Competitive and Sustainable Growth Programme

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PRICING **RO**AD USE FOR **G**REATER **R**ESPONSIBILITY, **E**FFICIENCY AND **S**USTAINABILITY IN CITIE**S**

Bristol • Copenhagen • Edinburgh • Genoa • Gothenburg • Helsinki • Rome • Trondheim

Deliverable D7.2

WP6 – Recommendations and Exploitation
Practical Implementation Guide for Cities

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1 INTRODUCTION

1.1 The PRoGRESS Project

The further development and exploitation of road pricing as a transport policy tool rests on resolving some key questions:

- What is the social and political acceptance of urban pricing schemes?
- How effective are these schemes in meeting social and transport goals?

These questions can only be fully answered through comprehensive, real-life demonstrations of transport pricing schemes. Therefore, the PRoGRESS project has set an overall goal:

> "to demonstrate and evaluate the effectiveness and acceptance of integrated urban transport pricing schemes to achieve transport goals and raise revenue.„

The demonstration and evaluation activities in PRoGRESS are being carried out across eight sites: Bristol, Copenhagen, Edinburgh, Genoa, Gothenburg, Helsinki, Rome, and Trondheim.

1.2 Scope of this Deliverable

This deliverable is intended as a practical implementation guide for cities that wish to develop pricing schemes. The recommendations are based on experiences from each of the eight cities taking part in PRoGRESS. Those experiences are presented in deliverable D7.1, Local Technology Implementation Plans. Together the two deliverables are the result of the PRoGRESS workpackage number 6 (WP6).

The objective of WP6 is to support the thematic network in providing policy results for the local, national, and European level covering:

- Recommendations and guidelines on implementing marginal cost road pricing schemes;
- Contributions to the standardisation and interoperability of electronic pricing schemes;
- Exploitation plans for the local implementation of marginal cost pricing.

The objective of D7.2 is to provide a short, but practical, set of recommendations regarding technology and its implementation to other cities that wish to take pricing schemes forward.

2 OVERVIEW OF THE PRICING SCHEMES

Seven of the PRoGRESS sites (Bristol, Copenhagen, Edinburgh, Genoa, Gothenburg, Rome, and Trondheim) have implemented or demonstrated a range of pricing schemes as shown in Table 2.1 below. The work in Helsinki has focussed on modelling the effects of road pricing schemes.

Table 2.1 Pricing Concepts and Technologies Across the PRoGRESS Sites

Scheme concept	Road-pricing technology basis		
	Electronic tag	**ANPR**	**GPS**
Cordon (per trip)	Rome Helsinki	Bristol Genoa Rome	Copenhagen Bristol
Cordon (per day)		Edinburgh	
Zone (per trip)	Trondheim Helsinki		Copenhagen
Distance-based			Copenhagen Gothenburg Bristol Helsinki

Notes:
1) ANPR – Automatic Number Plate Recognition using digital cameras and OCR (Optical Character Recognition)
2) GPS – Global Positioning System
3) Bristol is considering electronic tags for its full-scale scheme, although the trial through PRoGRESS, in association with the UK government, is with VPS (Vehicle Positioning Satellites). VPS is one of several names for GPS, which properly refers to the proprietary system owned by the US military.

Rome and Trondheim are the only full-scale implementations but Bristol, Edinburgh, and Genoa are all currently planning for a full-scale implementation. No such decisions have yet been taken in Copenhagen, Gothenburg, and Helsinki.

3 CONSULTATION AND INFORMATION

3.1 Experiences from Consultation

An experience from most of the sites is that road pricing is still very controversial. The experiences regarding consultation with the public and others can be summarised through the following lessons learnt and recommendations. Most of these confirm previous experiences.

Lesson 1: "Weak support for road pricing as an isolated measure,,
A lesson learnt in many sites (e.g. Gothenburg), as well as in previous research, is that a majority among the public tend to be against road pricing if presented as an isolated measure. There is generally widespread support for introducing measures that will reduce congestion and substantially improve public transport; however, there is normally opposition to the principle of road user charging. Reasons include the view that it is fundamentally unfair to charge people to drive around "their,, city, that charging will not reduce congestion, and that realistic public transport alternatives are not, and will not be, available.

A *recommendation* is *to present road pricing as part of a strategy*, including other measures, to solve congestion. It is then also crucial in the consultations to communicate clearly on how the problems experienced look today (and will look in the future), what can be achieved through road pricing and other measures, what are the scheme objectives, and so on. This recommendation is in line with findings from other schemes adopted by the EC, e.g. the CIVITAS initiative.

Lesson 2: "It is hard to find support for full-scale schemes,,
It is obvious from several of the sites that it has been difficult, from a political point of view, to implement full-scale road pricing schemes. Instead of full-scale schemes, demonstration projects have therefore been carried out in some cities (e.g. Bristol, Edinburgh, and Genoa) in order to learn more about how the technology works, how it affects the attitudes of participants and the general public, and such like. A lesson learnt is that this approach also provides experiences enabling cities to proceed with consultations leading to the development of a more appropriate full-scale road pricing scheme.

