/vkm	*€ct/vkm*	*€ct/vkm*	*€ct/vkm*	*€ct/vkm*	*€ct/vkm*	*€ct/vkm*	*€ct/vkm*	*€ct/vkm*
Austria	5.7 (-0.41-8.95)	0.41 (-0.68-0.68)	2.17 (-2.58-3.53)	41.92 (-2.58-119.64)	0.27 (-0.81-0.81)	7.46 (-15.06-21.16)	14.51 (-0.54-19.26)	0.41 (-0.41-0.41)	3.66 (-3.53-4.88)
Belgium	6.58 (-0.47-10.35)	0.47 (-0.78-0.78)	2.51 (-2.98-4.08)	48.43 (-2.98-138.25)	0.31 (-0.94-0.94)	8.62 (-17.4-24.45)	16.77 (-0.63-22.26)	0.47 (-0.47-0.47)	4.23 (-4.08-5.64)
Bulgary	1.24 (-0.09-1.95)	0.09 (-0.15-0.15)	0.47 (-0.56-0.77)	9.11 (-0.56-26.01)	0.06 (-0.18-0.18)	1.62 (-3.27-4.6)	3.16 (-0.12-4.19)	0.09 (-0.09-0.09)	0.8 (-0.77-1.06)
Switzer-land	4.36 (-0.31-6.85)	0.31 (-0.52-0.52)	1.66 (-1.97-2.7)	32.05 (-1.97-91.48)	0.21 (-0.62-0.62)	5.7 (-11.51-16.18)	11.1 (-0.41-14.73)	0.31 (-0.31-0.31)	2.8 (-2.7-3.73)
Cyprus	5.08 (-0.36-7.98)	0.36 (-0.6-0.6)	1.93 (-2.3-3.14)	37.35 (-2.3-106.62)	0.24 (-0.73-0.73)	6.65 (-13.42-18.86)	12.93 (-0.48-17.17)	0.36 (-0.36-0.36)	3.26 (-3.14-4.35)
Czech Republic	3.33 (-0.24-5.23)	0.24 (-0.4-0.4)	1.27 (-1.51-2.06)	24.5 (-1.51-69.94)	0.16 (-0.48-0.48)	4.36 (-8.8-12.37)	8.48 (-0.32-11.26)	0.24 (-0.24-0.24)	2.14 (-2.06-2.85)
Germany	4.12 (-0.29-6.47)	0.29 (-0.49-0.49)	1.57 (-1.86-2.55)	30.29 (-1.86-86.45)	0.2 (-0.59-0.59)	5.39 (-10.88-15.29)	10.49 (-0.39-13.92)	0.29 (-0.29-0.29)	2.65 (-2.55-3.53)
Denmark	4.44 (-0.32-6.97)	0.32 (-0.53-0.53)	1.69 (-2.01-2.75)	32.65 (-2.01-93.21)	0.21 (-0.63-0.63)	5.81 (-11.73-16.49)	11.31 (-0.42-15.01)	0.32 (-0.32-0.32)	2.85 (-2.75-3.8)
Estonia	3.24 (-0.23-5.09)	0.23 (-0.39-0.39)	1.23 (-1.47-2.01)	23.84 (-1.47-68.05)	0.15 (-0.46-0.46)	4.24 (-8.56-12.04)	8.26 (-0.31-10.96)	0.23 (-0.23-0.23)	2.08 (-2.01-2.78)
Spain	5.24 (-0.37-8.24)	0.37 (-0.62-0.62)	2 (-2.37-3.25)	38.57 (-2.37-110.08)	0.25 (-0.75-0.75)	6.86 (-13.85-19.47)	13.35 (-0.5-17.72)	0.37 (-0.37-0.37)	3.37 (-3.25-4.49)
Finland	3.43 (-0.25-5.4)	0.25 (-0.41-0.41)	1.31 (-1.55-2.13)	25.27 (-1.55-72.12)	0.16 (-0.49-0.49)	4.5 (-9.08-12.76)	8.75 (-0.33-11.61)	0.25 (-0.25-0.25)	2.21 (-2.13-2.94)
France	6.69 (-0.48-10.52)	0.48 (-0.8-0.8)	2.55 (-3.03-4.14)	49.25 (-3.03-140.56)	0.32 (-0.96-0.96)	8.77 (-17.69-24.86)	17.05 (-0.64-22.63)	0.48 (-0.48-0.48)	4.3 (-4.14-5.74)
Greece	5.29 (-0.38-8.32)	0.38 (-0.63-0.63)	2.02 (-2.39-3.28)	38.94 (-2.39-111.14)	0.25 (-0.76-0.76)	6.93 (-13.99-19.66)	13.48 (-0.5-17.89)	0.38 (-0.38-0.38)	3.4 (-3.28-4.54)
Hungary	2.78 (-0.2-4.37)	0.2 (-0.33-0.33)	1.06 (-1.26-1.72)	20.44 (-1.26-58.36)	0.13 (-0.4-0.4)	3.64 (-7.34-10.32)	7.08 (-0.26-9.4)	0.2 (-0.2-0.2)	1.79 (-1.72-2.38)
