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Final Report

**European Database of Vehicle Stock for the Calculation
and Forecast of Pollutant and Greenhouse Gases
Emissions with TREMOVE and COPERT**

LAT Report No: 08.RE.0009.V2
Thessaloniki
02 July 2008



E³M - Lab



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Project Title European Database of Vehicle Stock for the Calculation and Forecast of Pollutant and Greenhouse Gases Emissions with TREMOVE and COPERT	Call for Tender No ENV.C.5/SER/2006/0033
Report Title Final Report	Contract No 070501/2006/451259/ MAR/C5
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Summary This is the final report of a DG Environment project aiming at the collection of revised data for inclusion into the Tremove/COPERT software models. The report contains information on the data required by these two models, related to coverage, vehicle types and technologies and activity related information. Then, the report describes the procedure followed to collect data from different national and international sources and summarizes the primary information that was made possible to collect in this way. The data screening and processing is then presented which leads to developing a consistent dataset for each country, to be used in COPERT and TREMOVE. Finally, the results are presented in a consistent manner for all countries, including emission comparisons with the national submissions and the results of the GAINS model. The results of this study are also made available on the web to be used as a guide for official data submission.	
Keywords TREMOVE, COPERT, vehicle fleet, vehicle stock, mileage, lifetime functions	

Internet reference http://lat.eng.auth.gr/copert			
Version / Date Final Version / 02 July 2008		LAT Report Number 08.RE.0009.V2	
No of Pages 260	Price FREE	Classification PUBLIC	Bibliography YES

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Executive Summary

Background and Project Objectives

This report is the summary of the work carried out in the project *European Database of Vehicle Stock for the Calculation and Forecast of Pollutant and Greenhouse Gases Emissions with TREMOVE and COPERT* (Call for Tenders No ENV.C.5/SER/2006/0033) funded by the European Commission - Directorate General Environment (DG ENV). The study was carried out by a consortium of six European institutes, coordinated by the Laboratory of Applied Thermodynamics in the Aristotle University Thessaloniki (LAT/AUTH - GR) and consisting of Renault (FR), Ökopol (DE), the Energy - Economics - Environment Modelling Laboratory of the National Technical University Athens (E3M-Lab/NTUA - GR), KTI (HU) and EnviCon (DE). The project was carried out within 16 months, from Jan 2007 to Apr 2008.

The aim of the project was to collect detailed information on the stock of vehicles in operation in all EU27 countries and Croatia, Norway, Switzerland and Turkey. This information will be used to perform detailed emission calculations at a national and international level using the COPERT model. In addition, emission projections into the future and impact assessments on the effects of transport will be conducted with the Tremove model. Data from both road and non-road transport modes were considered for inclusion in the final project database. However, most of the emphasis had to be given to road transport which is a much larger contributor of emissions than non-road modes.

The detail of the data to be collected had to enable the direct use of the datasets in COPERT and Tremove. COPERT is a methodology and a software tool used by several EU member states (over 20) for the calculation of their national road transport emission inventories. Its development has been mainly funded by the European Environment Agency (EEA) through the workplan of the European Topic Centre on Air and Climate Change (ETC/ACC). The main development and technical support is provided by LAT/AUTH. COPERT contains detailed emission functions of speed for practically all major vehicle categories and technologies operating in Europe today. It also includes emission factors for vehicle technologies dating back to 1970, as well as emission factor estimates for future technologies (e.g. Euro 6). The main information required to perform a complete national run include the number of vehicles and the annual mileage per category and technology level and the mean travelling speeds as well as the mileage allocation in urban, rural and highway driving conditions. There are also some additional data needed, including fuel specifications, mean ambient temperature and temperature variation per month, etc.

Tremove is an impact assessment model which simulates the effect of different transport policy options on the emissions and the additional cost produced by transport. In principle it includes demand over cost functions (elasticities) to simulate the shift of demand (veh-km or ton-km) between different transport modes, when a policy option alters the cost of transport. It has been developed by TML (BE) in the framework of the AutoOil II activities and has been further extending thereafter by funds mainly provided by the European Commission. With regard to the emission calculation, Tremove has practically inherited the COPERT stock structure and emission functions. As a result, the stock and activity data required by COPERT to calculate an annual national inventory is sufficient information also for Tremove.

The dataset developed in the project is also very useful information in several other applications. EEA supports the transport and environment reporting mechanism (TERM), which should enable policy-makers to gauge the progress of their integration policies. The main aim of TERM is to monitor the progress and effectiveness of transport and environment integration strategies on the basis of a core set of indicators. One of the main indicators is TERM 34 *Proportion of vehicle fleet meeting certain emission standards*, which requires detailed stock information to accurately calculate. The current project can deliver this necessary detail. A second use is multi-modal impact assessment studies, such as the ones conducted by the RAINS/GAINS models in the framework of the earlier CAFÉ and the revision of the National Emissions Ceilings Directive (NECD). The detailed stock and emission information derived by the project will be useful input to such integrated modeling activities. Also, a potentially very important use of the datasets is by individual member states. Several countries either do not have the necessary detail or the expertise required to produce detailed stock classifications, down to vehicle technology level. For those countries, the project datasets are a very useful resource of information and will enable them to use the COPERT software. In addition, for countries with well-developed inventorying mechanisms, the current datasets can prove an interesting cross-checking exercise.

Data Detailing Requirements

Based on the project technical annex and the inception report, detailed technology classification should be provided for one year which, depending on the data availability, had to be either 2000 or 2005. Annual information on total stock size per vehicle category (passenger cars, light duty vehicles, heavy duty vehicles, busses and power two wheelers) and fuel consumption should be collected to the extent possible back to 1970, in order to provide the input for reliable time-series projections in the future. The information should refer to the operational national fleet in each of the EU27 countries and Croatia, Norway, Switzerland and Turkey. Based on the methodology followed to derive the vehicle technology classification, it was made possible to develop detailed stocks for the period 2000-2005 for all countries considered. The method followed and the results obtained are discussed in the following sections of this executive summary.

Definitions of the vehicle categories covered and the exact stock structure both for road and non-road methods is shown in Tables A.1 through A.7 of Annex I. Table E.1 provides a summary of the road transport vehicle categories considered and their correspondence to the UNECE (TRANS/WP.29/78/Rev.1/Amend.2) vehicle classes. The technologies considered were the ones with implementation date before 2006. In total 36 different types of vehicles, further disaggregated to 178 technologies were distinguished.

There are limited differences in the data structure between COPERT and Tremove. The most important one is the extended list of HDV classes in COPERT which have been drawn from the ARTEMIS (www.trl.co.uk/artemis) project and distinguish trucks in rigid and articulated with a further classification to several weight classes. Tremove is based on the older COPERT version (Version III) which contained only four weight classes for trucks and no distinction to rigid and articulated. An additional difference is that COPERT also provides emission factors for hybrid passenger cars while Tremove considers them as part of the gasoline car fleet. On the other hand, Tremove includes a separate category for CNG passenger cars, while COPERT does not. The final difference between the models is that Tremove considers three capacity classes for diesel cars while COPERT considers two (no distinction to <1.4 l for sub 2.0 l cars). It was decided to use the

COPERT classification in this project, as this is more detailed than the Tremove one. For those car classes that Tremove requires some additional information (i.e. CNG and small diesel) or lacks the necessary detail (i.e. HDVs) it is recommended to make some validated assumptions to transform the existing fleet classes.

Table E.1: Summary of the data structure requirements for road transport

Category	UNECE Classification	Fuels	Classes (Types)	Technologies
Passenger Cars	M1	Gasoline, Diesel, LPG	8	48
Light Duty Vehicles	N1	Gasoline, Diesel	2	10
Heavy Duty Vehicles	N2, N3	Gasoline, Diesel	15	71
Busses and Coaches	M2, M3	Diesel, CNG	6	29
Mopeds	L1	Gasoline	1	4
Motorcycles	L2, L3	Gasoline	4	16

Data Collection

The sources of data can be distinguished to national and international. Starting with international sources, Eurostat is a reliable source for most countries. Eurostat though provides stock information on a rather aggregated level, that is number of passenger cars, buses, trucks, mopeds and motorcycles distinguished per fuel used, as well as total fuel consumption. There is also some distinction of passenger cars according to engine capacity, and trucks per loading capacity but there is only a limited number of countries that report in such detailed level. Hence, Eurostat data were mostly considered to obtain time-series at an aggregated level (i.e. per vehicle category).

Detailed data on registrations of new cars and deregistration were obtained by ACEA, which provides time series of new registrations and deregistrations of cars and trucks per fuel type. These data are available for several countries from 2001 to 2006. There are no data for CY, HR, MT and TK while for BL and RO these are only available for 2006 and not earlier years. The information on new registrations and deregistrations has been used to derive the fleet replacement. The data made available by ACEA are derived by detailed sales databases operated by AAA. This database was made available to the consortium by one of the consortium partners and contains detailed information on sales per vehicle make and model and country for EU15. This information was mostly important to derive information on the N1 vehicle usage and not in the core development of the fleet.

A final international source utilized was a study conducted by the International Union of Public Transport for the EU27 countries excluding CY (no urban bus fleet) and SK. Aim of this study was to picture the technology and operation conditions of urban busses in major cities around Europe in 2005 and hence conclusions are based on a large sample collected. The information was used as input to estimate the technological distribution of urban busses. It does not contain total fleet numbers though.

With regard to national sources, the consortium had immediate information to detailed national data regarding DE, FR, GR and HU. For the remaining countries national data were obtained by contacting the national experts of the Task Force of Emission Inventories and Projections (TFEIP).

This is the group of people responsible of submitting the national inventories in the framework of the CLRTAP and UNFCCC conventions (names are given in Annex II). TFEIP members were contacted by personal invitations to submit data to our project, following an official invitation letter from the European Commission. All countries invited responded to this email except of HR and MT. MT responded that no such data were nationally available while no response was received for HR. Also BG only provided data for non road sources. In general, data in various degrees of detail were submitted by different countries. Some countries (12 in total, mostly EU15 ones) submitted complete data series including technology classification since 1990 or even earlier. Several countries submitted technology classification for a few recent years and longer time series of aggregated information. National data for new member states were also complemented by information that was collected in 2002 by a dedicated conference organized by KTI.

Constant format excel spreadsheets were developed to summarize all input information per country received from national and international sources. These spreadsheets were used as input to the reconciliation model presented in the following section. A summary of the content of these files per country is summarized in Table E.2.

With regard to non-stock input data (annual mileage, mean travelling speeds, etc.) data were obtained from national submissions for most of the countries. With reference to the effect of age on the mean mileage driven, the relevant Artemis report on the analysis of the annual mileage of road vehicles (Adra and André, INRETS Report LTE 0421, November 2004) was also a useful source of information. Finally, data on the usage and registration of N1 vehicles were obtained from the Renault Statistical World Wide Book.

Detailed lifetime functions were also developed per vehicle category, using the detailed datasets of Germany on vehicle scrappage as function of age.

Data Reconciliation

The dataset initially built by synthesizing data from different sources was evidently inconsistent, containing sometimes contradicting information related to the stock of vehicles even at an aggregated level. Hence, a round of email exchanges and phone calls was initiated with the national experts in each country to try to understand and clarify these inconsistencies. Most of the issues arose when trying to compare the national fleets used for the emission estimation with the stock of vehicles in the Eurostat databases. In such circumstances, the national expert was contacted and clarifications were given. In most of the cases, the Eurostat total stock data were retained, and the stock was accordingly corrected by the national expert. In some other cases, proper explanations were given and the national data were used instead of the Eurostat.

After the first level data screening and corrections, the input datasets were processed by a data reconciliation mathematical model which uses the available information to fill gaps and identify inconsistencies in the data series. The mathematical model takes into account all available information on stock development, data on registrations and deregistrations, implementation matrices for the introduction of new technologies and tries to produce a consistent time series. The process involved is a non-linear optimization programme, which is bound to the limitations involved. Expert judgment is also implemented in the programme by means of tunable parameters which can be adjusted to control the effect of variables that are considered "hard" (i.e. known with

high confidence) vs. the effect of "soft" variables, i.e those that are known with low confidence. By means of these tuning parameters, the model can be calibrated to fully respect the hard variables and approximate the soft ones in the best possible way.

Table E.2: Summary of data collected for each country. "Category Population" shows the years for which information on the total fleet size per vehicle category was available. "Technology Classification" shows the years for which detailed technology classification has been provided. Note: the table is a general overview, individual years and gaps in the data series may appear for specific vehicle technologies.

Country	Category Population	Technology Classification	Country	Category Population	Technology Classification
AT	1990-2005		IT	1970-2005	1995, 2000-2005
BE	2000-2005		LU	1990-2005	
BG	1989-2005	2005	LV	1990-2006	
CH	2000-2005		LT		
CY	1997-2006	2000	MT	1990-2006	2005
CZ			NL	1970-2005	2001-2005
DE	1995-2005		NO	1973, 1980, 1986-2005	
DK	1985-2005		PL		
EE			PT	1990-2005	
ES	1970-2005	1990-2005	RO	1990-2006	2005-2006
FI	1980-2005	1990, 2001, 2005	SE	1980-2006	
FR	1990-2006		SI	1989-2005	2000, 2005
GR	1970-2005	1995, 2000	SK	1990-2005	2002-2005
HR	1998-2005	2005	TR	1993-2005	2004 (only PC)
HU	2000-2005		UK	1995-2005	2000, 2005
IE	1970-2005	1990-2005			

During this process, a number of additional incompatibilities were identified in the original datasets. The most frequent problems observed were the introduction of technologies largely beyond their expected implementation matrices and stock of specific vehicle technologies that fluctuated over the years. These issues were again corrected with a second round of consultation with the national experts and/or implementing the experience of the study team.

Annual Mileage Estimates

The annual mileage driven by the stock of vehicle per year is an important parameter in emission calculation as it affects both the total emissions calculated but also the relative contributions of the vehicle types considered. Detailed data on mileage per vehicle type were submitted by several countries and a number of different sources were used to estimate the effect of different parameters. Analysis of the data collected leads to a number of interesting observations. First, older vehicles (in particular passenger cars) are driven less than new ones. The difference between a 20-year old car and a brand new may be up to twice the distance. Second, the annual mileage of diesel cars is much higher than gasoline ones. The difference in some countries exceeds 100% but it is mostly in the order of 70-80%. This is due to the lower fuel consumption but also the frequent use of diesel cars as company cars. Third, there are some important differences in the ranges considered for light and heavy duty vehicles. For example, a Euro II articulated truck of 14-20 t

seems to be driven from 20 000 km to 111 000 km with an average of 53 Mm in the countries that submitted data. Although this may reveal true differences in the operation and use of the vehicles in the various countries, different estimation methods might also be responsible for part of these deviations. For example, it is still not clear at a European level whether countries need to report on the basis of mileage conducted on their own ground or mileage of the national fleet, regardless of where this has taken place. This difference produces an inconsistency as to which mileage countries need to report per heavy duty vehicle. This issue is currently under consideration by the UNECE emission reporting guidelines revision (ECE/EB.AIR/WG.5/2008/6).

The mileage values that were collected from national sources have been retained and used in order to calculate emissions in all cases, even if this resulted in inconsistencies between the calculated fuel consumption and the official quantities reported by the countries. This was decided for transparency reasons. For some countries (mostly new member states) that reported no mileage values, the average EU15 mileage has been used. This in some cases produces large deviations between the statistical and the calculated fuel consumption. It is therefore stressed that the mileage data for these countries need to be tuned with regard to energy or transportation statistics before use.

N1 Stock and Registrations

According to the regulations, the N1 category contains vehicles of less than 3,5 t GVW which are used for the transport of goods. Therefore, the energy consumption of these vehicles should by definition be allocated to freight transport. However, several of these vehicles are in principle used for the transport of professionals (people) rather than goods, therefore the corresponding energy consumption should be allocated for passenger rather than freight transport. In addition, several passenger cars (M1) are on purpose registered as N1 ones to take benefit of reduced taxation and other fiscal incentives in several countries. Therefore, the exact mix of N1 vehicles and their use is quite uncertain.

In this report, we have used actual registration and market information to estimate the extent of the practice to register passenger cars as N1 in 2005. The data show that 5-58 % of the apparent N1 registrations actually correspond to passenger cars which have been on purpose registered as N1. Data show that these are in principle SUVs which are registered as N1s to evade taxation but also smaller cars, which can be used for the transport of professionals (people). It is expected that these numbers are also reflected to the total stock of N1 vehicles as well.

We have also collected typical information regarding the actual use of N1 vehicles. This shows that despite the longer hours that these vehicles operate compared to passenger cars, their average annual mileage does not differ much, due to the low average speed they are driven at. Based on this analysis it is concluded that the number of N1-registered vehicles which are primarily used for the transport of people and not goods is a quite significant number. Given the rather equal distances that N1 and M1 diesel cars are used per year, it is proposed that the number of passenger-oriented N1 vehicles derived by comparing sales with registration data can be used as a minimum to allocate fuel consumption between passenger and freight transport.

Road Transport Stock Evolution

Detailed stock evolution was calculated for all countries considered, generally from 1995 to 2005. There are some exceptions in some countries and for some vehicle categories due to the limited availability of data for some earlier years. The evolution of the vehicle number per category is in detail presented in the main report for each country considered. Only some major trends are discussed for the different regions considered in this executive summary.

The data clearly show the increase of diesel passenger cars and light duty vehicles in EU15, which reached 50 million and 20 million units in 2005, respectively. In new Member States a substantial increase in the total diesel car stock occurs only after 2004, together with their introduction in the EU. The gasoline car stock on the other hand is rather saturated in EU15, at 140 million cars, while it is even slightly decreasing after 2002. In new Member States and in non-EU countries the gasoline car stock steadily increases and the first signs of saturation do not appear before 2005. The large increase of diesel LDVs in EU15 has brought a significant decrease in the number of gasoline ones, which dropped from 5.3 million vehicles in 1995 to about 3.5 million ones in 2005. This trend is expected to continue in the future due to the superior fuel economy of diesel over gasoline light duty vehicles.

The heavy duty vehicle stock does not change much over a period of 10 years (1995-2005) in EU15, with some 5-5.5 million vehicles overall. On the contrary, the opening of the borders of new member states has brought a rather significant increase of 40% over the same period, due to the increased needs of transport to and from the rest of the European continent. The same increasing trend is observed in non-EU countries as well, guided mostly by Turkey (~70% increase in the stock of HDVs), again due to increasing needs of transport from and to EU.

The fleet of power two wheelers is also seen to increase rather significantly over the last nine years prior to 2005 in EU15 (24%). The increase is fuelled by both Mediterranean countries, which traditionally own a large stock of mopeds and motorcycles, but also from the increase in the new registrations of motorcycles in northern European countries. The latter is a confirmed trend which is linked to the increase in fuel prices and higher congestion in urban areas, but also due to an expected uplift in the social status of large motorcycle owners. The trend is opposite in new Member States where the stock has remained rather constant or even gradually decreasing, at about 4 million vehicles, in favour of passenger car ownership.

Fuel Balance and Emissions

Detailed fuel consumption and emission calculations were performed for the base year 2005, using the stock and activity data collected in the framework of this project and the latest version (v5.1 – February 2008) of the COPERT 4 model. The fuel consumption and the emissions were calculated with the national submissions in the framework of UNFCCC and LRTAP, and the basecase of the GAINS model. The results of this comparison are summarized in Table E.3 for all countries and are then summed up for three regions (EU15, EU27 and non-EU countries). All emissions were calculated using the mileage values that were provided by the individual countries. For those countries (mostly non-EU15) which provided no mileage values, the mean EU15 was used per vehicle type to calculate total emissions. Therefore, no mileage tuning has been performed to try to match the statistical with the calculated fuel consumption. Despite this, Table E.3 shows a very

good comparability of the current estimates with the statistical values of the different member states and the total CO₂ emissions reported to UNFCCC. At an EU15 level the current estimates result in 5.5 % higher gasoline consumption, 3.2 % lower diesel consumption and 20% lower LPG consumption than fuel statistics. In principle this shows a very close energy balance for the EU15 road transport sector. Indeed, the total CO₂ emissions calculated with the current fleet at EU15 differ by only 0.8% from the value calculated when summing up all individual member state submissions. The differences when considering all EU27 are slightly larger (+7% for gasoline, -3% for diesel, -31% for LPG and +1.7% for CO₂).

Table E.3: Comparison of calculated with statistical values (Year 2005).
All values (except deviations which are in percentage) are in million tones.

Country	Statistical			Calculated			CO2		Deviations (%)			
	G	D	LPG	G	D	LPG	Stat	Calc	G	D	LPG	CO2
Austria	1.49	3.32	0.00	1.50	2.99	0.00	23.0	21.7	0.9	-10.1		-5.8
Belgium	1.93	6.31		2.46	8.01		24.9	33.4	27.2	27.0		34.1
Bulgaria	0.54	1.38	0.31	1.50	2.75	0.14	7.2	13.9	176.0	99.4	-55	93.3
Croatia	0.69	0.96	0.02	0.89	0.93	0.01	5.3	5.8	28.7	-3.1	-45	9.6
Cyprus	0.30	0.52	0.00	0.35	0.37	0.00		2.3	16.8	-29.2		
Czech Rep.	2.06	3.72	0.24	1.69	2.17	0.00	16.0	12.2	-17.6	-41.6	-99	-23.7
Denmark	1.75	2.07	0.00	1.82	2.11	0.00	12.2	12.4	3.9	1.7	-5	2.4
Estonia	0.29	0.40	0.00	0.31	0.40	0.00	1.9	2.3	6.9	0.4		16.5
Finland	1.75	2.01	0.00	2.21	1.86	0.00	11.8	12.9	26.4	-7.5		9.3
France	10.70	29.87	0.14	10.26	30.74	0.14	131.5	130.3	-4.1	2.9	0	-0.9
Germany	23.16	26.89	0.00	25.05	25.17	0.00	152.2	159.0	8.2	-6.4		4.5
Greece	3.89	2.06	0.01	5.77	3.03	0.00	18.9	27.8	48.3	47.4	-78	47.4
Hungary	1.46	1.91	0.04	1.62	1.98	0.23	11.6	12.1	11.1	3.7	556	4.0
Ireland	1.71	2.24	0.00	1.69	2.16	0.00	12.5	12.2	-1.3	-3.5	-100	-2.1
Italy	13.45	22.53	1.03	12.49	23.03	1.02	117.0	115.5	-7.2	2.2	-1	-1.3
Latvia	0.34	0.46	0.00	0.64	0.93	0.03	2.6	5.1	92.1	101		96.4
Lithuania	0.34	0.76	0.21	0.42	0.52	0.21	3.9	3.6	24.9	-32.3	2	-7.4
Luxembourg	0.55	1.61	0.00	0.16	0.39	0.00	7.2	1.8	-70.3	-75.8	-87	-75.5
Malta	0.07	0.16	0.00	0.06	0.13	0.00		0.6	-8.8	-21.0		
Netherlands	4.16	6.16	0.38	4.36	4.70	0.30	33.9	29.6	4.9	-23.6	-21	-12.7
Norway	1.52	1.53	0.00	1.74	1.20	0.00	9.6	9.3	14.3	-21.2		-3.2
Poland	3.94	5.36	1.50	4.91	4.81	0.60	34.2	32.6	24.5	-10.3	-60	-4.9
Portugal	1.76	4.10	0.01	1.95	4.57	0.01	18.5	20.7	11.0	11.5	-30	11.4
Romania	1.54	2.14	0.03	1.95	3.49	0.19	11.5	17.8	26.9	62.9	439	54.9
Slovakia	0.70	1.19	0.03	0.76	1.26	0.03	6.1	6.5	8.6	5.3	5	6.4
Slovenia	0.65	0.73	0.00	0.58	0.21	0.00	4.3	2.5	-11.4	-70.6		-42.3
Spain	7.26	22.12	0.05	8.10	20.14	0.00	92.7	89.4	11.6	-9.0	-100	-3.5
Sweden	3.94	2.18	0.00	4.03	2.13	0.00	18.5	19.5	2.5	-2.3		5.4
Switzerland	3.60	1.71	0.00	3.10	1.10	0.00	15.1	13.3	-13.8	-35.9		-11.8
Turkey	2.64	6.33	1.36	6.44	15.97	2.62	34.5	78.9	143.6	153	93	128.6
UK	18.47	19.43	0.21	19.33	17.01	0.00	120.1	115.0	4.7	-12.4	-100	-4.2
EU15	96.0	152.9	1.8	101.2	148.0	1.5	794.9	801.3	5.5	-3.2	-19.7	0.8
EU27*	108.2	171.6	4.2	116.0	167.0	2.9	894.3	909.8	7.2	-2.7	-30.7	1.7
nonEU	8.5	10.5	1.4	12.2	19.2	2.6	64.5	107.3	44.0	82.5	90.8	66.4

* Excluding Malta and Cyprus for CO₂ emissions (no national data on UNFCCC)

When looking at individual countries and, in particular, in non-EU ones, differences are larger than what the average values show. This is because it has been decided not to tune the mileage values to match the statistical fuel consumption, in order to preserve the transparency of the calculations. However, using the average EU15 mileage per vehicle category for some of the new Member States and non-EU countries may overestimate emissions, as the lower per capita GDP may in average lead to lower mileage driven in these countries. Therefore, it is recommended that before using the data set for actual emission calculations, the mileage values are calibrated for some of

the countries (i.e. Belgium, Bulgaria, Greece, Finland, Latvia, Romania, Turkey) in order to better match the statistical fuel consumption. This can be performed in collaboration with the national experts in each country and using information from transport models.

Non-Road Transport

With regard to aviation, Eurocontrol possesses detailed data of each flight from and to Europe, including actual distance travelled and type of aircraft. They also collect detailed information on fuel used for international and domestic flights. Based on this information and using updated ICAO emission factors, Eurocontrol have set a web-application where detailed calculation of emissions and consumption per country can be performed, using the Tier 3 methodology of the EMEP/Corinair Emission Inventory Guidebook. A specific meeting with Eurocontrol was setup and an agreement was reached to provide this information to the European Commission. Therefore, this report does not contain data on aviation transport, as detailed data will become available directly from Eurocontrol to the European Commission.

For railways, the number of trains distinguished into locomotives and railcars, powered by diesel or electricity has been collected for each country. Also, the total passenger and freight activity per country has been assessed. The data have been derived from international statistics (Eurostat, UN Statistics, Worldbank) and national submissions. This information is sufficient to calculate emissions with the Tremove railways model.

Stock and activity data on navigation have been split into maritime activities and inland shipping. For maritime, the number of vessels distinguished into vessel type and the gross tonnage registered per country have been made available, according to Eurostat data and the national submissions. Also, the total freight activity (ton-miles) in EU coastal areas has been taken from the results of the Ex-tremis project. This information is not detailed enough to produce the input to the Tremove maritime module, which requires activity distinguished into port, manoeuvring, and open sea transport. However, the Tremove maritime module input detail is available either by commercial organisations (e.g. Lloyds Register) or can be produced by specific models, but it is not available by national or international statistics.

Finally, inland shipping is only relevant for a number of central European countries and not for all 31 countries considered in this report. For these countries that inland shipping is an important emission category, data on number of barges and dumb vessels (both distinguished into capacity classes), as well as total freight activity has been collected. Again, this information is sufficient to provide input to the Tremove inland shipping emission module.

Concluding Remarks

This study has tried to reflect to the degree possible the road transport vehicle stock evolution and technology mix in 31 countries in total, using the best available information from international and national sources, as well as expert judgement in cases of complete absence of data. In addition, a coherent methodology and a software model were built to develop consistent and detailed datasets of vehicle technologies per category, fulfilling the limitations imposed by the fleet evolution, the

number of new registrations of first and second-hand cars, the deregistrations, and the implementation matrix for new technologies. Data on non-road transport have also been collected from different sources and an integrated dataset has been built.

This has proven to be a particularly time-consuming and demanding process as the degree of refinement of national information varies a lot with the country considered in each case, ranging from fully developed datasets to only gross number per vehicle category. It is therefore highly recommended that the results of this work are fed back to the national experts in each country which then can provide feedback by comparing with national estimates. This will serve a number of purposes. First, this will identify areas where either the current dataset or the national dataset require further improvements. This may occur in countries with well developed national inventory systems where detailed comparisons may identify sources of errors. Second, this may be used to correct national inventories and submissions in countries which use simplified methods to estimate road-transport emissions. In addition, this will offer means to improve the knowledge and data collection processes in each country. Third, this iterative process may raise the attention from individual member states on the efforts of the European Commission to develop consistent inventories for transport along its region. As a result, this may indeed lead to higher quality and better worked-out inventories. It is therefore highly recommended that the European Commission continues the efforts initiated by this project to better support national experts and to further coordinate and improve the available information.

All data are publicly available (after registration) at <http://lat.eng.auth.gr/copert>.

Acknowledgments

This project involved the development of a network of people in each country in order to make possible the delivery of the national information requested. These people worked without funding and on a voluntary basis to provide the data requested. The consortium would therefore like to sincerely thank Barbara SCHODL (AT), Laurent BODARWE (Brussels), Pascal THATE (Wallonia), Ina DE VLIIEGER (Flanders), Tzvetina TZENOVA (BG), Mario KELLER (CH), Chrysanthos SAVVIDES (CY), Jiri DUFEK (CZ), Gunnar GOHLISCH (DE), Wolfram KNOERR (DE), Morten WINTHER (DK), Helen HEINTALU (EE), Antonio FERREIRO (ES), Kari MÄKELÄ (FI), Jean-Marc ANDRE (FR), Vasileios PAPATHANASIOU (GR), Eimer COTTER (IE), Riccardo DE LAURETIS (IT), Intars CAKAR (LV), Aurelija CICENAITE (LT), Frank THEWES (LU), Anco HOEN (NL), Alice GAUSTAD (NO), Janina FUDALA (PL), Pedro TORRES (PT), Vlad Ioan GHIUTA TARALUNGA (RO), Janka SZEMESOVA (SK), Magnus LINDGREN (SE), Martina LOGAR and Alenka FRITZEL (SI) and Melanie HOBSON (UK) for the delivery of available national data. We would also like to thank Stefan Karapentchev for providing the link to the Bulgarian authorities and translating the invitation letter and the directions for data collection and delivery in Bulgarian.

We would also like to thank Mr. Marek Sturc and Mr. Jacques Delsalle from the European Commission – Directorate General Environment for the excellent collaboration and for dealing with all administrative details of the project.

1 Introduction

1.1 Aim of the project

In December 2006 the European Commission/DG ENV awarded the contract for the formation of the European Database on vehicle stock to the consortium led by LAT/AUTH (LAT/Aristotle University of Thessaloniki), and which includes the Energy - Economics - Environment Modelling Laboratory (E3M-Lab/NTUA), Ökopol, KTI, Renault Automobile and EnviCon (Dr. Karl-Heinz Zierock). In addition, the International Institute for Applied Systems Analysis (IIASA) offered its support to supply data and assist with data interpretation.

According to the technical Annex of the call for tenders for this project the following service had to be provided:

1. Collection of information on actual operating vehicle parks in at least all EU27 Member States, and Croatia, Turkey, Switzerland and Norway. The information should not be limited to one source only if possible, but include various sources, such as official national databases, type-approval databases and databases obtained by official inspection schemes established in each country. Each data source has to be linked to a relevant person/service source which will be used to trace back information.
2. Detail the information collected in order to provide relevant data to execute calculations through the latest versions of Tremove and COPERT. Such data need to include fleet sizes, activity data (mean speeds, road shares, etc.) and technology classification to be compatible with the previously mentioned software programmes. Non-road vehicles need to follow the EMEP/CORINAIR classification. Also, some additional issues (use of light duty vehicles for transport or goods or people, new and alternative fuel and vehicle technologies) need to be given specific attention / distinction.
3. Perform consistency checks of the data to provide, to the degree possible, a coherent and consistent dataset of reliable information for each country which could be used for annual calculations and projections. The consistency checks should include both bottom-up and top-down approaches. The former could include internal cross-checking, comparisons of indicators for different countries, comparison with road counts, etc. The latter should include comparisons with energy statistics and independent inventories for GHGs and conventional pollutants.
4. Give emphasis on collecting information related to the actual environmental performance of the vehicles and therefore, factors that may influence this. For example, this may include state of maintenance, age distribution, fuel quality, specific tampering issues that may range between different countries, that all may affect the actual emission status of vehicles operating within their territory.
5. Provide this consistent and refined information as an electronic database which should contain web-based multi-criteria search mechanisms in accordance with the software

requirements of the EC, including manual and software maintenance. The details of this will be clarified with the Commission authorities in the course of the project.

6. Based on the information collected and the consistency checks performed, derive links between vehicle age and scrappage rates and annual mileage driven. This is required to establish the contribution of older vehicles and maybe, in the future evaluate the need for accelerated replacement plans.
7. Establish the physical and technical network required to maintain and update the database in the future. The technical requirements relate to the transparency and accessibility of information, which will enable straightforward comparisons with future data estimates. The physical network relates to the establishment of links with persons or services or authorities which will be contacted for the future maintenance and update of the data.

1.2 Background on the available tools

Tremove is a policy assessment model, designed to study the effects of different transport and environment policies on the emissions of the transport sector. It covers economic and technical aspects and it is therefore usable for a complex set of scenario options, e.g. road pricing, public transport pricing, emission standards, subsidies for cleaner cars, modal shifts, vehicle stock renewal and scrappage decisions.

The latest version available when drafting this report, Tremove 2.52 (as of July 2007), covers the transport modes road transport, rail, air and shipping. It contains, inter alia, information on the mileage travelled by vehicles in the different transport modes, the stock of transport means and its specific emissions and the costs of transport and technologies. Taking into account the influence of measures on transport possibilities, costs (including congestion costs) and standards, Tremove calculates the demand for passenger and freight transport for each mode. For this purpose Tremove links via estimated elasticities the costs associated with different modes of transport and models the repercussions of changes to the predefined baseline by assuming that the actors faced with a new situation would adapt by minimising their costs. In so far Tremove is an optimisation model which aims at identifying the least cost solution for a given transport situation. Tremove 2 has been developed by the K.U.Leuven and it incorporates components of various models, previously developed and used at European scale, e.g. it includes parts of the TRENEN model, EUCARS and FOREMOVE (all models developed for the European Commission) and a version of the COPERT methodology developed for the European Environment Agency (EEA)

COPERT 4 (current version 5.1 as of November 2007) is a software programme aiming at the calculation of air pollutant emissions from road transport. The development of COPERT has been financed by the European Environment Agency (EEA), in the framework of the activities of the European Topic Centre on Air and Climate Change. In principle, COPERT has been developed for use by the National Experts to estimate emissions from road transport to be

included in official annual national inventories. COPERT estimates emissions of all regulated air pollutants (CO, NO_x, VOC, PM) produced by different vehicle categories (passenger cars, light duty vehicles, heavy duty vehicles, mopeds and motorcycles) as well as CO₂ emissions on the basis of fuel consumption. Furthermore, emissions are calculated for an extended list of non regulated pollutants, including CH₄, N₂O, NH₃, SO₂, heavy metals, PAHs and POPs. Finally, the software provides NMVOC emissions allocated to several individual species, distinction of NO_x to NO and NO₂, and PM distinction to elemental carbon and organic material. In order to calculate emissions, the software includes emission factors for a number (more than 200) different vehicle categories/technologies which need to be combined with appropriate activity data (number of vehicles, mileage, circulation data) to calculate total emissions.

1.3 Structure of this report

Chapter 2 contains the data requirements of the two models in terms of temporal, spatial resolution and detailing. These provide the boundary conditions for the emission estimation.

Chapter 3 includes in summary of the data that were made available to the programme per country and per input source.

Chapter 4 describes the methodological steps followed to provide data according to the requirements of the Tremove and COPERT models, including data screening, reconciliation process and gap filling.

Chapter 5 includes the results of the project, where modelled and statistical information is compared for different levels of emission information.

2 Data Requirements

2.1 Temporal/Spatial Resolution

Annual data are considered for the calculations. Hence, the minimum temporal resolution of the data collection and the analysis is one year. The calculations should cover a range of years, from 1970 to 2030. Long historical time series are required in order to calibrate the tools to be developed with historical data and, therefore, provide more reliable projections into the future. It was expected from the beginning of the project that not all data, in the detail necessary for the final calculations, would be available since 1970. For example, it would be rather far-fetched to expect that all countries would have detailed recordings of passenger car emission levels since the PRE-ECE years. Therefore, it was agreed that only aggregate emission figures should be collected for early years, i.e. total number of main vehicle categories (passenger cars, heavy duty vehicles, etc.) and fuel consumption. Therefore, the models would need to be calibrated on the basis of fewer but rather more reliable figures. The exact methodology how this has been achieved follows in chapter 4.

It was also considered that for a few recent years rather more reliable figures would be made available. Therefore, it was decided that either Year 2000 or Year 2005 should be taken as the reference years, depending on the data availability. The 'reference' year is not so important to calculate the fleet evolution but is very important when using these fleets within Tremove to calculate emissions, because different 'reference' years include a different technology mix. Therefore, using year 2005 as a reference would be advantageous because this concerns a more recent vehicle technology mix. Given the availability of data from all countries, solid statistical information was collected for Year 2005, which can be now considered as the reference year,

Finally, data need to be collected for all EU27 countries and in addition, Croatia, Norway, Switzerland and Turkey. Different level of data availability wer expected for the range of countries included in the analysis. One could distinguish the countries in three different classes, regarding the data availability/quality. These three classes are:

Class I: Countries with very few data

Class II: Countries with good statistics which are, however, still not compiled

Class III: Countries with good data more or less ready for use

2.2 Model Requirements

2.2.1 Road transport

Both COPERT and Tremove include a detailed list of vehicle categories /technologies which have been defined by the legislation in Europe. The tables with the detailed category and technology classification, together with the implementation years of each technology are given

in Annex I. In total, COPERT 4 includes 223 individual vehicle descriptions that need to be annually calculated for the 35 years of time series included in this work.

Traditionally, Tremove has been defining vehicle categories/technologies following COPERT classification. Therefore most of the categories/technologies are equivalent between the two models. In 2006 COPERT 4 extended the heavy duty vehicle categorisation, as a result of the DG TREN (5FP) *ARTEMIS* project, which called for a more detailed categorisation as a need to better calculate emissions from such vehicles. This was not followed by Tremove, which still includes an earlier vehicle classification drawn from COPERT 3. The equivalence between the Tremove 2.52 and COPERT 4 heavy duty classification is shown in Figure 2-1.