A *recommendation* is therefore *to consider running demonstration projects* as a first step on the way towards implementing a full-scale road pricing scheme.

Regardless of whether demonstrations are carried out or not, urban road pricing schemes affect a number of goals and interested parties. Therefore, another *recommendation* is to *build coalitions* between several of these interests. Since interests overlap, compromises are often possible, especially if the revenue can be used to *compensate losers*.

Lesson 3: "Support tends to erode as more detailed plans are presented,,
At one site (Edinburgh), tracking public views over time has shown that support for road pricing schemes tends to erode as progressively more detailed designs are presented. The more detailed a design becomes, the less able it is to accommodate the

preferences of all the different factions, resulting in a steady reduction in support. Experience in other cities has also shown that support continues to fall as implementation approaches.

A *recommendation* is to be aware of this risk and to *discuss it with politicians and other stakeholders at an early stage*, so that they are not taken by surprise if and when support erodes. Demonstrations make it possible to better communicate the purpose and effects of road pricing schemes. Therefore they may help in preventing the gradual decline of public support. This is another reason why demonstrations may be a good idea.

Lesson 4: "Difficult to communicate scheme objectives,,
Opposition to the road pricing schemes seems to be reduced after implementation, but road user charging is still very controversial. A lesson learnt from the consultations carried out (in Gothenburg and Trondheim) is that it is difficult to communicate scheme objectives. The discussion tends to focus on the political process rather than whether the scheme will be able to meet its objectives. Usually, the politicians also wish to discuss other policy instruments than road pricing.

A *recommendation* is to put a lot of *emphasis on providing information on the scheme objectives and traffic effects of the scheme*. As pointed out in Lesson 1, it is also useful to present schemes as part of a strategy. The information has to be provided both before and after implementation, and it is also important to adjust the scheme design to accommodate unnecessary and unwanted side effects.

Lesson 5: "Businesses in city centres are often against road pricing,,
Commercial interests often seem to be against road pricing schemes, more so than residents (see Edinburgh and Rome), at least this seems to be true before the scheme has been implemented. However it seems that the fear of city centre decline can be reduced.

A *recommendation* is to *communicate closely with businesses and stakeholders* so that their fears and concerns can be allayed before the implementation of any measures. Another recommendation is to *announce close monitoring of effects and the possibility for redesigning the fee system* after a certain period of operation.

3.2 Experiences from Information

An experience from several of the sites is that they have faced an unexpected difficulty to inform the general public, and even participants in demonstrations, on the contents of schemes. The experiences regarding information can be summarised through the following lessons learnt and recommendations. Most of these confirm previous experiences; some new lessons learnt with respect to information are numbers 6, 7, 8 and 12.

Lesson 6: "Extensive communication is needed,,
A lesson learnt is that the need for information is immense when a road pricing scheme is to be implemented. At some sites (e.g., Genoa and Gothenburg) this difficulty to communicate and transfer information about road pricing to users and citizens was

unexpected. This occurred even after extensive explanations were provided through different channels.

A *recommendation* is therefore to *make a complete information and consultation plan early* in the implementation process and to budget large resources for the work.

Lesson 7: "Difficult to communicate changes in the schemes,,
It has been found difficult (in Rome) to inform those affected in time when changes to the road pricing systems have been carried out. Such changes may refer to the charging period or the charge levels. The huge number of violations registered when modifications were applied confirms the difficulties.

A *recommendation* is therefore to *provide abundant information before changes are made and to use several channels* for the information. One important channel is variable message signs placed at the roadside.

Lesson 8: "Good availability of information is needed even in field trials,,
A lesson learnt from the demonstration sites (e.g. Gothenburg) is that it is important to be available and supply information even though only field trials are conducted. Participants especially, but also media and the public, require a lot of information in order to understand fully how the scheme works and how they are supposed to act.

This underlines the *recommendations* that *thorough information is needed*, both before and during project implementation as well as when the schemes are running. Information can, e.g., be provided through letters, folders, telephone service, a website with FAQ (Frequently Asked Questions), and contacts.

Lesson 9: "It is hard for participants to understand different scenarios,,
An experience (from Gothenburg) is that behavioral differences for two different scenarios were not clear among test drivers who tried both scenarios. A probable explanation is that the test drivers did not understand the differences between the scenarios (congestion charging and an environmental scenario) and therefore did not react "logically,, to the measures.

A *recommendation* is therefore to *avoid letting the same person try different scenarios in field trials* and instead let different participants try different scenarios. The disadvantage is, of course, that more participants may be needed in order to get reliable behavioural results.

Lesson 10: "The press acts as both opinion makers and opinion reporters,,
Analysis of press coverage (in Edinburgh) has shown that the press tend to act both as opinion makers and opinion reporters. The finding that they act as opinion makers, through comments and a bias towards reporting on foreseen negative impacts, is not surprising. However, it is important to realise this.