Ireland	6.2 (-0.44-9.74)	0.44 (-0.74-0.74)	2.36 (-2.8-3.84)	45.59 (-2.8-130.12)	0.3 (-0.89-0.89)	8.11 (-16.38-23.01)	15.79 (-0.59-20.95)	0.44 (-0.44-0.44)	3.98 (-3.84-5.31)
Italy	4.78 (-0.34-7.51)	0.34 (-0.57-0.57)	1.82 (-2.16-2.96)	35.17 (-2.16-100.39)	0.23 (-0.68-0.68)	6.26 (-12.63-17.76)	12.18 (-0.46-16.16)	0.34 (-0.34-0.34)	3.07 (-2.96-4.1)
Lithuania	3.45 (-0.25-5.43)	0.25 (-0.41-0.41)	1.32 (-1.56-2.14)	25.4 (-1.56-72.51)	0.16 (-0.49-0.49)	4.52 (-9.13-12.83)	8.8 (-0.33-11.67)	0.25 (-0.25-0.25)	2.22 (-2.14-2.96)
Luxem-bourg	10.81 (-0.77-16.99)	0.77 (-1.29-1.29)	4.12 (-4.89-6.69)	79.54 (-4.89-227.05)	0.51 (-1.54-1.54)	14.16 (-28.57-40.16)	27.54 (-1.03-36.55)	0.77 (-0.77-0.77)	6.95 (-6.69-9.27)
Latvia	3.49 (-0.25-5.49)	0.25 (-0.42-0.42)	1.33 (-1.58-2.16)	25.69 (-1.58-73.33)	0.17 (-0.5-0.5)	4.57 (-9.23-12.97)	8.9 (-0.33-11.81)	0.25 (-0.25-0.25)	2.24 (-2.16-2.99)
Malta	1.28 (-0.09-2.01)	0.09 (-0.15-0.15)	0.49 (-0.58-0.79)	9.4 (-0.58-26.84)	0.06 (-0.18-0.18)	1.67 (-3.38-4.75)	3.26 (-0.12-4.32)	0.09 (-0.09-0.09)	0.82 (-0.79-1.1)
Nether-lands	3.2 (-0.23-5.03)	0.23 (-0.38-0.38)	1.22 (-1.45-1.98)	23.56 (-1.45-67.25)	0.15 (-0.46-0.46)	4.19 (-8.46-11.89)	8.16 (-0.3-10.83)	0.23 (-0.23-0.23)	2.06 (-1.98-2.74)
Norway	3.92 (-0.28-6.16)	0.28 (-0.47-0.47)	1.49 (-1.77-2.43)	28.85 (-1.77-82.34)	0.19 (-0.56-0.56)	5.13 (-10.36-14.56)	9.99 (-0.37-13.26)	0.28 (-0.28-0.28)	2.52 (-2.43-3.36)
Poland	3.25 (-0.23-5.1)	0.23 (-0.39-0.39)	1.24 (-1.47-2.01)	23.89 (-1.47-68.19)	0.15 (-0.46-0.46)	4.25 (-8.58-12.06)	8.27 (-0.31-10.98)	0.23 (-0.23-0.23)	2.09 (-2.01-2.78)
Portugal	6.35 (-0.45-9.98)	0.45 (-0.76-0.76)	2.42 (-2.87-3.93)	46.73 (-2.87-133.4)	0.3 (-0.91-0.91)	8.32 (-16.79-23.59)	16.18 (-0.6-21.48)	0.45 (-0.45-0.45)	4.08 (-3.93-5.44)
Romania	1.14 (-0.08-1.8)	0.08 (-0.14-0.14)	0.44 (-0.52-0.71)	8.41 (-0.52-24.01)	0.05 (-0.16-0.16)	1.5 (-3.02-4.25)	2.91 (-0.11-3.87)	0.08 (-0.08-0.08)	0.74 (-0.71-0.98)
Sweden	2.68 (-0.19-4.21)	0.19 (-0.32-0.32)	1.02 (-1.21-1.66)	19.72 (-1.21-56.28)	0.13 (-0.38-0.38)	3.51 (-7.08-9.95)	6.83 (-0.26-9.06)	0.19 (-0.19-0.19)	1.72 (-1.66-2.3)
Slovenia	4.45 (-0.32-6.99)	0.32 (-0.53-0.53)	1.69 (-2.01-2.75)	32.73 (-2.01-93.42)	0.21 (-0.64-0.64)	5.83 (-11.76-16.52)	11.33 (-0.42-15.04)	0.32 (-0.32-0.32)	2.86 (-2.75-3.81)
Slovakia	2.61 (-0.19-4.1)	0.19 (-0.31-0.31)	0.99 (-1.18-1.61)	19.19 (-1.18-54.78)	0.12 (-0.37-0.37)	3.42 (-6.89-9.69)	6.65 (-0.25-8.82)	0.19 (-0.19-0.19)	1.68 (-1.61-2.24)
United Kingdom	2.61 (-0.19-4.1)	0.19 (-0.31-0.31)	0.99 (-1.18-1.61)	19.19 (-1.18-54.77)	0.12 (-0.37-0.37)	3.42 (-6.89-9.69)	6.64 (-0.25-8.82)	0.19 (-0.19-0.19)	1.68 (-1.61-2.24)