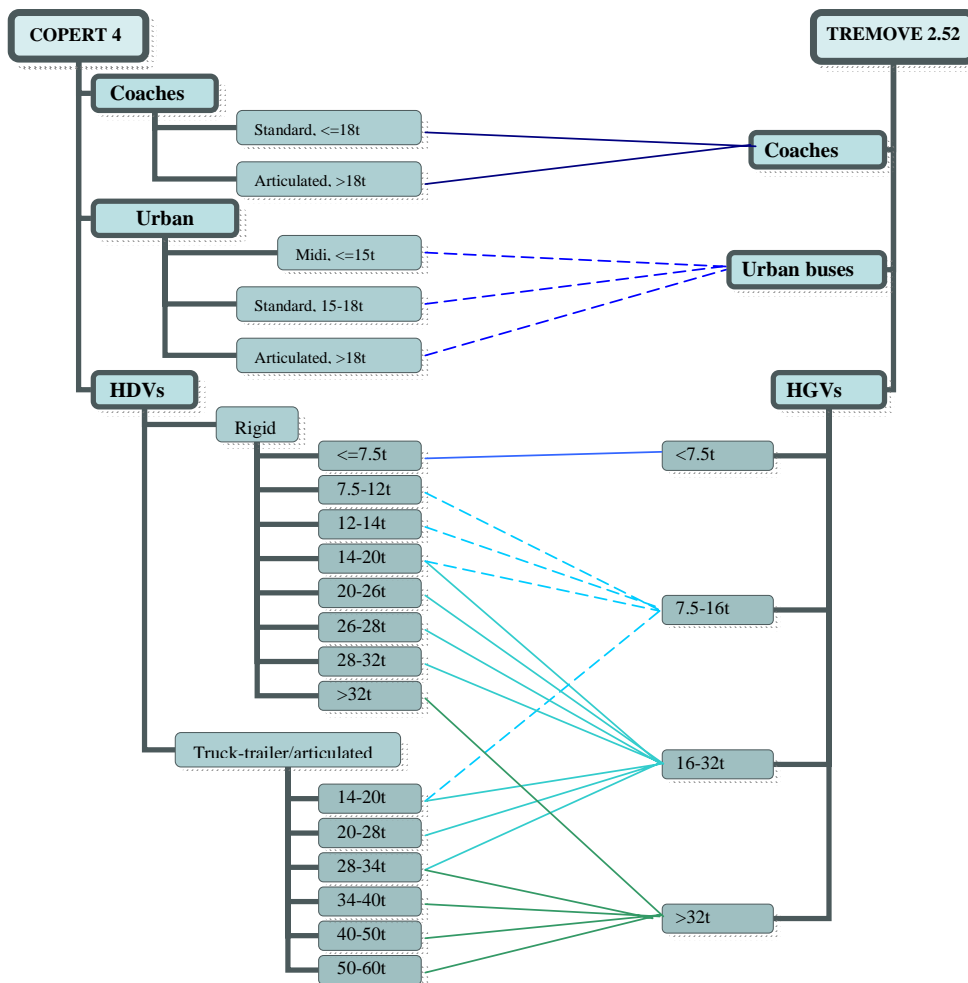


Figure 2-1: Equivalence between Tremive 2.52 and COPERT 4 heavy duty vehicle classification

A second difference between the two models, of less importance though, is the difference in the description of CNG vehicles. Tremove includes CNG passenger cars of Euro 3, 4 and 5 emission levels. It also includes CNG urban buses of Euro III technology. On the other hand, COPERT 4 does not include CNG passenger cars but it includes CNG buses of different emission levels. Finally, Tremove does not include hybrid passenger cars and includes a medium capacity category (1.4-2.0 l) for diesel passenger cars (differing only to CO₂ emissions than the other diesel classes).

In order to be able to cover the requirements of both models, the most detailed classification (this of COPERT) needs to be adopted. Any results can then be transferred to the Tremive classification by the equivalence shown in Figure 2-1. With regard to CNG passenger cars, they are only important for some markets (e.g. Italy has some 200-300 thousand CNG cars, Germany has some 55 thousand) and they are mostly retrofitted gasoline cars. In absolute terms, they constitute a small share of the total car market in Europe. For the markets where they are gaining momentum, national data will be used to describe their fleets.

In addition to size of the vehicle stock, which by itself is a very important figure, activity data need to be collected in order to allow the calculation of total emissions. The main activity data to be collected include the total mileage driven per year and per vehicle category, the share of mileage driven in urban, rural and highway road networks and the mean travelling speeds in these conditions.

2.2.2 Non-road transport modes

A less detailed category classification is required by Tremove for the non-road transport modes.

For aviation the required classification is into air distance travelled rather than aircraft type. Five air distance classes are specified: (i) up to 500 km, (ii) 500-1000 km, (iii) 1000-1500 km, (iv) 1500-2000 km and (v) more than 2000 km. The activity data required include total passenger-km over the entire flight, as well as during LTO (Landing and Take-Off) and cruise.

For inland shipping, three main vessel categories are identified, further distinguished into tonnage classes. The vessel population is not necessary; however activity data on vessel-km and ton-km are needed for the emissions calculations.

Twenty-four vessel types are included in maritime shipping. The activity data needed include vessel-km, which are distinguished into three types of activity: (i) sea cruising, (ii) port and (iii) manoeuvring. The vessel population is also required.

The activity data to be collected for railways transport include train-km, ton-km, passenger-km, average age and sulphur content of fuel. There are four main train categories, which are further distinguished into diesel and electric trains.

The tables with the detailed category classification for each of the above non-road modes are given in Annex I – Data Definitions and Structure Required.

2.3 Data detailing/quality requirements

Not all data require the same amount of detail in their description, because their end effect on total emission estimates varies.

Obviously, the total number of vehicles is of particular importance as emissions are directly proportional to the number of vehicles in circulation. The total vehicle number is a figure which is rather well known to public authorities, since they keep a register for each vehicle circulating in the country. These figures are also reported to EUROSTAT per vehicle category. One issue related to the size of the fleet is the extent to which some vehicles are registered but are not used during the year. These, despite they are included in the total fleet, are negligibly contributing to total emissions. The exact number of these vehicles is not an easy figure to estimate because it depends on the driving habits of particular drivers, the existence or not of scrappage incentives, taxation as a function of vehicle age, etc. Most of the times, targeted surveys are required. Such statistics are available for some countries (e.g. Cyprus, Germany, UK) while this is more difficult to estimate for others (e.g. France).

The second important element in the analysis is the classification of vehicles to different technology levels. Emission levels of vehicles regulated by different emission standards may differ by several percentage units and this has direct implications to the total emission calculations. For a given year considered, the exact technology classification is basically inherited from the previous year. New vehicle registrations will comply with the emission standard applicable to the particular year and this will modify the percentage contribution of each technology class. There are two issues that need to be considered in this analysis. The first is the new registrations of (imported) used vehicles which may be of various emission standards. This is mostly an issue for less developed countries, due to the lower cost of imported vehicles. The second is the extent and the technology level of vehicles scrapped each year, which again will have an effect on the technology structure. The exact technology classification requires the development of lifetime functions, which are discussed in chapter 4 of this report.

The vehicle distinction to fuel use is also a very important element in estimating total emissions. This is a rather well-known figure as vehicle registration includes the type of fuel used. Therefore, the same criteria as with total vehicle number also apply in this case. On the other hand, the distinction of passenger cars to capacity classes and the distinction of heavy duty vehicles to weight classes are important mainly for the correct estimation of CO₂ emissions, which directly increase with size. With regard to conventional pollutants, the engine capacity distinction for passenger cars is not of particular importance as there is no straightforward function of emission rate with engine size. For heavy-duty vehicles the distinction to weight classes is more important since, in this vehicle category, engines rather than vehicles are type-approved. Since larger vehicles require more energy and since engines are type-approved on a per unit energy basis, the emission level is a direct function of vehicle size. Therefore, a detailed distinction of heavy duty vehicles to different classes is required to obtain a better estimate of their emissions.

Of equal importance to total fleet and vehicle allocation to different technologies is the annual mileage driven by each vehicle. Again, total emissions are directly proportional to the total distance travelled in one year. There are not always detailed statistics available to estimate the annual mileage driven. However, large errors in the estimation can be avoided because

mileage is usually the tuning parameter to match the statistical with the calculated fuel consumption. One important element of the equation is the mileage vs. age function. It is generally known that the mileage driven each year drops as the vehicle age increases. This has an impact on the relevant contribution of old vs. more recent vehicle technologies. Such figures can be obtained from inspection and maintenance records available to each country.

The mean driving speed and the mileage allocation to different road networks are rather of secondary importance in the calculation of total emissions. This is not to say that emissions do not significantly depend on speed. Rather, the speed range variation expected, in particular, for rural and highway driving is not expected to lead to significant variation of the emission levels at such driving conditions. For urban driving, speed may have a more significant influence due to the higher dynamics involved in urban driving which affect the emission performance. Therefore, the urban driving speed needs to be estimated more accurately than urban or highway speeds.

Table 2-1 provides a summary of this discussion. The quality indicator in the availability of statistics refers to the 'average' country. It is obvious that the actual availability will differ from country to country.

Table 2-1: Importance and availability of statistics of different parameters

Parameter	Importance	Availability of statistics	Notes /Particular Issues
Total number of vehicles per class	↑	☞	Question is the scooter and mopeds registration availability
Distinction of vehicle to fuel used	↑	☞	Question is the availability of records for vehicles retrofitted for alternative fuel use
Distribution of cars/motorcycles to engine classes	→	☞	Not important for conventional pollutants, more important for CO2 emission estimates
Distribution of heavy duty vehicles to weight classes	↑	☞	Vehicle size important both for conventional pollutant and CO2 emissions
Distinction of vehicles to technology level	↑	☞	Imported, second-hand cars and scrappage rates are an issue
Annual mileage driven	↑	☞	Can be estimated from total fuel consumption. The effect of mileage with age requires attention.
Urban driving speed	→	☞	Affects the emission factors
Rural, highway driving speeds	↓	☞	Little affect the emission factors, within their expected range of variation
Mileage share in different driving modes	↓	☞	Little affect emissions, within their expected range of variation

3 Data Collection

3.1 Data collection process

In order to facilitate data collection, an invitation letter “to whom it may concern” was sent on behalf of the European Commission to the national experts, requesting the submission of official data. The European Commission letter and the template of the letter sent to national experts in each country is given as Annex II – Country Invitations. Also, a list of the national experts invited is given in the same annex. All letters were sent in the end of May, 2007 with a deadline for data submission on June 29, 2007. In reality, it proved a much more time consuming task to collect information from all countries. The last dataset was actually collected in February 2008.

Together with the invitation letter, two Excel files were disseminated to the experts to assist them with the data specification/collection process. The files included the data categorisation for road transport and non-road modes. An excerpt from the two files is also given in Annex II for reference.

In addition, different data sources from national or international organizations were a priori available to the consortium partners. These different sources and the data availability are also presented in the following sections.

3.2 Data made available to the consortium

3.3 International Organizations

3.3.1 Eurostat data

Eurostat is a source of complete data series but on an aggregated level. In principle, Eurostat (http://epp.eurostat.ec.europa.eu/portal/page?_pageid=0,1136228,0_45572945&_dad=portal&_schema=PORTAL) only includes total vehicle numbers and new registrations, distinguished per vehicle category (passenger cars, heavy duty vehicles, etc.) but contains no technological distinction. It also contains fuel consumption in road transport, distinguished per fuel type. This general picture may vary, depending on the country considered. Table 3-1 provides a summary of this information.

3.3.2 ACEA Statistics

The European Automobile Manufacturers' Association (ACEA) is also a source of information as it contains updated information of total number, registration and deregistration per vehicle category, and fuel type.

Table 3-1: Summary of statistical information provided by EUROSTAT

	AUT	BEL	DK	FIN	FR	GER	GRE	IRL
Population*	x (1989-2004)	x (1970-2004)	x (1970-2002)	x (1989-2004)	x (1970-2003)	x (1970-2003)	x (1970-2003)	x (1970-2004)
New registrations**	x (1989-2004)	x (1970-2004)	x (1970-2002)	x (1989-2004)	x (1970-2003)	x (1970-2003)	x (1970-2003)	x (1970-2004)
Fuel consumption (total)	x (1985-2004)	x (1985-2004)	x (1985-2004)	x (1985-2004)	x (1985-2004)	x (1985-2004)	x (1985-2004)	x (1985-2004)
	IT	L	NL	POR	ESP	SWE	UK	BUL
Population*	x (1970-2002)	x (1970-2001)	x (1970-2004)	x (1970-2002)	x (1970-2004)	x (1989-2004)	x (1970-2004)	
New registrations**	x (1970-2002)	x (1970-2001)	x (1970-2004)	x (1970-2002)	x (1970-2002)	x (1989-2004)	x (1970-2004)	
Fuel consumption (total)	x (1985-2004)	x (1985-2004)	x (1985-2004)	x (1985-2004)	x (1985-2004)	x (1985-2004)	x (1985-2004)	x (1990-2004)
	TCH	EST	HUN	LET	LIT	POL	ROM	SLV
Population*	x (1990-2003)	x (1990-2004)	x (1970-2004)	x (1970-2004)	x (1970-2004)	x (1970-2004)		x (1990-2004)
New registrations**	x (2003)	x (1992-2004)	x (1990-2004)	x (1995-2004)	x (1995-2004)	x (1990-2004)		x (1993-2004)
Fuel consumption (total)	x (1990-2004)	x (1990-2004)	x (1990-2004)	x (1990-2004)	x (1990-2004)	x (1990-2004)	x (1990-2004)	x (1990-2004)
	SLO	CYP	MAL	NOR	CRO	TUR		
Population*	x (1970-2004)	x (1990-2004)	x (1990-2002)	x (1988-2000)				
New registrations**	x (1992-2004)	x (1990-2004)	x (1990-2002)	x (1988-2000)				
Fuel consumption (total)	x (1990-2004)	x (1990-2004)	x (1990-2004)	x (1990-2004)	x (1990-2004)	x (1990-2004)		

* Per vehicle type. Few data by fuel.

** Passenger cars and motorcycles. Few data on lorries and buses.

Table 3-2a: Summary of statistical information provided by ACEA (Part A)

	AUT	BEL	DK	FIN	FR	GER	GRE	IRL	IT
Available data									
Population	x (2000-2006)	x (2000-2006)	x (2000-2006)	x (2000-2006)	x (2000-2006)	x (2000-2006)	x (2000-2006)	x (2000-2006)	x (2000-2006)
New registrations (by vehicle type)	x (2001-2006)	x (2001-2006)	x (2001-2006)	x (2001-2006)	x (2001-2006)	x (2001-2006)	x (2001-2006)	x (2001-2006)	x (2001-2006)
Deregistrations (only total vehicles)	x (1995-2005)	x (1991-2005)	x (2001-2005)	x (1992-2005)		x (1991-2005)	x (1991-2003)	x (1991-2002)	x (1991-2005)
Vehicles by age	x (2005)	x (2005)	x (2005)	x (2005)	x (2005)	x (2005)	x (2005)		x (2005)
Level of aggregation									
Total	x	x	x	x	x	x	x	x	x
Vehicle type	x	x	x	x	x	x	x	x	x
Fuel (only passenger cars)	x (1993-2005)	x (1991-2005)	x (2001-2005)	x (1993-2005)	x (1991-2005)	x (1993-2005)	x (1994-2005)	x (1992-2005)	x (1991-2005)

Table 3-2b: Summary of statistical information provided by ACEA (Part B)

	L	NL	POR	ESP	SWE	UK	BUL	TCH	EST
Available data									
Population		x (2000-2006)	x (2000-2006)	x (2000-2006)	x (2000-2006)	x (2000-2006)		x (2000-2006)	
New registrations (by vehicle type)	x (2001-2006)	x (2001-2006)	x (2001-2006)	x (2001-2006)	x (2001-2006)	x (2001-2006)	x (2006)	x (2003-2006)	x (2003-2006)
Deregistrations (only total vehicles)		x (1996-2005)		x (1991-2005)	x (1991-2005)				
Vehicles by age	x (2005)	x (2005)	x (2005)	x (2005)	x (2005)	x (2005)			
Level of aggregation									
Total	x	x	x	x	x	x	x	x	x
Vehicle type	x	x	x	x	x	x	x	x	x
Fuel (only passenger cars)		x (1991-2005)	x (2003)	x (1991-2005)	x (1991-2005)	x (1991-2005)		x (2005)	

Table 3-2c: Summary of statistical information provided by ACEA (Part C)

	HUN	LET	LIT	POL	ROM	SLV	SLO	CH	NOR
Available data									
Population		x (2000-2006)		x (2000-2006)					
New registrations (by vehicle type)	x (2003-2006)	x (2003-2006)	x (2003-2006)	x (2003-2006)	x (2006)	x (2003-2006)	x (2003-2006)	x (2001-2006)	x (2001-2006)
Deregistrations (only total vehicles)		x (2002-2005)							
Vehicles by age									
Level of aggregation									
Total	x	x	x	x	x	x	x	x	x
Vehicle type	x	x	x	x	x	x	x	x	x
Fuel (only passenger cars)									

3.3.3 AAA/CBD Databases

In addition to the above, the AAA database provides data on new registrations of passenger cars for 2000 and 2005. Data for 2000 are aggregated per vehicle manufacturer and not by country. 2005 data are available for each EU15 and include information on fuel type and engine size.

Further information on newly registered passenger cars per fuel type and engine size for the years 2000-2004 were extracted from the central CO₂ monitoring Database of the European Commission for each EU15 member state.

3.3.4 International Union of Public Transport

The public transport statistics report including figures on the urban bus fleet in the EU has been made available to the consortium. Data include information on urban buses circulating in cities of over 100,000 inhabitants around Europe, using a sample of vehicles from 25 member states (EU27 except Cyprus that has no urban bus fleet and Slovakia). Year 2005 is considered as the reference. The report does not contain total fleet values but only technology and configuration characteristics of the different busses. The information available includes distinction to fuel and drive-train technologies, Euro standards, accessibility features, age of fleet and some miscellaneous information. These data can be used to cross-check information generated within the project, rather as input information.

3.3.5 Eurocontrol

Eurocontrol was approached by the coordinator of the project with the request to deliver the detailed data they have on flight activities in all European countries. A specific meeting was set at Eurocontrol offices in Brussels. Indeed, Eurocontrol possesses detailed data of each flight from and to Europe, including actual distance travelled and type of aircraft. They also collect detailed information on fuel used for international and domestic flights. Based on this information and using updated ICAO emission factors, Eurocontrol have set a web-application where detailed calculation of emissions and consumption per country can be performed, using the Tier 3 methodology of the EMEP/Corinair Emission Inventory Guidebook. Figure 3-1 shows an example of the interface of the Eurocontrol Pagoda application for the case of Greece and years 2005-2007.

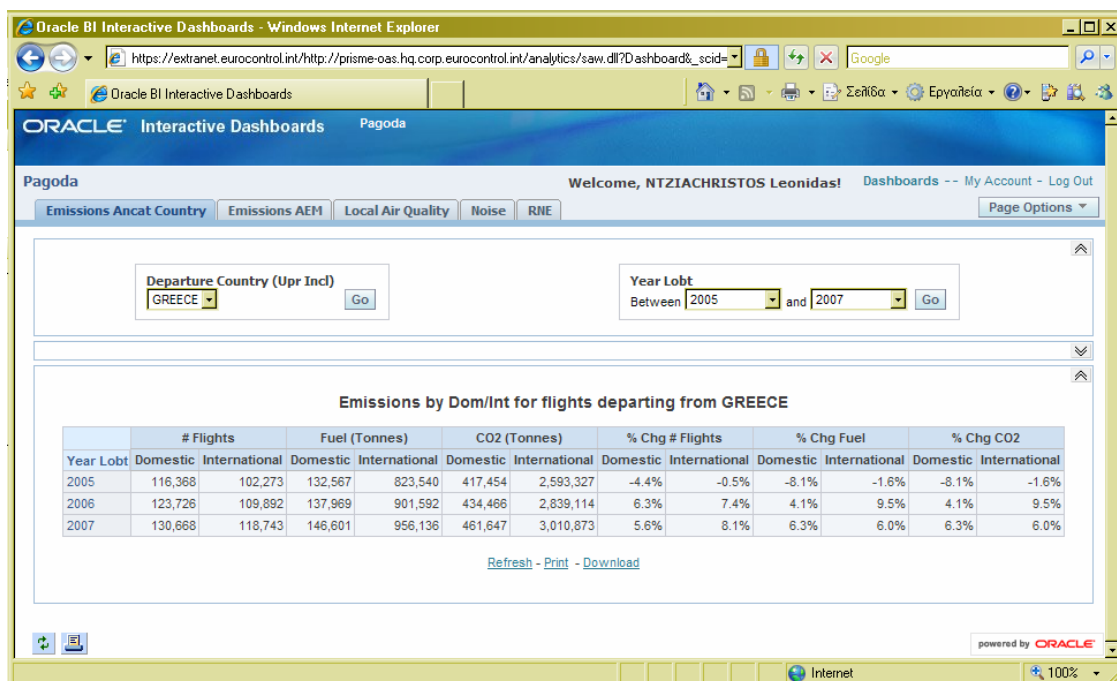


Figure 3-1: Example of the Eurocontrol Pagoda interface

Although Eurocontrol have not provided actual data to our project, they have confirmed their willingness to allow access to the Pagoda application website, which can then be used to extract all relevant information on any level of detail. In principle, the only information which is considered confidential is the aircraft type used for particular individual flights, as this is considered as an element of competition. Eurocontrol has requested a specific meeting with the European Commission and other stakeholders (e.g. EEA, TFEI, etc.) in order to clarify access rights and detail of the data delivery.

3.3.6 Other international sources

In addition to the previous data providers, data on both road and non-road modes and for EU15, new member states and non EU countries were collected from the UNECE Transport Statistics (<http://www.unece.org/trans/main/wp6/wp6.html>), from the UNCTAD (<http://www.unctad.org/>) and from the World Bank web-site (<http://www.worldbank.org>). All these sources have been used to fill gaps and cross-check information.

3.4 Independent Sources

3.4.1 Conference organized by KTI

In 2002, KTI (a partner to our consortium) organized a conference aiming at collecting information of road-transport fleets from new (at that time in the process of accession) member states. The information collected at that conference is summarized in Table 3-3.

Table 3-3: Summary of statistical information collected at the KTI conference

	TCH	EST	HUN	LIT	LET	MAL	POL	SLV
Years	1993-2005	1990-2006	2000-2005	1995-2005	1997-2006	1998-2006	1999-2004	1990-2005
Available data								
Population	x	x	x	x	x	x	x	x
New registrations			x (1990-2005)	x (2000-2005)				
Mileage (only few data)	x (1996-1998)		x (2002)	x (2004)	x (2004)	x (2000)	x (2002)	
Other activity data			shares					
Level of aggregation								
Total	x	x	x	x	x	x	x	x
Vehicle type	x	x	x	x	x	x	x	x
Fuel			x		x	x		
Technology			x					

3.4.2 IIASA/Met.No/ENTEC Report on maritime emissions

In 2006, a consortium of IIASA, Met.No and ENTEC compiled a report on ship emissions, in the framework of the revision of the National Emissions Ceilings Directive. In the report, vessel movement data for the year 2000 are available for EU27, Croatia and Turkey. The data are further distinguished into passenger and cargo ships, national and international ships (by flag). The primary information is not available in the report but the consortium expects that this will be made available through IIASA.

3.4.3 ARTEMIS information

The EU 5FP Artemis includes information related to activity statistics from different countries. These include travelling speeds, driving share in different road networks, average trip distance, etc. This will be summarized together with information from the national sources.

3.4.4 National data

A wealth of data became available to the consortium by contacting the national experts in all countries. All countries reported their available data except of Bulgaria, Croatia and Malta. The range of information submitted ranged from complete data series over a number of years, including the full technological split of vehicles (e.g. Denmark, France, Spain, Switzerland, Norway and others) to some aggregated data for only a number of years (e.g. Greece, Romania and others). Also, the quality of data ranged from fully consistent information related to stock development, registrations and deregistrations to inconsistent data related to the fleet size and the fleet replacement.

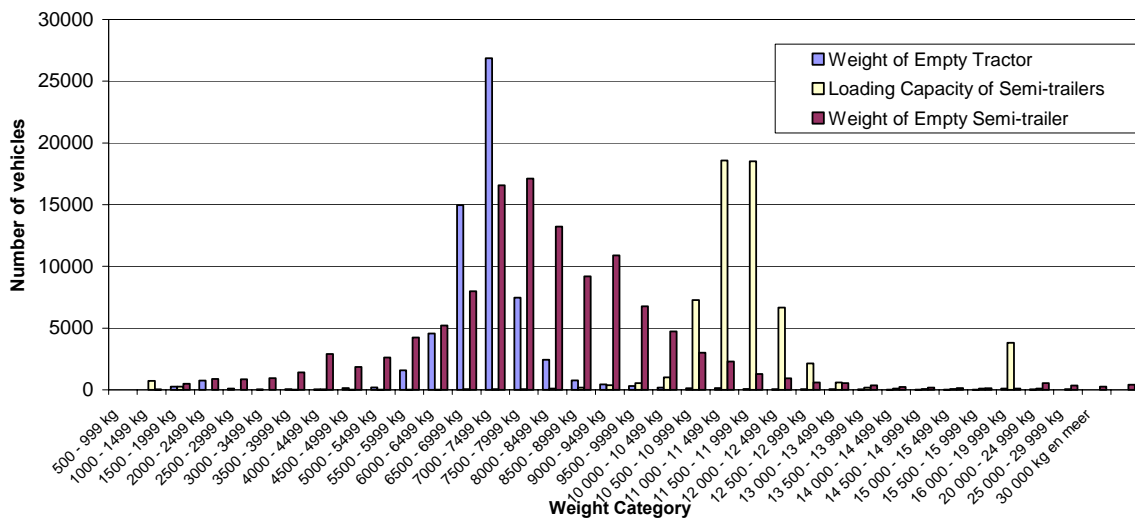


Figure 3-2: Articulated vehicle components weight in the Netherlands (data from CBS corresponding to 2001).

One issue that needs to be clarified is that national information was not always in the structure requested by the consortium. One typical example is the Netherlands, where no information on the classification of HDVs to different GVWs was available. This was confirmed by both the responsible inventorying agency in the Netherlands (Anco Hoen – MNP) and the statistics authority in the Netherlands (Hermine Molnar-in 't Veld – CBS). Instead, only the number of lorries (rigid trucks), tractors (articulated truck power movers), and the loading capacity and the weight of semi-trailers was available. In this case, the weight allocation of trucks had to be devised based on the available data. The classification of articulated vehicles components according to their weight is shown in Figure 3-2, with data corresponding to 2001. The figure shows that 86% of the tractors have an empty weight between 6-8 t. Similarly, the weight of 75% of the empty semi-trailers is between 6-9 t. Hence, it was considered that the combined weight of the empty semi-trailer and the tractor was 16 t. This weight was then added to the loading capacity to deduce the articulated vehicles classification

based on their GVW in the Netherlands. Similar examples of reallocations and processing of the available information has also been made in different countries.

3.4.5 Data Summary

A summary of the national data submitted in this way are presented in Table 3-4 (split to part-A and part-B due to space limitations). These tables are a composite of all the information that we managed to collect from all available sources (national, international and specific), after consultation within the study team and with the national experts. This is both primary information and information that the study team had to streamline before including it in the database. The table, although tries to present an overall summary fails to present all details for all countries considered. For example, data for some particular vehicle categories may be missing or being beyond the range of years shown in the tables. In addition, some data were received at the last minute and may not be fully reflected. Therefore, exact details of the datasets can be found in the electronic databases.

As a summary, the data that were made available to the consortium range from a few years and sparse information to complete data series including full technological distinction from a number of years. In general, total fleets distinguished per vehicle category were available in most countries and new registrations for passenger cars were also available. Technology splits and the distinction of heavy duty vehicles in the different categories. The information collected for non-road modes is more scarce. This is summarized in Table 3-5a & b.

3.4.6 Web-page for information storage

A data storage portal (eroom) was kindly offered by Renault to store all information that was collected and generated during the project. The web-page is accessible at https://collaboration.renault.com/eRoom/FAC_KORP1_23/TREMOVE (password protected).

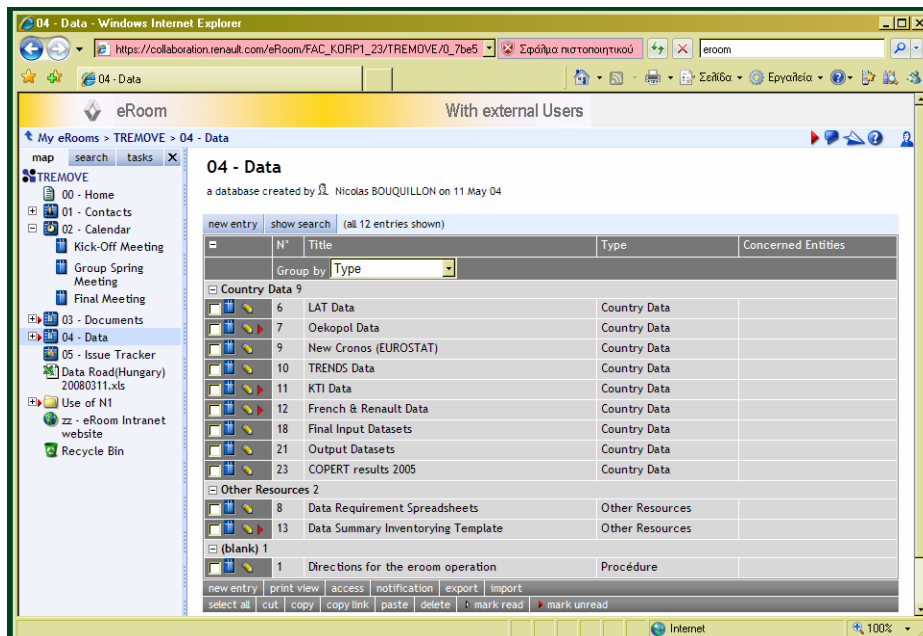


Figure 3-3: Example of the eroom interface, used for data collection and communication between the consortium partners and the Commission

Table 3-4a: Summary of national data submitted for road-transport (part A)

	AT	BE	BG	CH	CY	CZ	DE	DK	EE	ES	FI	FR	GR	HR	HU	IE	
Population	x (1990-2005)	x (1991-2005)	x (1989-2005)	x (1990-2006)	x (1995-2006)	x (1990, 1993-2006)	x (1995-2005)	x (1985-2005)	x (1999-2005)	x (1990-2005)	x (1989-2005)	x (1990-2006)	x (1990-2005)	x (1998-2005)	x (2000-2005)	x (1990-2005)	
<i>Vehicle category</i>	x	x (1991-2005)	x (2005)	x	x	x	x	x	x	x	x	x	x	x	x	x	
<i>Fuel</i>	x	x (1996-2005)	x (2005)	x	x (2000-2006)	x	x	x	x	x	x (1990, 1999-2005)	x	x	x (2000, 2005)	x	x	
<i>Size</i>	x	x (1996-2005)	x (2005)	x	x (2000)	x	x	x	x	x	x (1990, 1999-2005)	x	x	x (2005)	x	x	
<i>Technology</i>	x	x (1996-2005)	x (2005)	x	x (2000)	x (2002-2005)	x	x	x	x	x (1990, 2001, 2005)	x	x (1995, 2000)	x (2005)	x	x	
New registrations	x (1999-2004)	x (2001-2006)		x (1990-2006)	x (1987-2006)	x (2003-2006)	x (1991-2006)	x (1979-2006) PC & PTW (2001-2006)	x (various years)	x (1985-2006)	x (1996-2004)	x (1975, 1979-2006)	x (1985-2006)	x (1998, 2005)	x (2000-2005)	x (1990-2006)	
<i>Vehicle category</i>	x (only PCs)			x	x	x		x	x	x (2001-2006)	x		x	x	x	x	
<i>Fuel</i>	x (only PCs)	x (2001-2006)		x	x (1990-2006)		x (2002-2006)	x (2001-2006)	x	x (1993-2002)	x	x	x (1993-2006)	x (1999, 2000)	x	x (1990-2004, only PCs)	
<i>Size</i>	x (only PCs)								x				x (1995-2006)		x		
<i>Technology</i>																x	
Mileage	x (1990-2005)	x (2000-2005)		x (1990-2006)	x (2005, only HDV)	x (2002-2005)	x (1995-2005)	x (1985-2005)	x (1999-2005)	x (1990-2005)	x (1990, 2000, 2005)	x (1995, 2000, 2005)	x (2005)				x (1990-2005)
Fuel data	x (1985-2006)	x (1985-2004)		x (1970-2006)	x (1980-2006)	x (1993-2006)	x (1985-2005)	x (1985-2005)	x (1990-2005)	x (1985-2005)	x (1985-2004)	x (1985-2005)	x (1985-2004)	x (1991-2004)	x (1990-2004)		x (1985-2005)
Other activity data	shares, speeds			speeds, shares, load	occupancy rates (1985-2005)	speeds, shares, load		speeds, shares	shares, speeds, loads	shares, speeds, loads	shares, speeds, load	shares, speeds, loads	shares, speeds				shares, speeds, loads

Table 3-4b: Summary of national data submitted for road-transport (part B)

	IT	LT	LU	LV	MT	NL	NO	PL	PT	RO	SE	SI	SK	TR	UK
Population	x (1995-2005)	x (1990-2006)	x (1990-2005)	x (1990-2006)	x (1990-2006)	x (1991-2006)	x (1980, 1986-2005)	x (1990-2004)	x (1990-2005)	x (1990-2006)	x (1980-2006)	x (1989-2005)	x (1990-2005)	x (1995-2006)	x (1995-2005)
<i>Vehicle category</i>	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
<i>Fuel</i>	x		x	x	x (1999, 2000, 2002)	x	x	x (1995-2004)	x	x (2005-2006)	x	x	x (1990, 2002-2005)	x (2000, 2005, only LDVs)	x
<i>Size</i>	x (1995, 2000-2005)	x	x	x	x (1999, 2000, 2002)	x	x	x (2000-2001)	x	x (2005-2006)	x	x (1997-2000, 2005)	x (1990, 2002-2005)	x (2004, only gasoline PCs)	x
<i>Technology</i>	x (1995, 2000-2005)	x (age distributions)	x	x	Adopted from Cyprus	x (2001-2006)	x	x (2000-2001)	x	x (2005-2006)	x	x (2000, 2005)	x (1990, 2002-2005)	x (2004, only gasoline PCs)	x (2000, 2005)
New registrations	x (2001-2006)		x (1998-2006)	x (1995-2004)		x (1975-2006)	x (1988-2006)	x (1990-2004)	x (2001-2006)	x (1997-2006)	x (1989-2004)	x (1993-2006)	x (1996-2004)	x (1994-2006)	x (1990-2006)
<i>Vehicle category</i>	x		x	x		x	x (2001-2006)	x	x	x (only PCs)	x	x	x	x	x (2001-2006)
<i>Fuel</i>			x (2002-2006)	x		x (2002-2006)		x (1995-2004)			x	x (1993-2002, only PCs)	x		x (1992-2004, only PCs)
<i>Size</i>												x (1997-2002, only PCs)			x (1996-2004, only PCs)
<i>Technology</i>															
Mileage	x (1995, 2000-2005)	x (2005-2006)		x (1990-2006)		x (2005)	x (1980, 1986-2005)	x (2000-2001)			x (1980-2006)		x (1990, 2002-2005)		x (2000, 2005)
Fuel data	x (1985-2004)	x (1990-2006)	x (1985-2004)	x (1990-2006)	x (1990-2005)	x (1985-2004)	x (1986-2005)	x (1990-2005)	x (1985-2005)	x (1990-2006)	x (1980-2006)	x (1990-2004)	x (1990-2006)	x (1990-2004)	x (1985-2005)
Other activity data	shares, speeds, loads	shares, speeds, loads		shares, speeds			shares, speeds, loads	speeds, shares			speeds	speeds	shares, speeds		shares, speeds, loads

Table 3-5a: Summary of national data submitted for non-road transport modes (part A)

	AT	BE	BG	CH	CY	CZ	DE	DK	EE	ES	FI	FR	GR	HR	HU	IE
Air	x (1990-2005)		x (1990-2006)	x (2000-2005)	x (1980-2005)	x (1993-2006)	x (1980-2005)		x (2001-2005)							x (1990-2005)
<i>Type of data</i>	Pass-km		Pass-km	Fuel cons, number of passengers	Number of passengers, LTOs	Number of passengers, LTOs, Pass-km	Number of passengers		Number of passengers, Pass km							Energy cons, number of LTOs
<i>Level of aggregation</i>	Total		Total	Total	Total	Total	Total (only international)		Total							Domestic / International
Rail	x (1990-2005)		x (1996-2004)			x (1993-2006)	x (1985-2005)		x (1992-2006)		x (1995, 2000, 2005)					x (1996-2005)
<i>Type of data</i>	Train-km, Ton-km, load factors		Train-km			Population, Train km, Ton-km, Pass-km	Ton-km, Pass-km		Population, Train- km, Ton-km, Pass-km		Population, Train- km, Ton-km, Pass-km					Energy consumption
<i>Level of aggregation</i>	Total		Passenger/ Freight, train type, fuel			Passenger/ Freight, train type, fuel	Passenger/ Freight, train type, fuel		Passenger/ Freight, train type, fuel		Passenger/ Freight					Total
Inland shipping	x (1990-2005)		x (1990-2006)			x (1997-2006)	x (1960-2006)									x (1990-2005)
<i>Type of data</i>	Ton-km, load factors, fuel consumption		Vessel-km, Ton-km, population			Ton-km, Pass-km	Population									Energy cons, sulphur content
<i>Level of aggregation</i>	Total		Vessel type			Vessel type (for Ton-km only)	Passenger/ Freight, vessel type									Total
Maritime			x (1990-2006)		x (1980-2005)		x (1980-2006)		x (2002-2006)							
<i>Type of data</i>			Vessel-km, Ton-km, population		Vessels called		Population		Population							
<i>Level of aggregation</i>			Vessel type		Passenger/ Freight, vessel type (2005)		Passenger/ Freight, vessel type		Passenger/ Freight, vessel type							

Table 3-5b: Summary of national data submitted for non-road transport modes (part B)

	IT	LT	LU	LV	MT	NL	NO	PL	PT	RO	SE	SI	SK	TR	UK
Air		x (1990-2006)	x (1990, 2000-2006)	x (2003-2005)	x (1998-2006)	x (1990-2004)		x (2004-2006)		x (1990-2005)			x (2003-2005)	x (2000-2005)	
<i>Type of data</i>		Passengers, LTOs, Pass-km, Ton-km	Passengers, LTOs, freight carried	Pass-km	Number of passengers, LTOs	Fuel cons, number of LTOs		Number of passengers, LTOs		Pass-km			Pass-km	Pass-km	
<i>Level of aggregation</i>		Total	Total	Total	Total	Activity		Total		Total			Total	Total	
Rail		x (1991-2006)	x (1990, 2000-2006)	x (1980-2005)		x (2000-2005)		x (1990-2004)		x (1991-2005)			x (1999-2005)	x (2005-2006)	x (1990, 2000, 2005)
<i>Type of data</i>		Population, Train km, Ton-km, Pass-km	Pass-km, Ton-km	Ton-km		Fuel consumption		Population, Train-km, Ton-km		Population, sulphur content			Population, Ton-km, Pass-km	Train-km, Ton-km, Pass-km	Train-km, average age
<i>Level of aggregation</i>		Passenger/ Freight, fuel	Total	Total		Passenger/ Freight, fuel		Passenger/ Freight, train type, fuel		Fuel			Total	Passenger/ Freight, train type, fuel	Passenger/ Freight
Inland shipping		x (1991-2006)				x (1990-2004)		x (2005-2006)		x (1991-2005)			x (2002-2006)		x (2000, 2005)
<i>Type of data</i>		Ton-km, Population				Fuel consumption		Ton-km		Population			Ton-km		Ton-km
<i>Level of aggregation</i>		Vessel type (for population only)				Total		Total		Passenger/ Freight, vessel type			Total		Vessel type
Maritime		x (2000-2006)	x (2000-2006)		x (1996-2004)	x (1990-2004)				x (1991-2005)				x (2005-2006)	x (2000, 2005)
<i>Type of data</i>		Population	Population		Population	Fuel consumption				Population				Population	Population
<i>Level of aggregation</i>		Vessel type	Vessel type		Fuel, activity	Fuel, activity				Vessel type				Passenger/ Freight, vessel type	Passenger/ Freight, vessel type

4 Methodology and Data Processing

4.1 Templates

In chapter 3 it was shown that a large range of values is available, often in different format and level of analysis. It was therefore made clear that this information needs to be summarized in a consistent manner, in order to feed it as input to the data reconciliation model. A dedicated Excel file has been developed to summarize this information. The Excel file (Annex III provides an excerpt) consists of a well-defined data structure in different aggregation levels. Therefore, data at different detail can still be included in the same file. For example, a detailed technology classification of passenger cars may be available for one country while only the total number of passenger cars is available for another. These two pieces of information, which are at different aggregation level can still be summarized in the same Excel file. When this file is used as input to the data reconciliation model, the different level of aggregation is recognised and different routines are then applied. The development of this structure improves the transparency in data handling and accelerates the data processing.