A *recommendation* is to apply a pro-active approach and *formulate an information strategy for the contacts with media*. This can also minimize the risk of growing suspicion towards the project from the media.

Lesson 11: "Simple schemes are easier to communicate,,
A lesson learnt from the difficulties found in supplying sufficient information is that it is better to apply simple schemes, at least from a consultation and information point of view. The backdrop is, of course, that what is theoretically best in order to meet scheme objectives, may have to be sacrificed. However, from several sites (e.g. Genoa), the experience is that this may be a sound solution, especially at the beginning. A related experience (from Rome) is that implementation can be facilitated if the design, as far as possible, is made according to existing regulations.

A *recommendation* is therefore to *apply simple schemes*, as long as they can still satisfactorily meet the objectives, and then *gradually improve* them.

Lesson 12: "More information is needed in GPS-based systems,,
A lot of information has been needed in all the schemes. Overall, the need seems to be larger in the GPS-based systems than in the systems using short-range communication and/or cameras. The reason that more information to the participants is needed is because it is harder to explain how such an advanced system works, what the cost for a typical journey will be, how the control is carried out, and so on. There are also much larger amounts of information that have to be handled within the system, e.g. on where and when the car travels. See also the chapter on technology and transaction.

A *recommendation* is to *take the need for information into account* when deciding upon the technical solution to use in a road pricing scheme.

4 LEGAL AND INSTITUTIONAL ISSUES

The PRoGRESS projects have not primarily dealt with legal and institutional issues. However, experiences from such issues have been gained, and may be interesting for other cities. It needs to be stressed that it is difficult to give clear recommendations, since legal and institutional situations are more or less unique in every city in Europe. Many of the experiences also confirm previous experiences, although one new lesson learnt with respect to legal and institutional issues is number 6.

In this context, it is also worth stressing that not only can experiences from the PRoGRESS cities be useful for other cities, but the European Commission ought to be able to benefit from the experiences. There are many legal and other obstacles, different in different countries, facing cities wanting to implement road pricing schemes. It is obvious – from the PRoGRESS sites and elsewhere – that it is often a time-consuming and difficult task for a single city to overcome these obstacles. With a common European framework on some of these issues, some of the difficulties could probably be reduced. A *recommendation to the European Commission* is therefore *to continue to facilitate for cities* wanting to implement effective demand management measures such as road pricing, through directives and such like.

Lesson 1: "An unclear framework can complicate the debate and the decision process,,
The legal situation regarding road pricing is very different in different countries, for example there is a legal framework allowing road pricing on existing roads in the UK but not in Denmark or Sweden. In Italy there is a legal solution that makes it easy to implement road pricing for cities willing to do so, but at the time of the PRoGRESS demonstrations complicated intermediate steps were needed. A lesson learnt is that if no clear legal framework for road pricing is in place, this will complicate the debate and the decision-making process for the schemes.

Therefore, in cities where the legal framework for road pricing is not clear, it is *recommended* to *address legal issues at an early stage* of the process.

Lesson 2: "The legal situation may limit the possible scheme designs,,
A lesson learnt is that changes in legislation may be required in order to implement a preferred scheme design in a city, the situation in Trondheim being a good example of this. National legislation previously did not accept demand management to be the main rationale for road pricing schemes. However, based on new legislation, the city is now discussing pricing as an instrument for demand management. During the last two years, Norwegian privacy laws have also been changed, making it possible to offer electronic fee collection as the only charging method at the charging points.

An obvious *recommendation* to cities facing a limitation of scheme designs due to the legal framework is to *either adjust the legal framework* or to *adjust the scheme design*. Adjusting legislation can be very time consuming.

Lesson 3: "Introducing new legislation can give delays,,
One experience (from Edinburgh) is when the introduction of the scheme has depended on the passing of legislation this has meant an initial delay to the project. The approval

process as defined by the legislation is also an area where delays have been encountered.

The *recommendation* is that *delays* due to changes in the legal framework and/or the approval process *should be expected when making the time schedule* for the implementation of a road pricing scheme.

Lesson 4: "Regulation of revenue use can be important for successful implementation,,
One lesson learnt (in Gothenburg) is that road pricing can be more accepted if the legislation allows for revenues to be used directly for improving public transport or roads. It has also been found important that the revenues stay in the city or region affected. Regulation of revenue use is thus an important question, since high acceptance greatly facilitates implementation.

A *recommendation* is to *ensure that guarantees are given on how revenues will be used* and who will control them. This can be done either through legal regulation or through agreements with the government.

Lesson 5: "The traffic situation may change during the operation of the system,,
An experience (from Rome) is that the traffic situation may change during the operation of the system. Modifications of the scheme design may therefore be needed.

A *recommendation* is to *observe traffic flows and travel behaviour* at certain intervals over time and to run continuous panel surveys.