Table 4 **Unit values for external** Air pollution **costs in €ct/vkm (€2000) for passenger cars and heavy duty vehicles (Example Germany, Emissions from TREMOVE model, HEATCO and CAFE CBA cost factors for Germany used), Price base 2000**

Vehicle	Size	EURO-Class	Metropolitan	Urban	Interurban	Motorways	Average
			(€ct/vkm)	*(€ct/vkm)*	*(€ct/vkm)*	*(€ct/vkm)*	*(€ct/vkm)*
Passenger Car Petrol	<1,4L	EURO-0	5.9	2.3	1.7	1.9	2.0
		EURO-1	1.7	1.4	0.6	0.8	0.9
		EURO-2	0.9	0.6	0.3	0.4	0.4
		EURO-3	0.3	0.2	0.1	0.1	0.1
		EURO-4	0.3	0.1	0.1	0.1	0.1
		EURO-5	0.3	0.1	0.1	0.0	0.1
	1,4-2L	EURO-0	5.1	1.8	1.4	1.6	1.6
		EURO-1	1.7	1.5	0.6	0.8	0.9
		EURO-2	0.9	0.6	0.3	0.4	0.4
		EURO-3	0.3	0.2	0.1	0.1	0.1
		EURO-4	0.3	0.1	0.1	0.1	0.1
		EURO-5	0.3	0.1	0.1	0.0	0.1
	>2L	EURO-1	1.4	1.2	0.6	0.8	0.8
		EURO-2	0.8	0.6	0.3	0.4	0.4
		EURO-3	0.3	0.2	0.1	0.1	0.1
		EURO-4	0.2	0.1	0.1	0.1	0.1
		EURO-5	0.2	0.1	0.1	0.0	0.1
Passenger Car Diesel	<1,4L	EURO-2	4.0	1.8	0.8	0.9	1.1
		EURO-3	3.1	1.5	0.9	1.0	1.1
		EURO-4	1.7	0.8	0.5	0.5	0.6
		EURO-5	0.7	0.4	0.3	0.3	0.4
	1,4-2L	EURO-0	13.8	4.8	1.4	1.5	2.4
		EURO-1	4.8	2.0	1.0	1.3	1.4
		EURO-2	4.0	1.8	0.8	0.9	1.1
		EURO-3	3.1	1.5	0.9	1.0	1.1
		EURO-4	1.7	0.8	0.5	0.5	0.6
		EURO-5	0.7	0.4	0.3	0.3	0.4
	>2L	EURO-0	14.1	5.1	1.7	1.8	2.7
		EURO-1	4.8	2.0	1.0	1.3	1.4
		EURO-2	4.0	1.8	0.8	0.9	1.1
		EURO-3	3.1	1.5	0.9	1.0	1.1
		EURO-4	1.7	0.8	0.5	0.5	0.6
		EURO-5	0.7	0.4	0.3	0.3	0.4
Trucks	<7.5t	EURO-0	20.1	11.3	9.1	9.0	9.1
		EURO-1	12.0	6.7	5.4	5.3	5.4
		EURO-2	8.1	5.6	5.0	5.0	5.0
		EURO-3	7.5	4.8	4.0	3.9	4.0
		EURO-4	3.2	2.5	2.3	2.3	2.3
		EURO-5	2.3	1.6	1.4	1.4	1.4
	7.5-16t	EURO-0	28.2	15.7	11.9	11.1	11.6
		EURO-1	18.4	10.6	8.1	7.6	7.9
		EURO-2	12.4	8.5	7.2	6.9	7.1
		EURO-3	10.2	7.2	6.0	5.5	5.8
		EURO-4	5.3	4.1	3.5	3.3	3.4
		EURO-5	3.8	2.7	2.2	2.0	2.1
	16-32t	EURO-0	29.0	16.5	12.7	11.8	12.1
		EURO-1	16.3	9.9	7.8	7.3	7.5
		EURO-2	12.9	9.1	7.5	7.1	7.2
		EURO-3	9.4	7.0	5.8	5.3	5.5
		EURO-4	5.2	4.1	3.5	3.2	3.3
		EURO-5	3.8	2.7	2.2	2.0	2.1
	>32t	EURO-0	38.3	22.3	16.8	14.9	15.3
		EURO-1	28.1	16.1	12.0	10.6	10.9
		EURO-2	18.9	13.2	10.7	9.6	9.8
		EURO-3	14.6	10.6	8.5	7.6	7.7
		EURO-4	7.4	6.1	5.1	4.5	4.6
		EURO-5	5.2	3.8	3.1	2.8	2.8