4.2 Data screening and reconciliation

The main problem in developing a homogenized dataset involves the use of data and other information collected by the different sources and synthesises it in order to produce a full and consistent data set for all the items that are critical for model work and other analytical purposes.

The data collected from the different sources consist of time series covering the broad areas of fuel consumption (gasoline, diesel and LPG), vehicle population by sector and technology, new registrations by sector, de-registrations (scrappage) by sector, total vehicle kilometres by sector, and technology and annual mileage by sector and technology. Although all the countries of Europe are covered to some extent, considerable gaps exist in many of them for a number of years and concepts. Furthermore it is clear that a lot of the information included constitutes essentially what is usually termed as "soft data" i.e. results of estimates of varying degrees of accuracy produced through different procedures and methodologies involving varying degrees of rigour. It can therefore be reasonably assumed that such data is characterised by a considerable amount of uncertainty. In addition, very often the data appears to be "inconsistent" with regard to key identities as well as generally accepted technological, legal and socio-economic hypotheses. In some cases the evolution of some quantities over time also displays erratic patterns casting doubts on its credibility.

The main aim of the task is to use the data as collected and produce a full data set that contains no gaps, reproduces exactly some of the information (i.e. officially published data), is close to the different sources of other primary data (depending on their reliability) and follows the broad trends that are generally assumed or derive from specialised studies. Such a full

data set should also be sufficiently consistent to serve as model input for detailed analytical tools (e.g. Tremove, COPERT, PRIMES, etc.). Such consistency constitutes an absolute prerequisite in model building and use.

In addition, the task enables a degree of data appraisal concerning trends, the evaluation of sources and methods used and recommendations on areas for possible improvement.

4.3 Data generation

In the context of the current project and in order to address the problem outlined above, an integrated approach for simultaneous reconciliation of the different elements of information has been adopted and applied. Figure 4-1 presents a schematic overview of the data generation process adopted.

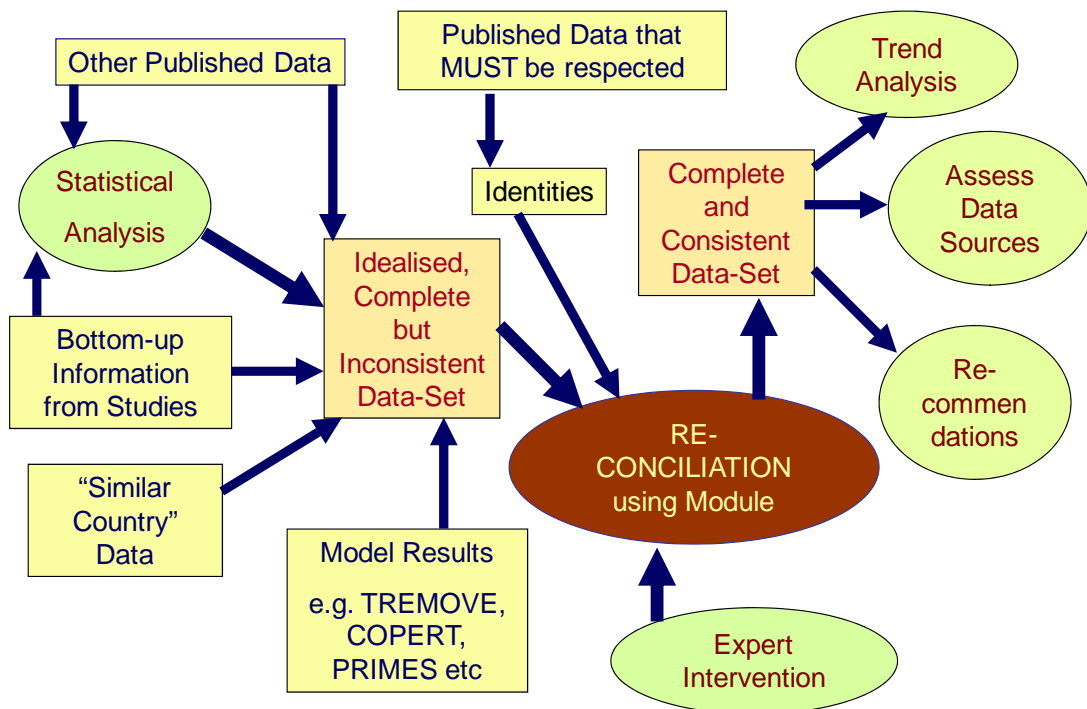


Figure 4-1: Data generation process

The broad methodology consists of three distinct stages:

- Integrate data collected from different sources with bottom-up information from specialised studies, model results together with statistical analysis performed within the current project in order to generate an idealised complete, but inconsistent, database.

-
- Use this dataset together with published “hard” data within a specific computerised tool, allowing for expert interaction to produce a complete and consistent dataset.
 - Analyse broadly the trends suggested by the latter dataset, compare it with the original data sources and attempt a data assessment and recommendations for improvement.

The data collected from different and mostly official sources (national authorities, EUROSTAT, etc.) constitute the essential building block for the creation of the idealised data set. In some cases it is highly detailed (e.g. time series for vehicle populations by technology). A considerable amount of data is highly stylised (e.g. assumptions about average annual mileage per vehicle) and often invariable over time (e.g. rural, urban, highway split). For some countries the coverage is cursory (very short time series and highly aggregated information). In such cases recourse had to be made to data from countries assumed to have similar structural characteristics in order to provide surrogate information. Some concepts are very scantily covered and yet constitute essential links to other data categories. Key among these concepts are vehicle vintages and, in particular, registrations and de-registrations by vehicle type and technology, which, together with initial stock data, can provide a breakdown by year of construction that can be used both to corroborate population data as well as in the form of key parameters for items such as efficiencies and annual vehicle use.

The highly variable state of affairs outlined in the previous paragraph has necessitated recourse to statistical analysis in order to complete the data items that must be covered in the idealised dataset. Such analysis uses as a basis bottom-up information from studies and, in particular, work performed within the TRENDS project in terms of specifications, but extends it by using advanced statistical methods such as non-linear regression (single equations or systems) with parameter restrictions, pooled cross-section and time series, maximum likelihood distribution fitting and seemingly unrelated estimators (SURE). In general emphasis has been given on transparency, homogeneity of treatment and speed (convenience) for performing the analysis.

In some instances model results and, in particular COPERT/TRENDS, have been used in order to impose broad patterns to otherwise estimated data. Such a practice has been followed very sparingly in order to avoid ultimately cyclicity in the analysis to be performed using the data (the data confirming the model from which it was derived).

Apart from the idealised set, a number of data items of a particularly “hard” nature are also introduced in the process. These are quantities that must be respected under all circumstances because they are officially published and widely used by scientists, policy analysts and informed society at large. Under this category come key aggregates such as vehicle stock, new registrations and fuel consumption. EUROSTAT data has been given broadly precedence on this issue, on the assumption that it is homogenised across countries through specific efforts undertaken by both EUROSTAT and national statistical agencies.

Another element that is naturally assumed to be given, is a set of identities linking different data items. Key among these are the motion equations describing the relation between stocks and flows (e.g. registrations, de-registrations and vehicle stock) as well as the consumption identities linking vehicle efficiency, numbers and use.

4.4 Data Reconciliation

The central element of the data generation process is the construction and use of a reconciliation module that uses the idealised but incomplete data set as input together with the published "hard" data and the identities to produce a complete and consistent data set.

The module consists of a non-linear optimization program that minimises the square differences of the logarithms of the "idealized" and the required data set subject to a set of restrictions requiring the latter to satisfy the identities linking it to the "hard" and otherwise published data. The objective is set to represent proportional rather than absolute deviations in order to avoid problems of scaling. Apart from the aforementioned identities other restrictions figure explicitly (for example it may be unacceptable that the fuel efficiency of a given vehicle type oscillates or indeed deteriorates at all from one year to the next). Some "soft" data may be "harder" than others. This can be handled by multiplying the squared differences by weights following a priori assessment.

Normally the problem contains many more variables than constraints and infeasibility rarely presents a problem, unless serious deficiencies with the "hard" data are encountered. On the other hand ill conditioning (an excess of degrees of freedom) does occur. Variable weighting in the objective function can handle this difficulty. Alternatively some variables or parameters are set at their ideal levels and the optimization problem re-solved with additional equality constraints.

The module is programmed in GAMS software as a Non-Linear Program. Its general algebraic specification is as follows:

$$\min_{x_{1t} \dots x_{nt}} \sum_{t=1}^T \left\{ \sum_{i=1}^n w_i \left[\ln \frac{x_{it}}{y_{it}} \right]^2 + \sum_{i=1}^n v_i \left[\ln \frac{x_{it}}{x_{it-1}} \right]^2 \right\}, \quad (1)$$

Subject to,

$$D_j(x_{1t} \dots x_{nt}) = 0, j = 1 \dots m, \quad (2)$$

$$F_k(x_{1t} \dots x_{nt}) = 0, k = 1 \dots l, \quad (3)$$

$$F_k(y_{1t} \dots y_{nt}) = 0, k = 1 \dots l, \quad (4)$$

$$lx_{it} \leq x_{it} \leq ux_{it}, \quad (5)$$

Where,

y_{it} : are "target" values, determined outside the reconciliation module

x_{it} : are the unknowns (missing data)

D_j : are identities that will always hold (links to "hard" data, "logical" identities i.e. balances)

F_k : are approximate behavioural or technical relations (their parameters can be treated as x variables and figure in the objective)

lx_{it}, ux_{it} : are optional bounds of x_{it}

w_i, v_i : are weights indicating the importance of approaching a target value

The module resolves the reconciliation problem simultaneously over the whole sample period. The first item in the objective function (equation 1) relates to the deviation of unknown variables that are determined within the model from the "ideal" values as they emerge from the idealised data set. The second item relates to the intertemporal behaviour of the series produced. It tends to penalise erratic intertemporal evolution of the time series. In fact several variants of the second item have been used in practice to enable capturing structural and conjunctural change according to a given typology. The types of changes considered include stylised representations from information bases, monotonic trend functions, second differential targets (trends may change but such changes are penalised), first differential targets (trends change smoothly) and white noise – purely conjunctural.

Equation 3 in most cases defines a new variable in terms of other variables, while equation 4 is identical and does the same for a target or idealised variable. They normally derive from the statistical analysis performed independently at the earlier data analysis stage.

The bounds (equation 5) can be used to avoid extreme or unreasonable values. In practice, the lower bound that is usually employed is zero on purely logical grounds (non-negativity of the quantities involved).

The use of the reconciliation module implies expert involvement in the process. This involvement follows sequentially and repeatedly the following steps:

- Establish an a priori "order of merit" for different data items, by introducing constraints to reproduce exactly the idealised data and using weights on the objective for different targets.
- Review results and obtain new ones by varying weights for targets in the objective function (routine option) and/or introducing constraints and composite targets.

-
- Examine the final solution in view of assessing the deviations from the targets and the dual values of the constraints (a mathematical indication on how restrictive a given constraint is).

Expert involvement in the use of the reconciliation module is also instrumental in identifying serious defects in the original dataset as well as on some occasions in the so called “hard” data. On a few occasions such defects are overcome by allowing a deviation from otherwise inviolable values. In such cases the action taken is clearly identified in a note.

4.5 Fleet Optimization Model

The reconciliation module has been first applied to generate data for the vehicle stock, registrations and de-registrations by sector, subsector, technology and year. This is one of the most complicated and data intensive areas of data generation, particularly because consistency in terms of different vintages has to be maintained. The task is made even harder because, even in countries where the fullest data is available, new registrations and de-registrations by vehicle type are generally lacking (some data for more aggregate new registrations is usually available).

One may define *Sect* to be the set of sectors considered (Passenger cars, Light duty vehicles, Heavy duty trucks, busses and coaches, two wheelers), *Subs* to be the subsectors considered (Gasoline<1.4lt, Gasoline 1.4-2.0lt, Gasoline>2.0lt, Diesel<2.0lt, Diesel>2.0lt, LPG passenger cars, 2-stroke passenger cars, etc.), *Tech* to be the set of technologies/legislation classes (Conventional, PRE-ECE, PC Euro I, etc.), *tfirst* to be the year of registration of a vehicle and *t* to be the time from year T1 to year T2.

The “target” values are:

$y_{pop_{Sect,Subs,Tech,t}}$: the population of vehicles in sector *Sect*, subsector *Subs* and of technology *Tech* in year *t*

$y_{nreg_{Sect,Subs,Tech,t}}$: the new registrations of vehicles in sector *Sect*, subsector *Subs* and of technology *Tech* in year *t*

$y_{dreg_{Sect,Subs,Tech,t}}$: the de-registrations of vehicles in sector *Sect*, subsector *Subs* and of technology *Tech* in year *t*

Accordingly the unknown variables are:

$x_{pop_{Sect,Subs,Tech,t}}$: the population of vehicles in sector *Sect*, subsector *Subs* and of technology *Tech* in year *t*

$x_{nreg_{Sect,Subs,Tech,t}}$: the new registrations of vehicles in sector *Sect*, subsector *Subs* and of technology *Tech* in year *t*

$x_{dreg_{Sect,Subs,Tech,t}}$: the de-registrations of vehicles in sector *Sect*, subsector *Subs* and of technology *Tech* in year *t*

In addition, the following unknown variable is defined (as intermediate for the calculations):

$xdreg_{Sect,Subs,Tech,t}$: the de-registrations of vehicles in sector $Sect$, subsector $Subs$ and of technology $Tech$, which have been registered in year $tfirst$, in year t

Z : the objective variable to be minimised

The algebraic formulation is as follows:

$$\max Z = \sum_{Sect} \sum_{Subs} \sum_{Tech} \sum_{t=T1}^{T2} (\tag{6}$$

$$wpop_{Sect,Subs,Tech,t} \cdot \left[\ln \frac{ipop_{Sect,Subs,Tech,t}}{ypop_{Sect,Subs,Tech,t}} \right]^2 + , \tag{6a}$$

$$vpop_{Sect,Subs,Tech,t} \cdot \left[\ln \frac{\frac{ipop_{Sect,Subs,Tech,t}}{ypop_{Sect,Subs,Tech,t}}}{\frac{ipop_{Sect,Subs,Tech,t-1}}{ypop_{Sect,Subs,Tech,t-1}}} \right]^2 + , \tag{6b}$$

$$wrdreg_bar_{Sect,Subs,Tech,t} \cdot \left[\ln \frac{xdreg_{Sect,Subs,Tech,t}}{xdreg_bar_{Sect,Subs,Tech,t}} \right]^2 + , \tag{6c}$$

$$wlegislation_{Sect,Subs,Tech,t} \cdot xnreg_{Sect,Subs,Tech,t}) + , \tag{6d}$$

$$\sum_{Sect} \sum_{Subs} \sum_{t=T1}^{T2} (wrpop_{Sect,Subs,t} \cdot \left[\ln \frac{\sum_{Tech} ipop_{Sect,Subs,Tech,t}}{\sum_{Tech} ypop_{Sect,Subs,Tech,t}} \right]^2 + , \tag{6e}$$

$$wnreg_{Sect,Subs,t} \cdot \left[\ln \frac{\sum_{Tech} xnreg_{Sect,Subs,Tech,t}}{\sum_{Tech} ynreg_{Sect,Subs,Tech,t}} \right]^2 + , \tag{6f}$$

$$wrdregsb_{Sect,Subs,t} \cdot \left[\ln \frac{\sum_{Tech} xdreg_{Sect,Subs,Tech,t}}{\sum_{Tech} ydreg_{Sect,Subs,Tech,t}} \right]^2 + , \tag{6g}$$

$$\sum_{Fuel} wnreg_fuel_{Sect,Fuel,t} \cdot \left[\ln \frac{\sum_{Tech} xnreg_{Sect,Subs,Tech,t}}{\sum_{Tech} ynreg_{Sect,Subs,Tech,t}} \right]^2 + , \tag{6h}$$

$$\sum_{Fuel} wdreg_fuel_{Sect,Fuel,t} \cdot \left[\ln \frac{\sum_{Tech} xdreg_{Sect,Subs,Tech,t}}{\sum_{Tech} ydreg_{Sect,Subs,Tech,t}} \right]^2 + , \tag{6i}$$

$$\sum_{Sect} \sum_{t=T1}^{T2} (wspot_{Sect,t} \cdot \left[\ln \frac{\sum_{Subs} \sum_{Tech} ipop_{Sect,Subs,Tech,t}}{\sum_{Subs} \sum_{Tech} ypop_{Sect,Subs,Tech,t}} \right]^2) + , \tag{6j}$$

$$\sum_{Sect} \sum_{t=T1}^{T2} (wcnreg_{Sect,t} \cdot \left[\ln \frac{\sum_{Subs} \sum_{Tech} xnreg_{Sect,Subs,Tech,t}}{\sum_{Subs} \sum_{Tech} ynreg_{Sect,Subs,Tech,t}} \right]^2) + , \tag{6k}$$

$$\sum_{Sect} \sum_{t=T1}^{T2} (wrdreg_{Sect,t} \cdot \left[\ln \frac{\sum_{Subs} \sum_{Tech} xdreg_{Sect,Subs,Tech,t}}{\sum_{Subs} \sum_{Tech} ydreg_{Sect,Subs,Tech,t}} \right]^2) + , \quad (6)$$

Subject to

$$xpop_{Sect,Subs,Tech,t} \equiv xpop_{Sect,Subs,Tech,t-1} + xnreg_{Sect,Subs,Tech,t} - xdreg_{Sect,Subs,Tech,t} , \quad (7)$$

$$xdregF_{Sect,Subs,Tech,tfirst,t} = (1 - F_{Sect,Subs,Tech,tfirst,t}) \left(xnreg_{Sect,Subs,Tech,t} - \sum_{time}^{t-1} xdregF_{Sect,Subs,Tech,tfirst,t} \right) \quad (8)$$

$$xdreg_bar_{Sect,Subs,Tech,t} = \sum_{time=T1}^t xdregF_{Sect,Subs,Tech,time,t} \quad (9)$$

$$F_{Sect,Subs,Tech,tfirst,t} = \exp \left[- \left(\frac{k_{tfirst,t} + b_{Sect,tfirst,t}}{T_{Sect}} \right)^{b_{Sect,tfirst,t}} \right] , \quad (10)$$

$$b_{Sect,tfirst,t} = b_{Sect,0} + b_{Sect,1} \cdot k_{tfirst,t} + b_{Sect,2} \cdot e^{b_{Sect,3} k_{tfirst,t}} \quad (11)$$

Equation 10 calculates a stylised survival rate of vehicles registered at time $tfirst$ after $t-tfirst$ years. It is derived from statistical analysis performed using data from Germany that included vintage information. It follows a version of the two-parameter Weibull distribution that is often used in survival analysis. $k_{tfirst,t}$ is an index measuring the number of years that have elapsed since registration. The parameter b in equation 10 is made a function of this time ($k_{tfirst,t}$) through equation 11. The estimation of 10 and 11 was performed simultaneously (for the parameters b_0, b_1, b_2, b_3 and T) for each sector $Sect$. The general specification of equation 6 in its full form is not used, some of the parameters being set to zero depending on the acceptance criteria used during the estimation.

Equation 8 gives the amount of vehicles registered in year $tfirst$ that are scrapped in year t . Equation 9 aggregates over the different vintages the scrapping of vehicles of a particular type. The variable $xdreg_bar_{Sect,Subs,Tech,t}$ appears in the objective function as a target for the scrapping to be evaluated by the module.

Equation 7 is the motion identity for the stock of vehicles of a particular type stating that vehicle population, at the end of a specific year, is equal to the population at the beginning of the year plus the new registrations that took place within the year and minus the number of vehicles de-registered within the same year. This identity is assumed to hold at all times and in cases where it produces an infeasible solution it provides a clear indication of serious inconsistencies in primary "hard" data.

Finally equation 6 is the objective function. In the above specification, the different parts of the objective function have been separated in order to facilitate the analysis. The minimisation is performed for all sectors, subsectors, technologies and years simultaneously.

"Sub"-equation 6a penalises the deviation of the unknown variable for the vehicle population $xpop$ from the ideal value $ypop$. The penalty is set by the parameter $wpop$.

“Sub” equation 6b penalises the erratic intertemporal behaviour of $xpop$ compared to the intertemporal behaviour of $ypop$. The penalty is the parameter $vpop$.

“Sub” equation 6c penalises the deviation of the vehicle de-registrations $xdreg$, which are calculated from the motion equation 7, from the vehicle de-registrations $xdreg_bar$, which is the scrapping according to the estimated survival curve. In this way, in cases where there is not de-registration information from the ideal dataset, the $xdreg_bar$ can be used as a target. The penalty is the parameter $wrdreg_bar$.

“Sub” equation 6d penalises the cases where new registrations occur at a specific time t for technologies which normally are not allowed at this specific time according to the implementation time of the corresponding directive of the legislation class of the given technologies. This has been introduced in the objective function, because in practise often the published data for vehicle population imply such violations. In this sense, the implementation years of each directive are not treated as an absolute constraint but as another target, the deviation from which is penalised with the penalty $wlegislation$.

“Sub” equation 6e, penalises the deviation of the population of each subsector from the target. The penalty to be paid is the parameter $wrpop$.

“Sub” equations 6f and 6g penalise the deviation of the new registrations in each subsector from the target and the deviation of the de-registrations in each subsector from the target. The corresponding weights are the parameters $wrnreg$ and $wrdreg$ respectively.

“Sub” equations 6h and 6i, penalise the deviation of the new/de- registrations of passenger cars per fuel (gasoline, diesel) from the corresponding targets.

“Sub” equation 6j forces towards respect of the target for the total population of each sector. The penalty $wspop$ should be high enough in order to ensure that the reconciliation module to give priority to the target of the total population per sector.

Finally, “sub” equations 6k and 6l force towards respect of the targets in the total new/de-registrations in each sector. The weights $wcnreg$ and $wdreg$ penalise the deviation from this target.

4.6 Review of the non-road transport emission methodology

Tremove is a partial equilibrium model (i.e. income and production levels remain constant in all scenarios compared to the base case) that has been developed to study the effects of different transport and environment policies on the emissions and the economic burden of the transport sector. Tremove estimates changes in the transport demand, compared to a modelled base case, due to changes in the cost structure. The key assumption is that the transport users will select the volume of transport and their preferred mode, period, region etc. based on the generalized price for each mode: cost, tax or subsidy and time cost per km travelled. In addition, changes in the emission factors can be modelled, keeping the transport demand stable, or, if these changes are associated with costs, e.g. for abatement technology,

changing the transport demand at the same time in accordance with the interdependencies inserted in the model.

Based on the inserted changes, and always compared to the base case, Tremove estimates – for the period 1995–2030 – the passenger and freight transport demands, modal shifts, vehicle stock renewal, emissions of air pollutants and the welfare for EU 27 plus six additional countries, based on the selected scenario assumptions.

In addition to the road sector, Tremove, version 2.5 (Ceuster et al., 2007) 2 covers the following non-road sectors:

- Railways
- Metro/Tram
- Inland waterway
- Air transport

In addition, Tremove covers maritime transport in a separate module. However, maritime transport demand is considered to be exogenous in Tremoe and it is assumed that maritime movements are not affected by policy measures on land-based transport and vice versa. Due to its stand-alone character, modal shift effects cannot be modelled in the current design of the module. However, the maritime sub-model is not described in the Tremove report so that no details can be given.

The methodologies applied for estimating the emissions of these sectors are reviewed in the following with the objective to identify shortcomings and to make proposal for possible improvements.

The economic part of the methodology is not included in the following analysis. The economic part, however, was already subject of a special review (Annema et al, 2006). From this analysis, at least one aspect should be highlighted again, since it has also major repercussions for the work presented here. The key findings of the review are:

1. The demand module is not autonomous, but depends on the availability of an external baseline. The module is only able to compute deviations basis from such a baseline rather than forecasting demand in a broader sense.
2. The demand module is based on a 'tree' of choices where Constant Elasticity of Substitution (CES) functions are applied at each level. Such an approach is unusual in transport demand analysis and is not suitable for analysing situations where large deviations from baseline are expected.
3. The segmentation of demand is very detailed so that a very complex tree is needed and a number of elasticity parameters, each summarising complex choices between alternatives, are needed. Realistically, many sources of possible uncertainty can rise

within such a complex structure. At the same time, the structure is quite rigid and makes it hard analysing the impact of changes in the values of parameters.

The demand baseline used by Tremove is intrinsically exogenous and is provided by the SCENES/ASSESS model. In fact, the current version of Tremove depends so heavily on SCENES/ASSESS that it could be considered as a programme designed to run sensitivity analyses of SCENES/ASSESS scenarios. This means that any weaknesses in the projections of the SCENES/ASSESS transport demand model as well as in the quantities and prices of different transport activities used in SCENES/ASSESS are passed on to Tremove. Although one stated aim of the Tremove modelling team is to allow alternative sources of demand projections to be used, the fact that SCENES/ASSESS is currently the key background of the model cannot be changed for the analysis carried out in the following.

In the light of the above, the scope of the review has to be defined. It is twofold:

1. To identify improvements to be implemented within the given structure of Tremove, e.g. implementing the proposal would just require a re-calibration
2. To identify the need for more radical changes in the methodology which would most likely require re-designing the baseline

This also means that it is not subject of this analysis to identify options how other transport or energy models could be integrated or, even more radical, how Tremove could become a stand-alone model.

4.6.1 General features used for the non-road sector

While the methodologies used in Tremove for the non-road sector differ in many details, they have nevertheless a few features in common:

Most of the non-road methodology follows in principle the on-road approach, e.g. the (simplified) general equations

$$\text{Emissions} = \text{Sources} * \text{Activities} * \text{Emission Factors} \quad (\text{"static" part})$$

$$\text{New Sources} = \text{Delta Replacement} + \text{New Activities} \quad (\text{"dynamic" part})$$

When applying such an approach, as a rule, it is necessary to compare the results with energy data, available from statistics or forecasted in other standard models. Tremove, however, does not include such a step as a general feature. Instead, the Tremove baseline is calibrated, taking into account PRIMES energy data (actually, no further details with regard to the reference are given). But the scenario runs are not balanced against energy data. In principle, this approach makes sense for some non-road modes because the statistical energy data are often not reliable, e.g. the electric energy consumption of rails ways (due to losses) or the national energy consumption data of inland waterways (due to fuel bunkered outside the countries). In other modes, e.g. air transport and diesel consumption of railways, the energy

data are very reliable and it would make sense to take them into account as input for calibrating the scenario runs. In fact, the quality of these data is so good that it is planned to make use of them for future emission trading systems.

The transport volumes of the baseline are, as mentioned above, mainly based on the ASSESS project (ASSESS, 2005) which used the SCENES (2002) model. The transport demand baseline in Tremove is based on several sources. The 1995 and 2000 historical figures are derived from the DG TREN statistics (Transport in Figures). For some countries, they have been updated with national statistics. The main source for the growth factors (passenger-km and tonne-km) is the Scenes run for the ASSESS project. The partial scenario, described in the ASSESS reports is considered the most likely future scenario. (Remark: ASSESS has two partial scenarios (A and B). It is not clear from the report which one has been taken for what purpose). For road freight transport, the growth factors have been derived from the most recent Energy Outlook (PRIMES model). The vehicle-km for road are also derived from the ASSESS project. The vehicle-km for rail and inland waterways come from sources as the TRENDS and International Union of Railways (UIC), and have been made consistent with the pkm and tkm. In principle, for a model like Tremove (see comments given to the review report) this makes sense since the national transport statistics contain key data on transport volume, which can be used for the future calibration work, as shown in the Annex which summarises the data available in the EUROSTAT databank (relevant are here the code numbers 121/124/125/126/128 and 129). Thus, this part of the methodology should not be modified when addressing improvements within the given system. However, this means that Tremove will continue depending in future on high quality transport volume input, including consistent projections. In fact, this could be considered as a weakness of the model. An interview with a key model builder of SCENES, Prof. Dr. Rothengatter (IWW, Karlsruhe), gave clear signals that he considers the SCENES version used for calibrating Tremove version 2.5 as out-of-date. In the Tremove report it is mentioned that the TRANS-TOOLS model is expected to replace SCENES in the REFIT project, currently ongoing.

Somewhat simplified, and as already mentioned, one could say, that the Tremove methodologies are composed of a "static" and a "dynamic" part. The static part covers the basic equations used to calculate emissions. The dynamic part deals with the turnover of the fleets. That is, starting from the transport demand forecasts and 1995-2005 vehicle stock data, the sales model and the scrappage model in the vehicle stock turnover module are used in Tremove to allocate transport volumes to specific vehicle types for all modes. Both parts of equal importance and for both the general "wisdom" of modeling should apply: use and leave untouched as much as possible good quality data, and - since in no case only such data are available - estimate or model with priority such data that are of less good quality. The review carefully analyses whether this golden rule is applied for the non-road sectors. Another rule is that the efforts should increase with the importance of the source. For non-road sectors this means that aviation should receive major attention, followed by - equally - rail and inland waterways (metro/tram, is about 15 % of Rail). The PRIMES baseline projection can be used as a guide to this rule (Table 4-1).

Table 4-1: PRIMES Baseline projection

Mtoe	2005	2010	2015	2020	2025	2030
Rail transport	8,7	8,0	7,1	6,6	6,3	6,2
Aviation	48,5	53,0	57,4	63,3	65,7	71,2
Inland Waterways	5,8	6,3	6,7	7,1	7,4	7,8

Tremove is a country specific model, e.g. it consists of about EU 27 + 6 non-EU country models. This means that the values of parameters considered in the following, as a rule, differ among countries. In theory, one could develop for some countries more and for other countries less sophisticated methodologies because the availability and the quality of the data bases differ among countries. However, this makes little sense for a centralized applied EU model since it is difficult to execute scenarios applying a number of different non-road methodologies and, for obtaining results acceptable in the political discussions, there must be something like a common yardstick applied to all countries. This yardstick is the common methodological treatment of all countries linked to the joint boundary conditions used for the baseline run. The fact that the data quality among countries differ is sufficiently reflected by the input data used. This, however, means that one should in fact use the best quality input data available for the individual countries, e.g. carefully identify and apply these data country-by-country, and that one has to make methodological compromises between “best” and “worst” national data availability.

In the following sections of this review, parameters and equations are used in order to explain the methodologies. With regard to Tremove it is worth indicating the character of the parameters in order to distinguish between

- **Parameters** which are given in Tremove and which are, as a rule, **not modified in the scenario runs**; they have a **blue** colour;
- **Parameters** which **can be modified in the scenario runs**; they have a **red** colour;
- **Parameters** which are **calculated in the dynamic part** of the model; they have a **green** colour. These parameters are an endogenous output of the model calculations used internally;
- **Parameters** which are **output of Tremove**; they have an **orange** colour.

Some parameters are set (**blue**) but could be modified in scenario runs, if desired. In these cases they are **put into red brackets** (black brackets have no specific meaning; they are just used to as a mathematical notation or to display the mathematical formula in an easy-to-read form).

It should be noted that the fact that all data are country-specific is not further highlighted in the equations or attributed to the parameters by indices; it is just assumed to be known.

Tremove delivers comprehensive output in great detail. In the Annex the output relevant for non-road sectors is shown. This allows also identifying the key variables taken into account by the methodology.

4.6.2 Railways

4.6.2.1 Basic methodology

The key equations used for estimating the emissions of the rail sector ("static part") are:

$$E_{ijklmnt} = (TVP/OR) * ENP * (EF) + (TVF/LF) * ENF * (EF) \quad (12)$$

With

$E_{ijklmnt}$ = Emissions of pollutant i in region j at trip distance k and time period l of train type m and fuel type n in the year t (unit: tons)

TVP_{jklmnt} = Total transport volume of passenger trains in region j at trip distance k and time period l of train type m and fuel type n in the year t (unit: pkm)

OR_{jm} = Occupancy rate of passenger train type m in the region j (unit: pkm/vkm)

ENP_{jlmn} = Specific energy consumption of passenger train type m and fuel type n in region j at the time period l (unit: kJ/vkm)

EF_{imn} = emission factor of pollutant i of train type m powered by fuel type n (tons/kJ)

TVF_{jklmt} = Total transport volume of freight trains in region j at trip distance k and time period l of train type m in the year t (unit: tkm)

LF_{jm} = Load factor of freight train type m in the region j (unit: tkm/vkm)

ENF_{jlmn} = Specific energy consumption of train freight type m and fuel type n in region j at the time period l (unit: kJ/vkm)

And with the indices

i = pollutants (CO₂, CO, VOC, NO_x, PM, SO₂)

j = Region (urban, metropolitan, non-urban)

k = trip distance (short, long)

l = time period (peak, off-peak)

m = train type (9 types in total: passenger locomotive diesel, passenger railcar diesel, passenger locomotive electric, passenger railcar electric, passenger train electric, passenger high speed train electric; freight locomotive diesel; freight railcar diesel, freight locomotive electric, freight railcar electric)

n = fuel type (electric, diesel)

t = year

The parameters TVP and TVF are results of the dynamic calculations, which are initiated by the scenario settings.

The methodology does not distinguish between technologies within the defined train types, e.g. the emission factors do not change with time.

The key “dynamic” equation which determines the turnover of the fleet is:

$$(N)_{jklmt} = TVF_{jklmt} / (AM * LF) + TVP_{jklmt} / (AM * OR) \quad (13)$$

With

N_{jklmt} = Number of vehicles of train type m in region j at trip distance k and time period l in the year t (unit: -)

AM_m = Annual mileage of train type m (unit: vkm/year)

In numerical terms the parameters LF and OR are the same as in equation (12).

In policy simulations the sale shares, thus the evolution of the train stock, can be changed exogenously (therefore N is put into red brackets). This allows simulating the effects of policies related to e.g. accelerated introduction of electric trains or high-speed trains.

The parameter AM is derived from historic UIC fleet and vehicle-km statistics and is assumed to remain constant in the forecast years.

Since the methodology does not distinguish between technologies there is no technology turnover. The information with regard to data and parameter names included in the Tremove report is summarized in Table 4-2.

4.6.2.2 Assessment of the basic Tremove methodology

Based on equations (12) and (13) it is obvious that improvements of the methodology (within the given boundaries of Tremove) should concentrate on improving the parameters OR and LF, ENP and ENF as well as EF used for the countries.

The issues to be looked at are:

1. Trends: How do these parameters change with time: Are these changes reflected in the database and the methodology?
2. National particularities: Have national data been taken into account, or are averaged data being used?
3. Break-downs: Are the covered break-down, expressed by the indices, sufficiently detailed, e.g. the source category split, or could one increase the parameterisation? Alternatively, are they too detailed?