Lesson 6: "Using an arm's length company can work well,,
In some sites (Rome and Edinburgh) a problem encountered in local government was in the delivery of major transport infrastructure projects. The decision was therefore taken to establish an arm's length company, owned by the council, but with the freedom to operate in a private sector environment. This seems to have worked well and the Scottish Executive is now considering this approach for transport delivery throughout Scotland.

The *recommendation* to a city wanting to implement road pricing is to *consider if this solution is suitable* in that particular city.

5 TRANSPORTATION POLICY

Most of the experiences regarding transportation policy are either country-specific or confirm previous experiences. Some new lessons learnt with respect to transportation policy are, however, numbers 4 and 7.

Lesson 1: "Distance-based systems give higher flexibility for transportation policy„
Distance-based systems are flexible and can easily be used to solve local congestion problems. GPS technology is well suited for such systems. Systems based on cordons or zones are less flexible and may also create barriers between areas. DSRC and/or ANPR technology is normally sufficient in such systems. In a transportation policy where GPS technology is used, the road pricing can thus be used as a more fine-tuned instrument. On the other hand this technology is not as mature as the others for road pricing, and may therefore be difficult to use as a tool in transportation policy (see the chapter on technology and transactions).

A *recommendation* is to *follow the development of GPS-based systems* in order to decide when, and if, it can be a practical tool for road pricing in urban areas.

Lesson 2: "Uncertainty has to be handled„
One experience (from e.g. Gothenburg) is that people want answers to many questions regarding road pricing. The uncertainty of what a potential scheme really will imply is extensive. People do find the present traffic and environmental situation problematic, but the scepticism towards pricing is large. Often, there are also a lot of political questions unanswered, such as funding, revenue use, and complementary measures.

A *recommendation* is to *form a strategy for how a fact-based dialogue* on advantages as well as disadvantages of road pricing can be achieved. One solution is: as a first step to present facts; as a second step to conduct an extensive dialogue; and as a third step to fine-tune the design of the system. After implementation it is suitable to constantly adjust the scheme to revealed behaviour and needs.

Lesson 3: "Use of revenues must be settled before implementation„
Issues such as acceptance, distributional effects, and the possibility to invest in complementary measures are important in transportation policies. The use of revenues is central for the outcome of these issues. Therefore revenue use must be settled before implementation (see e.g. Copenhagen and Trondheim).

A *recommendation* is, first of all, to *present* to politicians *facts on the distributional effects* of different schemes, *on acceptance and on transport demand* as well as supply. Thereafter, at an early stage in the process, a decision is needed on how revenues should be used. In some countries it may be necessary to constitute new laws in order to make it possible to use the revenues as decided.

Lesson 4: "Funds are needed before implementation„
A conclusion from the experience that improved provision of public transport is necessary in order to get acceptance and that thorough consultation exercises are needed, is that funding must be available at an early stage. It is thus not only funds for

the actual implementation of the road pricing scheme that are needed before implementation.

A *recommendation* is therefore to try *to get a clear commitment* at an early stage from the decision makers that funding will be supplied and that necessary improvements in the transport system will *be in place already from day one* of the scheme.

Lesson 5: "Transportation policy must deal with social equity,,
It is clear, from all sites, that different schemes will have different effects on social equity. This will not only be a matter for acceptance, it is also an important task on the political agenda.

A *recommendation* is to *analyse effects of road pricing together with other pricing instruments* such as costs for parking, public transport fares, and Park and Ride. Together, they can be used as a sophisticated set of tools for mobility management.

Lesson 6: "Transportation policy must deal with impacts for business sector,,
Several sites in PRoGRESS (e.g. Edinburgh) have pointed out the business sector as an important segment to analyse separately. This sector has its specific needs, and impacts from schemes on businesses may have an important influence on the regional economy.

A *recommendation* is therefore to undertake *separate analyses* and *separate consultation exercises with the business sector*. This is an area of increasing interest in the transport policy work that has not had so much focus in research.

Lesson 7: "A winning idea is to confirm earlier strategies,,
An experience (from e.g. Rome) is that implementing road pricing schemes can be facilitated if transport strategies emphasise earlier objectives of a city's transportation policy. It is an advantage if the design of the road pricing scheme is in line with earlier work undertaken in the city, having used other tools. Another experience is that it takes time to inform people in time when changes are undertaken.

A *recommendation* is therefore to *use road pricing schemes to strengthen previously defined transportation strategies* and objectives. It is also important to inform on the scheme objectives. Over time, road pricing may then be considered as a part of the city infrastructure.

Lesson 8: "Implementation in London supports other cities,,
The implementation in London supports other cities that wish to develop transportation policies that include road pricing. The general support towards measures solving traffic congestion problems as well as the subsequent pollution has shown an increase (in Rome) since the implementation in London.

A *recommendation* is to *learn from other cities that have gone along with full-scale implementations*. In communication, this can be used as reference material since real-life experience is easier to accept than theoretical results.