Source emission factors: TREMOVE Base Case (model version 2.5.1).
Note: metropolitan: cities with >0.5 million inhabitants, urban: cities with < 0.5 million inhabitants

Table 5 **Unit values for external marginal** noise **costs for different network types (€ct/vkm) for road and rail traffic**

	Time of day	Urban	Suburban	Rural
Car	Day	**0.76** (0.76 – 1.85)	**0.12** (0.04 – 0.12)	**0.01** (0.01 – 0.014)
	Night	**1.39** (1.39 – 3.37)	**0.22** (0.08 – 0.22)	**0.03** 0.01 – 0.03
MC	Day	**1.53** (1.53 – 3.70)	**0.24** (0.09 – 0.24)	**0.03** (0.01 – 0.03)
	Night	**2.78** (2.78 – 6.74)	**0.44** (0.16 – 0.44)	**0.05** (0.02 – 0.05)
Bus	Day	**3.81** (3.81 – 9.25)	**0.59** (0.21 – 0.59)	**0.07** (0.03 – 0.07)
	Night	**6.95** (6.95 – 16.84)	**1.10** (0.39 – 1.10)	**0.13** (0.06 – 0.13)
LGV	Day	**3.81** (3.81 – 9.25)	**0.59** (0.21 – 0.59)	**0.07** (0.03 – 0.07)
	Night	**6.95** (6.95 – 16.84)	**1.10** (0.39 – 1.10)	**0.13** (0.06 - 0.13)
HGV	Day	**7.01** (7.01 – 17.00)	**1.10** 0.39 – 1.10	**0.13** (0.06 – 0.13)
	Night	**12.78** (12.78-30.98)	**2.00** 0.72 – 2.00	**0.23** (0.11 – 0.23)
Passenger train	Day	**23.65** (23.65 – 46.73)	**20.61** 10.43 – 20.61	**2.57** (1.30 – 2.57)
	Night	**77.99**	**34.40**	**4.29**
Freight train	Day	**41.93** (41.93 – 101.17)	**40.06** 20.68 – 40.06	**5.00** (2.58 – 5.00)
	Night	**171.06**	**67.71**	**8.45**

Central values in bold, ranges in brackets.

Note: The lower limit of the bandwidth is based on dense traffic situations, while the upper limit is based on thin traffic situations. Central values (in bold) chosen based on the predominant traffic situation in the respective regional cluster: urban: dense; suburban/rural: thin.

Table 6 Unit values for external Climate change **costs in €/ct/vkm for passenger cars and trucks. The central value is based on costs factors (€/t CO_2) for 2010 (**Error! Reference source not found.**). Bandwidths arise from using the lower and upper values according to** Error! Reference source not found.