Table 4-2: Information summary for railways emission methodology

Demand and Stock Emissions	Description	Parameter	Quality
Rail transport volumes	Activity by train type: pkm, tkm vkm, load factor from UIC, 1995, Tab 21; UIC, 1995, Tab 41; UIC 2000, supplementary statistics, Tab A24; TRENDS	TACTTRENDSalleng, TVKMTRENDS, TLOADfDif <u>In equations given above:</u> TVP, TVF LF	OK
Rail vehicle stock	Base year stock of train vehicles per train vehicle type and age from UIC 2000, supplementary statistics, Tab A24	TSTBY, TSTNBY <u>In equations given above:</u> N	OK, data quality for new countries rather poor.
Rail electricity consumption	Train electricity consumption factor from UIC, 1995, Tab 21; UIC, 1995, Tab 41; UIC 2000, supplementary statistics, Tab A24; TRENDS	TCONSFelec <u>In equations given above:</u> ENP, ENF (indirectly; needs to be derived from TCONSFelec)	Data for all countries available.
Rail Emissions and fuel consumption	Train direct emission factor from UIC, 1995, Tab 21; UIC, 1995, Tab 41; UIC 2000, supplementary statistics, Tab A24; TRENDS	TEMIF <u>In equations given above:</u> EF	Data for EU15 used for all countries.
Parameters			
Name	Description		
TSTNBY	Base year stock of train vehicles per train vehicle type and age - in thousands vehicles		
TACTTRENDSalleng	TRENDS activity by train type - million pkm or tkm per year – historic years and projections		
TVKMTRENDS	TRENDS vehicle-kilometres by train type - million vkm - historic years and projections		
TLOADfDif	UIC % difference between load factor for diesel and electric - 0 for electric		
TEMIF	Train direct emission factor - g per vkm		
TCONSFelec	Train electricity consumption factor - kWh per vkm		

In theory, the issues should be evaluated for all countries by Tremove. However, the budget does not allow such an extensive analysis. Therefore, the analysis is carried out taking mainly German data as point of comparison (IFEU, 2005).

From the Tremove report and the identified methodology it can be concluded that the key parameters OR and LF as well as the parameters ENP and ENF are set. They are mainly

derived from TRENDS data (Georgakaki et al., 2002). The parameters OR and LF differ for different train types (e.g. high speed trains have higher occupancies) but are kept constant in the model. In TRENDS the parameters ENP and ENF differ from country to country (see Table 7.2 of the TRENDS report). In Tremove, TCONSFelec, the train electricity consumption factor (in kWh per vkm), is the same for each country and TEMIF, the train direct emission factor (in g per vkm), differs from country to country. With regard to OR and EF there are clear indications from the German data that both parameters change over time (see Table 4-3). The parameters ENP and ENF change as well over time since they are calculated from the quotient energy consumption/driven vehicle mileage. With regard to EF it should be noted that the parameter is partly outside the scope of this analysis because for electric trains it relates to the emissions of power plants. For diesel-powered trains the 1995 average emission factors that are derived from TRENDS are applied to the whole 1995-2020 period within Tremove, i.e. they are kept constant. This is a questionable assumption since the emission standard change over time (see Table 4-4).

Table 4-3: Occupancy rates for German trains (PNV = short distance passenger train, PFN = long distance passenger train, GV = freight train – Source: IFEU, 2005)

	PNV	PFV	GV
1994	26,0%	42,1%	30,0%
1995	26,0%	43,4%	29,6%
1996	26,0%	42,5%	35,9%
1997	26,0%	39,9%	29,2%
1998	24,9%	39,0%	32,2%
1999	21,9%	38,3%	33,4%
2000	21,8%	40,2%	36,3%
2001	20,9%	42,3%	34,1%
2002	19,5%	39,7%	34,9%
2003	20,6%	41,0%	38,0%
2004	20,6%	42,6%	41,8%
Quelle: Bahn-Umwelt-Zentrum; PNV vor 1997 geschätzt			IFEU Heidelberg 2005

Thus, in the German TREMOD model the emission factors are inserted as a function of time (Table 4-5). Another issue is the share between diesel and electric traction. In Tremove this is defined by the “dynamic” equation (13). However, from the Tremove report it remains unclear whether the replacement of vehicles change take into account the shift from diesel to electric traction. In the German TREMOD model this issue is covered (Table 4-6).

Table 4-4: Emission limit values (g/KWh)for trains depending on their registration (Source: IFEU, 2005)

	Gültig ab*	Leistungs-klasse	CO	HC	NO _x	Part
Triebwagen						
Stufe IIIa	1/2006	Alle	3,5	4,0		0,2
Stufe III b	1/2012	Alle	3,5	0,19	2,0	0,025
Lokomotiven						
Stufe IIIa	1/2007	P ≤ 560 kW	3,5	4,0		0,2
Stufe IIIa	1/2009	P > 560 kW	3,5	0,5	6,0	0,2
Stufe IIIa	1/2009	P > 2000 kW	3,5	0,4	7,4	0,2
Stufe IIIb	1/2012	All	3,5	4,0		0,025
Bemerkungen: *Gültig für neue Fahrzeuge; neue Typen 6-12 Monate später; P: Motorleistung						
Quelle: EU 2002a						

Table 4-5: Emission factors (g/kg fuel) for diesel trains in Germany (Train categories as in caption of Table 4-3 - Source: IFEU, 2005)

Komp.	Zugart	1995	2004	2010	2020	2030
CO	Rangieren	18,0	11,5	6,8	4,4	4,4
	GV	11,5	9,5	8,1	7,1	7,1
	PFV	14,1	8,0	6,1	5,4	5,4
	PNV	10,8	5,9	4,8	4,7	4,7
HC	Rangieren	2,9	2,9	2,1	1,8	1,8
	GV	5,3	5,8	3,4	1,9	1,9
	PFV	6,8	3,4	2,5	2,4	2,4
	PNV	4,1	2,2	2,2	2,0	2,0
NO _x	Rangieren	49,4	42,7	34,7	29,5	29,5
	GV	50,6	55,0	48,3	41,1	41,1
	PFV	60,0	49,3	47,4	43,2	43,2
	PNV	51,2	49,6	40,4	29,6	29,6
Part	Rangieren	1,87	1,64	0,78	0,43	0,43
	GV	1,90	1,74	0,92	0,40	0,40
	PFV	1,77	0,95	0,91	0,90	0,90
	PNV	1,89	0,67	0,72	0,56	0,56
SO ₂	alle	3,00	0,02	0,02	0,02	0,02
Quelle: IFEU 2003c						

Table 4-6: Share of diesel/electric train activity in Germany (Train categories as in caption of Table 4-3 - Source: IFEU, 2005)

Zuggattung	Betriebsart	2004	2010	2020	2030
GV	Diesel	7,2%	6,0%	5,0%	4,0%
GV	Elektrisch	92,8%	94,0%	95,0%	96,0%
PFV	Diesel	2,4%	2,0%	2,0%	2,0%
PFV	Elektrisch	97,6%	98,0%	98,0%	98,0%
PNV	Diesel	22,9%	20,0%	18,0%	16,0%
PNV	Elektrisch	77,1%	80,0%	82,0%	84,0%
Quelle: DB AG, IFEU-Annahmen					

With regard to the parameterisation, the Tremove split, including the source category split, seems reasonable.

4.6.2.3 Proposals for improvements assessment

With regard to improvements of the current methodology, the following are recommended: From the assessment of the previous section it seems to be worth considering to insert the parameters LF and OR, ENP and ENF as well as EF, country-by-country, as variables which change over time. Moreover, the split into diesel and electric traction should be inserted, country-by-country, as a variable.

With regard to improvements based on a re-design of the given methodology, the following recommendations can be made:

The methodology applied in Tremove as such seems to be reasonable. It would be difficult to find data for a more refined methodology, but it is as well unnecessary to take a less detailed approach.

From the German TREMOD experiences it is obvious that special attention has to be given to the correct allocation of the energy consumption to rail transport. Therefore, it is worth checking whether Tremove data and (corrected) national statistics fit to each other.

4.6.3 Metro/tram

4.6.3.1 Basic Tremove equations

In theory, this is a sub-sector of railways. However, since the data sources are different it makes sense to treat this sector separately. The equations used in Tremove are much simpler than for the railways sector. The key equations for estimating the emissions of the metro/tram sector ("static part") are:

$$E_{ijl\text{mnt}} = (\text{TV}/\text{OR}) * \text{ENP} * (\text{EF}) \quad (14)$$

With

E_{ijlmt} = Emissions of pollutant i of metro/trams in region j at the time period l and fuel type n in the year t (unit: tons)

TVP_{jit} = Total transport volume of metro/trams trains in region j at the time period l in the year t (unit: Pkm)

OR_j = Occupancy rate of metro/trams in the region j (unit: Pkm/vkm)

ENP_j = Specific energy consumption of metro/trams in region j (unit: kJ/vkm)

EF_{il} = emission factor of pollutant i of metro/trams powered by electricity at time period l (unit: tons/kJ)

And with the indices

i = pollutants (CO₂, CO, VOC, NO_x, PM, SO₂)

j = Region (urban, metropolitan)

l = time period (peak, off-peak)

m = train type (just one type: metro/tram)

n = fuel type (just one: electric)

t = year

There is no explicit “dynamic” equation that determines the turnover of the fleet. In theory, the following equation applies:

$$N_{jlmnt} = TVF_{jlmnt} / (AM * LF) \quad (15)$$

With

N_{jlmnt} = Number of metro/tram vehicles in region j at the time period l in the year t

AM = Annual mileage of metro/tram

However, in practical terms it is assumed that there will be always enough metro/trams available so that only the vehicle mileage counts. This means that the equation (14) for the emission calculation is simplified to

$$E_{ijlmt} = TVP/OR * ENP * (EF) \quad (16)$$

Thus, the vkm are a direct result of the demand calculations since the parameters OR and ENP are kept stable. Since there is no turn-over of technologies, EF is kept stable (but could be modified internally, if desired). The Tremove report provides information with regard to data and parameter names, which is summarized in Table 4-7. The parameter TVP is the result of the dynamic calculations, which are initiated by the scenario settings. The parameter EF is outside the scope of this analysis because it relates to the emissions of power plants.

Table 4-7: Information summary for metro/tram emission methodology

Data			
Demand and stock and emissions	Description	Parameter	Quality
Rail electricity consumption	Metro, tram electricity consumption factor from UIC, 1995, Tab 21; UIC, 1995, Tab 41; UIC 2000, Supplementary statistics, Tab A24; TRENDS	METRAMCONSFelec, <u>In equations given above:</u> ENP	Data for all countries available.
Parameter names			
METRAMCONSFelec	Metro and tram electricity consumption factor - kWh per vkm.		

4.6.3.2 Assessment of the basic Tremove methodology

Based on equations (15) and (16) it is obvious that improvements of the methodology (within the given boundaries of Tremove) should concentrate on improving the complex $((TVP/OR) * ENP)$, e.g. by improving the parameters OR and ENP used for the individual countries. In the current version of Tremove the parameters OR and ENP are set and kept constant. According to the Tremove report ENP is set at 3 kWh/vkm. The TRENDS report does not include data for metro. In the German TREMOD model metro and tram is included in short-distance electric rail transport of passengers, e.g. what has been said above under rail applies here as well. Thus, improvements of the complex $((TVP/OR)*ENP)$ require the availability of more detailed data.

4.6.3.3 Proposals for improvements assessment

As mentioned two aspects are of importance for this review: Improvements of the given structure and more radical changes in the methodology.

With regard to the given methodology and from the assessment of the previous section it seems to be worth considering to insert the parameters OR and ENP or the complex $((TVP/OR)*ENP)$ as well as EF, country-by-country, as variables which change over time.

With regard to a redesign of the current methodology, it can be generally stated that the methodology applied in Tremove as such seems to be reasonable. Although it seems possible to obtain more detailed data (e.g. from cities) it seems not to be worth to define a more detailed methodology since the source category as such is too small (see criterion most efforts to biggest polluter).

4.6.4 Inland waterways

4.6.4.1 Basic Tremove equations

Inland waterways do not exist as a transport option for all countries. Therefore, only countries where inland waterways have a significant transport share are included in Tremove, e.g. Austria, Belgium, Switzerland, Czech Republic, Germany, Slovakia, France, Hungary, Italy, Netherlands, Poland and Romania.

Passenger transport is not covered by the methodology due to its negligible volume. The key equations used in Tremove for estimating the emissions of the sector inland waterways ("static part") are:

$$E_{ijkmnt} = (TVF/LF) * (EF) \quad (17)$$

With

E_{ijkmnt} = Emissions of pollutant i in region j at trip distance k of vessel type m and commodity type n in the year t (unit: tons)

EF_{im} = Emission factor of pollutant i of vessel type m (unit: tons/vkm)

TVF_{kmnt} = Total transport volume of inland waterways at trip distance k of vessel type m of commodity type n in the year t (unit: tkm)

LF_m = Load factor of vessel type m (unit: tkm/vkm)

And with the indices

i = pollutants (CO₂, CO, VOC, NO_x, PM, SO₂, N₂O, CH₄, NMVOC)

j = Region (just one: non-urban)

k = trip distance (short = national; long = international)

m = vessel type (21 types in total)

n = commodity type (bulk, general cargo, unitized)

t = year

The parameter LF is set and kept constant.

The parameter TVF results from the dynamic calculations, which are initiated by the scenario settings.

Endogenous 'allocation keys' are used to allocate tkm to specific ship types. The vehicle-km is further split to configurations by using a 'configuration matrix' in conjunction with the allocation keys. This allows allocating vehicle-km by vessel type and configuration (i.e. the kind of propulsion technology) in each country. In practical terms the endogenous "allocation matrix" and "configuration key" distribute the transport volume on the vessels.

For inland waterways there is no “dynamic” equation which determines the turnover of the fleet. However, a turnover of the engines used in the vessels can be applied which is based on configuration matrix. For each vessel type, this matrix specifies the share of different fuel–engine–equipment configurations. In the base case as well as in the simulation, the share figures in the configuration matrix for each year and each vessel type is determined by solving a ‘technology-cost minimising problem’. However, in the baseline, only one configuration (1 type of fuel, 1 type of engine) is available for each ship type. Thus, the engine turn-over is an option which is currently not used in Tremove. To make use of it would require to fill-in the configuration matrix, e.g. with emission factors and costs for new engines. The Tremove reports provides the information in Table 4-8 with regard to data and parameter names

Table 4-8: Information summary for inland shipping emission methodology

Demand and stock and emissions	Description	Parameter	Quality
Inland waterways vkm	Inland waterways stock, engines	IWCONFIG <u>In equations given above:</u> TVP	OK, predominantly Dutch data.
Inland waterways emission factors	Inland waterway fuel consumption and emission factors from preliminary Artemis	IWCONSffuel, IWEMIF <u>In equations given above:</u> EF	OK, predominantly Dutch data.
Parameter names			
I IWTKMSHexo	Share of total tonne-kilometres transported by a specific ship type - allocation key – country specific % of total tonne-kilometers for a type of good and trip distance <u>In equations given above:</u> None		
IWLFexo	Inland ship load factor – tonnes per ship <u>In equations given above:</u> LF		
IWCONFIG	Indicates for each configuration if and when it becomes available for each vessel type separately – only one configuration is modelled in the base case <u>In equations given above:</u> None		
IWCONSffuel	Inland waterway fuel consumption factor - g per vkm <u>In equations given above:</u> EF		
IWFREDUC	Reduction in fuel consumption of the configuration compared to the basecase configuration - % <u>In equations given above:</u> None		
IWEMIF	Inland waterway emission factor per vessel type and pollutant - g per vkm <u>In equations given above:</u> EF		

4.6.4.2 1.5.2 Assessment of the basic Tremove methodology

The Tremove methodology is mainly based on an inland water way model used for the Netherlands. This explains the extremely differentiated source category split (21 categories).

Since the model has no real dynamic part the detailed split does not influence the turn-over of the fleet but is just of importance for the allocation of emission factors. The fuel consumption and emission factors as such are used throughout the 1995 to 2030 period, e.g. there is no improvement over time.

4.6.4.3 Proposals for improvements Assessment

With regard to the current methodology, and taking equation (17) and the explanations given it is obvious that improvements of the methodology (within the given boundaries of Tremove) should concentrate on improving the parameters EF and LF.

The emission factors, EF, are taken from the ARTEMIS project (Gergakaki et al., 2002). As mentioned, the fuel consumption and emission factors are used throughout the 1995 to 2030 period. In reality the emission factors and fuel consumption factors are a function of the waterway depth and width and the vessel speed. In Tremove just one factor per vessel type is taken for all countries (and all waterways). In summary, the methodology simplifies the emissions factors with regard to the boundary conditions of vessel usage and technology improvement over time but complicates the methodology with regard to vessel types. One could wonder whether this is justified. An alternative approach would be to reduce the number of vessel types but to vary the emission factors at national level, e.g. based on data on river dimensions and average vessel speed.

The emission factors are expressed in g/vkm. In principle, this makes sense, since emission factors expressed in g/kg fuel consumed would require high quality energy consumption statistics. However, the available energy consumption data are not very reliable since vessel bunker fuel wherever it is cheapest. This makes it very difficult to allocate emissions correctly.

As a rule vkm data can be obtained for all countries since the tkm are given in the statistics. These have to be corrected by the load factor. It is therefore the load factor LF to which attention should be given.

The load factors used are based on historic load factor figures and allocation keys valid for the Netherlands. This information was derived from Dutch government statistics (i.e. CBS database). Different load factors and allocation keys are specified by type of good, domestic vs. international trips and vessel type, as differences between types of good and domestic vs. international are important. In summary, the issues to be looked at are national emission factor and load factors and their trends.

With regard to a redesign of the current methodology, one may say that the Tremove methodology is very detailed, mainly due to the source category split. One could wonder whether this it is necessary since the transport demand and the emissions can be modelled

using a much simpler approach. In fact, for most of the Member States such a detailed category split cannot be provided. The Tremove methodology simply assumes that the detailed Dutch source applies to other countries as well without being able to verify the data.

A simpler methodology could be based on the tkm which are given in national statistics and apply emission factor expressed in g/tkm. For example, the German methodology is based on transported tkm (from statistics) and uses for all vessels a fuel consumption factor of 10 g/tkm. This allows calculating the fuel consumption (statistics are of no help in this case because the vessels bunker a significant share of diesel fuel in the neighbouring countries) which is then multiplied by a set of emission factors expressed in g pollutant/g fuel (Table 4-9). Instead of using a dynamic turn-over approach (for engines as foreseen, but practically not used in Tremove) the emissions factors are simply reduced based on reasonable assumptions.

Table 4-9: Emission factors for inland shipping in TREMOD (Source: IFEU, 2005).

Komponente	EFA(g/kg):	Kommentar:
HC	5	Nach //IFEU 1994a/
CO	12	Nach //IFEU 1994a/
NOx	60	Nach //IFEU 1994a/
Part	2	Nach //IFEU 1994a/
CO ₂	3175	
CH ₄	0,12	Nach //IFEU 1995b/
NMHC	4,88	Nach //IFEU 1995b/
SO ₂	3	
Benzol	0,095	Nach //IFEU 1995b/
IFEU Heidelberg 2002		

In the light of the fact that inland waterways are used as a means of transport just in a few Member States, one could wonder whether this approach would not fit the purpose.

4.6.5 1.6 Air transport

4.6.5.1 Basic Tremove equations

The key equations used in Tremove for estimating the emissions of the air transport sector ("static part") are:

$$E_{ijkInt} = TVP * ((EF)/OR) \quad (18)$$

With

E_{ijknt} = Emissions of pollutant i in region j at trip distance k and time period l of fuel type n of air transport in the year t (unit: tons)

TVP_{kit} = Total transport volume of air transport at trip distance k and time period l in the year t (unit: Pkm)

OR = Occupancy rate of passenger aircrafts (unit: Pkm/vkm)

EF_{ik} = emission factor of pollutant i of at trip distance k (tons/vkm)

And with the indices

i = pollutants (CO₂, CO, VOC, NO_x)

j = Region (just one: non-urban)

k = trip distance (> 500 km; 500-1000 km; 1000-1500 km; 1500-2000 km; > 2000 km)

l = time period (peak, off-peak)

n = fuel type (just one: kerosene)

t = year

There are no "dynamic" equations, e.g. there is no turnover of the fleet.

The Tremove reports provides the information summarized in Table 4-8, with regard to data and parameter names for aviation emissions.

4.6.5.2 Assessment of the basic Tremove methodology

The parameters OR and EF are set and are assumed to remain constant in the forecast years. They are mainly derived from TRENDS/AVIOPOLL (psiA Consult, 2002) data.

With regard to OR, an overall occupancy rate of 70 % is taken and kept constant.

With regard to EF the fuel consumption and emissions figures from the AVIOPOLL database given in seatkm are used and recalculated to pkm assuming OR (70 %). The factors in gram per pkm, for each distance class, obtained in this way are kept constant. The factors are then multiplied for each distance class (0-500 km, 500-1000 km, 1000-1500 km, 1500-2000 km, +2000 km) with the pkm from the demand module in order to obtain emission figures.

The transport demand module assumes flight distances when calculating the number of pkm. For planes, the real distance may vary, as planes usually take detours. Therefore, a detour factor is included in the model as an input variable. In theory, this simple approach is supposed to enable Tremove modelling "Single European Sky" policies, which aim at reducing detours in air transport.

Freight transport is not covered by Tremove although figures suggest that it currently accounts to about 3 % of total air transport with increasing tendency.

As fuel only kerosene is taken into account. This is reasonable since the consumption flight petrol is negligible (below about 0,3 %).

Based on equation (18) and the explanations given above it is obvious that improvements of the methodology (within the given boundaries of Tremove) should concentrate on improving the parameters OR and EF used for the countries as well as, if possible, the detour factors (figures not given in the Tremove report – to be extracted from the model from the parameter AIRDETOUR).

Table 4-10: Information summary for aviation emission methodology

Demand and stock and emissions	Description	Parameter	Quality
Air Transport classes	Air distance classes	AIRFRACT	Values for EU25, CH and NO are from ASSESS-Scenes and TIF, sometimes updated with national data. Values from other countries are based on national statistics and growth factors. An update of both EU25 and other countries is needed, and will be done in the iTREN2030 project (by 2008).
Air transport emissions	TRENDS & "Atmosfair Emissions Calculator": detour, fuel consumption, LTO and cruise split, emission factors	AIR_DETOUR, AIR-CONSFfuelID, AIRCONSFfuelIDsplit_alt, AIREMIFD, AIREMIFDsplit_alt <u>In equations given above:</u> EF (via fuel consumption)	OK, data quality for new countries rather poor.
Parameter names			
AIR_DETOUR	% detour-deviation from straight OD distance. AIR_DETOUR indicates the difference between crow's flight and real distance. In the base case the detour factor values are: 25% for <500 km flights and 11.1% for >500 km flights		
AIRCONSFfuelIDsplit_alt	LTO and cruise in total aircraft fuel consumption		
AIREMIFDsplit_alt	LTO and cruise in total aircraft emissions		
AIRCONSFfuelID	Fuel consumption factor for aircrafts by distance class - g fuel per pkm		
AIREMIFD	Emission factor for aircrafts by distance class - g pollutant per pkm		

4.6.5.3 Proposals for improvements Assessment

Improvements of the given methodology should concentrate on EF and OR. The emission factors used in Germany, for example, are a function of time (Table 4-11) and it is more than likely that this holds as well for other countries. ICAO also has new emission factors that can be provided through EUROCONTROL.

The occupancy rate OR should vary as well. However, since - as a rule of thumb - air transport needs OR values of about 65 % to operate profitable it is not unreasonable to keep OR constant at a level of 70 %. However, more detailed data and trends, if possible as a function of distance, could improve the quality of the emission estimates

Table 4-11: Emission factors (g/kg fuel) for aviation used in TREMOD (Source: IFEU, 2005)

Emissionsfaktoren für Flugzeuge (in g/kg Kraftstoff)								
Jahr	CO₂	H₂O	SO₂	NO_x	NMHC	CH₄	CO	Partikel
Flugturbinenkraftstoff								
Flugverkehr der ehemaligen DDR (nur grenzüberschreitend)								
1980	3120	1350	1,0	10	5	0,25	16	0,2
1990	3120	1350	1,0	12	3	0,15	10	0,1
Inlandsverkehr der BRD (1995 und 2020: Deutschland)								
1980	3120	1350	1,0	12	3,3	0,18	12	0,1
1990	3120	1350	0,6	15	1,4	0,08	6	0,06
1995	3120	1350	0,6	11,1	1,6	0,08	7,4	0,06
2005	3150	1280	0,4	14	1,61	0,04	9,2	0,04
2020	3150	1280	0,2	12	1,4	0,03	7,0	0,02
Grenzüberschreitender Verkehr der BRD (1995 und 2020: Deutschland)								
1980	3120	1350	1,0	12	2,4	0,13	8	0,1
1990	3120	1350	0,8	15	1,4	0,08	3	0,06
1995	3120	1350	0,8	12,9	0,83	0,04	4,0	0,02
2005	3150	1280	0,4	14	1,61	0,04	9,2	0,04
2020	3150	1280	0,2	12	1,4	0,03	7,0	0,02
Flugbenzin								
Flugverkehr der BRD, der DDR und Deutschlands								
1980-2020	3100	1400	0,4	3	18	1,0	250	0,1
<small>Anmerkungen: Werte für die Darstellung z.T. gerundet; NMHC = Nicht-Methan-Kohlenwasserstoffe; 2010 = Vorschläge für eine Trendabschätzung der Emissionsfaktoren im Jahre 2010; NMHC und CH₄ ohne Treibstoffschneidablässe, Betankungs- und Leckagenverluste sowie ohne Verdampfungsemissionen; NMHC = Kohlenwasserstoffe ohne Methan; Werte für 1995 aus /TÜV Rheinland 1999a/, Werte für 2005 und 2020 aus /UBA 2004a/</small>								
<small>IFEU Heidelberg 2005</small>								

One could wonder whether a split into distance classes is the most appropriate one. However, as mentioned above, the whole methodology is mainly based on TRENDS/AVIOPOLL. This includes in particular as well the sub-source category split. It is therefore not possible to change the source category split without modifying at the same time the methodology as such.

With regard to improvements of the current methodology, the psiA-Consult report provides a comprehensive overview about the state-of-the-art of air transport modeling. The Tremove

methodology which is based on this work can therefore be considered as still up-to-date. However, there are two possibilities to modify the methodology: a simplification, e.g. as done in Germany or a further sophistication, e.g. on the basis of more detailed data.

A simplification might be interest because it allows using statistics generally available, e.g. the energy consumption of the sector, and to up-date emission factors in an easier way, losing, however, at the same time some transparency. The key for this approach is a "corrected fuel consumption" calculation (if, for example, the emission factors mentioned above would be considered as appropriate).

The German TREMOD model energy estimates the fuel consumption of passenger flights on the basis of the following equations:

$$BL = (PVL \cdot WPP + GVL) / ALG \quad (19)$$

with

ALG = weight-related load factor [%]

WPP = Weight per passenger (= 92 kg for inland and 97,5 kg for international flights (Lufthansa data))

PVL = Passenger transport volume [Pkm]

GVL = Freight (goods and mail) transport volume [tkm]

BL = offered transport capacity [otkm]

and

$$KV_i = KV_t \cdot BL_i \cdot 1,5 / (BL_i \cdot 1,5 + BL_a) \quad (20)$$

$$KV_a = KV_t \cdot BL_a / (BL_i \cdot 1,5 + BL_a) \quad (21)$$

both, in accordance with the availability of statistics, differentiated for regular and charter flights, with

KV = Fuel consumption [t]

BL = offered transport capacity [otkm]

and the indices

i = National traffic

a = Departing international traffic

t = total

The factor 1,5 results from the (statistically proven) assumption that inland flights consume in average and related to the offered transport capacity 50% more fuel than international flights.

For each of these four groups (regular/charter and national/international) the distribution of the fuel consumption is calculated with the equations:

$$KVP = KV * PVL * WPP * 1,7 / (PVL * WPP * 1,7 + GVL) \quad (22)$$

$$KVG = KV - KVP \quad (23)$$

with

KVP = fuel consumption for passenger transport

KVG = Fuel consumption for freight transport

The factor 1,7 results from Lufthansa estimates between the ratio of passenger to freight transport and corrects for the fact that passenger transport is more transport volume intensive (In practical terms it means that the fuel consumption related to pkm is about 1,7 times higher than the fuel consumption related to tkm). The data necessary for these calculations are available in German statistics. This, of course is just an example which illustrates the need to carry out national calculations in order to obtain fuel consumption data which can be applied to the available emissions factors. The very limited data available from national statistics (mainly number of LTOs and passenger-km) makes it difficult for this methodological approach to be applied for other countries as well.

A sophistication of the methodology would go into a detailed aircraft-type/fuel consumption-based emission inventory. The basis for such an inventory could be the reporting under the Commission proposal for a Directive of the European Parliament and of the Council amending Directive 2003/87/EC so as to include aviation activities in the scheme for greenhouse gas emission allowance trading within the Community (<http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=SEC:2006:1684:FIN:EN:HTML>). 7The monitoring is planned to be based on the actual fuel use by airlines on a flight by flight basis. Moreover, it is planned to use a standardised tiered method to estimate emissions (CO₂ in first place, NO_x at a later stage).

Concerning emission factors, there is wide agreement among experts who studied the monitoring issue that CO₂ emissions factors are not a complex issue in the aviation sector as the fuel used is relatively homogenous. It seems also to be possible to agree on emission factors for other pollutants on this basis.

Since the Commission will in cooperation with Member States and Eurocontrol follow developments in the implementation of the proposed Directive and the main sources of data will be the annual reporting of emissions data from operators combined with data on any non-compliant operators and air traffic data provided by Eurocontrol it can be assumed that a very rich data bank will be available in a couple of years (The co-decision procedure should allow the directive to enter into force around 2008, with monitoring and reporting obligations starting in 2010 and compliance obligations starting in 2011.). In accordance with the transparency rules of the Commission these data (The data to be reported are defined in the Commission's proposal under amendments to Annex IV.), may be slightly aggregated, would be public and could therefore be used for a sophisticated methodology.

5 Results

5.1 Annual mileage driven

5.1.1 Mileage estimation methods

The mileage driven by each vehicle type per year is an important parameter for emissions inventorying for a number of reasons. First, the mileage per vehicle multiplied by the vehicle fleet provides the total activity level in this country, i.e. the total vehicle-kilometre driven, which are proportional to the total emissions produced in the country. Second, the annual mileage is a measure of the vehicle usage in each country. Long mileage distances driven per year correspond to an earlier degradation of the average fleet emission level due to normal ageing effects on the engine and aftertreatment devices. They also mean an earlier vehicle retirement on average. Therefore precise estimate of the total mileage per year is an important input to accurate emission estimates.

There are a number of available techniques to estimate the mileage driven per year. One of the most reliable ones is to compare records of the same car during consecutive years, as it is examined by national inspection and maintenance programmes. In this case, the car is identified by its number plate as it is found in the centralised register of the I&M tests conducted in each country. Subtraction of the total mileage values recorded in consecutive years corresponds to the annual mileage of the car in the previous year. Although this sounds as a quite straightforward procedure, there are several confounding factors that may provide difficulties in obtaining an accurate picture. First, this test is not obligatory for the first few years of vehicle life (4-5 years) in several countries, and therefore, only cumulative information exists during these first years. Second, several owners try to escape the test to avoid the associated cost and the risk of having their car rejected. This reduces the availability of cars. Third, odometers are sometimes turned back to lower mileage, especially when vehicle owners try to sell their cars, in order to make them more attractive to the potential buyer. This falsifies the estimation of annual mileage. Also, what mostly is a problem for old cars, some odometers have only five digits (99.999 km) and these are several times exceeded during the vehicle lifetime leading to an unknown total distance driven. Finally, I/M registers do not include records as to whether the car is of special use, e.g. company or private car, only family car, secondary car, etc. Therefore I&M records are more appropriate to obtain an average picture of the fleet rather than detailed data per each vehicle type. The same method can be used on official car dealers who have detailed data on mileage, as new cars are taken in to follow their scheduled maintenance plan. This can particularly be efficient to obtain data during the first years of a car, after its registration.

A second method to collect information on the average mileage per year is by surveys of vehicle owners either in random checks or in a more systematic way. This is more subjective than the previous method as vehicle owners might have some misconceptions on what is the distance they travel per year. However, it can also provide some more detailed responses on whether the car is a single family car, if it is a leased or a company car and other feedback related to the

actual vehicle usage (e.g. time of day or day of week the car is driven). Such surveys may be good complementary tools in data obtained from national registers.

5.1.2 Definitions

Before presenting results on mileage there need to be given some definitions related to what annual mileage stands for, in terms of its use as input to emission inventories. According to the draft revised UNECE guidelines for reporting emissions (ECE/EB.AIR/WG.5/2008/6), Article 15 states: "For emissions from transport, Parties should calculate and report emissions consistent with national energy balances reported to Eurostat (the Statistical Office of the European Communities) or the International Energy Agency. For example, emissions from road vehicle transport should be attributed to the country where the fuel is sold to the end-user. Alternatively, a Party may report emissions from road vehicle transport calculated on the basis of national vehicle kilometres. If cross-border movement of fuel in or out of the geographic area of a Party accounts for a significant proportion of its emissions in a particular source category, as calculated on this basis, the Party should provide separate estimates to quantify the effect of such fuel transfer on the emissions from the source category concerned and on its total national emissions. The basis for the separate estimates should be clearly specified in the IIR. Any approach chosen should be used consistently across all years and pollutants."

The definition of "national vehicle kilometres" in the guidelines is equivocal. One could consider the vehicle kilometres driven by the national fleet despite which territory (country) these distances are driven. The other way of considering the term national vehicle kilometres would be only the vehicle-kilometres occurring within each country's territory both from the national fleet and due to international traffic. The first definition is consistent with the emission models in all countries (e.g. COPERT, TREMOD, EMV, etc.) because it is this (total) mileage that can be revealed by the vehicle statistic sources in each country. The second definition is more appropriate when emission models are combined with transport activity statistics models, e.g. models which estimate total veh-km within each territory. The mileage considered in this report is consistent with the first definition, i.e. total mileage driven per national fleet vehicle, regardless of where this mileage has been driven. This has been decided as national and international stock databases refer to the number of vehicles registered by each country and not the number of vehicle operating in each country. Using this definition, care has to be given when comparing data from activity models to the total veh.km calculated by the data presented in this report. It may occur that activity models refer only to the activity taking place in the territory of each country.

5.1.3 Tank tourism effect on mileage

Ideally, the total mileage driven in each country should be proportional to the total fuel sold in the country. However, this is not always the case as, in several countries, there is significant 'tank tourism', i.e. vehicles are refuelled in a neighbouring country where fuel is cheaper and consume this fuel in the country where they are registered (or vice versa). Therefore, tank tourism between countries takes place whenever the price differences of fuels at the pump are high. As a consequence the fuel consumed in a country is not represented by the statistics which

correspond to the fuel sold in the country. As a rule, only neighbouring countries are affected and the effect is stronger for diesel than for petrol due to the mainly diesel freight transport. The effect is known to a number of countries, causing several problems in energy balances and the allocation of emissions ¹²³. It is important to consider the extent of tank tourism when using the statistical fuel consumption to calibrate the activity level in each country, using the fuel consumption figures of each vehicle category. In countries where significant (positive or negative) tank tourism takes place, e.g. the fuel sold in the country is much less than what is actually consumed because the price in neighbouring countries is much cheaper, then one should allow for a margin between the statistical and the calculated fuel consumption.

Tank tourism is not a stable phenomenon but changes over time due to changes in the fuel prices and the transport volume. As a rule countries with more transit transport are more affected than those with little transit. For the year 2006 the countries potentially affected by tank tourism can be identified on the basis of the valid excise duties on fuels, see <http://www.acea.be/files/2007ACEATaxGuidedef~Introduction.pdf> and a summary of those is provided in Table 5-1.

Table 5-1: Major tank tourism between countries in Europe

Country	Diesel imports likely from	Gasoline imports likely from
AT		
BE	LU	LU
DE	AT,BE,NL,PL,HR,LU,DK,SL,SE	AT, PL, HR, LU, DK, SI
DK		SE
FI		SE, EE, LT, LV, PL
FR	ES, LU, BE	ES, LU
GR	BU	
HR	PL	
HU	BU, RO	BU, RO
IE		
IT	AT, GR, FR	AT
NL	BE, LU	
PT	ES	ESP
RO	BU	
SE	FI	
SK	PL	
UK	IE, FR	IE, FR

¹ http://ec.europa.eu/environment/climat/pdf/lux_nap_final.pdf

² <http://www.umweltbundesamt.at/fileadmin/site/publikationen/REP0058.pdf>

³ http://www.statistics.gov.uk/downloads/theme_environment/transport_report.pdf

5.1.4 Mileage tuning

In many of the cases identified in the table the error associated with tank tourism is most likely too small to be worth considering it further. Small in this sense means that it is smaller than the usual uncertainties of the methods used to produce total mileage estimates. If to be considered further, the following values need to be compared:

- The statistical fuel consumption per fuel
- The calculated fuel consumption, derived on the basis of consumption factors multiplied by the total vehicle-kilometres

The most straightforward way to alter the calculated fuel consumption in order either to match the statistical one or to account for the tank tourism is to adjust the total mileage driven per vehicle category. This is a usual practice, since the stock size is usually known with good confidence, while total mileage is a more 'soft' parameter, i.e. it is bound to larger uncertainties. Therefore, mileage is usually tuned during the compilation of an emission inventory to provide the desired total fuel consumption.

No tuning of the mileage has been attempted in this report. This is due to two reasons: First, data collected from national experts have, to a large extent, already adjusted to account for differences in the statistical and calculated fuel consumption. The extent of matching the two has been left to the national experts who are aware of the effect of the problem in each country, and no additional correction has been attempted. The second reason is because we believe that results are more transparent in this way. Any calibration of the annual mileage to reach the statistical fuel consumption can also be attempted at wish, before using the data. The comparison of the statistical with the calculated fuel consumption is given for each country in the final section of this report.

5.1.5 Parameters that affect mileage

The total annual mileage driven by each vehicle is a function of several factors. Based on the relevant ARTEMIS report (Adra and André, 2004) the main factors are:

- The vehicle characteristics, i.e. category, size and weight, fuel and age
- The vehicle owner, i.e. sex, age, income, societal and family status
- The type of usage, e.g. passenger or freight transport, private or company car, urban or non urban area use, first or second car in the family

Based on data that have been collected in France, Switzerland and Great Britain, the effect of these factors in dimensionless form are summarized in Table 5-2, which also originates from the same ARTEMIS report. The effect is given as a usage factor which is expressed as the ratio of the annual mileage actually driven by each vehicle category (passenger cars, LDV, HDV, busses and coaches, two-wheelers) over the mileage driven during the first complete year after vehicle registration.