6 TECHNOLOGY AND TRANSACTION

In this chapter, recommendations regarding technology and transaction are given. The lessons learnt mainly focus on the experiences from the GPS-based systems since the other technologies are more mature and already tested in full-scale. All the lessons regarding GPS are thus more or less new, whereas the other lessons mainly confirm previous experience.

6.1 Experiences from GPS-Based Systems

Lesson 1: "GPS systems have been shown to work,,
A lesson learnt from the sites using GPS-based systems (Bristol, Copenhagen, and Gothenburg) is that it does work for demonstrations and that a lot can be done to overcome for weaknesses found. There are still improvements needed before it can be implemented on a full-scale in urban areas. However, experience from the demonstrations shows that greater understanding is achieved if congestion charges are limited to times and roads where congestion exists. This is one reason why it is desirable that a more complex but also fairer system is possible to achieve.

A *recommendation* is to *develop the technology further* and in doing so pay consideration to *learning from the demonstrations* that have taken place in PRoGRESS. It is, after all, difficult to find any other measure with the same potential for efficient and flexible management of traffic in major cities.

Lesson 2: "GPS is hardly mature enough for full-scale systems in urban areas,,
Another lesson learnt (in Bristol, Copenhagen, and Gothenburg) is that there are still a lot of problems regarding technology that have to be solved before a GPS system can be implemented in full-scale in urban areas. The main problem with GPS-based systems is that they will require a unit installed in all cars and such an installation activity is enormous and very costly. Also, much further work needs to be carried out concerning methodological, software, and technical issues – see some of the following lessons.

A *recommendation* is to *use more mature techniques* (DSRC and/or ANPR) if the road pricing scheme is to be implemented *in urban areas in the near future.*

Lesson 3: "The equipment does not always work properly,,
During the demonstrations problems were experienced (in Copenhagen and Gothenburg) regarding loss of battery power, poor quality of GPS reception, and loss of signals, especially at start-up.

Some *recommendations* are to undertake *massive testing of prototypes* before implementing the final product and to *check the quality of the GPS signal* received when installing the equipment. To compensate for the loss of signals, methods such as *dead reckoning and real-time map matching* can be used.

Lesson 4: "Many pitfalls in field trials using advanced technology,,
An experience (from Copenhagen and Gothenburg) is that there are several things regarding technology that may go wrong in a field trial. This is not surprising since testing the technology is one of the purposes of a field trial. In Gothenburg, there were

also several controls of the data carried out and errors corrected. However, with even more validation under way, some more pitfalls could probably have been avoided.

A *recommendation* is to make *controls that log data are collected properly several times during field trials*, and to test if it looks reasonable. To detect errors, it is necessary to carry out more thorough analyses at an early stage than in ordinary surveys of attitudes. It may also be necessary to go through such analyses several times during the trial. Running a small-scale pilot, that includes analyses of the log data, before the field trial is also recommended.

Lesson 5: "Avoid allocation of functionality to the on-board unit,,
Another experience (from Gothenburg) is that the allocation of the price calculation to the on-board unit puts very high requirements on the system in all respects. Such requirements include large needs of memory to store price lists, high processor capacity to calculate the fee in real time, and power capacity for the display. Thus, also the complexity of the system increases, and consequently the sources of errors in all steps of the system development and operations process. Another disadvantage is that updating of the software of the on-board unit becomes complicated.

A *recommendation* is therefore to *allocate all functions except the journey recording to roadside or central systems*. This can be done with retained integrity level. The loss is the continuous display of the cost incurred. The gain is that it is possible to create an interoperable solution without excess requirements on memory and processor capacity.

Lesson 6: "New equipment is often blamed for car malfunctioning,,
In one of the demonstrations (Copenhagen) a significant number of participants claimed that their battery was flat because of the GPS unit. It seems that every time a battery goes flat the car driver expect the taximeter to be the culprit even though there might be other causes. The lesson learnt is that clarification of the responsibility for car malfunction can be very difficult and new equipment will always be expected to be the main culprit.

A *recommendation* is to *try to identify and solve such problems during the testing* of the prototypes, but also to be aware that there is a risk for this reaction anyhow.

Lesson 7: "The equipment is not distracting and integrity is not a big issue,,
A lesson learnt from the demonstrations (in Gothenburg) is that that the equipment was not distracting, the drivers did not feel under surveillance, and that the question of integrity was not an important issue. Further, from a technical point of view, it is no more difficult to guarantee privacy in a GPS-based system than in other systems.

A *recommendation* is to *refer to these experiences* if and when the issue of surveillance is brought up in the debate preceding the decision on the technology to use.

Lesson 8: "GPS-based systems are too advanced to be needed for zone charging,,
An experience (from Copenhagen) is that while GPS or similar technology is necessary to be able to implement kilometre charging, the situation is different for zone charging. Such a system does not require the continuous monitoring that is a main benefit of a GPS system.

A *recommendation* is, instead, to *consider number plate recognition (ANPR) or DSRC technologies*, which are proven to function well, are cheaper, and easier to implement. This will probably make more sense from economic and organisational perspectives.

