6 CONCLUSIONS

6.1 Comparison Among Road Pricing (RP) Scheme Characteristics

Table 6.1 compares the main information provided by cities on the road pricing schemes being investigated and demonstrated. It is noted that not all the cells of the table have been assigned a value since for some cities modeling of full-size schemes was still not available, or the indicators provided were not applicable with respect to the specific parameter.

The table is split into two sections:

a) *Full scale real RP scheme:* data relevant to the i) design and ii) expected outcomes (by modeling and simulation analysis) of a full-size real-scale RP scheme
b) *Demonstration design parameters:* data relevant to the design of the PRoGRESS demonstration

6.1.1 Type and Extent of RP Full-Size Scheme

The PRoGRESS cities have studied two basic types of pricing schemes: cordon (pay each time crossing the border of a "priced" zone or zones) and distance (pay proportionally to the length and type of route performed). Rome and Genoa are considering only one single central zone, as are Bristol for the full-scale scheme. The full scheme for Edinburgh may be a single city centre cordon, or may involve a second cordon at the city ring road. Copenhagen and Gothenburg are both testing distance-based charging schemes, some with multiple zones, while Helsinki are performing modelling analysis on distance-based and trajectory-based systems. Trondheim already operate a multiple zone system, and are adding a new CBD zone and examining through charging as well as simple cordon-crossing charges.

It is noted that the choice of a better RP scheme is strictly related to the final main scope (protect environment, raise revenues) and the extent of the urban area of application. Therefore, "best" schemes cannot be defined in general.

Distance based schemes involve a greater area of application (citywide), while multiple zone cordon (Edinburgh, Trondheim) affects only a portion of the entire urban area (up to 250 km^2), and single zone cordon (Edinburgh, Genoa, and Rome) affects central areas of only a few square km (less than 25 km^2). This subdivision is important also with respect to the objective of RP application: in the first cases RP is applied mainly to reduce congestion and to get revenues for transport improvements, in particular for public transport; while in the latter case the aim is also to protect valuable areas against private traffic impacts in conjunction with general traffic reduction and revenue generation.

A great variance is found with reference to the applied fee, that varies from 0.5€ (Genoa, low fare case) up to 8€ (Bristol, high fare case) per passage for cordon based schemes,

and is between 0.02-1.5€ per km for distance based schemes i.e. an average per-trip fee of about 0.5-8€, reflecting the aim of raising revenues with respect to reduce impacts.

Exempted users (in the real schemes) tend towards a minimum number in the distance based citywide schemes; conversely, in the single central cordon schemes, the requirements for exempted user categories (residents, handicapped, goods distribution, operators, services, etc.) may be of greater importance and in some cases (as in Rome and Genoa, where exemptions are from 40% to 70% of total traffic within RP area) may ask for a specific and heavy management organisation.

6.1.2 Tolling Technology

The project is testing a wide set of different tolling technolgies. Dedicated Short Range Communication (DSRC), Optical Character Reconition (OCR), Automatic Number Plate Reconition (ANPR) are used, also combined, to allow for the detection of vehicle passages in cordon schemes. Vehicle Positioning Systems (VPS), using on-board GPS and GSM units, are adopted in the distance-based schemes. Insight on comparison among system characteristics and performances will be provided in following deliverables (D5.1, Demonstration Implementation Report).

6.1.3 Accompanying Measures

The design and modelling study has demonstrated that road pricing reaches the maximum beneficial effects if combined with the application of complementary interventions on mobility. These must facilitate the mobility of users affected by the pricing measure, thus promoting the shift from private car mode to other modes (public transport, intermodality, walking, cycling, etc.).

Only the cities bringing in full, real RP schemes will be implementing complementary measures through PRoGRESS. Rome envisages mainly adjustments to PT surface supply, and also new Park and Ride facilities and other synergic interventions like taxi-bus and pop-up traffic inhibitors. Trondheim presents dynamic information systems, parking charging facilities and integration of the payment system. Genoa foresees a dedicated shuttle service connecting Park and Ride cordon locations to the city centre and RP-integrated fares for parking within the RP area. Bristol and Edinburgh are both planning to implement RP as part of an integrated package of complementary transport measures, although these will not be brought in complement the demonstrations run through PRoGRESS. Copenhagen, Gothenburg, and Helsinki are all considering the improvements in PT and other services if they do introduce full schemes in the future.

6.1.4 Expected Effects of RP Application

It is remarked that modeling of full-size RP schemes has been conducted by the cities at different level of extent and with different approaches, therefore only few basic indicators for six of the cities are comparable.