Table 5-2: Parameters that affect mileage and relative effect (usage factor) over annual mileage at first year of registration

Vehicle category	Factor	Usage factor	LDV			
Passenger cars			Fuel type	Petrol Diesel	0.5 1.2	
Fuel type	Petrol	0.8-0.9	Age (year)	<1	1.7	
	Diesel	1.3-1.4		1-5	1.4	
Engine power (horsepower)	Petrol	0.7	6-10	0.9		
	Diesel	1.45-1.5	>10	0.6		
	Gas	1.1	HGV			
Car rank	One car	0.9	Age (year)	Lorries (by type)		
	First - main	1-1.5	Time	<5	1.6	
	Second	0.7-0.97		6-10	1	
	Other	0.5-0.9		11-15	0.5	
Age (year)	<=10	1.1		Tractors		
Engine capacity (cc)	<=1350	0.8	<5	<5	1.4	
	1351-1650	0.9	6-10	6-10	0.7	
	1651-1950	1	11-15	11-15	0.5	
	1951-2250	1	11-15	Tractors		
	2251-2550	1.1	<5	<5	1.4	
Geographical area	Large cities	0.9	6-10	6-10	0.7	
	rural	1.03	11-15	11-15	0.4	
Household income	Low	0.7-0.9	Vehicle type	Correction functions		
	High	1.1-1.2	Rigid	Rigid	0.7	
Household size (no. persons)	1	0.9-0.96	Artics	Artics	1.8	
	2	0.95-0.97	Lorries	Lorries	0.6	
	3	1.01-1.08	Tractors	Tractors	1.4	
	4	1-1.02	Vehicle weight	Rigid		
	> 5	1-1.04	Over 3.5-7.5 t	Over 3.5-7.5 t	0.6	
Engine capacity (cc)	<=1350	0.8	Over 7.5-17	Over 7.5-17	0.7	
	1351-1650	0.9	Over 17-25	Over 17-25	0.9	
Geographical area	Large cities	0.9	Over 25	Over 25	0.9	
	rural	1.03	Artics	Artics	1.5	
Household income	Low	0.7-0.9	Over 3.5-33 t	Over 3.5-33 t	1.9	
	High	1.1-1.2	Over 33	Over 33	1.9	
Household size (no. persons)	1	0.9-0.96	Mode of working	Main public account	1.4	
	2	0.95-0.97	Own account	Own account	0.5-0.7	
	3	1.01-1.08	Buses and coaches			
	4	1-1.02	Vehicle type	Coaches	0.9	
	> 5	1-1.04	Buses	Buses	1.2	
Engine capacity (cc)	<=1350	0.8	Coaches	Vehicle weight		
	1351-1650	0.9	<= 18t	<= 18t	0.93	
Geographical area	Large cities	0.9	>18t	>18t	1.37	
	rural	1.03	2-Wheelers			
Household income	Low	0.7-0.9	Motorcycles	50-80	0.6-0.9	
	High	1.1-1.2	Engine capacity (cc)	81-125	0.6-0.9	
Household size (no. persons)	1	0.9-0.96	126-250	126-250	0.8-1	
	2	0.95-0.97	251-500	251-500	0.9-1	
	3	1.01-1.08	501-625	501-625	1-1.2	
	4	1-1.02	626-750	626-750	1-1.3	
	> 5	1-1.04	751-999	751-999	1.2-1.4	
	Motorcycle rank	First	1.1	>1000	>1000	1.5
	Second	0.7	Other	Other	0.8	

The qualitative trend of the values on these tables is confirmed by a number of independent studies related to factors that affect the mileage. Figure 5-1 shows the effect of vehicle age on emissions, based on some 85000 vehicle records from I&M programmes in the provinces of Milan and Ferrara, Italy (Caserini et al. 2007). This study clearly shows that there is a constant decrease of mileage as the vehicles grow older, with a 20-year old car driven only by a fraction of 10-17% of the mileage it used to run during its first year of operation. The same figure shows the significant impact that this mileage reduction has on the mean mileage of each passenger car technology class. Evidently, this will also bring proportional reductions to the total emissions from these technology classes.

Figure 5-2 on the other hand shows the link between the vehicle engine capacity and the annual mileage driven, from a sample of ~40000 vehicles tested in Greece (GMEPP, 200). The annual mileage increases with capacity for a number of reasons. Larger cars are more frequently used for extra-urban trips than small ones since they are more comfortable and offer better

performance and safety. In addition, large cars are bought by high income families which use their cars more often than public transport.

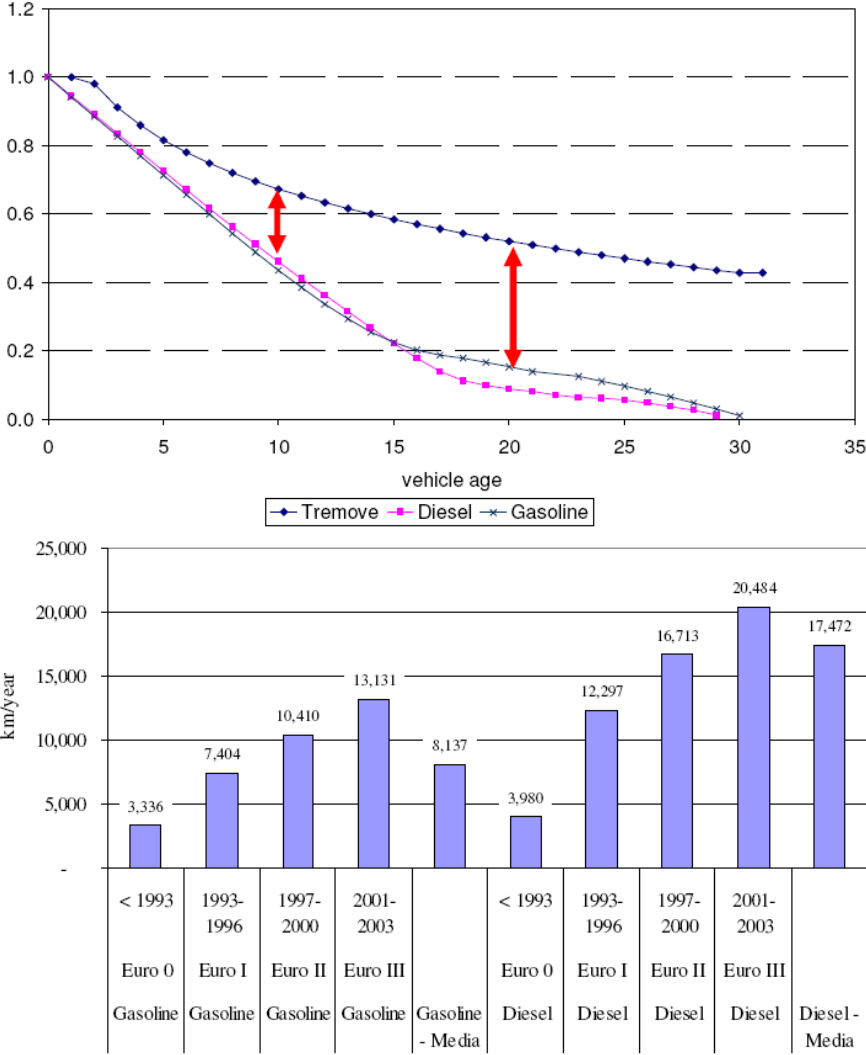


Figure 5-1: (Top) Effect of vehicle age on mileage driven by diesel and gasoline cars, (Bottom) Impact of the decreasing mileage with age for different Euro classes of passenger cars in Italy (Year 2005-2006). Source: Caserini et al. 2007.

5.1.6 Annual Mileage per Country

Table 5-3 shows the annual mileage collected for the different countries, based on the national data submitted. The table is split in two parts, Part A corresponding to passenger cars and Part B corresponding to all other vehicle categories. Only a few types have been included per category due to space limitations. The database collect detailed data for all types involved.

As regards the general trends, most of the countries report a falling annual mileage with vehicle age, as also discussed in the previous section. They also report a higher mileage driven by larger than smaller passenger cars. Finally, diesel cars are consistently shown to be driven by 50% to more than 100% more than gasoline ones. Most probably, the cheaper price and fuel

consumption of diesel, as well as the most frequent use of diesel cars as company cars is the driving force of this distinction. A typical example is Greece where diesel passenger cars are banned from the two major cities (Athens and Thessaloniki) for pollution control. The only diesel cars allowed are Taxis, hence the average mileage is over 80 Mm per year.

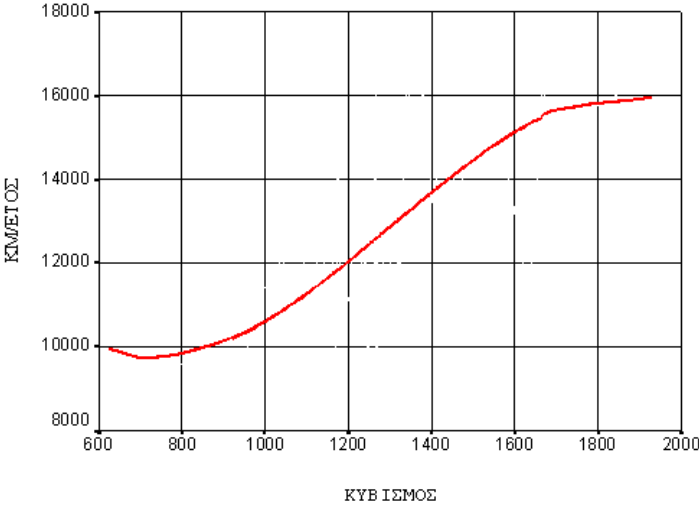


Figure 5-2: Association of engine capacity (x-axis) with the annual mileage (y-axis) driven by gasoline passenger cars in Greece Source: GMEPP (2002).

With respect to the absolute values of annual mileage driven per year, there are some important differences between the countries. For example, a Euro 2 gasoline passenger car (1.4-2.0 l) is shown to be driven by some 11 Mm in Italy, Germany, Netherlands and Spain by up to 17,5 Mm in Denmark and 22 Mm in Ireland. In part, this is due to different urban and commuting conditions in each country. However, one cannot exclude part of the differences to be also attributable to the different annual mileage estimates in each country.

These differences are even more important in the case of light duty and heavy duty vehicles. For example, the mean annual mileage of a Euro 2 diesel light duty truck seems to range from ~12 Mm in Spain to 59 Mm in Ireland. This again may reflect differences in freight transport between the two countries. Small trucks may be used more often to deliver goods in the countryside of Ireland while vans maybe mostly used for urban freight transport in Spain. In another example, an articulated Euro II truck of 14-20 t seems to operate for ~20 Mm per year in Switzerland to 111 Mm in UK. Again, this may reveal a true difference in the operation vehicles in the countries concerned. However, such differences are rather large to expect on average for the total fleet and the estimation methods need to be clarified to understand them.

Table 5-3 only includes 16 countries (some additional countries submitted data at a very late stage to be included in this report – they can be found in the electronic database files). In order to facilitate emission calculation for the countries that submitted no information we assumed that the average mileage of these countries that submitted data is a good estimator for the unknown mileage driven in the rest of the countries. This is shown in Table 5-4 and includes the effects of vehicle size and fuel on the annual mileage driven.

Table 5-3a: Annual mileage per country, provided by the national sources. Part A: Passenger cars

Category	Type	Technology	Austria	Denmark	Cyprus	Finland	France	Belgium (Wal)	Germany	Greece	Ireland	Italy	Netherlands	Norway	Spain	Sweden	Switzerland	UK		
Passenger Cars	Gasoline <1,4 l	PRE ECE	4404	11037		2000			8692	1699		2500	8200			3504	1 069			
		ECE 15/00-01	4404	11037		3000				1747		2500	8200	13635				1627		
		ECE 15/02	4404	11037		5000	2010			5163	2022		2500	8200	13635		4446			
		ECE 15/03	4404	11037		8000	4443			6127	3761		2500	8200	13635	10797	7014	2 693		
		ECE 15/04	4404	11037		10000	6634	15394		7287	6309	18000	5500	8200	13635	10847	8189	4 252	9035	
		Improved Conventional								6993				8200						
		Open Loop								7252	8638			8200			8873			
		PC Euro I - 91/441/EEC	11800	12828		13000	8824	15394		9082	8638	19000	7500	8200	13635	10779	9992	6 926	11400	
		PC Euro II - 94/12/EEC	11800	17465		15000	10527	16716		10783	9585	20000	9000	11000	13635	10779	11373	11 581	14257	
		PC Euro III - 98/69/EC Stage2000	11800	21983		22000	12474	16847		11603	10858	20000	10000	13500	13635	10779	16476	13 270	18043	
		PC Euro IV - 98/69/EC Stage2005				22000	13934			12695	13103	20000	11000	21100		10779	15775	12 380	20683	
		PC Euro V (post 2005)																		
		Gasoline 1,4 - 2,0 l	PRE ECE	4404	11037		3000			8692	2310			3500	8200			3744	1 309	
	ECE 15/00-01		4404	11037		4000				2376			3500	8200	13635				2 011	
	ECE 15/02		4404	11037		6000	4360			5163	2750		3500	8200	13635		5424			
	ECE 15/03		4404	11037		9000	6793			6127	5115		3500	8200	13635	10774	6810	3 282		
	ECE 15/04		4404	11037		12000	8983	15394		7287	8580	19000	6500	8200	13635	10816	9005	5 198	9035	
	Improved Conventional									6993				8200						
	Open Loop									7252	11748			8200			10217			
	PC Euro I - 91/441/EEC		11800	13691		15000	11173	17235		9082	11748	22000	8500	8200	13635	10711	11839	8 464	11400	
	PC Euro II - 94/12/EEC		11800	17475		16000	12877	15394		10783	13035	22000	11000	11000	13635	10711	13895	14 172	14257	
	PC Euro III - 98/69/EC Stage2000		11800	21861		24000	14824	17115		11603	14767	22000	12500	13500	13635	10711	17519	16 174	18043	
	PC Euro IV - 98/69/EC Stage2005					25000	16284			12695	17820	22000	13000	21100		10711	16301	15 095	20683	
	PC Euro V (post 2005)																			
	Gasoline >2,0 l		PRE ECE	4404	11037		4000			8692	2472			4500	8200			3777	1 501	
		ECE 15/00-01	4404	11037		5000				2542			4500	8200	13635				2 343	
		ECE 15/02	4404	11037		6000	5358			5163	2943		4500	8200	13635		4462			
		ECE 15/03	4404	11037		10000	7792			6127	5473		4500	8200	13635	10762	7814	3 770		
		ECE 15/04	4404	11037		12000	9982	15394		7287	9181	19000	8000	8200	13635	10785	11148	5 994	9035	
		PC Euro I - 91/441/EEC	11800	13587		17000	11442	15394		9082	12570	21000	10000	8200	13635	10660	13455	9 775	11400	
		PC Euro II - 94/12/EEC	11800	17764		22000	13876	15394		10783	13947	22000	12000	11000	13635	10660	16473	16 451	14257	
		PC Euro III - 98/69/EC Stage2000	11800	22039		25000	15822	15394		11603	15801	22000	13000	13500	13635	10660	20119	18 786	18043	
		PC Euro IV - 98/69/EC Stage2005				29000	17282			12695	19067	22000	14000	21100		10659	19789	17 517	20683	
		PC Euro V (post 2005)																		
		Diesel <2,0 l	Conventional		21880		16000	12010	29967	10203	84152	30000	14000	15000	18166	17264	16179	9 100	8457	
			PC Euro I - 91/441/EEC		26472		19000	14875	27708	12528	84152	30000	16000	15000	18166	17295	20051	18 359	10391	
			PC Euro II - 94/12/EEC		34638		28000	16308	27708	17912	84152	31000	17500	20700	18166	17295	23573	23 848	12921	
	PC Euro III - 98/69/EC Stage2000			43419		30000	17945	27708	22860	84152	31000	18500	24700	18166	17295	33772	24 914	18293		
	PC Euro IV - 98/69/EC Stage2005					30000	19173			25773	84152	30000	19500	45900		17295	24642	17 196		
	PC Euro V (post 2005)																			
	Diesel >2,0 l	Conventional		21880		20000	13051	42308	10203	84152	30000	15000	15000	18166		18532	9856	8457		
		PC Euro I - 91/441/EEC		26935		22000	15916	40622	12528	84152	30000	17000	15000	18166		22929	20541	10391		
		PC Euro II - 94/12/EEC		35215		30000	17349	27708	17912	84152	30000	18000	20700	18166		28703	26 656	12921		
PC Euro III - 98/69/EC Stage2000			43691		38000	18986	27708	22860	84152	31000	19000	24700	18166		40683	28 129	18293			
PC Euro IV - 98/69/EC Stage2005					40000	20214			25773	84152	20000	45900			26239	19 342				
PC Euro V (post 2005)																				
LPG	Conventional		11037			9291	27951		84152			17300	13300							
	PC Euro I - 91/441/EEC					14127	24630		84152			18000	13300							
	PC Euro II - 94/12/EEC					16545	24630		84152			18500	19900							
	PC Euro III - 98/69/EC Stage2000					19308	25464		84152			19500	23200							
	PC Euro IV - 98/69/EC Stage2005					21380	28440					20000	64400							
	PC Euro V (post 2005)																			
2-Stroke	Conventional				4000															
	PC Euro IV - 98/69/EC Stage2005							17590					21100							
	PC Euro IV - 98/69/EC Stage2005							18290					21100							
Hybrid Gasoline <1,4 l	PC Euro IV - 98/69/EC Stage2005							24810					21100							
	PC Euro IV - 98/69/EC Stage2005												21100							

Table 5-3b: Annual mileage per country, provided by the national sources. Part B: Light and heavy duty vehicles and power two wheelers

Category	Type	Technology	Austria	Denmark	Cyprus	Finland	France	Belgium (Wal)	Germany	Greece	Ireland	Italy	Netherlands	Norway	Spain	Sweden	Switzerland	UK	
Light Duty Vehicles	Gasoline <3,5t	Conventional	22983	14797		8000	3433	7743	12640	19916	44000	9500	11300	13635	4965	7857	4 598	11738	
		LD Euro I - 93/59/EEC	22983	14797		8000	10767	10037	15135	19916	44000	12500	11300	13635	4965	11055	11 147	16621	
		LD Euro II - 96/69/EEC	22983	14797		10000	13469	10167	18414	19916	44000	13500	16300	13635	4965	14418	16 523	20681	
		LD Euro III - 98/69/EC Stage2000	22983	14797		13000	15786	10189	27696	19916	44000	14500	22500	13635	4965	17368	18 104	28445	
		LD Euro IV - 98/69/EC Stage2005				13000		10580	28698	19916	44000	15000	32500			15639	15 979		
	LD Euro V - 2008 Standards																		
	Diesel <3,5 t	Conventional	18713	31047		13000	9780	11755	7672	19916	59000	15125	15000	16742	11910	11741	5 442	12474	
		LD Euro I - 93/59/EEC	25033	31047		15000	18243	12434	15151	19916	59000	17500	15000	16742	11906	16949	11 609	15305	
		LD Euro II - 96/69/EEC	25033	31047		16000	21361	12476	21415	19916	59000	18500	20000	16742	11906	19692	18 804	19044	
		LD Euro III - 98/69/EC Stage2000	25033	31047		20000	24034	11874	26192	19916	59000	19500	30000	16742	11906	19883	19 753	26193	
		LD Euro IV - 98/69/EC Stage2005				20000			28780	19916	59000	20000	35000			11591			
	LD Euro V - 2008 Standards																		
	LPG	Conventional							16190					17500					
		LD Euro I - 93/59/EEC							16190					17500					
		LD Euro II - 96/69/EEC							16190					25000					
LD Euro III - 98/69/EC Stage2000								16190					4000						
LD Euro IV - 98/69/EC Stage2005								16190					5000						
LD Euro V - 2008 Standards																			
Heavy Duty Trucks	Gasoline >3,5 t	Conventional	21005	34709	13597	20000	36054	75897				38000	5000			43684	9000		
		Conventional	26102	56191	13597	15000	6368		23414			59000	25000	25600	14631	49455	8268	2 111	25645
		HD Euro I - 91/542/EEC Stage I	26102	56191	13597	20000	26359		31938			59000	27000	29900	14631	49462	17750	4 526	34365
		HD Euro II - 91/542/EEC Stage II	26102	56191	13597	25000	47991		42580			59000	28000	34200	14631	49455	27048	8 763	51458
		HD Euro III - 2000 Standards	26102	56191	13597	30000	72327		63899			59000	30000	51300	14631	49457	31176	8 598	60107
	HD Euro IV - 2005 Standards			13597	35000			74681			59000		68400		49453		6 100		
	HD Euro V - 2008 Standards			13597															
	Rigid >=7,5 t	Conventional	26102	87030	13597	15000	7026		23414				37000	25600		52914	22667	81 685	25645
		HD Euro I - 91/542/EEC Stage I	26102	87030	13597	25000	35634		31938				54000	29900		53233	17000	53 074	34365
		HD Euro II - 91/542/EEC Stage II	26102	87030	13597	30000	57266		42580				55000	34200		53457	29000	85 830	51458
		HD Euro III - 2000 Standards	26102	87030	13597	35000	81603		63899				60000	51300		53455	28200	91 059	60107
		HD Euro IV - 2005 Standards			13597	35000			74681					68400		53455		53 205	
	HD Euro V - 2008 Standards			13597															
	Rigid >32 t	Conventional	48980	46761	37293	40000	8485		31445				37000	33100	32566	49461		7 774	68800
		HD Euro I - 91/542/EEC Stage I	48980	46761	37293	50000	37758		43820				54000	38700	32566	49439		16 246	78152
HD Euro II - 91/542/EEC Stage II		48980	46761	37293	60000	59391		73313				55000	44200	32566	49460		20 242	113611	
HD Euro III - 2000 Standards		48980	46761	37293	90000	83727		123014				60000	60700	32566	49460		28 499	135176	
HD Euro IV - 2005 Standards				37293	90000			138544					88400		49457		18 874		
HD Euro V - 2008 Standards			37293	90000															
Articulated 14 - 20 t	Conventional	48980	87030	37293	40000	7026		31445				37000	33100	32566	49461		7 774	68800	
	HD Euro I - 91/542/EEC Stage I	48980	87030	37293	50000	35634		43820				54000	38700	32566	49439		16 246	78152	
	HD Euro II - 91/542/EEC Stage II	48980	87030	37293	60000	59391		73313				55000	44200	32566	49460		20 242	113611	
	HD Euro III - 2000 Standards	48980	87030	37293	90000	83727		123014				60000	60700	32566	49460		28 499	135176	
	HD Euro IV - 2005 Standards			37293	90000			138544					88400		49457		18 874		
HD Euro V - 2008 Standards			37293	90000															
Articulated 50 - 60 t	Conventional	48980	87030	37293	40000	7026		31445				37000	33100	32566	49461		7 774	68800	
	HD Euro I - 91/542/EEC Stage I	48980	87030	37293	50000	35634		43820				54000	38700	32566	49439		16 246	78152	
	HD Euro II - 91/542/EEC Stage II	48980	87030	37293	70000	57266		73313				55000	44200	32566	49460		20 242	113611	
	HD Euro III - 2000 Standards	48980	87030	37293	90000	81603		123014				60000	60700	32566	49460		28 499	135176	
	HD Euro IV - 2005 Standards			37293	90000			138544					88400		49457		18 874		
HD Euro V - 2008 Standards			37293	90000															
Buses	Urban Buses Standard 15 - 18 t	Conventional	52005	115061		30000	9835	70241	26333			71500	45000	26900	45751	75901	42333	28 900	23536
		HD Euro I - 91/542/EEC Stage I	52005	115061		35000	38338	129614	36078			71500	45000	27900	45751	75902	52250	45 814	35932
		HD Euro II - 91/542/EEC Stage II	52005	115061		70000	50339	126770	42934			71500	45000	27900	45751	75901	66889	54 463	54042
		HD Euro III - 2000 Standards	52005	115061		90000	63840	129137	50390			71500	45000	27900	45751	75901	71500	57 456	62769
		HD Euro IV - 2005 Standards				90000			54326			71500		77800		75903		30 256	64090
HD Euro V - 2008 Standards				90000															
Coaches Standard <=18 t	Conventional	52005	80181		45000	11124		45994	65000	74000	51000	26900			63175	33600	21 983	23536	
	HD Euro I - 91/542/EEC Stage I	52005	80181		55000	39627	70241	50676	65000	74000	51000	27900			63169	37000	45 589	35932	
	HD Euro II - 91/542/EEC Stage II	52005	80181		70000	51628	72770	59693	65000	74000	51000	27900			63146	47385	55 142	54042	
	HD Euro III - 2000 Standards	52005	80181		90000	65129	70241	73742	65000	74000	51000	27900			63178	62000	54 685	62769	
	HD Euro IV - 2005 Standards				90000			68599			74000		77800		63160		28 822	64090	
HD Euro V - 2008 Standards				90000															
Power Two Wheelers	<50 cm³	Conventional	1000	1291		1600	2045	1500	2331	4000	12500	3400	1800	3200		851	710	2775	
		Mop - Euro I	1000	1291		1600	2045	1500	2528	4000	12500	3900	1800			1059	2 179	2775	
		Mop - Euro II	1000	1291		1600	2045	1500	3219	4000	12500	3900	1800			691	1779	2 726	2775
		Mop - Euro III				1600	2045												
	2-stroke >50 cm³	Conventional	2800	6267		4000	5034	3638	2492	9000			3400	6800	1804	1842	1 647	5138	
		Mot - Euro I				5000	5034	3638	2941	9000			4500		1804	2688	3 468	5138	
		Mot - Euro II				5000	5034	3638	4097	9000			6100			2529	3 518	5138	
		Mot - Euro III				5000	5034												
	4-stroke 250 - 750 cm³	Conventional	2800	6267		5000	6293	3638	3122	9000	20500	5300	3400			1804	2105	2 448	5639
		Mot - Euro I		6267		5000	6293	3638	3665	9000	20500	6000	4500			1804	3833	4 629	5639
		Mot - Euro II		6267		5000	6293	3638	5024	9000			6100			3667	5 046	5639	
		Mot - Euro III				5000	6293												

Table 5-4: Average mileage considered for countries that provided no data

Category	Type	Technology	Mileage (km/a)	Category	Type	Technology	Mileage (km/a)
Passenger Cars	Gasoline <1,4 l	PRE ECE	4789	Heavy Duty Trucks	Gasoline >3,5 t	Conventional	29694
		ECE 15/00-01	5769			Conventional	25027
		ECE 15/02	5842			Euro I	29344
		ECE 15/03	6884			Euro II	34573
		ECE 15/04	9248			Euro III	40456
		Impr. Conv.	7597		Euro IV	43747	
		Open Loop	8241		Euro V	13597	
		Euro 1	11467		Conventional	25746	
		Euro 2	12900		Euro I	32331	
		Euro 3	14885		Euro II	37972	
	Euro 4	15768	Euro III		44907		
	Euro 5		Euro IV		49023		
	Euro V		Euro V		13597		
	Gasoline 1,4 2,0 l	PRE ECE	5133		Rigid 7,5 - 12 t	Conventional	22452
		ECE 15/00-01	6145			Euro I	23326
		ECE 15/02	6447			Euro II	35058
		ECE 15/03	7390			Euro III	43739
		ECE 15/04	9938			Euro IV	45108
		Impr. Conv.	7597		Euro V	13597	
		Open Loop	9354		Conventional	28257	
		Euro 1	12632		Euro I	35433	
		Euro 2	13869		Euro II	40833	
		Euro 3	16003		Euro III	47342	
	Euro 4		Euro IV		48380		
	Euro 5		Euro V		13597		
	Gasoline >2,0 l	PRE ECE	5398		Rigid 14 - 20 t	Conventional	28299
		ECE 15/00-01	6458			Euro I	35905
		ECE 15/02	6570			Euro II	41173
		ECE 15/03	7793			Euro III	48899
		ECE 15/04	10339			Euro IV	44550
		Euro 1	12934		Euro V	13597	
		Euro 2	14803		Conventional	28186	
		Euro 3	16480		Euro I	34893	
		Euro 4	18527		Euro II	39883	
		Euro 5			Euro III	46865	
	Diesel <2,0	Conventional	16787		Rigid 20 - 26 t	Euro IV	48135
		Euro 1	18911			Euro V	13597
		Euro 2	22275			Conventional	28251
		Euro 3	25275			Euro I	35147
		Euro 4	25498			Euro II	40440
	Diesel >2,0	Conventional	18538		Rigid 26 - 28 t	Euro III	48019
		Euro 1	21002			Euro IV	45263
		Euro 2	23611			Euro V	13597
		Euro 3	27601			Conventional	34807
		Euro 4	28559			Euro I	38406
	LPG	Conventional	27172		Rigid >32 t	Euro II	47127
		Euro 1	30842			Euro III	54279
		Euro 2	32745			Euro IV	49723
		Euro 3	34325			Euro V	13597
Euro 4		33555	Conventional	38605			
2-Stroke	Conventional	4000	Articulated 14 - 20 t	Euro I	44476		
	Hybrid<1,4 l	19345		Euro II	53214		
Light Duty Vehicles	Gasoline <3,5t	Conventional		13140	Euro III	Euro III	66348
		Euro 1		15124		Euro IV	70428
		Euro 2		16918		Euro V	63646
		Euro 3	19192	Conventional		40810	
		Euro 4	21701	Euro I		49481	
	Diesel <3,5 t	Conventional	17288	Articulated 20 - 28 t	Euro II	58052	
		Euro 1	20056		Euro III	70352	
		Euro 2	22062		Euro IV	70428	
		Euro 3	24071		Euro V	63646	
		Euro 4	27755		Conventional	43813	
LPG	Conventional	16845	Articulated 28 - 34 t	Euro I	51411		
	Euro 1	16845		Euro II	61489		
	Euro 2	20595		Euro III	74157		
	Euro 3	28095		Euro IV	80739		
	Euro 4	33095		Euro V	63646		
Power Two Wheelers	<50 cm³	Conventional	2786	Articulated 34 - 40 t	Conventional	41781	
		Euro 1	2937		Euro I	53713	
		Euro 2	2179		Euro II	63708	
		Euro 3	1823		Euro III	76918	
		Euro 4	1823		Euro IV	81538	
	2-stroke >50 cm³	Conventional	4143	Articulated 40 - 50 t	Euro V	63646	
		Euro 1	4321		Conventional	48235	
		Euro 2	4895		Euro I	59168	
		Euro 3	5017		Euro II	72803	
		Euro 4	5367		Euro III	86942	
4-stroke <250 cm³	Conventional	5523	Articulated 50 - 60 t	Euro IV	81538		
	Euro 1	6213		Euro V	63646		
	Euro 2	5567		Conventional	44744		
	Euro 3	5646		Euro I	55090		
	Euro 4	5646		Euro II	58800		
4-stroke 250 - 750 cm³	Conventional	5523	Urban Buses Midi <=15 t	Euro III	62723		
	Euro 1	6213		Euro IV	59254		
	Euro 2	5567		Euro V	60000		
	Euro 3	5646		Conventional	47378		
	Euro 4	5646		Euro I	57582		
Buses	4-stroke >750 cm³	Conventional	5606	Urban Buses Standard 15 - 18 t	Euro II	64182	
		Euro 1	6389		Euro III	68444	
		Euro 2	5713		Euro IV	66268	
		Euro 3	5646		Euro V	90000	
		Euro 4	5646		Conventional	45388	
	Urban Buses Midi <=15 t	Conventional	5606	Urban Buses Articulated >18 t	Euro I	57994	
		Euro 1	6389		Euro II	65222	
		Euro 2	5713		Euro III	68222	
		Euro 3	5646		Euro IV	65721	
		Euro 4	5646		Euro V	90000	
Coaches Standard <=18 t	Conventional	5606	Coaches Articulated >18 t	Conventional	45654		
	Euro 1	6389		Euro I	53380		
	Euro 2	5713		Euro II	58849		
	Euro 3	5646		Euro III	63702		
	Euro 4	5646		Euro IV	66639		
Coaches Articulated >18 t	Conventional	5606	Euro V	90000			
	Euro 1	6389	Conventional	45183			
	Euro 2	5713	Euro I	54471			
	Euro 3	5646	Euro II	62220			
	Euro 4	5646	Euro III	65950			
Euro 5	5646	Euro IV	65884				
Euro V	90000	Euro V	90000				

5.2 Lifetime functions

In the EU, a number of legislative interventions have over the last two decades obliged the car manufacturing industry to produce "cleaner", environmentally friendly, cars to replace the older, more polluting, ones. This implies that the vehicle fleet turnover, the rate at which old vehicles are scrapped and replaced with new ones, is an important parameter for the emission impact of vehicles. Within the FLEETS project vehicle lifetime functions have played an important role in the estimation of the highly disaggregated data on vehicle fleets.

The functional form most widely used in the literature is an S-shape curve, which is obtained by using a "modified" Weibull distribution with three parameters:

$$\varphi(k) = \exp\left[-\left(\frac{k+b}{T}\right)^b\right]; \varphi(0) = 1 \quad (24)$$

where:

$\varphi(k)$ is the probability that a vehicle will survive k years after its registration

b is the failure steepness for the vehicle ($b > 1$ which implies that the failure rate increases over time). It can be roughly approximated by the 50th percentile of the lifetime.

T is the characteristic service life for the vehicle and it can be approximated by the 99th percentile of the lifetime.

The estimation of the lifetime functions requires long time series of vehicle stock, vehicle scrapping and vehicle new registrations, which must be available by each vehicle type and age. In the context of the FLEETS project the estimation was based on data provided for Germany, due to the lack of suitable information for the rest of the countries considered in the project. The analysis was carried out for passenger cars, light duty vehicles, buses, heavy duty trucks and motorcycles. The functions obtained for Germany were used in the reconciliation process for the rest of the countries, in order to provide an initial indication of individual country survival rates for each vehicle type in a way that ensured overall consistency specifically for the country.

In order to estimate equations following the general specification of equation 24 for each vehicle type non linear methods were used. We have experimented with the many alternative specifications of the parameter b , including the examination of different b by vintage for the same vehicle type as well as specification involving b as a function of k . This led to a simultaneous estimation procedure. The general algebraic specification of the estimation model used is given below:

$$\varphi_i = \exp\left(-\left(\frac{k_i + b_i(k_i)}{T}\right)^{b_i(k_i)} + \varepsilon_i\right) \quad (25)$$

$$b_i(k_i) = h_{1,i} + h_{2,i} \cdot k_i + h_{3,i} \cdot e^{h_{4,i} \cdot k_i} \quad (26)$$

where i is the vintage of the vehicle type under consideration and ε_i is the error term of the estimated equation. In the above specification the estimated parameters are the T and $h_{j,i}$, $j=1...4$ for each vehicle type of vintage i . The estimation method used is the Seemingly Unrelated Regression (SUR) method, which is appropriate when all right hand side regressors are assumed to be exogenous and the errors are heteroscedastic and contemporaneously correlated. It should be noted that filters have been used whenever discontinuities in the dataset used for the estimation process were identified.

The following set of experiments were studied in detail in the context of the FLEET project regarding the alternative specifications of the parameter b :

- Different b according to vintages (but b 's are not functions of age)
- Formation of groups of vintages (1980-1991, 1992 onwards) and estimation of one b per each group. This discontinuity is mainly due to the German unification
- One single b for all vintages (but b is not a function of age)
- One single b for all vintages as a linear function of vintage
- One single b for all vintages as an exponential function of vintage

In Figure 5-4 an example of the experiments assuming different b according to vintage i is given. The figure shows the mean and the ± 2 standard errors range. The concrete algebraic specification of the estimation model is:

$$\varphi_i = \exp\left(-\left(\frac{k_i + b_i}{T}\right)^{b_i} + \varepsilon_i\right) \quad (27)$$

The above specification implies a b , which is not a function of age. The estimation process gave robust results, as can be judged by the small error ranges in comparison to mean values of the betas displayed in the graph. Two main groups of vintages can be easily identified in the graph: cars registered from 1980-1991 and cars registered from 1992 onwards. The means of b of the first group are higher than the means of the second group implying higher failure rates for the older cars.

Looking at the range of betas of the first group, it can be assumed that the sample of betas could have been derived from one distribution. This is also noticeable for the second group, although there are some cases when this assumption does not appear to be statistically valid. This has led to the next experiment, which was to estimate one single beta for each one of the two groups above. By forming two groups of vintages (1980-91, 1992-onwards), the following estimation model was applied:

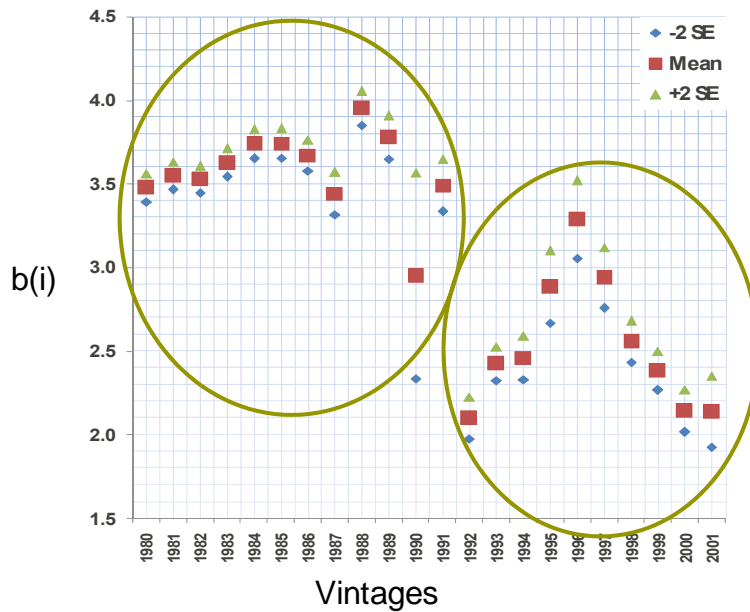


Figure 5-3: Example of the experiments assuming different b according to vintage i - Passenger cars in Germany

$$\varphi_i(k_i) = \exp\left(-\left(\frac{k_i + b_i}{T}\right)^{b_i} + \varepsilon_i\right), \quad i=80-91, 92-01 \quad (28)$$

Figure 5-4 presents the results of the estimation process. The t-Statistic of the estimated coefficients is very high, which implies robust estimation results. The two estimates of the betas are negatively correlated, with a correlation coefficient of approximately -0.42. This implies that a probability of a high b in the post 1992 period increases if the b in the earlier period turns out lower.