Vehicle	Size	EURO-Class	Metropo-litan	Urban	Interurban	Motorways	Average
			(€ct/vkm)	*(€ct/vkm)*	*(€ct/vkm)*	*(€ct/vkm)*	*(€ct/vkm)*
Passenger Car Petrol	<1,4L	EURO-0	0.7 (0.2-1.2)	0.6 (0.2-1.1)	0.4 (0.1-0.8)	0.5 (0.2-1.0)	0.5 (0.1-0.9)
		EURO-1	0.6 (0.2-1.2)	0.6 (0.2-1.2)	0.4 (0.1-0.8)	0.4 (0.1-0.8)	0.5 (0.1-0.9)
		EURO-2	0.6 (0.2-1.1)	0.6 (0.2-1.1)	0.4 (0.1-0.7)	0.4 (0.1-0.7)	0.4 (0.1-0.8)
		EURO-3	0.6 (0.2-1.1)	0.6 (0.2-1)	0.4 (0.1-0.7)	0.4 (0.1-0.7)	0.4 (0.1-0.8)
		EURO-4	0.5 (0.1-0.9)	0.5 (0.1-0.9)	0.4 (0.1-0.6)	0.4 (0.1-0.7)	0.4 (0.1-0.7)
		EURO-5	0.5 (0.1-0.9)	0.5 (0.1-0.8)	0.3 (0.1-0.6)	0.3 (0.1-0.6)	0.4 (0.1-0.7)
	1,4-2L	EURO-0	0.9 (0.2-1.5)	0.7 (0.2-1.3)	0.5 (0.1-0.9)	0.7 (0.2-1.2)	0.6 (0.2-1.1)
		EURO-1	0.8 (0.2-1.4)	0.8 (0.2-1.4)	0.5 (0.1-0.9)	0.5 (0.1-0.9)	0.6 (0.2-1.0)
		EURO-2	0.7 (0.2-1.3)	0.7 (0.2-1.3)	0.5 (0.1-0.8)	0.4 (0.1-0.8)	0.5 (0.1-0.9)
		EURO-3	0.7 (0.2-1.2)	0.7 (0.2-1.2)	0.4 (0.1-0.8)	0.4 (0.1-0.8)	0.5 (0.1-0.9)
		EURO-4	0.6 (0.2-1.1)	0.6 (0.2-1.1)	0.4 (0.1-0.7)	0.4 (0.1-0.8)	0.5 (0.1-0.8)
		EURO-5	0.6 (0.2-1.0)	0.6 (0.2-1)	0.4 (0.1-0.7)	0.4 (0.1-0.7)	0.4 (0.1-0.8)
	>2L	EURO-1	1.0 (0.3-1.8)	1.0 (0.3-1.8)	0.6 (0.2-1.1)	0.6 (0.2-1.1)	0.7 (0.2-1.3)
		EURO-2	1.0 (0.3-1.7)	1.0 (0.3-1.7)	0.6 (0.2-1.1)	0.6 (0.2-1.1)	0.7 (0.2-1.3)
		EURO-3	0.8 (0.2-1.5)	0.8 (0.2-1.4)	0.5 (0.1-0.9)	0.5 (0.1-0.9)	0.6 (0.2-1.0)
		EURO-4	0.9 (0.2-1.6)	0.8 (0.2-1.5)	0.5 (0.1-0.9)	0.5 (0.1-0.9)	0.6 (0.2-1.1)
		EURO-5	0.8 (0.2-1.4)	0.8 (0.2-1.4)	0.5 (0.1-0.8)	0.4 (0.1-0.8)	0.5 (0.2-1.0)
Passenger Car Diesel	<1,4L	EURO-2	0.4 (0.1-0.8)	0.4 (0.1-0.8)	0.3 (0.1-0.6)	0.3 (0.1-0.6)	0.3 (0.1-0.6)
		EURO-3	0.4 (0.1-0.7)	0.4 (0.1-0.7)	0.3 (0.1-0.5)	0.3 (0.1-0.5)	0.3 (0.1-0.6)
		EURO-4	0.4 (0.1-0.7)	0.4 (0.1-0.7)	0.3 (0.1-0.5)	0.3 (0.1-0.5)	0.3 (0.1-0.5)
		EURO-5	0.4 (0.1-0.7)	0.4 (0.1-0.7)	0.3 (0.1-0.5)	0.3 (0.1-0.5)	0.3 (0.1-0.6)
	1,4-2L	EURO-0	0.5 (0.1-1.0)	0.5 (0.1-0.9)	0.3 (0.1-0.6)	0.4 (0.1-0.7)	0.4 (0.1-0.7)
		EURO-1	0.6 (0.2-1.0)	0.6 (0.2-1.0)	0.4 (0.1-0.8)	0.5 (0.1-0.8)	0.5 (0.1-0.9)
		EURO-2	0.6 (0.2-1.0)	0.6 (0.2-1.0)	0.4 (0.1-0.7)	0.4 (0.1-0.8)	0.5 (0.1-0.8)
		EURO-3	0.5 (0.1-0.9)	0.5 (0.1-0.9)	0.4 (0.1-0.7)	0.4 (0.1-0.7)	0.4 (0.1-0.8)
		EURO-4	0.5 (0.1-0.8)	0.5 (0.1-0.8)	0.3 (0.1-0.6)	0.4 (0.1-0.6)	0.4 (0.1-0.7)
		EURO-5	0.5 (0.1-0.9)	0.5 (0.1-0.9)	0.4 (0.1-0.6)	0.4 (0.1-0.7)	0.4 (0.1-0.7)