Mobility

Table 6.1 indicates the hourly volume of users (in peak-hour) that, on the basis of the present travel behaviour, are likely to be affected by the RP measure in the full-size, or real, scheme. This clearly shows that the design of the scheme is dependant both on the objectives of the interventions, the nature of the geography, and the traffic movement within the city. This value is then compared with the expected hourly volume of users that simulations indicate will pay the RP fee. This value is substantially different from the previous one only if the adopted scheme allows the user to make an alternative travel choice with no additional charges (like, for example, in Genoa).

For all cities, as expected, RP application induces a reduction of private traffic, which is in percentage more consistent in ones adopting a cordon pricing to protect only a limited central area, with several crossing route alternatives outside the RP area.

From simulations, this reduction varies from -11% up to -30% (respectively, for Rome and Genoa), depending on the fee level and the period of day and, in particular, on the availability of complementary travel supply of lower generalised cost. An increase of traffic just outside the cordon is to be expected in some places; however, simulations have shown values not exceeding +10%, leading to overall benefits for the entire city in terms of car density and congestion reduction. In some cases (Edimburgh), traffic reductions are expected also outside RP area due to the pricing measure application (due to reduction of car use).

In the other cities, adopting different schemes, citywide private traffic reduction obtained by simulations is limited to a few percent. It is however noted that, in these cases, the use of RP as a mean for demand management allows to increase mobility efficiency (and reduce impacts) by re-directing traffic to less congested nodes/routes and distribute it more uniformly upon the day.

Environment

In the case of cordon schemes, energy use and pollutant emissions within the RP area are lowered up to –35% as a consequence of car density reduction (less traffic volume and higher travel speed). In the external areas, where an increase of these impacts is to be expected due to border effects, the increment is however limited and spans between the values of +5% to +11%. Globally, by RP application even at low fee levels, the city gets a beneficial effect in terms of impacts reduction.

In the citywide distance pricing schemes, the use of RP as a demand management tool allows for an overall reduction of environmental impacts. These were not however computed by specific simulations within the performed study.

Revenues

The expected global yearly revenues that can be obtained by the full-size scheme designs are between 2-5m€ for cordon schemes aimed only to protect a central area (Bristol, Genoa, Rome, Trondheim), however in general exceeding cost of technology installation and maintenance/service. For other schemes, aimed also to get revenues, these have been computed between 60m€/year up to 150m€/year (Gothenburg, Edinburgh).

6.1.5 PRoGRESS Demonstration Schemes

The eight city projects described in this deliverable reflect the different levels of development in the introduction of road pricing schemes. There are four distinct groups of demonstrations:

A) Modelling demonstration only: Helsinki is not going to implement a pricing scheme or trial, but is testing a number of scenarios to feed into the national debate.

B) Demonstration trial: Copenhagen and Gothenburg are running demonstration trials of road pricing with volunteer motorists. Neither Denmark nor Sweden has primary legislation as yet and the results of the trial will input to the national debate.

C) Development of real schemes and demonstration trial: Bristol, Edinburgh, and Genoa are all working towards the introduction of full-size real pricing schemes, but due to timescale constraints will be running demonstration trials as part of PRoGRESS. For the three cities, both the PRoGRESS demonstrator and the proposed full scheme are described in this deliverable.

D) Demonstration trials based on real schemes: Rome and Trondheim are implementing changes to real road pricing schemes.

It is noted that the volume of users affected by the pricing measure during demonstration is related to the two types of organisations proposed: 50-400 users for volunteer based demo (Bristol, Copenhagen, Edinburgh, Gothenburg, Genoa), up to 3,300-10,000 users/hour in case of full-size demo on real schemes (Rome, Trondheim).

Table 6.1 Comparison Among Scheme Characteristics

	Scheme Parameter	*UoM*	**Helsinki (2)**	**Copenhagen**	**Gothenburg**	**Bristol**	**Edinburgh (4)**	**Genoa**	**Rome**	**Trondheim**
Real-scale RP Scheme: design parameters	Type of pricing scheme	-	Distance/ Cordon	Cordon/km Charging	Distance pricing	Cordon / Distance (10)	Cordon / Double cordon	Cordon	Cordon Annual fare	Zonal, per trip
	Extent of Scheme	-	Citywide	Citywide	Citywide	CBD/Citywide	City Centre/~90% of city	Central	CBD	Citywide
	Area involved	km^2	740	250	445	2.5	25 / 250	1	5.5	46.8
	Type of tolling technology (11)	-	-	VPS	VPS	DSRC/VPS (10)	ANPR	Video OCR	Video OCR + DSRC	DSRC
	Complementary measure(s)	-	Parking / public transport fare	Metro	Parking Payment	Comprehensive package of transport improvements	Comprehensive package of transport improvements	Shuttle line P&R	PT improvem., express-lines introduction	Electronic Ticketing, Info. System
	RP exemptions	%	none	-	-	3-5%	5%	40%	70%	4%
	Mean fee level		(several)	0-0.70/km	7 / 0.5 (8)	1.50-8	3	0,50/1,00 x pass.	150/year	1.5
Real-scale RP Scheme: expected outcomes	Present volume of users potentially involved in RP (peak hour)	*Users/h*	50,000 - 115,000	-	-	23,000	11,000 / 26,000	3,100	3,300	20,000
	Volume of users paying a RP fee (peak hour)	*Users/h*	50,000 - 115,000	-	105,000	-	10,450 / 24,700	2000 / 1550 (1)	3,300	10,000
	Private traffic reduction in RPA	%	0 - 19%	-	-3% / -1% (6)	-	-26% / -12%	-20% / -30% (1)	-15%/ -20% (9)	-1%
	Private traffic increase in RPA external areas	%	6%	-	+9% / +1% (6)	-	-6% / -4%	6% / 10% (1)	5%	0%
	Emission reduction in RPA	%	0 - 17%	-	-1.5% (7)	-	-	-25% / -35% (1)	-8%	0%
	Revenues from RP application	*M€/year*	-	-	60	-	90 / 150	2,3 / 3,6 (1)	1.8	4.75 (5)