	Coefficient	Std. Error	t-Statistic	Prob.
B_1980-1991	3.509233	0.019142	183.3235	0.0000
T	18.48026	0.025678	719.6898	0.0000
B_1992	2.572252	0.036112	71.22988	0.0000

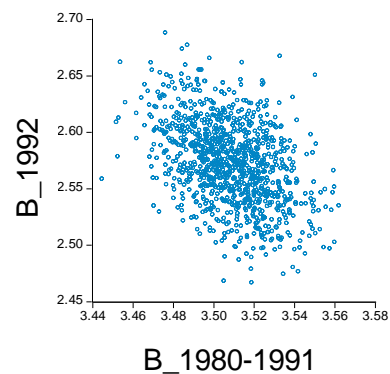


Figure 5-4: Example of the experiments assuming different b for each group of vintages

By plotting the survival curves and the scrapping rates of these two groups of vintages it can be seen that scrapping rates are more concentrated in the period between 7 to 23 years after the first registration for both groups.

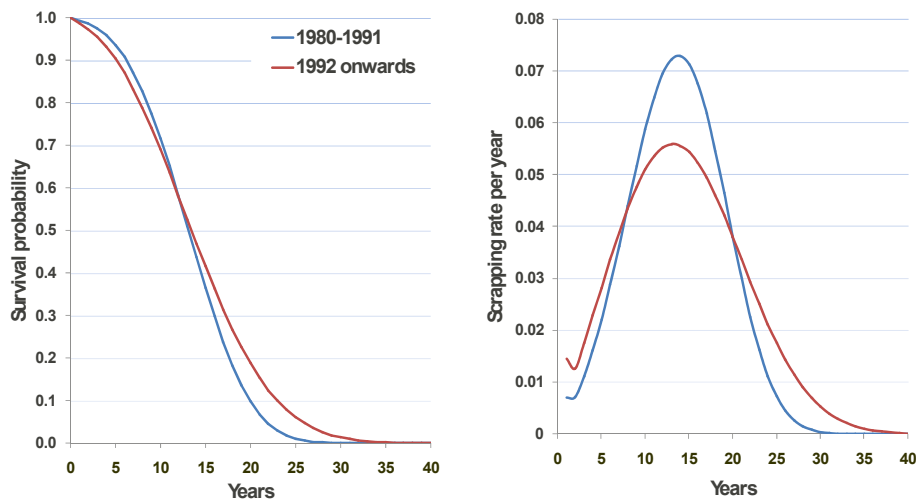


Figure 5-5: Survival curve and scrapping rates in the case of two groups of vintages (passenger cars in Germany)

The third experiment performed is to use the classical survival curve model described by equation 24. The results of estimating one beta for passenger cars in Germany are given in Table 5-5. In comparison with the approach of two betas it can be seen that the T parameter is more or less the same, implying the stability of this estimator, while the mean of the beta is closer to the mean of the beta of the first group which can be explained by the fact that the share of these cars in deregistration is significantly higher than the cars of the second group.

Table 5-5: Example of the experiments performed using a single beta - Passenger cars for Germany

	Coefficient	Std. Error	t-Statistic	Prob.	
B	3.490394	0.016736	208.5564	0.0000	Single beta
T	18.43489	0.024116	764.4182	0.0000	
	Coefficient	Std. Error	t-Statistic	Prob.	
B_1980-1991	3.509233	0.019142	183.3235	0.0000	Two groups of beta (repeated for comparison)
T	18.48026	0.025678	719.6898	0.0000	
B_1992	2.572252	0.036112	71.22988	0.0000	

By plotting the survival curve function of the single beta experiment and the scrapping rate curve and comparing them with the ones of the two betas approach (Figure 5-7), it can be seen that the single beta function has lower scrapping rates at the early years and higher scrapping rates at later years while at the same time imply very small probabilities of survival in the very long term (above 25 years). All the above are intuitively sound.

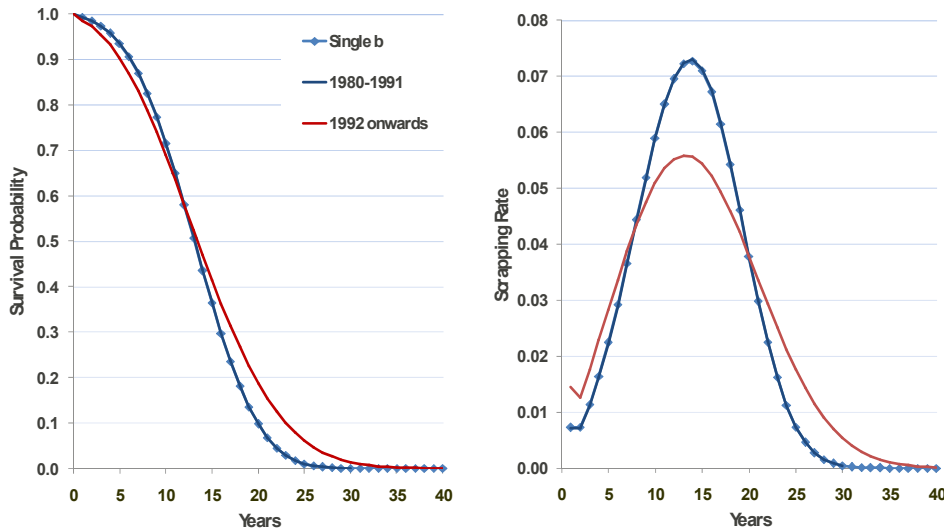


Figure 5-6: Comparison of the survival curve and scrapping rates in the cases of a single beta and two groups of vintages

The next experiment was to make beta a linear function of vintage. The estimation model used is the following:

$$\varphi(k) = \exp\left(-\left(\frac{k + b(k)}{T}\right)^{b(k)} + \varepsilon\right) \quad (29)$$

$$b(k) = h_1 + h_2 \cdot k \quad (30)$$

An example of the output of the estimation for buses is given in Table 5-6..

Table 5-6: Example of making b a linear function of age - Buses in Germany

	Coefficient	Std. Error	t-Statistic	Prob.
H(1)	1.698018	0.080206	21.17070	0.0000
H(2)	0.030591	0.014619	2.092611	0.0378
T(1)	28.99423	0.985381	29.42439	0.0000

By plotting the survival curve and scrapping rates and comparing them with the single beta approach it can be observed that the linear function produces higher scrapping rates in the later years than the single beta function. As an example, the traditional approach of a single beta gives 20% probability that a vehicle of 40 years of age will be still operational, while if the linear function is used this probability falls to around 5%. The latter result is by far more acceptable.

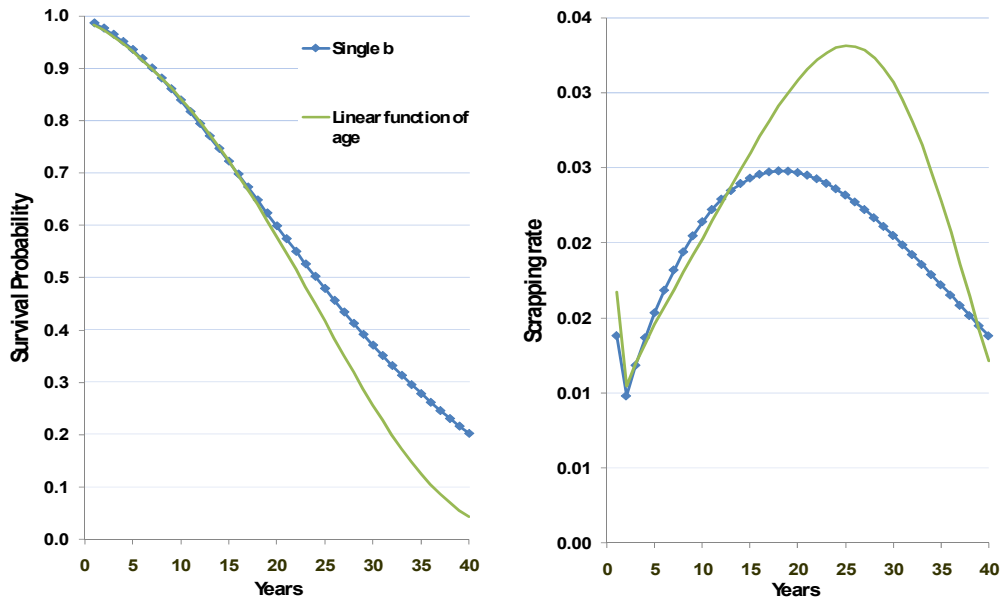


Figure 5-7: Comparison of the single beta with the linear approach

The last type of experiment examined in the context of the FLEETS project was to make beta an exponential function of age. The estimation model used in this experiment is:

$$\varphi(k) = \exp\left(-\left(\frac{k + b(k)}{T}\right)^{b(k)} + \varepsilon\right) \quad (31)$$

$$b(k) = h_1 \cdot e^{h_2 \cdot k} \quad (32)$$

Table 5-7 presents the estimation output in the case of the Heavy Duty Vehicles.

Table 5-7: Example of making b an exponential function of age - Heavy duty trucks in Germany

	Coefficient	Std. Error	t-Statistic	Prob.
H(1)	3.498560	0.260080	13.45188	0.0000
H(2)	-0.024968	0.005169	-4.830016	0.0000
T	15.33555	0.086397	177.5004	0.0000

By comparing the survival curves and the scrapping rates of the single beta approach, the beta as a linear function of age and the beta as an exponential function of age for the case of the heavy duty trucks it can be observed that the exponential function constitutes a better specification than the other two. It does not display the undesirable property of the linear function to become negative in the later years and it also has lower scrapping rates than the single beta approach.

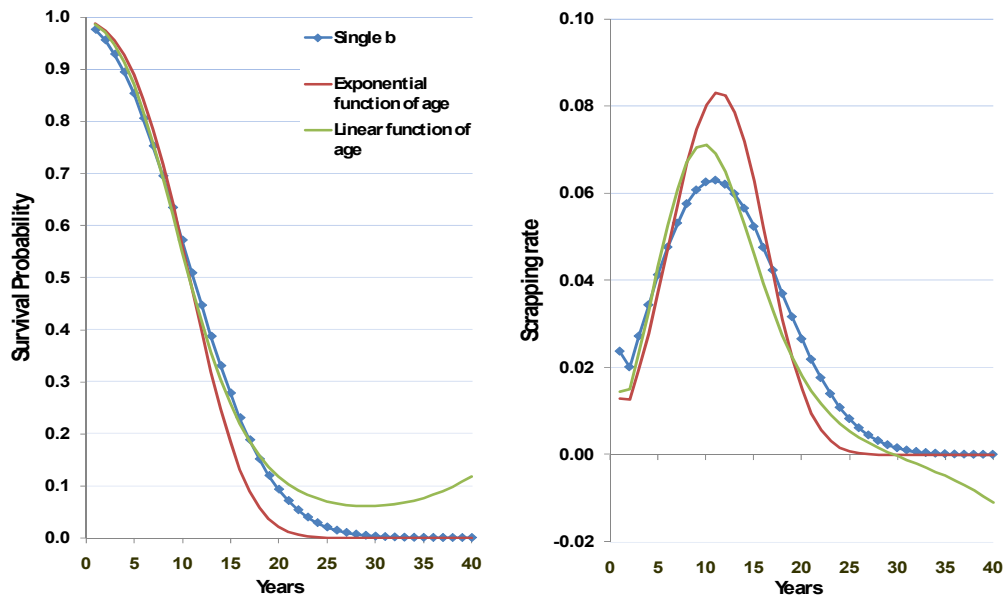


Figure 5-8: Comparison of survival curves and scrapping rates - Heavy duty vehicles in Germany

Table 5-10 presents a comparison between the estimated survival curves and scrapping rates for the different vehicle types for Germany. It can be seen that trucks and light duty vehicles display the highest scrapping rates in the early years, since these are commercial vehicles and their renewal can be viewed as capital turnover subject to strict productivity considerations. Passenger cars also display a narrow scrapping rate distribution over time reflecting during the last decade a shift in consumer preference for newer cars. Buses display significantly lower rates than the other vehicle types to the point of producing paradoxical situations (survival and presumably circulation of buses older than 40 years in substantial numbers). This, however, is confirmed by other studies on survival curves (e.g. Tremove). It must be noted that most buses belong to public authorities and maybe subject to different de-registration requirements. An even more acute problem is identified in motorcycles where the very long survival of part of the fleet is difficult to justify. A very likely reason for this seeming paradox is that de-registration of two wheelers is not always recorded with the vehicles may either abandoned or kept without using them. The seeming long life of two wheelers has also been identified in earlier studies.

Although a comparison of the above lifetime functions with the lifetime functions used in Tremove, TRENDS and ARTEMIS project is tempting, such a comparison cannot be made because:

- The estimation in FLEETS was based only on data for Germany because there were no other available sources in the project
- Even if the same data sources were used, the specification of the lifetime functions is different between the FLEETS and the other projects.
- In FLEETS project direct statistical methods were used instead of ad-hoc approximations

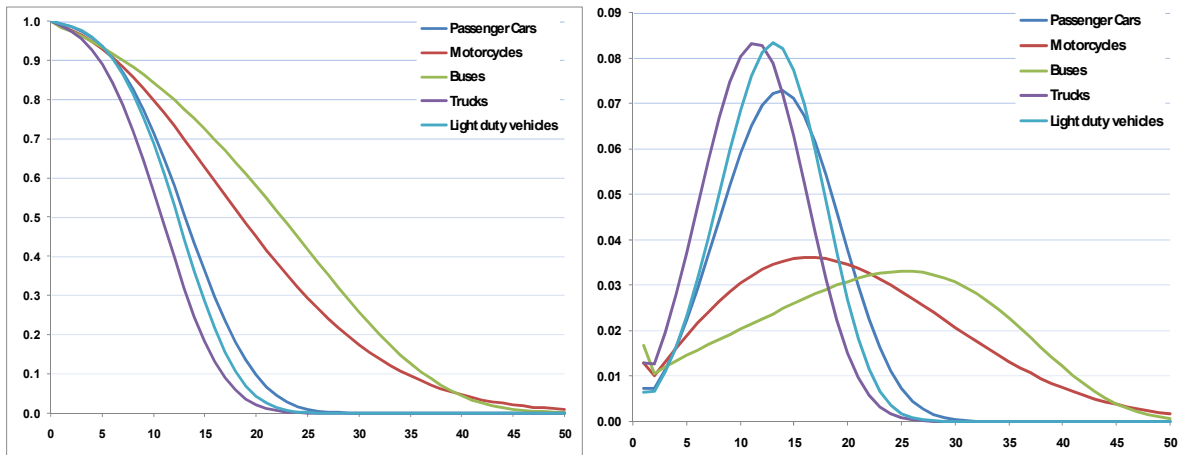


Figure 5-9: Results of the estimated survival curves and scrapping rates for the different vehicle types in Germany

An attempt of a comparison is given in the figure below for passenger cars in France. Although the FLEETS curve has been estimated using data from Germany, it follows the actual data better than the lifetime function of the Tremove.

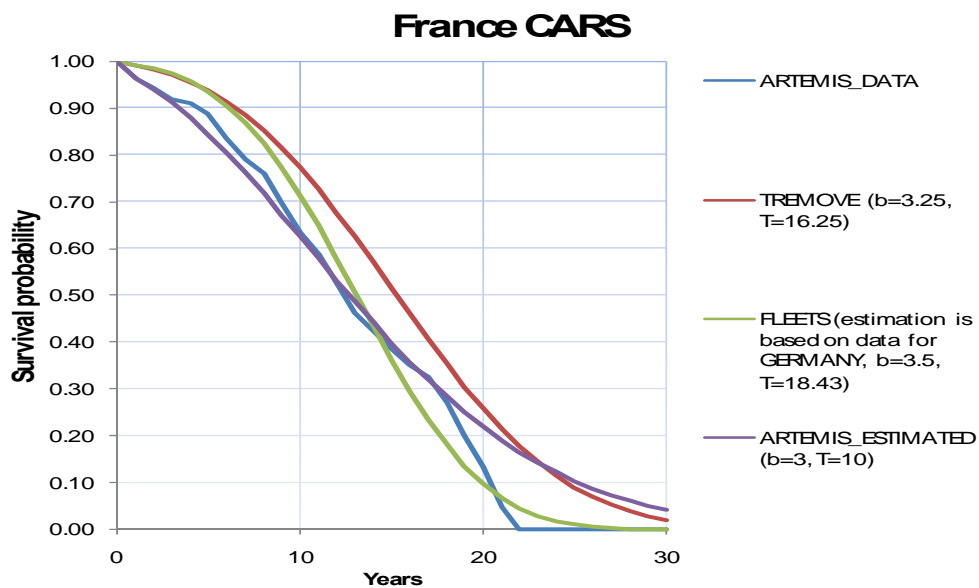


Figure 5-10: Comparison of lifetime functions of FLEETS and the ones used in ARTEMIS and Tremove

In comparison with the ad-hoc estimation it can be seen that the FLEETS project by using direct statistical methods displays lower absolute error, especially in the later years. Finally Table 5-8 displays in an aggregate form the estimated lifetime functions and their parameters obtained in the FLEETS project using data for Germany.

Variable	Coefficient	Std. Error	t-Statistic	Prob.
B	3.752580	0.127444	29.44493	0.0000
T	11.90511	0.344965	34.51109	0.0000

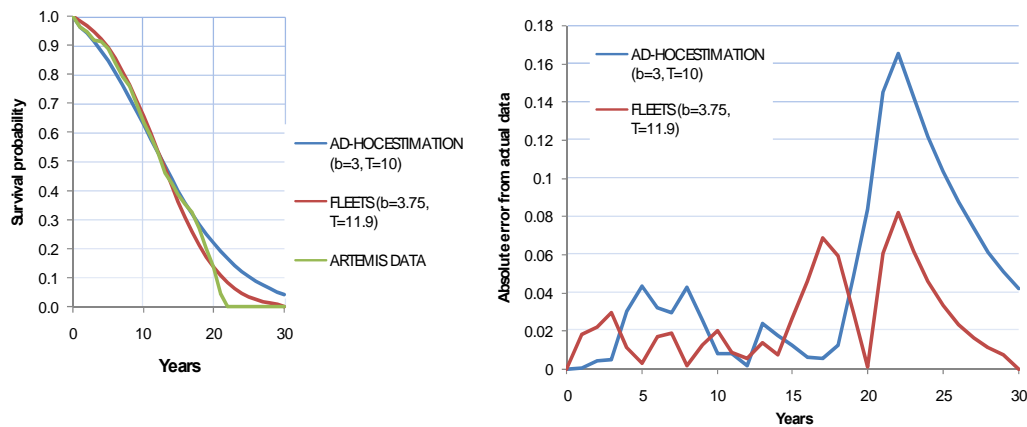


Figure 5-11: Comparison of the passenger cars lifetime function between FLEETS and ad-hoc estimation for FRANCE (using data from the ARTEMIS project)

Table 5-8: Overview of the obtained life time functions and their parameters

PASSENGER CARS

$$\varphi(k) = \exp\left[-\left(\frac{k+b}{T}\right)^b\right]; \varphi(0)=1$$

	Coefficient	Std. Error	t-Statistic	Prob.
B	3.490394	0.016736	208.5564	0.0000
T	18.43489	0.024116	764.4182	0.0000

TWO WHEELERS

$$\varphi(k) = \exp\left[-\left(\frac{k+b}{T}\right)^b\right]; \varphi(0)=1$$

	Coefficient	Std. Error	t-Statistic	Prob.
B	2.101381	0.012820	163.9165	0.0000
T	24.56400	0.071218	344.9140	0.0000
FILTER_1989-1994	-0.086336	0.008104	-10.65291	0.0000

BUSES

$$\varphi(k) = \exp\left[-\left(\frac{k+(h_1+h_2 \cdot k)}{T}\right)^{(h_1+h_2 \cdot k)}\right]; \varphi(0)=1$$

	Coefficient	Std. Error	t-Statistic	Prob.
H(1)	1.698018	0.080206	21.17070	0.0000
H(2)	0.030591	0.014619	2.092611	0.0378
T	28.99423	0.985381	29.42439	0.0000

LIGHT DUTY VEHICLES

$$\varphi(k) = \exp\left[-\left(\frac{k+(h_1 e^{h_2 \cdot k})}{T}\right)^{(h_1 e^{h_2 \cdot k})}\right]; \varphi(0)=1$$

	Coefficient	Std. Error	t-Statistic	Prob.
H(1)	3.498560	0.260080	13.45188	0.0000
H(2)	-0.024968	0.005169	-4.830016	0.0000
T	15.33555	0.086397	177.5004	0.0000

HEAVY DUTY TRUCKS

$$\varphi(k) = \exp\left[-\left(\frac{k+(h_1 e^{h_2 \cdot k})}{T}\right)^{(h_1 e^{h_2 \cdot k})}\right]; \varphi(0)=1$$

	Coefficient	Std. Error	t-Statistic	Prob.
H(1)	2.931193	0.272243	10.76684	0.0000
H(2)	-0.016694	0.006329	-2.637554	0.0092
T	17.38097	0.163947	106.0158	0.0000

5.3 Registration and use of N1 vehicles

In Tremove, light duty vehicles are further split into 'trucks' and 'vans'. The vehicles used for freight transport are considered as light duty trucks while those used for the transfer of professionals (plumbers, electricians, etc.) are considered as vans. This distinction is derived from the need to separate fuel consumption to the part used for the transfer of freight over the part used for the transfer of people. However, the use of the term *Van* for the transport of people may be confusing as manufacturers consider vans as any vehicles less than 7,5 t which are used for the transfer of goods. But even more generally, a point of confusion is the distinction of N1 vehicles for the transfer of goods or people. According to the regulations N1 are by definition only used for the transfer of goods.

In order to provide some clarifications with regard to terminology but also in order to identify which vehicles fall under which category, we have used market information to provide the distinction between M1/N1 vehicles and shed some light on the use of N1 vehicles in the real-world.

5.3.1 Definitions

Euro 3/4

M1 and N1 vehicles are classified according to their weight, their purpose and the number of their seats. Figure 5-12 shows the vehicle distinction to the different classes according to the number of seats and the maximum technically admissible laden weight (MTALW).

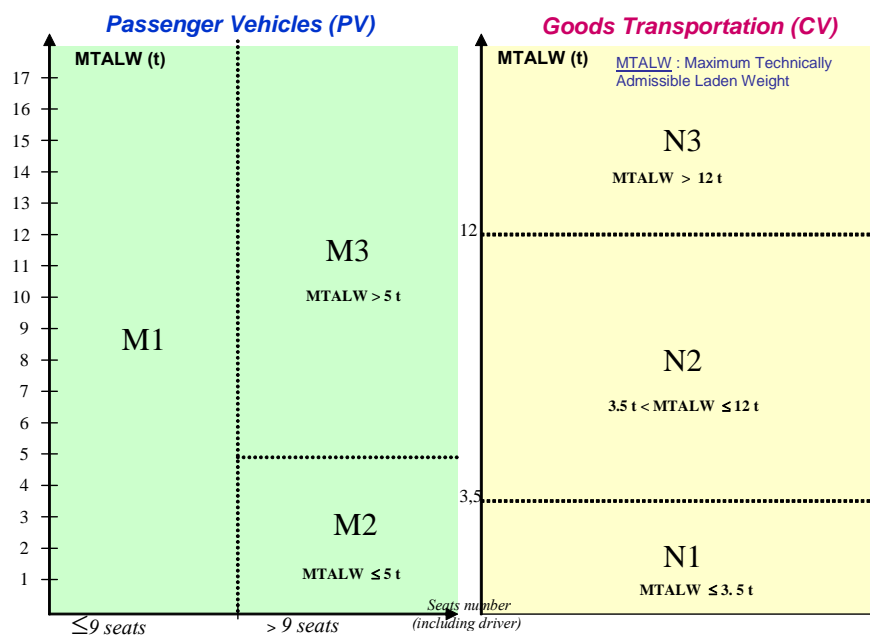


Figure 5-12: Distinction to UNECE categories according to weight and number of seats.

N1 are primarily used for good transportation and their MTALW is below 3,5 t (Directive 70/156/EV amended by 2006/40/EC). At the request of the manufacturer, homologation

granted to M1 or N1 Diesel vehicles can be extended to M2 and N2 respectively under specific conditions. This is only valid for M2 and N2 vehicles having a reference mass (unladen mass in running order + 100 kg) less or equal than 2 840 kg.

Directive 80/1268/EEC amended by 2004/2/EC requires fuel efficiency/CO₂ measurement for N1 according to the schedule below:

- N1 class 1: New Types Jan/01/05 – All Types Jan/01/06
- N1 class 2 & 3: New Types Jan/01/07 – All Types Jan/01/08.

If the total annual worldwide production is less than 2000 units and if the engine is certified according to Directive 88/77/EEC, the fuel consumption would not be requested. In addition, it should be noted that engine test bench instead of vehicle chassis emission type-approval was allowed for Euro 3 N1 but very few type approvals were done following this option. Starting with Euro 4, exhaust emission tests and efficiency are tested (Directive 80/1268) jointly over NEDC cycle either for M1 or N1.

Euro 5

Euro 5 will be implemented by EU Regulations instead of a Directive. A Regulation is directly applicable by Member States. The political content (implementation dates, limits ...), so called co-decision part involving Parliament, Council and Commission has been issued. The technical annexes of Euro 5 have not yet been issued in the Official Journal (expected July 2008).

The scope of Euro 5 is motor vehicles M1, M2, N1, N2, as defined in Directive 70/156/EEC with reference mass not exceeding 2610 kg. At the manufacturer’s request, type approval may be extended to M1, M2, N1, N2 with reference mass between 2610 and 2840 kg.

Note: Motor vehicles M1, M2, N1, N2 with a reference mass over 2610 kg have to be certified according to the 2005/55/EEC and 2005/78/EEC directives (HDV certification), notwithstanding the extension rule for vehicles with a reference mass not exceeding 2840 kg.

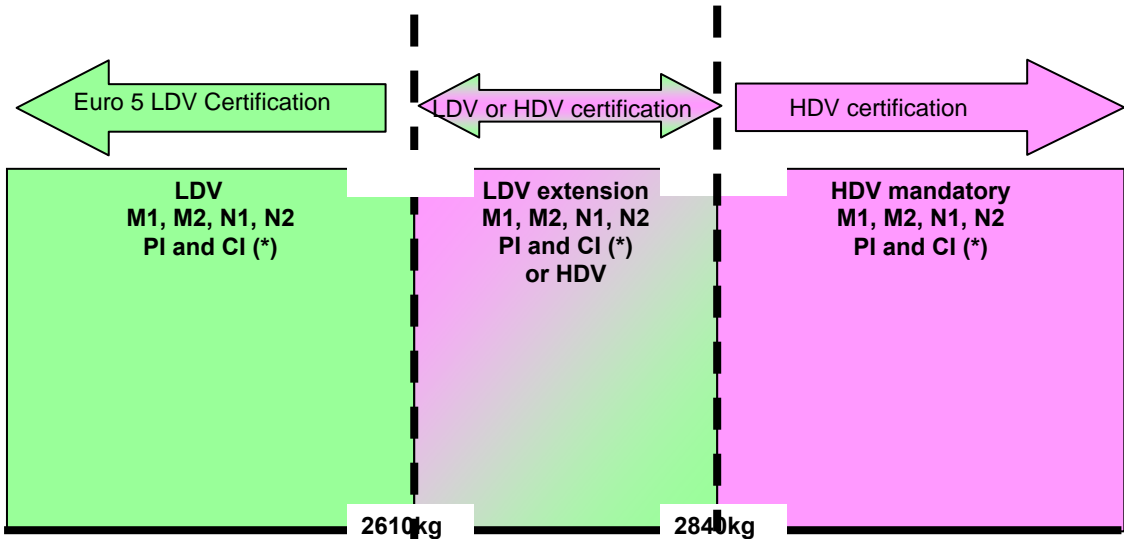


Figure 5-13: Type approval procedure for Euro 5 (Euro V) vehicles. (*) PI : Positive Ignition CI : Compression Ignition

Euro 5 regulation introduces a new definition of “vehicles designed to fulfill specific social needs” as Diesel vehicles in category M1 which are either:

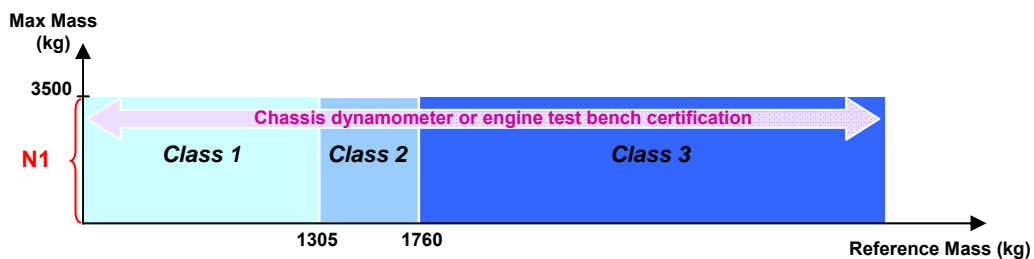
- Special purpose (as defined in Directive 70/156/EEC) with RM > 2000 kg, or
- Vehicles with RM >2000 kg and designed to carry 7 or more occupants including the driver, with the exclusion, as from 1st September 2012 of vehicles of category M₁G as defined in Directive 70/156/EEC, or
- Vehicles with RM >1760 kg for commercial purposes to accommodate wheelchair use inside the vehicle

Also, with Euro 5, N1 with reference mass above 2610 kg may not be submitted to FC tests.

Summary of definitions

Based on these definitions, N1s are distinguished in the different classes according to their weight, as shown in Figure 5-14.

Euro 3 or Euro 4



Euro 5

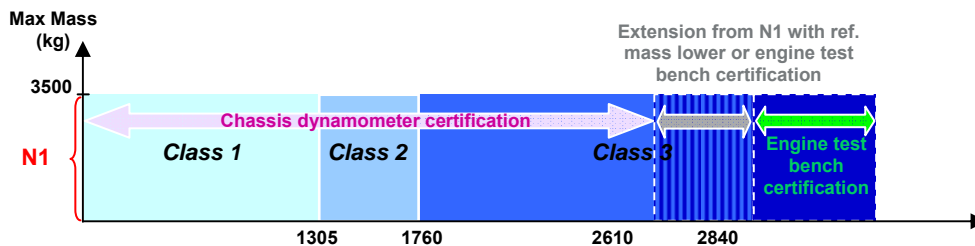


Figure 5-14: Summary of definitions for N1 vehicle classification, according to pre Euro 5 and Euro 5 regulations

5.3.2 Conversion of M1 to N1

Even if in a regulatory language the distinction between M1 (passenger Vehicles) and N1 (goods transportation) is simple, fiscal incentives sometimes lead to specific adaptation of M1 into N1 in order to minimize taxation on private companies.

For example, in the case of France (but similar conditions apply to other countries as well), vehicles used for private companies are submitted to a “Taxe sur les véhicules de société” (TVS). The legal coverage of this tax is passenger vehicles (M1). It is interesting to note that

according to “la loi de Finance 2006, article 16”, the amount of the tax may vary according to CO₂ exhaust emission value. Seven categories of cars are defined according to their CO₂ emission. For example, the annual tax for a car with an emission rate of 180 g/km is in category n°5 (15 €/km) and therefore the CO₂ tax is 2700 €.

On the other hand, corporate N1 cars are not submitted to TVS. In fact, considering the case of France, N1 vehicles used for companies are exempted from:

- TVS : “Taxe Véhicule de Société”
- VAT on the purchasing price
- VAT on fuel & periodic maintenance

Consequently, there is a share of M1 cars that are transformed into N1 to benefit from the lower taxation. We have conducted an investigation to figure out the process of transformation of M1 into N1. The process involves the vehicle dealer, who will send the car (a M1 car, e.g. ranging from Twingo to Espace) to a specific society (e.g. NOVETUDE KIT). The society will re-design the interior of the car in order to make it suitable for goods transportation. Registration papers are modified from M1 to N1 and a specific sticker (so called “sticker de charge”) is put on the right fender. After that the vehicle is sold as a N1. This operation is usually reversible and initial backseats may be stored to re-equip the original car. Therefore, a big part of true M1 cars may be registered as N1 but are solely used for the transport of people.



Figure 5-15: Same car used for different purpose (left: M1, right: N1).

The fiscal requirements are not the same and vary from member state to member state. Internet provides many “company car tax choosers” or “fiscal calculators” enabling companies to choose the best scheme.

5.3.3 Scope of the Study

Several manufacturers produce models which can be used either for the transport of people or, with minor modifications, for the transport of goods. Also, in order to take advantage of fiscal incentives, several M1 vehicles are “in paper” converted to N1s but are still used for the transport of people. Therefore, there is a certain overlap between the M1/N1 vehicles.

Therefore, we have tried to reveal the extent of this overlap in order to estimate the fraction of N1 vehicles which are used for the transport of people.

Case 1: M1 with interior transformation into N1. It is not the main subject of this report because car manufacturers are not specifically involved in the process, However, it is a real problem for the N1 world and in particular for the energy allocation. An estimate has been done for EU15, year 2005.

Case 2: Given our industrial data, we will try first to focus on “real N1” (Ex : Master, Traffic). Those cars may also be considered as a M1 but in that case it implies a body transformation and **external visible changes**. Technically the vehicle platform is the same but the body is specific.

5.3.4 Data providers

We have considered three data providers:

- 1st Source: Aggregated new vehicle sales data that are issued from the Renault Statistical World Wide Book (SWWB). This source contains Light Commercial Vehicle world. Data are classified as shown in Figure 5-16:

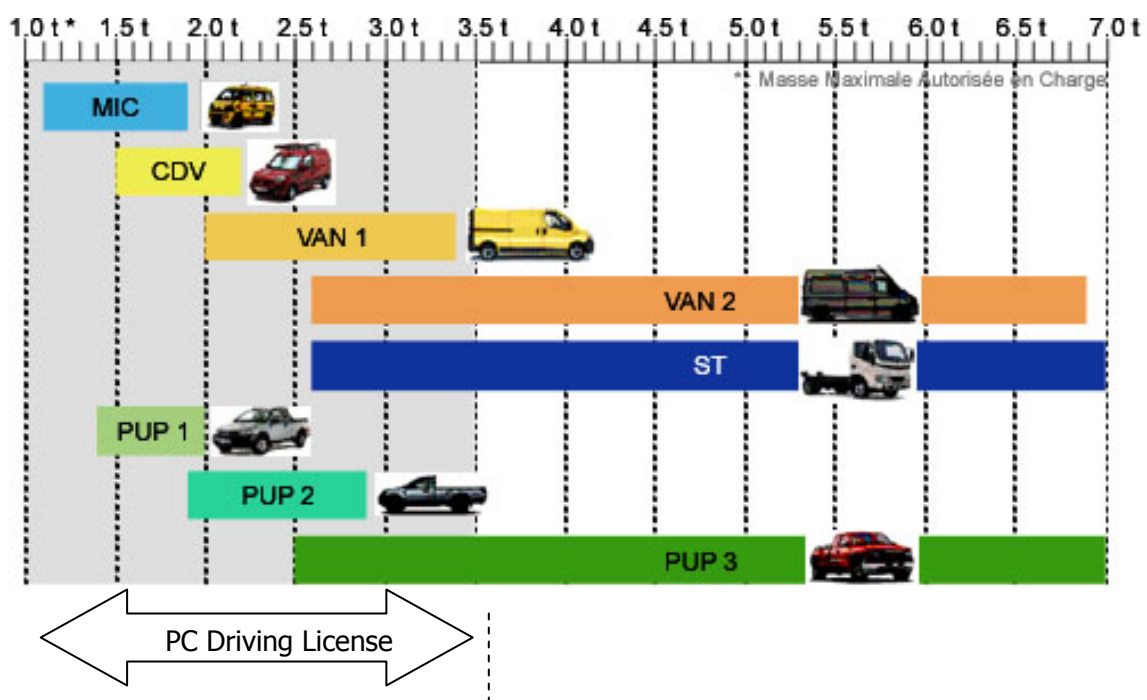


Figure 5-16: Classification of N1s according to the Renault statistical world-wide book (SWWB)

The acronyms in Figure 5-16 stand for:

MIC: MicroVans, Trucks (for Japan only)

CDV: Car Derived Vans – Delivery vans derived from passenger cars with added rear load cell or delivery vans with load cells integrated with the body (“véhicule de société excluded”)

VAN1: Light commercial vehicles in the same class with Renault Trafic (<3,5 t GVW & 5 m³)

VAN2: Light commercial vehicles in the same class with Renault t Master (<7 t GVW)

ST: Small Trucks etc.

For the purpose of this study we have made several hypothesis concerning the study :

- **HYP 1:** N1 category comprises of CDV, VAN1 & VAN2. N1 class 1 is represented by the CDV category whereas N1 classes 2 & 3 are represented by VAN1 & VAN2 categories.
- **HYP 2:** N1 class 2 vehicle volumes are not significant (used for very specific purposes)
- **HYP 3:** there is negligible number of N1 in ST category
- **HYP 4:** there are very few N2 in the CDV, VAN1, VAN2 category
- **HYP 5:** Even if VAN2 GVW upper limit is theoretically 7 t, there are mainly N1 vehicles in this category (MTALW ≤3,5T) for specific purposes:
 - Above 3,5 t, the driving PC license type is not valid anymore (N2 fall under HD driving license)
 - N2 (HD) speed is limited (90 km/h) but there may be specific areas which, according to national legislation, speed limits are different.
- 2nd Source: Association Auxiliaire de l’Automobile (AAA) aggregated data: Figures of new registrations for M1 cars
- 3rd Source: Le Comité des Constructeurs Français d’ Automobiles (CCFA) on registrations of N1 new vehicles

5.3.5 N1 new registration analysis

Table 5-9 presents the number of new N1 registrations per European country (data where available) for the different years, originating from the CCFA database. These are actual N1 registrations, regardless of the original purpose of use and construction of the car. That is, the table includes both original M1 that have been converted to N1 and original N1 vehicles.