	>2L	EURO-0	0.7 (0.2-1.3)	0.7 (0.2-1.3)	0.5 (0.1-0.8)	0.5 (0.1-0.9)	0.5 (0.2-1.0)
		EURO-1	0.8 (0.2-1.4)	0.8 (0.2-1.4)	0.6 (0.2-1.1)	0.6 (0.2-1.1)	0.7 (0.2-1.2)
		EURO-2	0.8 (0.2-1.4)	0.8 (0.2-1.4)	0.6 (0.2-1)	0.6 (0.2-1.1)	0.6 (0.2-1.1)
		EURO-3	0.7 (0.2-1.3)	0.7 (0.2-1.3)	0.5 (0.1-0.9)	0.5 (0.1-0.9)	0.6 (0.2-1.0)
		EURO-4	0.6 (0.2-1.1)	0.6 (0.2-1.1)	0.5 (0.1-0.8)	0.5 (0.1-0.9)	0.5 (0.1-0.9)
		EURO-5	0.6 (0.2-1.2)	0.6 (0.2-1.2)	0.5 (0.1-0.8)	0.5 (0.1-0.9)	0.5 (0.1-0.9)
Trucks	<7.5t	EURO-0	1.3 (0.4-2.4)	1.3 (0.4-2.4)	1.2 (0.3-2.2)	1.2 (0.3-2.1)	1.2 (0.3-2.2)
		EURO-1	1.1 (0.3-2.0)	1.1 (0.3-2.0)	1.0 (0.3-1.9)	1.0 (0.3-1.9)	1.0 (0.3-1.9)
		EURO-2	1.1 (0.3-1.9)	1.1 (0.3-1.9)	1.0 (0.3-1.8)	1.0 (0.3-1.8)	1.0 (0.3-1.8)
		EURO-3	1.1 (0.3-2.1)	1.1 (0.3-2.0)	1.1 (0.3-1.9)	1.1 (0.3-1.9)	1.1 (0.3-1.9)
		EURO-4	1.1 (0.3-1.9)	1.1 (0.3-1.9)	1.0 (0.3-1.8)	1.0 (0.3-1.8)	1.0 (0.3-1.8)
		EURO-5	1.1 (0.3-2.0)	1.1 (0.3-2.0)	1.0 (0.3-1.8)	1.0 (0.3-1.8)	1.0 (0.3-1.8)
	7.5-16t	EURO-0	2.0 (0.6-3.7)	2.0 (0.6-3.7)	1.8 (0.5-3.2)	1.7 (0.5-3.0)	1.7 (0.5-3.1)
		EURO-1	1.8 (0.5-3.2)	1.7 (0.5-3.1)	1.6 (0.4-2.8)	1.5 (0.4-2.6)	1.5 (0.4-2.7)
		EURO-2	1.7 (0.5-3.0)	1.7 (0.5-3.0)	1.5 (0.4-2.7)	1.4 (0.4-2.6)	1.5 (0.4-2.6)
		EURO-3	1.8 (0.5-3.2)	1.8 (0.5-3.2)	1.6 (0.4-2.8)	1.5 (0.4-2.6)	1.5 (0.4-2.7)
		EURO-4	1.6 (0.5-3.0)	1.6 (0.5-2.9)	1.5 (0.4-2.6)	1.4 (0.4-2.5)	1.4 (0.4-2.5)
		EURO-5	1.7 (0.5-3.0)	1.7 (0.5-3.0)	1.5 (0.4-2.7)	1.4 (0.4-2.5)	1.4 (0.4-2.6)
	16-32t	EURO-0	2.0 (0.6-3.7)	2.0 (0.6-3.7)	1.8 (0.5-3.2)	1.7 (0.5-3.0)	1.7 (0.5-3.1)
		EURO-1	1.8 (0.5-3.2)	1.8 (0.5-3.2)	1.6 (0.4-2.8)	1.5 (0.4-2.6)	1.5 (0.4-2.7)
		EURO-2	1.7 (0.5-3.0)	1.7 (0.5-3.0)	1.5 (0.4-2.7)	1.4 (0.4-2.5)	1.4 (0.4-2.6)
		EURO-3	1.8 (0.5-3.2)	1.8 (0.5-3.2)	1.6 (0.4-2.8)	1.5 (0.4-2.6)	1.5 (0.4-2.7)
		EURO-4	1.6 (0.5-3.0)	1.6 (0.5-2.9)	1.5 (0.4-2.6)	1.4 (0.4-2.4)	1.4 (0.4-2.5)
		EURO-5	1.7 (0.5-3.0)	1.7 (0.5-3.0)	1.5 (0.4-2.7)	1.4 (0.4-2.5)	1.4 (0.4-2.5)
	>32t	EURO-0	2.9 (0.8-5.3)	2.9 (0.8-5.3)	2.5 (0.7-4.6)	2.3 (0.6-4.1)	2.3 (0.6-4.2)
		EURO-1	2.6 (0.7-4.7)	2.6 (0.7-4.7)	2.2 (0.6-4.0)	2.0 (0.6-3.6)	2.0 (0.6-3.7)
		EURO-2	2.5 (0.7-4.5)	2.5 (0.7-4.5)	2.2 (0.6-3.9)	2.0 (0.5-3.5)	2.0 (0.6-3.6)
		EURO-3	2.6 (0.7-4.7)	2.6 (0.7-4.7)	2.2 (0.6-4.0)	2.0 (0.6-3.6)	2.0 (0.6-3.7)
		EURO-4	2.4 (0.7-4.3)	2.4 (0.7-4.3)	2.1 (0.6-3.7)	1.9 (0.5-3.3)	1.9 (0.5-3.4)
		EURO-5	2.5 (0.7-4.4)	2.4 (0.7-4.4)	2.1 (0.6-3.8)	1.9 (0.5-3.4)	1.9 (0.5-3.5)