	Scheme Parameter	UoM	Helsinki (2)	Copenhagen	Gothenburg	Bristol	Edinburgh (4)	Genoa	Rome	Trondheim
Demo design parameters	Extent of Scheme	-	-	Citywide	Citywide	CBD/Citywide	2 cross sections	Central	CBD	Citywide
	Area involved in the demo scheme	km^2	-	250	445	-	-	1	5.5	46.8
	Volume of RP demo involved users (pk hr)	Users/h	-	400	350	50-100	200	150 / 3100 (3)	3300	10000
	Duration of RP demo	Days	-	300	300	180	180	150	Continuous	120

Notes:
- = not applicable / not computed
(1) First value: 0.5€ fee, second value: 1.0€ fee
(2) In Helsinki no demonstration is planned
(3) First value volunteers demonstration, second value full-scale demo
(4) For the real scheme, there are still two options: a city centre cordon / a double cordon around city centre and outer ring road
(5) Including all revenues from the tolling system of Trondheim
(6) First value: Congestion Pricing Scheme (CPS); second value: Mobility Management Scheme (MMS)
(7) Reduction of CO_x emissions
(8) CPS and MMS values per average trip during charging period
(9) During the period where the system is active (6.30am-6pm)
(10) Current proposed "real" scheme is using DSRC technology but options are open, demonstration will use VPS
(11) VPS=Vehicle Positioning System; DSRC=Dedicated Short Range Communication; ANPR=Automatic Number Plate Reconition; OCR=Optical Character Reconition

6.2 Achievements Against Workpackage Objectives

The main objective of workpackage WP2 was:

> *"To develop integrated urban transport pricing schemes based on the concept of marginal-cost pricing, in the real urban situations of the cities of Bristol, Copenhagen, Edinburgh, Genoa, Gothenburg, Helsinki, Rome, and Trondheim."*

Additional aims were: a) to set a design for future application of real-life RP schemes, feasible in the city specific context, and b) to set a design for implementation of the demonstration scheme(s) to be carried on in PRoGRESS.

These aims have been reached by all cities.

As far as the concept of marginal social cost pricing is concerned, it is noted that this is one that is increasingly being considered by transport professionals and is gradually becoming incorporated in the policies from the Commission. The principle of marginal social cost pricing is to ensure that the full cost of travel is incurred, this includes the costs of externalities such as environmental costs.

Much work has been undertaken to try and define the value of these costs and how to apply them to a pricing scheme. It is clear from the work undertaken in the cities that the issues surrounding the introduction of pricing schemes are related to mobility efficiency and comfort, environment, and other social costs. However, for many of the cities it would be impossible to introduce a charging scheme on the basis of true marginal social cost pricing for acceptability reasons, and in these cases the proposed RP solutions are finalized to the scope of raising revenues.

6.3 Conclusive Remarks

In this Deliverable D3.2, in order to present the results of RP scheme design activities performed in PRoGRESS WP2 by the 8 cities, the descriptions of the various types of RP schemes adopted in the 8 different urban contexts, model and simulation results, and information related to the process performed to develop the 8 PRoGRESS demonstration systems, are presented.

Deliverable D3.2 has been developed on the basis of previous D3.1. It includes updates of the previous city databases and final definition of RP schemes. Models of the selected schemes have been developed and finalised; indeed, for some cities (Bristol, Edinburgh, Genoa), definitive scheme characteristics have not been completely provided. Further updates about adopted RP schemes and related modelling will be included in future PRoGRESS deliverables; in particular, in D5.1 (Demonstration Implementation Report) and in D6 (Local Impact Analysis Report).