Table 5-9: New registrations of N1 vehicles according to the CCFA database

Units	1980	1985	1990	1995	2000	2001	2002	2003	2004	2005	2006
Germany	175 687	133 834	203 389	260 512	314 804	296 601	270 567	264 745	283 401	295 627	304 433
Austria	21 821	21 330	29 211	27 889	36 457	32 535	29 864	34 195	39 507	37 678	38 793
Belgium	34 478	31 946	46 670	42 799	66 125	72 969	60 266	62 363	70 093	75 083	72 079
Denmark	19 469	38 458	23 031	30 838	38 108	36 326	36 822	37 403	51 210	64 293	71 965
Spain	105 934	131 941	249 185	185 447	335 684	325 625	305 900	333 107	374 058	430 611	318 526
Finland	17 699	18 566	32 154	10 571	18 128	18 150	18 328	18 829	22 096	19 955	20 941
France	323 291	342 164	446 983	357 776	477 204	496 263	460 937	431 446	459 851	480 122	498 397
Greece	53 500	18 965	30 075	17 818	25 015	22 832	20 296	20 710	26 284	25 538	26 391
Ireland	11 905	15 898	28 087	16 342	46 261	42 895	38 328	34 477	34 416	41 965	46 957
Italy	122 293	113 643	159 322	160 844	268 057	268 524	307 597	237 844	254 712	246 894	271 388
Luxembourg	1 300	3 875	2 961	2 915	4 642	5 185	5 028	4 772	3 834	4 605	4 675
Norway	15 135	42 530	23 035	37 996	35 618	37 458	28 523	31 327	38 408	42 681	49 243
Netherlands	47 926	63 107	68 791	65 254	114 354	101 449	95 526	90 977	101 455	80 771	84 713
Portugal	46 967	23 146	71 904	70 230	161 045	106 251	84 731	73 362	76 611	71 982	70 472
United Kingdom	274 143	286 797	293 473	252 672	301 523	316 084	324 742	366 106	392 225	388 410	389 496
Sweden	19 684	22 933	33 133	14 818	38 474	35 266	34 576	34 278	37 371	41 807	47 194
Switzerland	22 418	20 486	28 165	19 544	29 345	31 583	26 769	23 809	25 651	26 702	28 932
Union Eur. (15 pays)	1 276 097	1 266 603	1 718 369	1 516 725	2 245 881	2 176 955	2 093 508	2 044 614	2 227 124	2 305 341	2 266 420
Europe (17 pays)	1 313 650	1 329 619	1 769 569	1 574 265	2 310 844	2 245 996	2 148 800	2 099 750	2 291 183	2 374 724	2 344 595
Central & Eastern Europe	850 000	1 050 000	874 072	358 760	579 060	481 924	519 875	628 479	776 898	847 773	882 627

Based on these data, we make a more specific analysis for the N1 registrations in 2005. Table 5-10 makes a comparison between actual N1 sales and actual registrations per country. Columns 2 to 4 (CDV, VAN1, VAN3) include the total number of N1 vehicle sales. For the vehicle models that are included in the SWWB database, columns 5 and 6 (M1_cl1 and M1_cl2) show the number of registrations as M1 cars.

Table 5-10: Sales and actual registrations of N1 cars in 2005

YEAR 2005	Total Sales of N1 models (SWWB)			Total M1 Registrations of N1 models (AAA)		Number of N1 Class I	Number of N1 Class III	Total N1 Registrations (CCFA)	Difference between Registrations and Sales (absolute)	Difference between Registrations and Sales (%)
	CDV	VAN1	VAN2	M1_cl1 (Cars)	M1_cl2 (Minibus)	=CDV-M1_cl1	=VAN1+VAN2-M1_cl2	N1		
AT	10143	12760	9382	3348	4656	6795	17486	28878	4597	16%
BE	36143	18537	20199	19580	4794	16563	33942	62672	12167	19%
DE	99780	114792	108229	60960	68059	38820	154962	202335	8553	4%
DK	8804	11338	9588	3264	1985	5540	18941	58079	33598	58%
ES	128246	59651	52316	0	3051	128246	108916	387203	150041	39%
FI	1754	9410	6445	845	1385	909	14470	16211	832	5%
FR	163472	73387	111039	62511	15072	100961	169354	420065	149750	36%
IT	59588	31166	72637	17336	8723	42252	95080	218514	81182	37%
LU	1923	980	1484	1068	553	855	1911	3064	298	10%
NL	24317	28626	16035	4920	2874	19397	41787	66236	5052	8%
PT	16661	8953	7904	1171	89	15490	16768	66774	34516	52%
SE	15164	11288	7654	2524	1914	12640	17028	35095	5427	15%
UK	102239	92379	96857	15084	2891	87155	186345	330436	56936	17%
IS	610	662	358							
NO	9839	11522	2536							
CH	6770	8322	8688							
EFTA (3)	17219	20506	11582							
EU(15) + EFTA(3)	17219	20506	11582							
BU	3769	368	2434							
HR	4463	1582	2846							
CZ	6055	4481	6668							
EE	2201	967	1062							
HU	6173	4110	6966							
LV	1330	623	924							
LT	1432	641	1103							
PL	5770	1702	8928							
RO	5770	1702	8928							
SK	3384	985	2510							
SI	2744	1360	2168							
New EU Members	43091	18521	44537							

The number of actual sold N1 vehicles that are registered as N1s is shown in columns 7 and 8. Column 7 values are calculated if we subtract the M1_cl1 vehicles from the CDV ones. Similarly, column 8 values are calculated if we subtract M1_cl2 vehicles from the sum of VAN1

and VAN2. Column 9 shows the total number of N1 registrations according to the CFFA. If we subtract sales from actual registrations, after correcting sales for the number of vehicles registered as M1s, there is a large difference occurring which ranges from 5% to 58% of total N1 sales. A possible reason for this deviation is the M1 conversion into N1, following fiscal incentives. Most probably, this conversion will lead to a N1 car which will be used for passenger transport.

To illustrate this between registrations and sales, we have taken the example of Renault Clio for France, a very popular model. Part of the total sales are typical passenger cars (AAA database) and a smaller part is sold as company cars with only 2 seats (SWWB). The share of N1/PC for year 2005 is 38% for France only. This figure is close to the data extracted in the previous table.

Nevertheless, according to our EU27 marketing data, figures are very different from country to country. For example, in Spain and Canary Islands, there are many 4x4 and high-class company cars sold as Light Commercial Vehicles. There are also some specific conditions in Italy and Czech Republic, Belgium and other specific areas. There are more detailed data available (confidential to the consortium only) that confirm that a large number of typical passenger cars are registered as N1s in different countries. The data include sporty cars and luxury cars that by no means can be considered for the transfer of goods.

The conclusion from the analysis presented in this section is that a large number of assumingly N1 cars are actually M1s which are registered as N1s to evade taxes. Despite the analysis in Table 5-10 is prone to some uncertainty originating from the mutual transfer between M1 and N1 categories, this still shows that the number of N1 vehicles which are used for the transfer of people is quite significant. It is suggested that these values can be used as a minimum to allocate energy consumption to N1s used for the transport of people. In reality, several of the true-N1 cars (mainly falling in the N1 class I category) are also used for the transport of people (professionals) and not goods. Information on the share of Class I vs Class III vehicles can still be obtained from Table 5-10 and can be also used as additional guidance to estimate the allocation of energy for passenger transport.

5.3.6 Actual use of N1 vehicles

Table 5-11 gives statistical results of average mileage (moyenne) and variation (écart type) of Renault N1 (Trafic & Master) compared to Renault M1 (small & bigger cars). The mileage is given as cumulative values over a period of five years. The results, which are based on real-world recordings, show that N1 vehicles are not used in average more than diesel passenger cars. In fact, large diesel passenger cars are driven longer distances than the N1 vehicles. A reason for this maybe that N1 are mostly used in urban conditions with low mean speeds compared to passenger cars. The latter may also more frequently be driven in extra-urban conditions with higher average speeds.

Table 5-11: Mean mileage (Moyenne) and range of variation (Ecart type) of different vehicle types/models in France

Trafic Diesel France:

Trafic Diesel France	1an	2 ans	3 ans	4 ans	5 ans
Moyenne	31000	57000	77000	93000	109000
Ecart type	21000	34000	42000	50000	55000
M+3σ	94000	159000	203000	243000	274000

Master Diesel France:

Master Diesel France	1an	2 ans	3 ans	4 ans	5 ans
Moyenne	30 000	54 000	75 000	95 000	115 000
Ecart type	25 000	40 000	47 000	53 000	58 000
M+3σ	105000	174000	216000	254000	289000

Segment M1 Diesel France:

M1 Diesel France	1an	2 ans	3 ans	4 ans	5 ans
Moyenne	26 500	48 500	70 000	89 000	106 000
Ecart type	16 000	28 500	36 000	43 000	49 000
M+3σ	74500	134000	178000	218000	253000

Segment M1 Diesel France:

M1 Diesel France	1an	2 ans	3 ans	4 ans	5 ans
Moyenne	31 500	61 500	90 000	115 000	140 000
Ecart type	19 000	35 500	45 000	53 000	60 000
M+3σ	88500	168000	225000	274000	320000

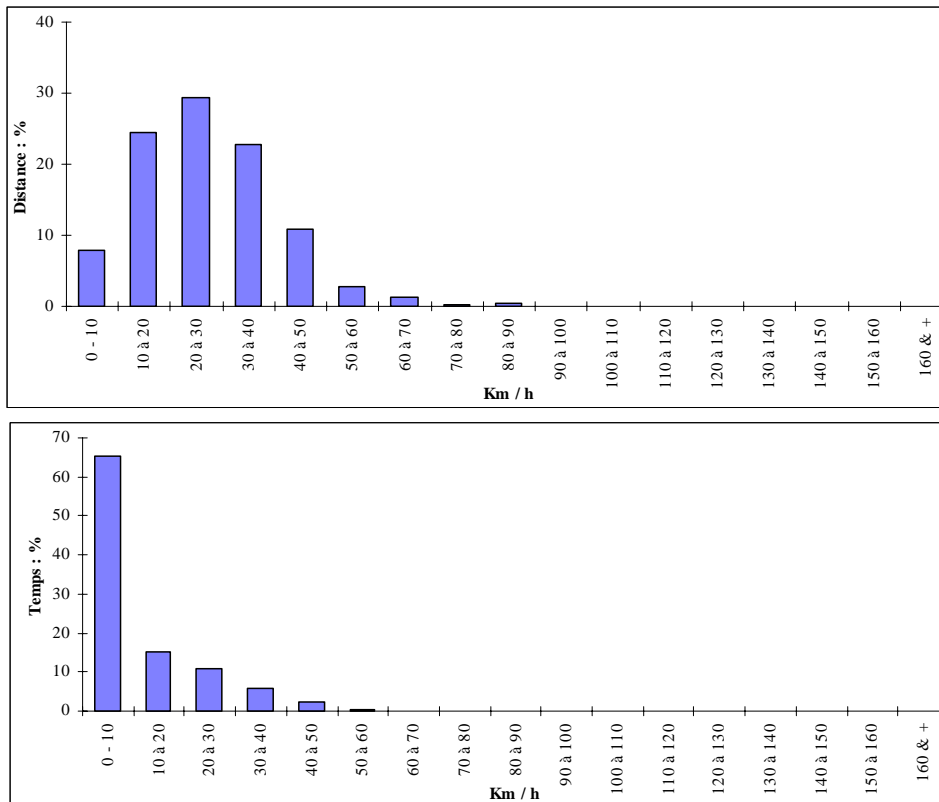


Figure 5-17: (Top) Speed vs percentage of distance, (Bottom) Speed vs percentage of time spent by a typical Renault Kangoo used for mail delivery in France.

This argument is confirmed when looking at real-life recordings of N1 vehicles in use. As an example we take a Renault Kangoo (“Kangoo de la Poste”) operating for mail delivery in Paris. The vehicle is equipped with a 1,5 L diesel engine. The average daily distance of such a vehicle is 40, 3 km driven in 4h 33’ with an average speed of 8,85 km/h. The specific use of those cars (lots of idling, very low speeds) remains a specific liability issue for car manufacturers. Figure 5-17 shows a typical analysis of the distance vs. speed and speed vs. time profile for this vehicle. More than 60% of the engine operation is spent idling or at speeds below 10 km/h.

The second example is for a bigger car – Traffic – and the area covered is an intermediate suburb town (Guyancourt). The Engine is a Diesel – 1,9 L Displacement – and all the figures below are representative of real- life recordings. In this case the mean speed is higher (24/4 km/h) while the maximum speed can reach 120 km/h for a small part of the trip. Figure 5-18 again shows the profile of distance vs speed and speed vs time spent by this vehicle.

Table 5-12: Typical trip characteristics of an N1 vehicle used for suburban deliveries

Distance	131	km
Rolling Time	5 h 22 min 39 s	
Total Time	9 h 09 min 46 s	
Mean Speed	24,4	km/h
Number of restarts	63	
Mean Fuel consumption	11,7	l/100 km

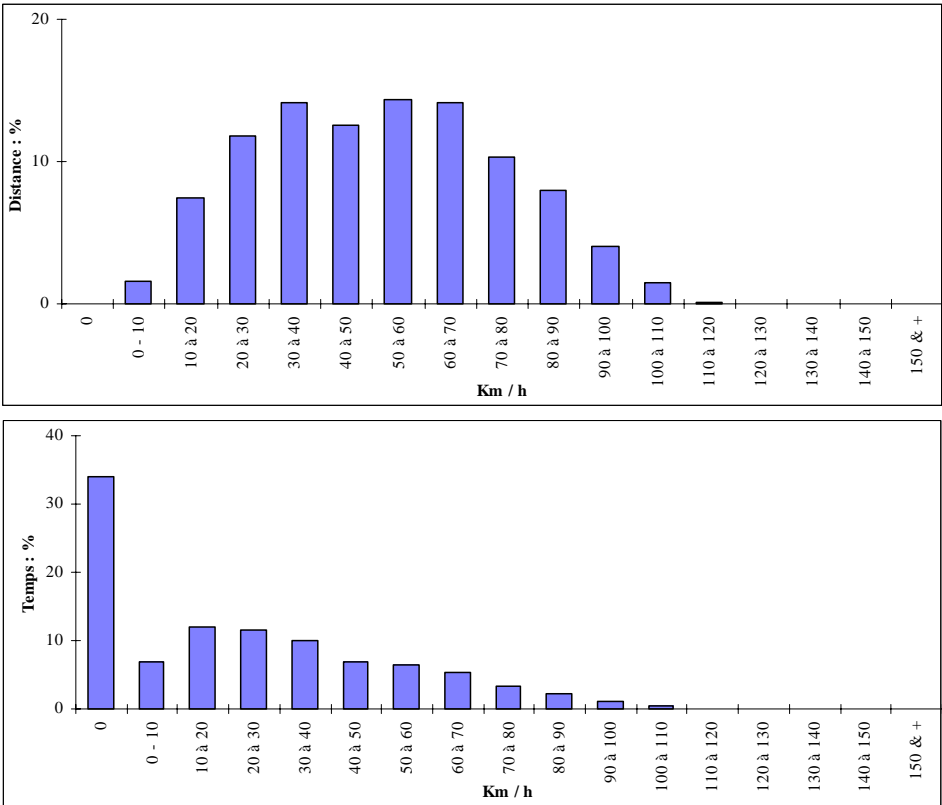


Figure 5-18: (Top) Speed vs percentage of distance, (Bottom) Speed vs percentage of time spent by a typical Renault Traffic used for suburban deliveries in France.

These two examples are useful in understanding typical operation conditions of two different classes of N1 vehicles. The most striking differences compared to passenger cars are the long durations of very low travelling speeds and idling as well as the many restarts over one day.

5.4 Non-Road Modes

The following tables summarize the information on non-road modes that was made available to the consortium. The information in these tables is at a quite an aggregated mode. More details per vehicles type are given in the electronic version of the database. No data on aviation are provided, as this will be directly given from Eurocontrol to the European Commission.

5.4.1 Rail Transport

Table 5-13 presents at an aggregated form the number of trains in the EU15 and EU12, based on the findings of the Ex-tremis (2008) project. The classification is in locomotives (including both line-haul and shunting) and railcars. Also, a classification according to power source (diesel, electric, high-speed electric and high-speed diesel) is included. Table 5-14 further distinguishes the number of locomotives per country. All locomotive types are included in this table (electric, diesel, line-haul and shunting). Further classification into source of power is given the electronic database, in the DVD accompanying this report. Table 5-15 shows the corresponding number of railcars in the 31 countries concerned. Finally, Table 5-16 shows the total railways activity, distinguished into passenger and freight transport, for all countries concerned.

Table 5-13: Evolution of the locomotives stock fleet in EU15 and EU12 by type of vehicle and power source (Source: Ex-tremis, 2008)

Country Group	Power Source	Train type	1980	1990	2000	2005
EU12	Diesel	Locomotive	11 165	9 900	8 619	7 352
		Railcar	2 007	1 837	1 789	1 903
	Electric	Locomotive	4 196	5 291	5 276	4 848
		Railcar	1 126	1 843	1 788	1 916
	High-speed electric	Railcar	0	0	3	10
EU15	Diesel	Locomotive	20 023	18 375	10 645	8 444
		Railcar	6 073	5 152	7 261	6 483
	Electric	Locomotive	10 386	11 020	10 189	9 129
		Railcar	8 222	8 827	11 648	13 095
	High-speed diesel	Railcar	0	0	0	204
	High-speed electric	Railcar	0	306	721	1 031

Table 5-14: Evolution of number of locomotives in the 31 countries for selected years (further distribution into power source available in the electronic database). Sources: Eurostat and WorldBank.

Country	1980	1985	1990	1995	2000	2004
Austria	<i>na</i>	1 220	1 221	1 179	<i>na</i>	<i>na</i>
Belgium	1 147	1 095	1 038	969	969	769
Bulgaria	<i>na</i>	<i>na</i>	608	873	713	<i>na</i>
Croatia	<i>na</i>	<i>na</i>	<i>na</i>	<i>na</i>	<i>na</i>	<i>na</i>
Cyprus	0	0	0	0	0	0
Czech Republic	<i>na</i>	<i>na</i>	<i>na</i>	2 968	2 829	<i>na</i>
Denmark	300	419	341	283	215	<i>na</i>
Estonia	<i>na</i>	<i>na</i>	<i>na</i>	143	119	273
Finland	476	494	567	661	641	631
France	6 060	5 858	5 654	5 295	4 983	4 670
Germany	<i>na</i>	<i>na</i>	<i>na</i>	8 985	7 054	<i>na</i>
Greece	194	214	232	234	157	<i>na</i>
Hungary	1 978	1 623	1 536	1 380	1 107	1 034
Ireland	192	156	126	114	107	<i>na</i>
Italy	3 529	3 260	3 172	3 204	3 270	<i>na</i>
Latvia	<i>na</i>	<i>na</i>	484	349	248	217
Lithuania	<i>na</i>	<i>na</i>	<i>na</i>	329	278	251
Luxembourg	82	85	80	<i>na</i>	<i>na</i>	<i>na</i>
Malta	0	0	0	0	0	0
Netherlands	447	584	520	535	<i>na</i>	<i>na</i>
Norway	<i>na</i>	<i>na</i>	326	235	172	<i>na</i>
Poland	<i>na</i>	7 762	5 454	4 428	4 027	4 416
Portugal	311	322	257	315	229	<i>na</i>
Romania	2 682	4 460	4 303	4 127	<i>na</i>	<i>na</i>
Slovakia	<i>na</i>	<i>na</i>	<i>na</i>	1 322	1 209	1 072
Slovenia	<i>na</i>	<i>na</i>	236	214	186	162
Spain	1 154	1 380	1 223	1 090	899	821
Sweden	1 215	1 249	1 062	788	582	<i>na</i>
Switzerland	<i>na</i>	<i>na</i>	1 435	1 454	<i>na</i>	<i>na</i>
Turkey	1 009	973	666	743	602	<i>na</i>
United Kingdom	2 566	2 247	2 227	<i>na</i>	<i>na</i>	<i>na</i>

Table 5-15: Evolution of number of railcars in the 31 countries for selected years (further distribution into power source available in the electronic database). Sources: Eurostat and WorldBank.

Country	1980	1985	1990	1995	2000	2004
Austria	<i>na</i>	281	322	363	<i>na</i>	<i>na</i>
Belgium	593	689	689	610	701	759
Bulgaria	<i>na</i>	<i>na</i>	94	86	<i>na</i>	<i>na</i>
Croatia	<i>na</i>	<i>na</i>	<i>na</i>	<i>na</i>	<i>na</i>	<i>na</i>
Cyprus	0	0	0	0	0	0
Czech Republic	<i>na</i>	<i>na</i>	<i>na</i>	960	973	<i>na</i>
Denmark	<i>na</i>	481	569	312	414	<i>na</i>
Estonia	<i>na</i>	<i>na</i>	<i>na</i>	80	77	44
Finland	276	213	102	100	112	129
France	1 526	1 613	1 737	1 895	2 175	2 479
Germany	2 404	2 177	2 170	2 774	6 946	<i>na</i>
Greece	119	117	168	196	90	<i>na</i>
Hungary	276	305	259	282	339	370
Ireland	<i>na</i>	78	40	57	117	<i>na</i>
Italy	<i>na</i>	1 750	1 646	1 456	1 445	<i>na</i>
Latvia	<i>na</i>	<i>na</i>	265	246	181	159
Lithuania	<i>na</i>	<i>na</i>	<i>na</i>	70	63	62
Luxembourg	<i>na</i>	<i>na</i>	19	<i>na</i>	<i>na</i>	<i>na</i>
Malta	<i>na</i>	<i>na</i>	<i>na</i>	<i>na</i>	<i>na</i>	<i>na</i>
Netherlands	685	691	715	675	<i>na</i>	<i>na</i>
Norway	<i>na</i>	<i>na</i>	160	145	172	<i>na</i>
Poland	<i>na</i>	1 400	1 347	1 372	1 266	1 207
Portugal	272	272	273	318	351	<i>na</i>
Romania	157	161	151	139	<i>na</i>	<i>na</i>
Slovakia	<i>na</i>	<i>na</i>	<i>na</i>	373	361	279
Slovenia	<i>na</i>	<i>na</i>	122	113	114	114
Spain	637	718	699	728	794	826
Sweden	361	324	288	353	170	<i>na</i>
Switzerland	<i>na</i>	<i>na</i>	252	245	<i>na</i>	<i>na</i>
Turkey	92	103	122	159	377	<i>na</i>
United Kingdom	4 485	3 592	4 316	<i>na</i>	<i>na</i>	<i>na</i>

Table 5-16: Evolution of total railways activity split in passenger and freight, per country.
Sources: UN-Statistics, Worldbank, Eurostat.

Country	Passenger Transport (million pass.km)				Goods Transport (million ton.km)			
	1990	1995	2000	2005	1990	1995	2000	2005
Austria	8 463	9 625	8 206	9 061	12 682	13 715	17 110	18 957
Belgium	6 539	6 757	7 755	9 150	8 354	7 287	7 674	8 130
Bulgaria	7 793	4 693	3 472	2 389	14 132	8 595	5 538	5 163
Croatia	3 429	<i>na</i>	1 252	1 266	6 535	1 974	1 788	2 835
Cyprus	0	0	0	0	0	0	0	0
Czech Republic	13 313	8 005	7 300	6 667	41 150	22 623	17 496	14 866
Denmark	4 851	4 684	5 327	5 764	1 787	1 985	2 025	1 967
Estonia	1 510	421	263	248	6 977	3 846	8 102	10 639
Finland	3 331	3 184	3 405	3 478	8 357	9 293	10 107	9 706
France	63 740	55 560	69 870		51 530	49 170	55 450	0
Germany	61 985	74 970	75 111	74 946	103 093	70 500	77 500	95 421
Greece	1 978	1 569	1 629	1 854	647	306	427	614
Hungary	11 403	8 441	9 693	9 880	16 781	8 422	8 095	9 090
Ireland	1 226	1 291	1 389	1 781	582	602	491	303
Italy	44 709	43 859	47 133	50 088	21 170	24 050	25 839	22 760
Latvia	5 366	1 256	715	894	18 538	9 757	13 310	19 779
Lithuania	3 640	1 130	611	428	19 258	7 220	8 918	12 457
Luxembourg	261	286	332	272	705	564	678	414
Malta	0	0	0	0	0	0	0	0
Netherlands	11 060	13 977	14 666	14 730	3 070	3 097	4 522	5 028
Norway	2 136	2 381	2 707	2 715	2 354	2 684	2 955	3 149
Poland	50 373	26 635	24 093	18 155	83 530	69 116	54 448	49 972
Portugal	5 664	4 840	3 834	3 753	1 588	2 342	2 569	2 826
Romania	30 582	18 879	11 632	7 985	48 912	17 907	16 354	16 582
Slovakia	6 381	4 202	2 870	2 182	23 181	13 674	11 234	9 463
Slovenia	1 429	595	705	777	4 209	3 076	2 857	3 245
Spain	16 736	16 582	19 958	<i>na</i>	11 613	10 419	12 071	0
Sweden	6 600	6 833	8 243	8 900	19 102	19 391	20 088	21 783
Switzerland	12 678	11 713	12 620	<i>na</i>	8 345	7 979	9 937	0
Turkey	6 410	5 797	5 833	5 036	8 031	8 632	9 895	9 152
UK	33 191	30 039	38 200	43 211	16 000	13 136	18 100	22 100
Total	426 777	368 204	388 824	285 610	562 213	411 362	425 578	376 401

5.4.2 Maritime Transport

Table 5-17 shows the evolution of the vessel fleet in the 31 countries considered. Further distribution on vessel types is given in the electronic database. The total freight transport activity in EU maritime coastal areas is shown in Table 5-18. Also, the gross tonnage of registered vessels in each country is shown in Table 5-19. In general, this information is not sufficient to provide the detail of information required by the maritime model in Tremove which requires separate number of vessel-km in ports, manoeuvring and open sea. However, the information required by Tremove is not available in international or national statistics, or it is commercially protected, and hence a model needs to be developed to produce the detail required. For example, Ex-tremis (2008) presents such a model.

Table 5-17: Evolution of the vessel fleet in the 31 countries for selected years (further distribution into vessel type also available in the electronic database). Sources: Eurostat, National Submissions

Country	1980	1985	1990	1995	2000	2005
Austria	0	0	0	0	0	0
Belgium	7 875	7 835	7 731	7 592	7 650	8 083
Bulgaria	<i>na</i>	624	687	770	870	858
Croatia	<i>na</i>	<i>na</i>	<i>na</i>	<i>na</i>	<i>na</i>	25 733
Cyprus	<i>na</i>	<i>na</i>	<i>na</i>	<i>na</i>	<i>na</i>	1 270
Czech Republic	0	0	0	0	0	
Denmark	85 059	82 820	87 057	87 966	89 034	89 994
Estonia	<i>na</i>	<i>na</i>	4 727	2 459	2 620	2 589
Finland	7 948	9 403	9 515	10 017	10 305	10 134
France	16 424	17 504	18 804	19 146	18 951	17 354
Germany	25 255	25 816	26 475	25 598	29 641	24 886
Greece	32 815	79 979	69 701	90 470	93 624	106 304
Hungary	0	0	0	0	0	0
Ireland	2 710	2 878	3 283	3 325	3 176	3 115
Italy	123 122	118 062	117 110	110 881	111 285	98 428
Latvia	<i>na</i>	<i>na</i>	<i>na</i>	<i>na</i>	550	519
Lithuania	<i>na</i>	<i>na</i>	<i>na</i>	<i>na</i>	682	683
Luxembourg	<i>na</i>	<i>na</i>	<i>na</i>	<i>na</i>	139	134
Malta	<i>na</i>	<i>na</i>	<i>na</i>	888	553	858
Netherlands	11 589	11 313	11 586	11 884	12 029	11 987
Norway	<i>na</i>	<i>na</i>	8 087	7 899	9 195	8 554
Poland	<i>na</i>	<i>na</i>	<i>na</i>	<i>na</i>	3 011	3 430
Portugal	2 766	2 728	2 962	2 901	2 871	3 407
Romania	<i>na</i>	<i>na</i>	<i>na</i>	<i>na</i>	740	937
Slovakia	0	0	0	0	0	0
Slovenia	<i>na</i>	<i>Na</i>	429	464	497	546
Spain	22 139	27 386	29 735	29 144	29 767	29 141
Sweden	24 664	22 363	21 459	21 303	21 598	21 992
Switzerland	0	0	0	0	0	0
Turkey	<i>na</i>	<i>na</i>	<i>na</i>	<i>Na</i>	6 735	10 230
United Kingdom	40 278	37 312	37 920	35 798	38 737	34 530

It should be also stressed that the European Commission may be in a better position than our consortium to collect available commercial information and detail gridded data of maritime

activity by means of individual funded pieces of work, such as a special contract in the revision of the National Emissions Ceilings Directive (Cofala et al., 2006).

Table 5-18: Evolution of seaborne freight activity (million ton.miles) in EU Maritime Coastal Areas for selected years. Source: Ex-tremis (2008)

EU Maritime Coastal Area	1980	1985	1990	1995	2000	2005
Belgium	192 337	213 943	262 311	267 955	317 898	381 546
Bulgaria	30 532	32 837	23 139	16 245	18 516	23 884
Cyprus	<i>na</i>	<i>na</i>	1 859	1 880	1 789	2 083
Denmark	<i>na</i>	<i>na</i>	64 973	79 458	46 505	43 629
Estonia	<i>na</i>	<i>na</i>	7 141	9 521	24 126	43 337
Finland	46 107	44 068	48 260	57 234	57 745	48 028
France: Atlantic / North Sea	<i>na</i>	<i>na</i>	<i>na</i>	<i>na</i>	294 755	325 475
France: Mediterranean – incl. Monaco	<i>Na</i>	<i>na</i>	<i>na</i>	<i>na</i>	131 846	138 289
Germany: Baltic	13 310	11 839	12 608	16 946	20 278	19 204
Germany: North Sea	211 152	187 809	200 011	268 829	321 682	423 363
Greece	47 327	41 312	51 954	61 121	63 581	77 187
Ireland	16 368	17 418	22 845	28 342	38 223	42 246
Italy	406 949	373 965	449 065	446 832	495 234	560 630
Latvia	27 746	29 782	27 272	29 393	39 088	62 647
Lithuania	<i>na</i>	<i>na</i>	13 403	10 576	18 893	29 160
Malta	<i>na</i>	<i>na</i>	<i>na</i>	<i>na</i>	<i>na</i>	1 455
Netherlands	629 816	596 744	677 970	691 994	776 135	879 557
Poland	72 893	60 415	56 585	58 399	58 481	72 262
Portugal	31 913	34 131	70 879	74 818	69 140	72 640
Romania	<i>na</i>	<i>na</i>	63 117	37 361	35 095	65 954
Slovenia	4 297	6 776	9 090	11 256	14 937	21 614
Spain: Atlantic (North)	88 065	95 915	101 965	110 287	127 234	175 401
Spain: Mediterranean & Atlantic (South)	184 878	189 584	213 230	249 423	301 658	467 323
Sweden: Baltic	41 440	41 133	41 578	47 757	52 534	58 906
Sweden: North Sea	19 072	18 932	19 136	21 980	25 529	29 403
United Kingdom (Great Britain & Northern Ireland)	368 958	402 713	428 030	476 922	498 585	599 023
Total	2 433 162	2 399 315	2 866 419	3 074 530	3 849 484	4 664 247

Table 5-19: Evolution of gross registered tonnage in the 31 countries for selected years (further distribution into vessel type also available in the electronic db). Sources: Eurostat, National data

	1980	1985	1990	1995	2000	2005
Austria	0	0	0	0	0	0
Belgium	104 399	109 190	112 072	110 285	117 097	123 408
Bulgaria	<i>na</i>	4 633	4 952	4 704	6 088	6 084
Croatia	<i>na</i>	<i>na</i>	<i>na</i>	<i>na</i>	<i>na</i>	36 031
Cyprus	<i>na</i>	<i>na</i>	<i>na</i>	<i>na</i>	<i>na</i>	12 255
Czech Republic	0	0	0	0	0	0
Denmark	247 374	251 188	264 384	251 080	260 289	264 327
Estonia	<i>na</i>	<i>na</i>	59 388	27 181	28 789	28 757
Finland	108 343	128 215	134 474	140 755	150 841	151 772
France	9 232	187 272	294 869	311 460	297 954	287 341
Germany	229 700	227 946	242 878	240 132	285 164	244 325
Greece	161 841	159 409	161 750	174 627	184 412	203 327
Hungary	0	0	0	0	0	0
Ireland	32 807	38 940	40 823	44 473	40 968	40 218
Italy	393 314	398 472	435 358	454 250	468 663	476 421
Latvia	<i>na</i>	<i>na</i>	<i>na</i>	<i>na</i>	5 539	5 096
Lithuania	<i>na</i>	<i>na</i>	<i>na</i>	<i>na</i>	6 140	6 621
Luxembourg	<i>na</i>	<i>na</i>	<i>na</i>	<i>na</i>	<i>na</i>	<i>na</i>
Malta	<i>na</i>	<i>na</i>	<i>na</i>	18 721	11 374	20 100
Netherlands	156 418	154 205	169 573	168 210	174 470	175 904
Norway	<i>na</i>	<i>na</i>	51 187	52 933	70 787	53 805
Poland	<i>na</i>	<i>na</i>	<i>na</i>	<i>na</i>	24 128	27 854
Portugal	25 698	26 443	28 050	29 538	30 348	35 490
Romania	<i>na</i>	<i>na</i>	<i>na</i>	<i>na</i>	9 464	11 631
Slovakia	0	0	0	0	0	0
Slovenia	<i>na</i>	<i>na</i>	4 567	<i>na</i>	5 732	6 208
Spain	196 377	266 933	304 495	311 549	322 977	337 910
Sweden	233 742	238 696	246 121	255 580	267 839	271 992
Switzerland	0	0	0	0	0	0
Turkey	<i>na</i>	<i>na</i>	<i>na</i>	<i>na</i>	<i>na</i>	<i>na</i>
United Kingdom	493 852	468 190	509 586	503 081	555 207	496 384

5.4.3 Inland shipping

Inland shipping includes mainly the transport of freight in the river network of central European countries and it is not relevant for all countries. The following tables (Table 5-20 and Table 5-21) provide statistics on two categories of vessels, i.e. self-propelled ones (barges) and tug or towed ones (dumb vessels). Also, the total freight activity in different European countries is shown in Table 5-22. More information on the classification of vessels into different load capacities is given in the electronic database.

Table 5-20: Evolution of self-propelled barges in Europe for selected years (further distribution into load capacity classes also available). Sources: Eurostat, National submissions

Country	1980	1985	1990	1995	2000	2005
Austria	<i>na</i>	<i>na</i>	39	22	32	<i>na</i>
Belgium	2 811	2 332	1 611	1 388	1 363	1 279
Czech Republic	<i>na</i>	<i>na</i>	<i>na</i>	80	67	<i>na</i>
Estonia	<i>na</i>	<i>na</i>	3	4	0	1
Finland	<i>na</i>	<i>na</i>	109	132	138	135
France	4 013	3 425	2 300	1 485	1 190	970
Germany	3 190	2 616	2 207	3 122	<i>na</i>	<i>na</i>
Hungary	43	39	29	28	237	135
Italy	<i>na</i>	<i>na</i>	<i>na</i>	2 973	3 102	<i>na</i>
Latvia	23	19	12	<i>na</i>	<i>na</i>	<i>na</i>
Lithuania	18	15	10	12	11	30
Luxembourg	18	17	21	<i>na</i>	<i>na</i>	<i>na</i>
Netherlands	8 576	6 847	5 772	<i>na</i>	4 480	<i>na</i>
Poland	331	328	319	172	105	93
Slovakia	<i>na</i>	<i>na</i>	8	9	12	27
Switzerland	<i>na</i>	<i>na</i>	129	89	<i>na</i>	<i>na</i>
United Kingdom	311	<i>na</i>	<i>na</i>	186	186	151

Table 5-21: Evolution of dumb and pushed vessels in Europe for selected years (further distribution into load capacity classes also available). Sources: Eurostat, National submissions

Country	1980	1985	1990	1995	2000	2005
Austria	<i>na</i>	<i>na</i>	171	126	139	<i>na</i>
Belgium	190	181	167	173	158	244
Czech Republic	<i>na</i>	<i>na</i>	<i>na</i>	292	176	<i>na</i>
Estonia	<i>na</i>	<i>na</i>	2	<i>na</i>	<i>na</i>	3
Finland	<i>na</i>	<i>na</i>	23	19	30	32
France	1 211	1 304	768	749	681	533
Germany	622	527	516	1 290	<i>na</i>	<i>na</i>
Hungary	191	203	192	150	394	113
Italy	<i>na</i>	<i>na</i>	<i>na</i>	431	434	<i>na</i>
Latvia	52	40	41	<i>na</i>	<i>na</i>	<i>na</i>
Lithuania	26	19	18	16	11	27
Netherlands	4 855	4 059	3 783	<i>na</i>	2 862	<i>na</i>
Poland	1 239	1 155	1 018	565	387	494
Slovakia	<i>na</i>	<i>na</i>	255	233	202	204
Switzerland	<i>na</i>	<i>na</i>	40	7	<i>na</i>	<i>na</i>
United Kingdom	1 228	<i>na</i>	<i>na</i>	361	361	339

Table 5-22: Evolution of total freight activity (million ton-km) for selected years (further distribution into vessel type also available). Source: Eurostat

Country	1980	1985	1990	1995	2000	2005
Austria	<i>na</i>	<i>na</i>	2 046	2 444	1 753	<i>na</i>
Belgium	5 015	5 389	5 731	7 215	8 566	5 015
Bulgaria	<i>na</i>	<i>na</i>	<i>na</i>	<i>na</i>	757	<i>na</i>
Czech Republic	<i>na</i>	<i>na</i>	<i>na</i>	89	63	<i>na</i>
France	8 394	<i>na</i>	<i>na</i>	9 578	8 905	8 394
Germany	48 183	54 803	45 832	66 465	64 096	48 183
Hungary	<i>na</i>	<i>na</i>	<i>na</i>	<i>na</i>	891	2 111
Luxembourg	304	362	338	378	342	304
Netherlands	32 373	35 661	35 457	41 271	42 225	32 373
Poland	<i>na</i>	<i>na</i>	<i>na</i>	<i>na</i>	327	<i>na</i>
Romania	<i>na</i>	<i>na</i>	<i>na</i>	<i>na</i>	8 435	<i>na</i>
Slovakia	<i>na</i>	<i>na</i>	<i>na</i>	<i>na</i>	88	<i>na</i>

5.5 Road Stock and emissions per country

The following sections detail the data estimated for each country, based on the data collected and the results of the reconciliation procedure. Four pages have been prepared for each country.