Source emission factors: TREMOVE Base Case (model version 2.5.1).

Annex I: Pricing policy leaflet

Pricing policies for solving urban mobility issues

Information leaflet

Congested access or inner city roads? Shortage of parking places or car free areas? These and other mobility issues can to a large extend be solved by **pricing policies**. Why would one consider pricing mobility? Because experiences in practise show that pricing policies work in tackling negative effects of urban mobility, such as congestion, accidents and air pollution.

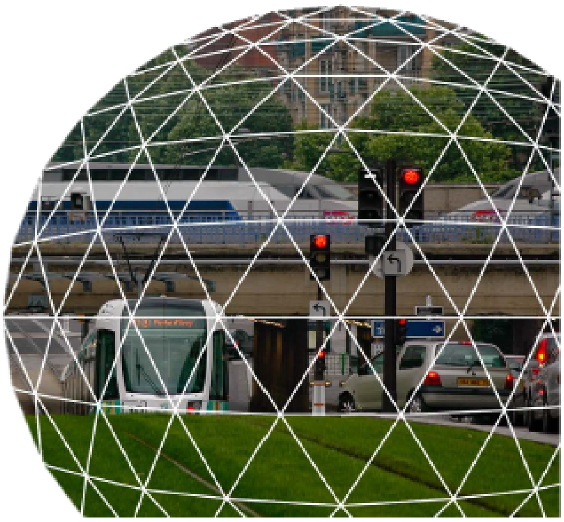
This leaflet provides a brief guideline on how to design a possible pricing policy for your city. Although not exhaustive, the following steps provide an approach in structuring the policy.

Step 1: Define the issue(s) to be tackled

- Do the negative effects occur within the entire city, a certain area or perhaps on a specific stretch of infrastructure?
- Who is affected; people living in the area or users of certain infrastructure?
- Does it concern a mobility specific issue, or a more broad spatial problem?
- What is causing the issue(s); moving vehicles or parked vehicles, modal choice of travellers, etc.?

Step 2: Set targets

Before turning to solutions, consider the size of the negative impacts that currently exist and the desired reduction of those impacts. Try to make sure that the instrument and its expected impacts are quantified, allowing for monitoring (and evaluation) before, during and after the introduction of a pricing policy. More on this in the next step.