6.2 Experiences from DSRC and ANPR Systems

Lesson 9: "DSRC works successfully,,
Experience, both in the PRoGRESS sites (Trondheim) and other cities, is that the technologies using short-range communication (DSRC) work well. It is also a technology that is comparatively cheap to operate, has been used for quite some time and now is becoming standardised. However, it is rather costly to implement, not least since equipment is needed in all cars.

A *recommendation* is to *use this technology* (or pure ANPR systems), as long as it is not crucial for the fulfilment of the scheme objectives to use distance-based systems. The impacts of a distance-based system can also be emulated through the use of several DSRC portals.

Lesson 10: "ANPR works well but does not recognize all vehicles,,
A lesson learnt from the demonstrations is that the technology using automatic number plate recognition (ANPR) is quite good and affordable. It does, however, have an intrinsic rate of non-recognition in the real operational environment (7% and 15% in Genoa and Rome, respectively).

A *recommendation* is that this technology can be *used as an alternative to DSRC* solutions. A benefit is that it is cheaper and easier to implement since it does not require in-vehicle equipment, though it is probably more expensive to operate. If the scheme objectives calls for several zones or time-differentiated fees, it is, however, probably better to use DSRC. Even then, ANPR will be a more or less necessary complement for enforcement purposes.

Lesson 11: "Non-detection and incorrect reads in ANPR systems can be reduced,,
The major cause of both non-detection and incorrect reads in one of the ANPR systems (Edinburgh) was the non-overlapping fields of view of the cameras at each site, resulting in lane-straddling vehicles frequently being incorrectly read.

A *recommendation* is to include *overlapping fields of view* for the cameras and also *both front- and rear-facing cameras*.

6.3 Experiences Regarding Transactions

Lesson 12: "Operational costs differ between payment channels,,
Transactions requiring manual labour, such as call centres or retail outlets, are more costly than more automated payment channels (Edinburgh).

A *recommendation* is, therefore, to *promote the use of low-cost payment channels* such as the Internet or SMS-based systems.

Lesson 13: "License purchasing systems can perform well,,
A licence purchasing system can perform well. In one of the sites (Edinburgh) there were no reported occasions when the telephone service did not function or provided an engaged or unobtainable signal to volunteers, and all recorded telephone licence requests were successfully transcribed into the licence file.

A *recommendation* is that the operation of license purchasing systems *does not have to be a major concern*, apart from the obvious fact that it may be rather costly.

6.4 Experiences Regarding Standardisation

Lesson 14: "It is difficult to standardise the on-board equipment,,
An experience (from Gothenburg) is that the on-board equipment functionality should be minimized. This conclusion should be valid also for the electronic fee collection (EFC) standardisation in DSRC systems. One reason why on-board functionality should be minimised is that it will be difficult for all European countries and operators to agree on one single service, and even to agree on a generic vehicle classification. Secondly, it will be extremely difficult to organise a pan-European solution where payment information, with the need for security protection, is communicated and understood.

A *recommendation* is that harmonisation of distance-based EFC should be based on *harmonisation of the message containing the time-stamped travel path*. This will minimise the payment information flow, and reduce the need for security measures. Integrity may be protected by e.g. the selection of the trusted body used for performing the payments.

Lesson 15: "For DSRC, standardisation has come a long way,,
For the DSRC systems, some issues regarding standardisation have been solved, like the 5.8 GHz communication link that has been used at all the sites using DSRC. However, some issues remain and are under consideration in CEN.

An obvious *recommendation* is to *adapt to the new standard* wherever it has been completed.

Lesson 16: "A benefit if the EFC service can be included in the GPS systems,,
Experiences from the PRoGRESS trials show that GPS-based systems are still far from mature to be implemented. Standardisation of GPS solutions is, however, going on. There is a need to guarantee European interoperability at some basic level.

A *recommendation* is therefore to *include* the European DSRC-based common *EFC service* in every *GPS system* as an interface to the numerous existing and emerging systems all over Europe. Another recommendation would be to promote the development of a European *framework for enabling cross-border enforcement* of users that do not pay.

7 ENFORCEMENT

Many of the lessons learnt regarding enforcement confirm previous experiences. Some new lessons are, however, numbers 1, 4, and 6.

7.1 Experiences from GPS-based Systems

Lesson 1: "It is difficult to enforce large GPS systems,,
At present there is no fully operational control and enforcement system in relation to distance-based charging. The general problem with a GPS-based system is that it has to be working all the time the car is in a charged area. Here a cordon-based system is much less demanding, because the technology only needs to work when a cordon is crossed, which reduces enforcement to primarily checking the cars crossing cordons. One conclusion (from Copenhagen) is that to fully enforce a large GPS system will be almost impossible.

A *recommendation* is to use one of two less complete alternatives. One way is to install a monitoring system in the car that *continuously checks if the GPS system is working* when the car's engine is operating. Another way is *enforcement by mobile and stationary checkpoints*. The drawback is that cars only driving in limited areas might easily avoid these checkpoints.