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Pricing policies for solving urban mobility issues

Information leaflet

Step 3: Towards solutions

Before introducing a pricing policy, make sure that the current impacts of the issue you are trying to solve are known; one could perform a **baseline measurement.** An advisable next step could be to **communicate your ideas to the public**, and **create public and political support** for your ideas and validate them.

Before introducing a more definite form of pricing policy, one could consider running a **trial or pilot phase** of the policy. Not only can this create support for the policy, but it also allows you to **make adjustments** to the policy. By **measuring the effects and communicating them,** not only the effectiveness of the policy is increased but again support can be heightened

After **introducing the actual policy,** it remains important to **monitor the impacts,** to ensure the effectiveness of the policy.

Parking policies can be seen as a first and cheaper step towards road charging

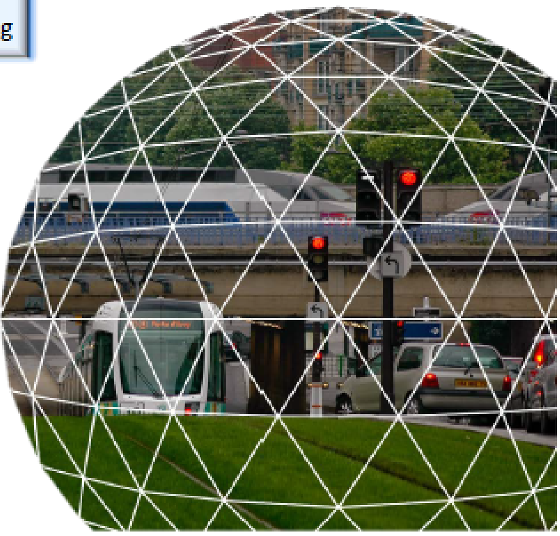
Technologies

For the collection of fees, many different technologies exist that allow to price mobility in an urban context. From manual scanning of number plates up to fully automated systems that include in-build systems in vehicles or automated scanning through video-camera's. The choice for any technology depends mainly on the desired result of the measure, and the accuracy with which one wants to know what the effect of a measure is.

When it comes to monitoring, more sophisticated technologies often allow for more accurate measurements of effects, and therefore allow for instance to closely monitor the result of an adaptation (for instance the effect of a price increase).

Public acceptance

Referenda often lead to the dismissal of pricing policies, as people might consider the policy as yet another form of taxation. However, the Stockholm referendum (after a trial of seven months) was a success. The Stockholm case shows that once a policy has been implemented, the public supports the policy because they notice the positive effect it has.



Pricing policies for solving urban mobility issues

Information leaflet

How then to design a specific pricing policy? Experiences tell us that any policy is dependent on a wide range of factors, such as the traffic intensity, many of which are case specific. Different geographical or political circumstances may require a different approach in designing a pricing policy.

For more information on designing the pricing policy that will help your city battle negative effects of urban mobility, you are referred to the following literature:

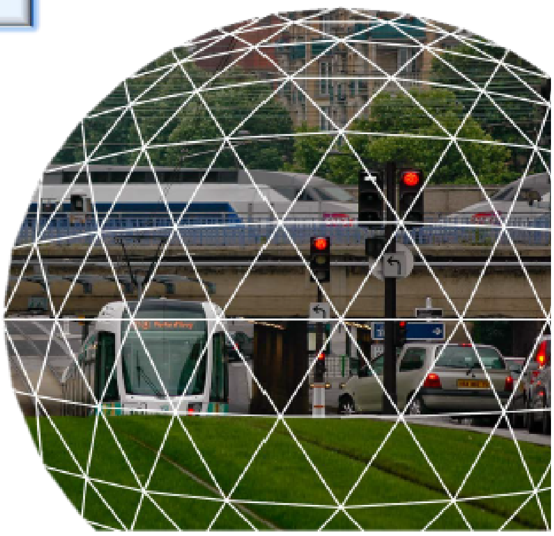
- Urban Aspects of the Internalization of External Costs study
- IMPACT handbook

Please contact the European Commission - Mobility and Transport DG - Library (DM28, 0/36) - B-1049 Brussels

Urban mobility

Mobility and Parking are essential for the development and functioning of cities. Pricing therefore can not been seen as an isolated phenomenon only related to the use of parking places or infrastructure. It is intertwined with social and economic functioning and development of the city.

It has a direct and positive impact on the use of other transport modes like public transport or bike; an impact which will be more substantial if good alternatives are available. Therefore pricing should be seen in the broader perspective of the impact on the city, its inhabitants and visitors and it's sustainable urban transport system as a whole.



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