Lesson 2: "The chosen subject of control has big consequences for the system design,,
The subject of control in distance-based charging systems determines how the enforcement system should be designed. One possibility is a control aimed at the functionality of the system, in order to detect fraudulent behaviour or equipment manipulation. Another possibility – recommended in Gothenburg – is a control system aimed at the verification of duly performed payments.

A *recommendation* is to *base the control system on verification of performed payments* and not the functionality of the on-board equipment. Another recommendation would be that *all control functions should reside outside the vehicle*. This means that the vehicle equipment does not perform any payment activity, but only communicates transport data to a trusted partner that calculates the fee and performs the payment.

7.2 Experiences from ANPR Systems

Lesson 3: "ANPR systems work sufficiently well,,
A lesson learnt at many sites (e.g. Bristol, Edinburgh, Genoa, Rome, and Trondheim) is that ANPR systems work fairly well. There will probably always be a share of the cars that cannot be identified, but this share is not so high that it should discourage anyone from using ANPR. There are also some improvements that can be made, such as the inclusion of overlapping fields of view for the cameras as well as both front- and rear-facing cameras (see technology and transaction).

The *recommendation* is to *use ANPR-systems* for enforcement and to use the *improvements* described above.

Lesson 4: "ANPR is more efficient than manual control,,
At one of the sites (Rome) enforcement was previously carried out manually through police surveillance. After the ANPR system was implemented, the illegal access rate went down drastically. This shows that automatic systems such as ANPR are more efficient than systems using only manual control.

The *recommendation* is, once again, to *use automatic systems, such as ANPR*, for enforcement.

Lesson 5: "Registration of license plates can be done manually,,
Even though a lesson learnt is that the enforcement system should be automatic, it is not necessary that the actual registration of the video picture be done automatically. This is shown by experience from one system (Trondheim) that is based on taking video pictures of those vehicles violating the regulations and where the operator then registers the licence plates from the pictures as manual work.

A *recommendation* is therefore that *enforcement does not have to be fully automatic in small-scale schemes* with a short planned lifetime. In e.g. demonstration projects it might not be profitable to develop a more automated procedure, due to the need for high investments in the total enforcement system.

Lesson 6: "Illegal access can be due to insufficient information,,
At one site (Rome), peaks in illegal access were detected at special events, where the operating time window of the system was enlarged. The reason was that not all citizens were reached by information on this, showing that a high rate of illegal access may be due to insufficient information.

The *recommendation* is once again to *put a lot of effort on information, especially when changes to the scheme are applied*. One way of doing this is to use small variable message signs or special lights in order to inform the people directly before passing the gates.

Lesson 7: "Penalty management can probably be co-ordinated,,
In many cities it is probably possible to expand the existing management of penalty charges for parking violations to also handling penalty charges from road pricing. Likewise, payment of congestion charges could sometimes be co-ordinated with payments for parking. Such solutions could probably lower the investment and operation costs for the road pricing system.

A *recommendation* is therefore to *examine the possibility to co-ordinate the handling of penalty charges* from road pricing with the handling of penalty charges for parking violations.

8 USER ACCEPTANCE

Many of the lessons learnt regarding user acceptance confirm previous experiences. Some new lessons learnt are, however, numbers 1, 4, 6, 7, and 10.

Lesson 1: "Surveillance is not a big issue,,
A lesson learnt in many of the PRoGRESS sites (e.g. Copenhagen and Gothenburg) was that surveillance was not a big issue among the participants. The reason seems to be that people have become accustomed to using systems where, in principle, it is possible to track them (e.g. credit cards and the Internet). The result is the opposite of the role that surveillance has in the press and among politicians. This lack of fear of intrusion of privacy clears the way for electronic systems.

A *recommendation* is to *communicate,* to the public and the press as well as to politicians, *the fact that surveillance has not been a big issue* at the sites.

Lesson 2: "Verify that traffic problems are actually solved by road pricing,,
A lesson learnt during the demonstrations is the importance of verifying that traffic problems experienced are actually solved by road pricing. A majority at most of the sites agree that traffic congestion will get worse and needs to be reduced. At one of the sites (Edinburgh) up to two-thirds thought that charging would have no effect, because people are too used to using their cars.

Another lesson learnt (from Gothenburg) is that road pricing is more accepted if revenues are used to improve public transport as well as environment. That a road pricing scheme can give satisfactory environmental impacts seems to be a result that is possible to communicate.

A *recommendation* is to *focus on traffic behaviour*, rather than political issues before implementation. It is therefore necessary to communicate clear and distinct facts on effects on traffic behaviour.

Lesson 3: "Support tends to increase after implementation,,
An experience from the demonstrations (in Trondheim) is that support tends to increase after implementation. One possible interpretation of the resistance before implementation is that this might be in order to try to influence the decision and thus prevent implementation. Polls have showed that for one scheme, 75% were negative before the scheme started operating. Two months after implementation, the negative share had dropped to below 50%. After two years, approximately 30% were negative. If benefits become clear – which usually does not occur until after implementation – support thus seems to increase.

A *recommendation* is to undertake measures to *increase options for people influenced* by the system when it is implemented. Another recommendation is to *develop such measures and to communicate benefits at an early stage*. A road pricing scheme associated with a package solving growing congestion and environmental deterioration may become a success, whereas a stand-alone road pricing scheme is likely to fail.

Lesson 4: "Misconceptions easily arise,,
Even though a field trial is working well, people seem to exaggerate problems that could potentially occur. Examples mentioned (in Edinburgh) are, for instance, that the website may crash if too many people purchase a license at the same time, that the telephone system may not have enough lines, and that cameras will not pick up enough car registration numbers. However, experience from the sites show that such problems have not materialised.

A *recommendation* is to *map the possible misconceptions* and to give extensive and clear *information on how these topics are going to be solved*.

Lesson 5: "Aesthetic issues are important,,
Different technologies have different requirements on roadside equipment, and thus affect aesthetic issues differently. Public acceptance may be influenced by the design of the roadside equipment (see Bristol and Rome). Large gantries may, for example, become an aesthetic issue if they are not adjusted to the environment where they are installed.

A *recommendation* is to *involve an architect* when planning for the roadside equipment. It is especially important to consider aesthetic values in culturally valuable areas, such as old city centres. *Another solution is to use a GPS system*, which greatly reduces demand for extensive roadside infrastructure.

Lesson 6: "Easy payment channels are requested,,
A lesson learnt (in Edinburgh) is that paying by telephone or Internet, when applicable, implies only little hassle. A key finding at one site was that among those participating in the trials some were still unsure of elements in the trial. It was, for instance, found that people do not always read the information provided with regard to payment.

A *recommendation* is to facilitate payments by *supplying several purchase channels*, with high accessibility. These options should also be clearly communicated.

Lesson 7: "Time to accustom should not be underestimated,,
People need time to get used to and accept changes in transport policy, even when it comes to modifications of an existing system. An experience (from Rome) is that it was a lengthy and complicated political process to obtain user acceptance of the new scheme, despite the fact that access control already had existed in the city for several years. It also took a long time to establish the procedures for releasing access permits to business services (such as taxis, freight deliveries, and coaches). These city council decisions were, however, part of the process necessary to obtain user acceptance for the new scheme.

A *recommendation* is to *approve a fair time schedule.* A short time schedule may undermine the possibility to use road pricing to solve traffic problems in the foreseeable future.

Lesson 8: "Scepticism due to current provision of public transport,,
A lesson learnt (in Edinburgh) is that scepticism towards charging often hinges on criticism of the current provision of public transport. Support would rise substantially if

people really believed that considerable improvements in public transport would be undertaken.

A *recommendation* is to provide substantial *improvements in public transport*, at the same time or even before, implementing road pricing. One possibility is to constitute laws with a commitment to reinvest revenues into improved public transport, making such investments before implementation.

Lesson 9: "Views and needs may change,,
A lesson learnt from the schemes (in e.g. Trondheim) is that views and needs may change as the scheme is implemented.

A *recommendation* is that *changes in views and needs should be monitored* by continuous surveys, even when the scheme is running. The new information should be used to adjust the scheme design.

Lesson 10: "Successful real-life implementations is useful,,
Experience from real life implementations is useful for cities considering a full-scale scheme. One reason is that it can be used as reference material in communication. Accordingly, the successful implementation of the London congestion charging scheme seems to have helped PRoGRESS sites (e.g. Edinburgh, Genoa, and Rome) in making the case for road pricing schemes. Acceptance also grows if you can refer to a real-life implementation. One sign that these experiences do increase the interest for road pricing is that around 15 Italian cities are now beginning to implement automatic road pricing systems, with financial support by the Italian ministries.

A *recommendation* is to *learn and communicate from other success stories*.

9 SUMMARY

This report summarises 60 lessons learnt and recommendations from the modelling work, trials, demonstrations, and real-life road pricing implementation carried out during the PRoGRESS project. These cover the topics:

Topic	Number of lessons	Section of report
Consultation and information	12	3
Legal and institutional issues	6 (+1)	4
Transportation policy	8	5
Technology and transaction	16	6
Enforcement	7	7
User acceptance	10	8

The project has shown that thorough consultation and information activities play a vital role in the success of road pricing implementation. It has also shown that experiences regarding legal and institutional issues can be interesting for other cities, although the situation differs a lot between different countries. Furthermore, it has been shown that road pricing can be an efficient transportation policy measure and that distance-based road pricing systems give higher flexibility for transportation policy.

GPS-based systems have been shown to work, though they are hardly mature enough for full-scale systems in urban areas. The project has also shown that DSRC and ANPR technologies work well, even in full-scale implementations, including enforcement. Last, but certainly not least, the project has shown how the acceptance for road pricing in urban areas can increase.