Page 1 provides a summary of the statistical data that were made available for each country by the available sources (Eurostat, national experts, own data, ACEA, other sources). Then, four sub-figures are presented under the heading [CR].1 where the stock of vehicles in four main categories (PCs, LDVs, HDV+Buses, and PTWs) are presented from the current work ("Current") and are compared with the corresponding stock from the available statistics ("Statistics") and from the most recent (v2.52) Tremove version. A discussion on the main trends of fleet evolution is also included on this page.

Page 2 provides more analysis on the split of each category into types. PCs are split into the main five types, i.e. gasoline fuelled in three types and diesel ones in two types. LDVs are split according to the fuel used and heavy duty vehicles are split into rigid, articulated and busses (including coaches). Finally, PTWs are split according to the engine type and their capacity.

Page 3 provides a summary of the implementation matrix (Table [CR].1) and the technology mix (Table [CR].2) per year. The implementation matrix shows the technology share of new registrations per vehicle type and per year. In countries where new sales dominate new registrations, the implementation matrix shows mostly 100% introduction at a single technology level. In cases where second-hands are an important share of new registrations, then the implementation matrix shows registrations from multiple technologies on a given

year. Table [CR].2 presents the technology mix of the running stock of vehicles per category per year. In this table, the letter "C" corresponds to non-catalyst (Conventional) technologies.

Page 4 offers a validation of the data produced in this project for the Year 2005, which will be used as the reference year for projections. The first panel of Figure [CR].3 compares the statistical fuel consumption per fuel type used in road transport taken from Eurostat with the corresponding fuel consumption calculated using COPERT 4 (v5.1) and the fleet from the current project. This comparison shows how well is the size and the total activity of the road transport stock represented by our current estimates. The three remaining panels compare emissions of NO_x, VOC and exhaust PM per vehicle category as calculated by the model, according to the GAINS model (Baseline scenario) and according to the official national submissions to UNFCCC/CLRTAP by each country (obtained from http://unfccc.int/national_reports/annex_i_ghg_inventories/national_inventories_submissions/items/4303.php) and to EMEP (<http://webdab.emep.int>). It should be noted that the VOC emissions of the current analysis include evaporation losses per vehicle type, which are not included in the other sources. Hence, gasoline-related VOCs should be higher in our results.

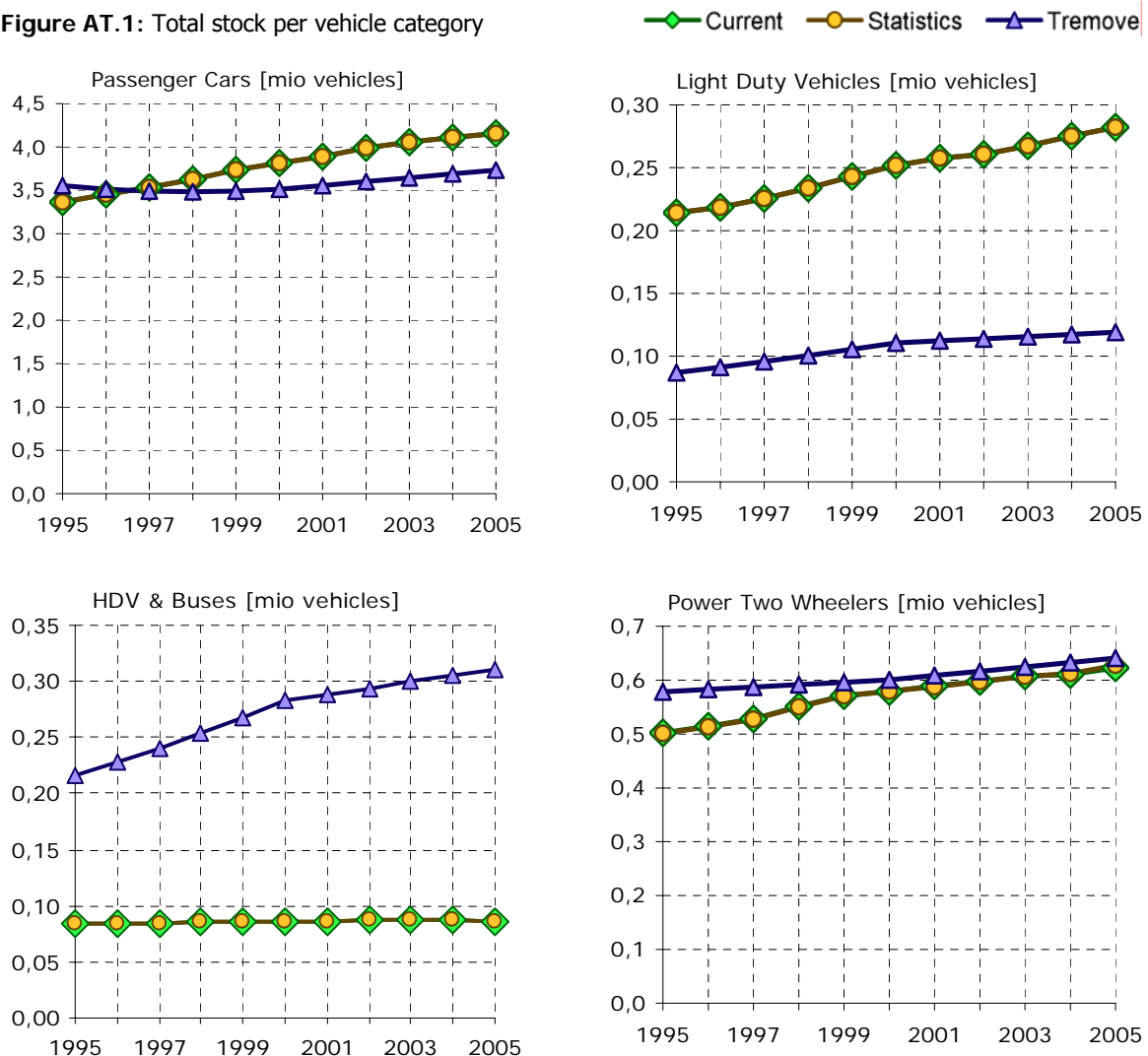
The following were the main sources of information:

- Austrian Federal Environment Agency: population, total veh. km, mileage, speed, share (1990-2005)
- Eurostat: fuel data (1985-2000), population of passenger cars (99-04), new registrations passenger cars (1999-2004) & motorcycles (1989-2004)
- Other sources included UITP, ANFAC Car Park Report, ACEA, Central database of the European Commission for new M1's

The missing information that had to be calculated for Austria was 13% (mostly deregistrations, 100% of the stock in operation was given) The total fleet and the distinction to categories and types should be considered reliable as it originates from updated official databases.

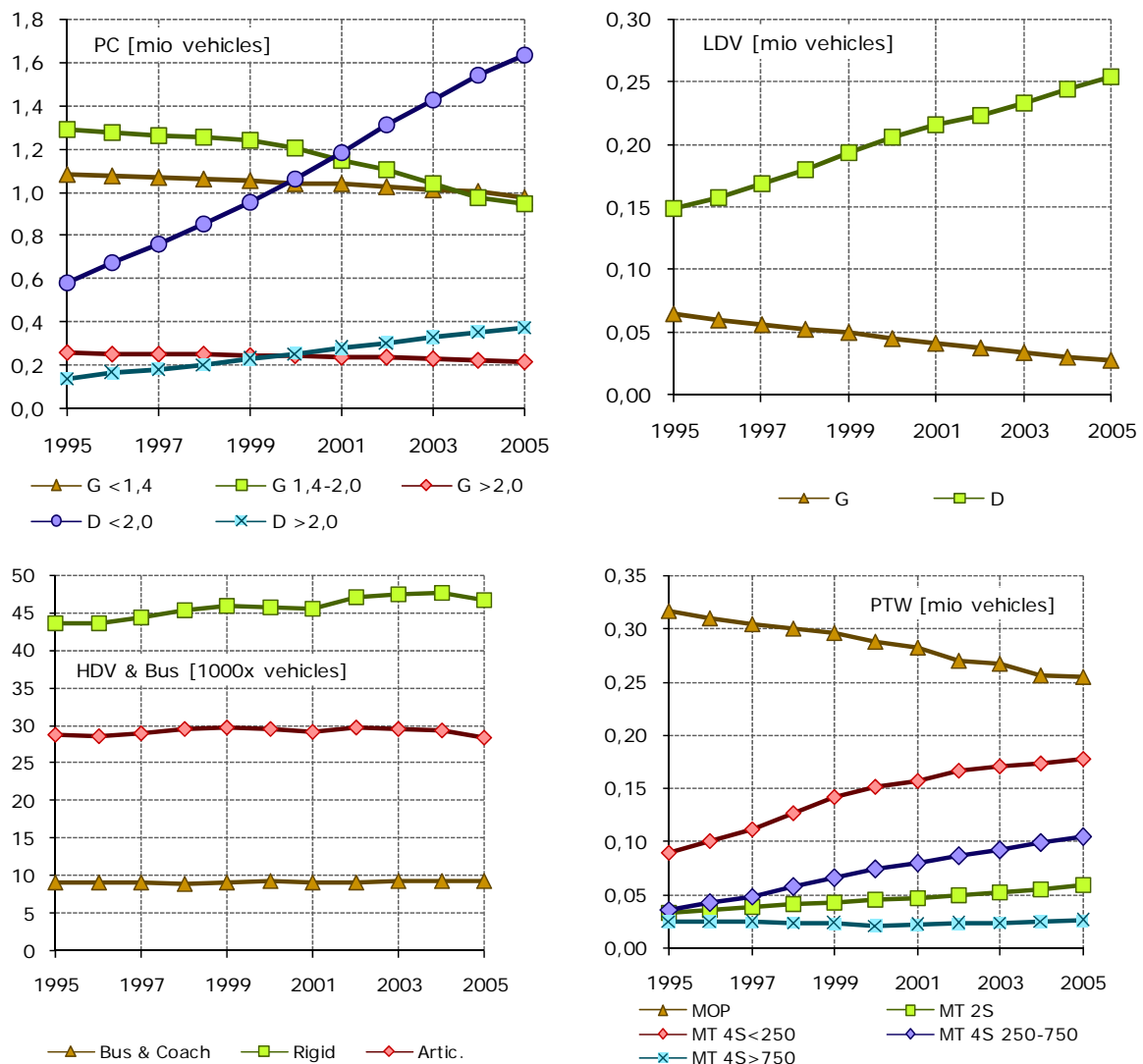
The number of passenger cars increased by 24% between 1995 and 2005, and LDV by 32%. For the latter, the share remained nevertheless at a constant 5% of the total fleet while passenger cars increased their share by 9% being 81% in 2005. The number of HDV & buses remained at a low share of 1%. The growth rate of PTW was 24% and their share increases by 1 % to 12% in comparison to the total vehicle fleet.

Figure AT.1: Total stock per vehicle category



The passenger car fleet is dominated by D-PC < 2,0l increasing their share from 17% in 1995 to 39% in 2005. A similar development with a smaller overall share can be observed for D-PC > 2,0l increasing their share from 4% to 9%. Diesel vehicles accounted for 48% of the total passenger cars fleet in 2005. To the same extent all G-PC categories decreased, in particular the G-PC 1,4-2,0 vehicles. A similar development regarding dieselisation can be observed for LDV's, although the share D-PC has been very high (70%) already in 1995. In 2005 only 10% of all LDV's were gasoline fuelled. The number of buses & coaches as well as articulated vehicles remains quite constant over the years. A slight increase can be observed for rigid vehicles. While the share of mopeds decreased by 22%, the share of all motorcycles up to 750cm³ increased. The number of motorcycles having an engine capacity between 250-750cm³ has almost tripled leaving their share at 17% among all PTWs. The number of motorcycles < 250cm³ has doubled and their share increased from 18% in 1995 to 28% in 2005 in comparison to all PTW's.

Figure AT.2: Evolution of vehicle type population per subsector



Country: Austria	AT3/4
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In general, the implementation matrix largely follows the implementation dates considered by the regulations, except for PTW where the Euro 2 standard has already been introduced in 2001. For gasoline and diesel passenger cars a very high number of Euro 4 vehicles have been introduced in 2005.

The technology mix in Austria (Table AT.2) shows that more than half of the G-LDV is comprised of non-catalyst cars, followed by Euro 2 G-LDV accounting for 25%. This concurs with the declining share of those vehicles, reducing the exchange rate of the vehicles and hindering new technologies to establish a relevant number of vehicles within the LDV-fleet. Therefore the opposite effect can be observed for D-LDVs where the share of non-catalyst cars was reduced by half from 2000. At the same time the share of Euro 3 increased to 45% and the Euro 2 standard is being fulfilled by 32% of the D-LDV fleet in 2005. Although the Euro 2 standard has been introduced quite early for PTW in Austria, their share is still quite low.

Table AT.1: Implementation matrix (introduction of technologies per year)

Cat.	G-PC			D-PC			G-LDV				D-LDV				BUS			HDT			PTW	
	2	3	4	2	3	4	1	2	3	4	1	2	3	4	II	III	IV	II	III	IV	I	II
2000	7	93	0	7	93	0	0	100	0	0	0	100	0	0	100	0	0	100	0	0	100	0
2001	14	86	0	0	100	0	0	30	70	0	0	8	92	0	19	81	0	0	100	0	63	37
2002	2	98	0	0	100	0	0	0	100	0	0	0	100	0	0	100	0	0	100	0	58	42
2003	12	88	0	0	100	0	0	0	100	0	0	0	100	0	0	100	0	0	100	0	57	43
2004	17	83	0	0	100	0	0	0	100	0	0	0	100	0	0	100	0	0	100	0	50	50
2005	0	14	86	0	12	88	0	0	100	0	0	0	100	0	1	99	0	0	100	0	64	36

Table AT.2: Technology mix of the stock per subsector per year

Cat.	G-PC					D-PC					G-LDV					D-LDV					BUS					HDT					PTW		
	C	1	2	3	4	C	1	2	3	4	C	1	2	3	4	C	1	2	3	4	C	I	II	III	IV	C	I	II	III	IV	C	I	II
2000	26	48	21	4	0	7	39	42	13	0	71	10	19	0	0	36	14	50	0	0	55	14	31	0	0	32	14	54	0	0	48	52	0
2001	23	47	22	8	0	5	34	37	24	0	67	11	20	2	0	31	13	46	10	0	49	14	31	5	0	26	12	50	11	0	45	52	3
2002	20	45	22	12	0	4	29	33	34	0	64	11	22	3	0	27	12	43	19	0	45	13	31	11	0	21	10	43	26	0	42	53	5
2003	19	42	23	17	0	3	24	30	42	0	61	11	23	5	0	22	10	39	28	0	39	13	30	18	0	18	8	37	37	0	39	53	8
2004	17	39	23	21	0	2	21	28	50	0	57	11	24	8	0	19	9	35	37	0	33	12	29	25	0	14	7	32	47	0	37	53	10
2005	15	36	23	21	4	2	17	25	47	9	52	11	25	11	0	16	8	32	45	0	29	12	28	30	0	12	6	27	54	0	34	54	12

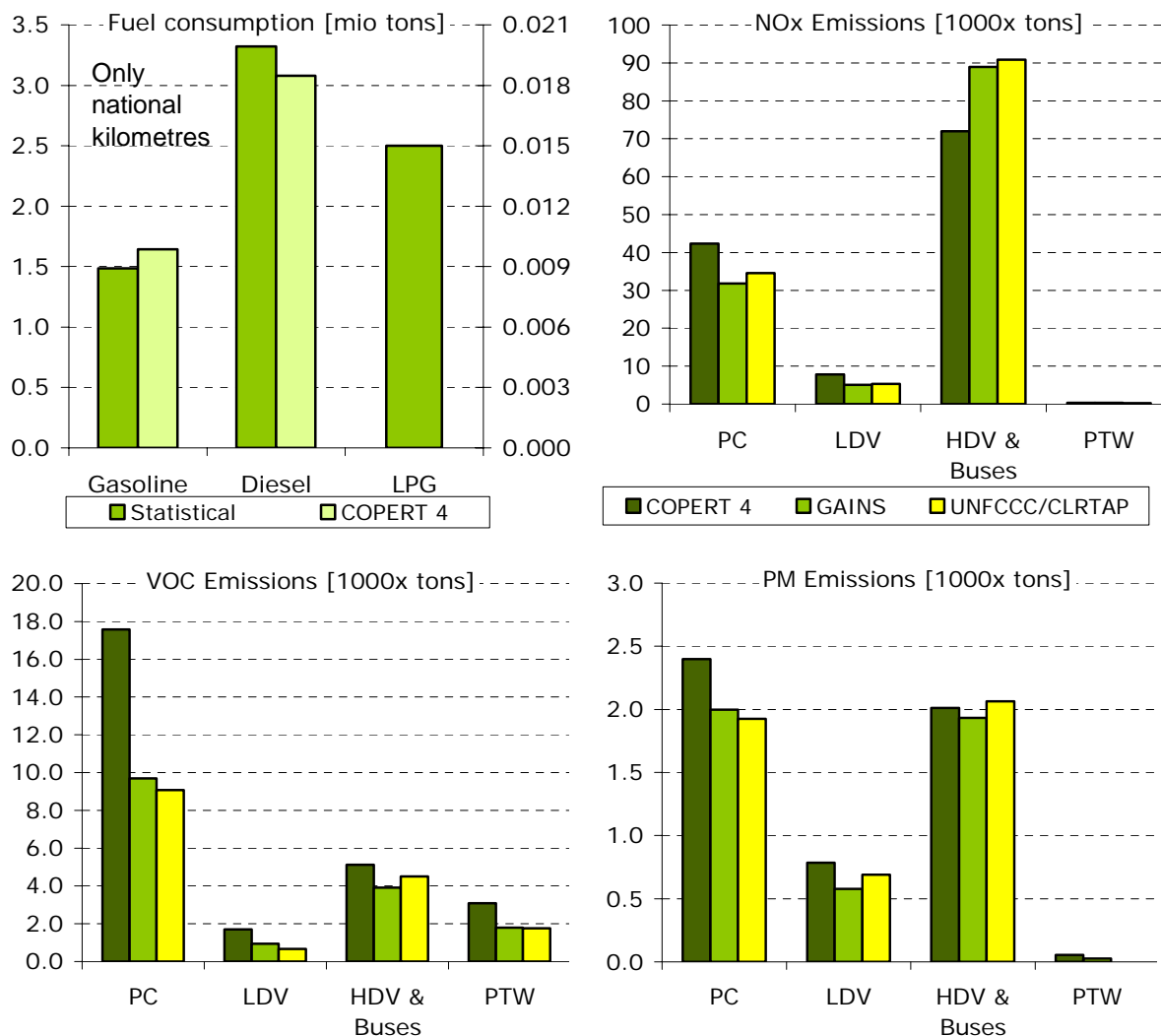
Austria submitted data separately for the total distances driven by the total fleet within Austria and in other territories. Therefore, it was made possible to compare the fuel consumption sold with the fuel consumption consumed in the Austria territory. As seen in Figure AT3, the match between the statistical and the calculated fuel consumption is very good. There is some lower fuel consumption estimated for diesel and this should be because there has been no information submitted on the mean slope and the load of the HDVs driving.

However, emissions of GAINS and the submissions to UNFCCC include both the kilometers that are driven in the inland of Austria as well as international kilometers driven by the Austrian fleet. Therefore, the COPERT 4 calculation also includes international kilometers in this case. The comparison for NOx is quite good although COPERT lacks a bit of HDV NOx. Most probably this is because of the slope and load corrections required. This is something that we have to look at together with the Austrian authorities, in order to improve the calculation.

The main contributor to VOC emissions are passenger cars emitting around 9.000t (UNFCCC/CLRTAP & Gains) up to 14.000t (COPERT). COPERT also includes evaporation losses in VOC as well (~3 kt). Also, the temperatures used in the two calculations may not be identical, which also significantly affect VOC emissions. Depending on the source, the second largest emitter is HDVs & buses. Slope and load do not affect VOC emissions and in this case COPERT and the national submissions are identical. The VOC emissions are larger from PCs in the current calculation due to the more detailed evaporation method that has been used.

Depending again on the source of calculations, the largest emitters of PM are either passenger cars or HDV's & buses with roughly 2.000t per year. Similar to NOx, there is again a 15% deficit of COPERT to replicate the national submissions for HDVs and busses but this is again because no load and slope corrections have been included. An additional reason may of course be that non-exhaust PM are not included in the submissions.

Figure AT.3: Results of the calculations with COPERT 4 and the updated fleets compared to other sources

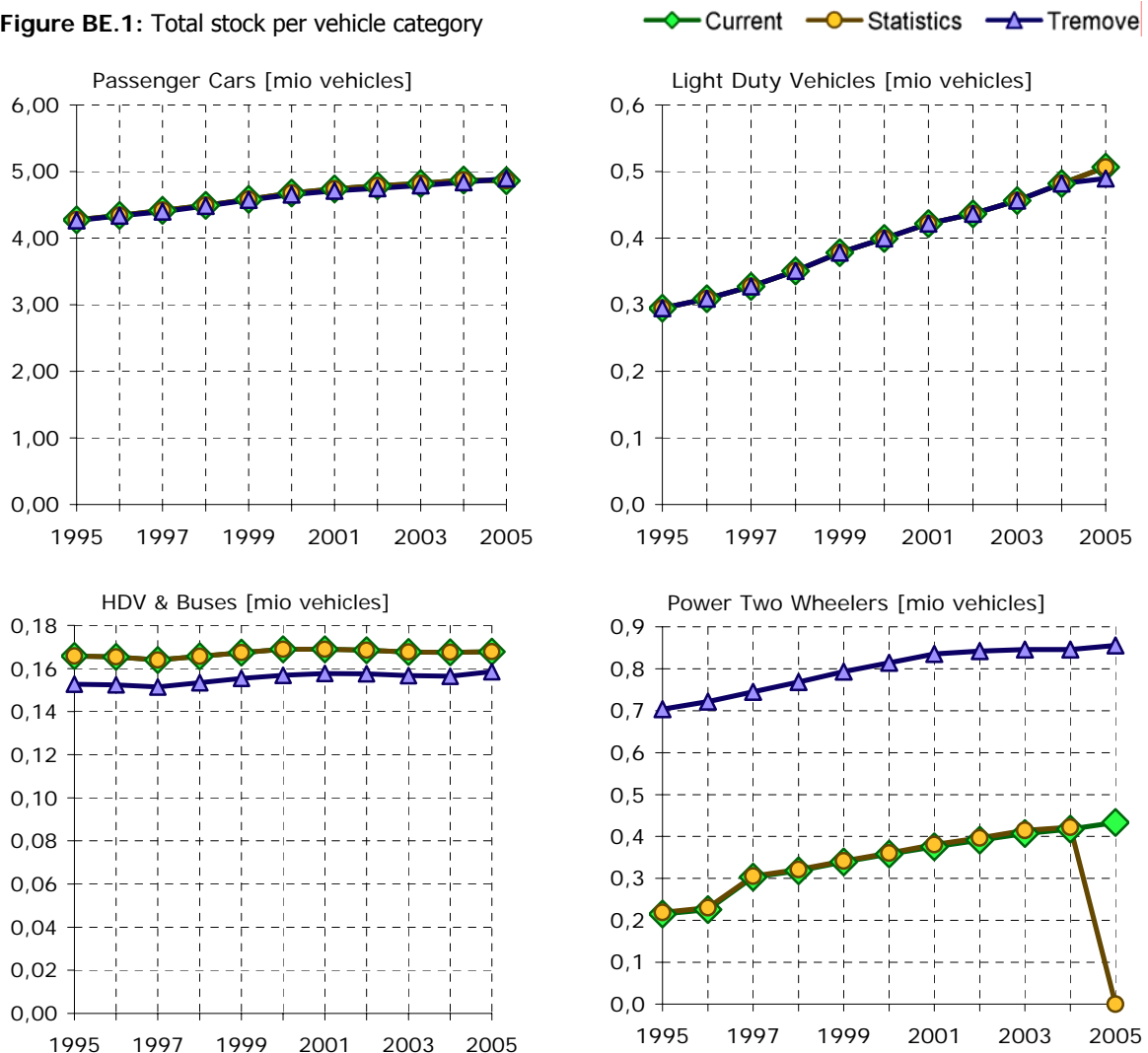


The following were the main sources of information:

- Ministère de la Région wallonne,
- Flemish Environment Agency, Flemish Institute for Technological Research
- Institut Bruxellois pour la gestion de l'environnement
- Service public fédéral Mobilité et Transports de la Belgique
- Other sources included Eurostat, UITP, ANFAC Car Park Report, ACEA, Central database of the European Commission for new M1's

The missing information was 36%, mostly due to number of registrations; the missing information on fleet was 26%. The main information missing were details on small urban buses and differentiated ECE standard for G-PC technology. A difficulty that was raised was the absence of a consolidated Belgian data set which lead to the incorporation of data relating to a different number of regions (Brussels, Flanders, Wallonia). Still the total fleet and the distinction to categories and types should be considered reliable as it originates from official databases. The number of passenger cars increased by 14% having a share of 81% in 2005. The number of LDV increases by 72% augmenting their share from 6% in 1995 to 8% in 2005. The number of HDV's and buses remains constant over the period. The number of PTW doubles between 1995 and 2005 increasing their share by 3% to a total of 7% in comparison with the whole vehicle fleet.

Figure BE.1: Total stock per vehicle category



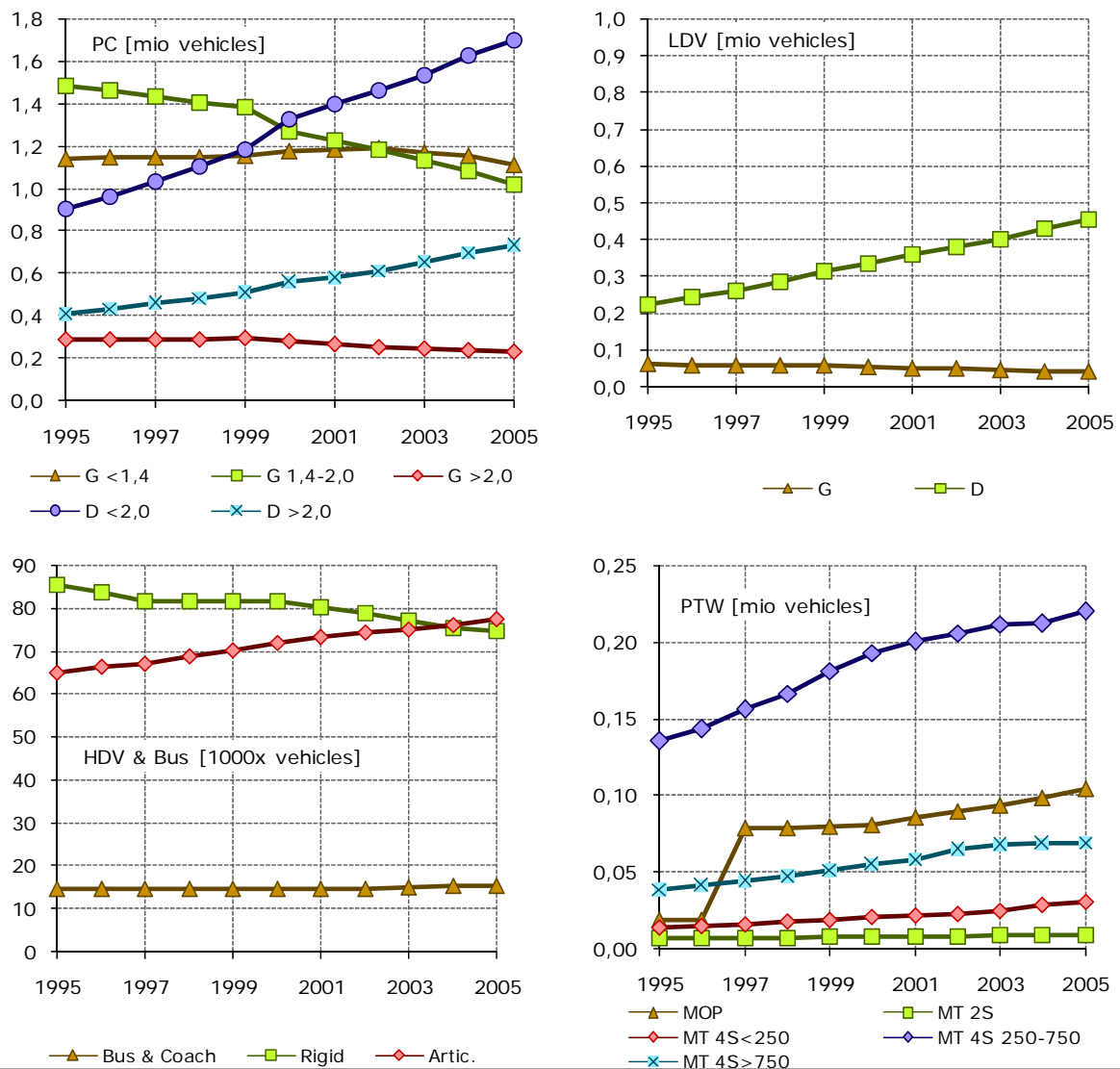
The development of the passenger fleet is dominated by the high increase of diesel cars in particular those having an engine capacity > 2,0l. They have increased their share by 14% being 35% in 2005. In total, the share of diesel fuelled vehicles accounts for half of the passenger car fleet. Among the G-PC's all categories decrease significantly.

The same trend is observable for the LDV although D-LDV presented the majority already in 1995. The number of D-LDV has double from 1995 to 2005 and their share amounts to 90% in 2005.

The bus and coach stock remains quite constant. The number rigid vehicles decreases by about the same rate as the number of articulated vehicles is increasing.

There are no data on mopeds before 1996, so their fleet appears to make a jump from 1996 to 1997 but this is an artifact only. The fleet of motorcycles in Belgium increases at a rather slow pace between 1995 to 2005. In particular, the stock of 2S motorcycles seems to remain rather constant over the years. Larger growth rates are only observable for motorcycle having an engine capacity between 250-750cm³.

Figure BE.2: Evolution of vehicle type population per subsector



Country: BELGIUM	BE3/4
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For gasoline and diesel passenger cars and light duty vehicles a high number of Euro 4 vehicles have been introduced in already in 2004 and 2005.

Table BE.2 shows an even distribution of technologies for G-PC having still a high share of conventional vehicles and a low Euro standard. For diesel vehicles whose registration rate has changed dramatically, the number of Euro 3 standard is more widespread accounting for almost half of the fleet in 2005. The situation with the LDV mirrors this development, although the share of conventional G-LDV is significantly higher. Still in absolute values the number of conventional G-LDVs is significantly lower than the number conventional G-PC's.

Another remarkable point is the constant very high share of conventional PTW.

Table BE.1: Implementation matrix (introduction of technologies per year)

Cat.	G-PC			D-PC			G-LDV				D-LDV				BUS			HDT			PTW	
	2	3	4	2	3	4	1	2	3	4	1	2	3	4	II	III	IV	II	III	IV	I	II
2000	47	53	0	26	74	0	7	36	57	0	0	0	100	0	100	0	0	100	0	0	100	0
2001	29	71	0	6	94	0	28	16	56	0	0	32	68	0	60	40	0	56	44	0	100	0
2002	0	100	0	0	100	0	53	0	47	0	0	0	100	0	8	92	0	29	71	0	100	0
2003	0	100	0	0	100	0	0	0	100	0	0	0	100	0	2	98	0	0	100	0	33	67
2004	0	82	18	0	74	26	0	0	78	22	0	0	79	21	13	87	0	0	100	0	5	95
2005	0	40	60	0	24	76	0	0	38	62	0	0	39	61	8	92	0	0	100	0	75	25

Table BE.2: Technology mix of the stock per subsector per year

Cat.	G-PC					D-PC					G-LDV					D-LDV					BUS					HDT					PTW		
	C	1	2	3	4	C	1	2	3	4	C	1	2	3	4	C	1	2	3	4	C	I	II	III	IV	C	I	II	III	IV	C	I	II
2000	45	26	23	6	0	28	26	31	14	0	79	11	7	3	0	40	24	25	12	0	61	15	23	0	0	55	15	30	0	0	93	7	0
2001	40	25	24	11	0	22	24	30	24	0	76	11	8	5	0	35	21	23	21	0	55	15	27	3	0	49	14	33	4	0	90	10	0
2002	35	24	24	17	0	17	21	28	34	0	72	12	8	8	0	29	19	22	30	0	48	14	27	11	0	44	12	33	11	0	88	12	0
2003	30	24	23	23	0	13	18	25	44	0	69	12	9	10	0	24	17	20	39	0	43	14	26	18	0	40	11	31	18	0	85	13	2
2004	25	23	23	28	1	9	15	22	50	3	65	12	9	13	1	20	15	18	44	3	38	13	25	23	0	36	10	29	25	0	82	12	6
2005	21	21	22	31	5	7	13	19	48	13	63	12	9	14	3	17	13	16	44	10	32	14	25	29	0	33	9	26	32	0	83	11	6

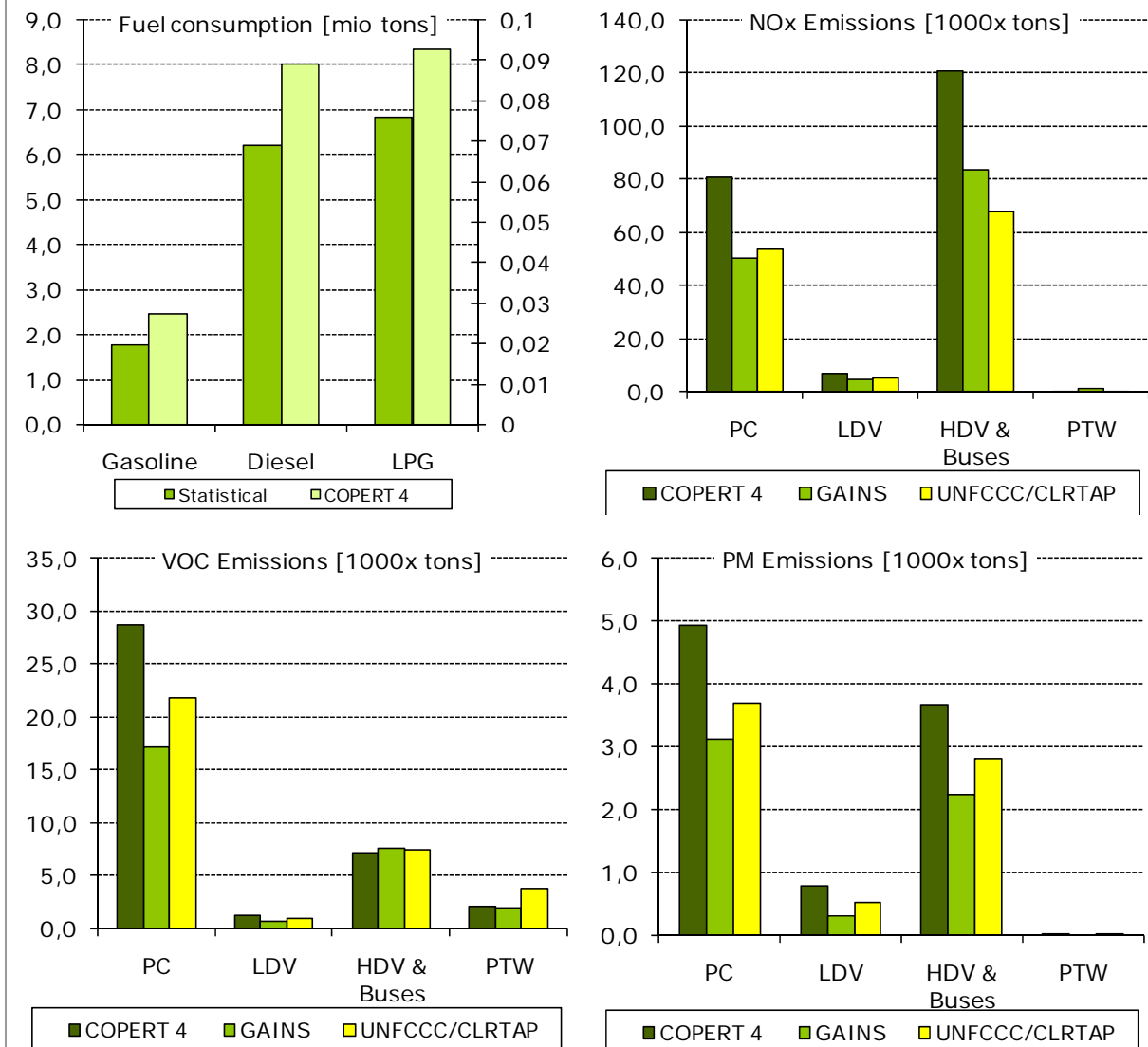
The fuel consumption differs for gasoline by 700.000t, for diesel by 1,8 mio tons and for LPG by 17.000t. The estimations of COPERT are always higher than the values from Eurostat. This is the result of using an average mileage value for the whole Belgian stock, although official mileage submissions were only provided by the Wallon region. The higher consumption calculated with COPERT is also reflected to higher emissions for both gasoline and diesel. Adjusting the mileage value to fit the statistical fuel consumption would also bring emissions more in line with national submissions.

Depending on the source the highest emitter of NOx are HDV & buses or passenger cars. The range of values from HDV's and buses starts at 68.000t (UNFCCC/CLRTAP) and goes up to 120.000t (COPERT). For passenger cars the lowest values is 50.000t according to Gains and 81.000t according to COPERT. The emissions from LDV remain largely below 8.000t. Again COPERT estimated the highest value with 7.200t.

Regarding VOC emissions passenger cars emit most. The range of emission starts at 17.000t (Gains) to 29.000t (COPERT). The second largest emitters are HDV's and buses with emission around 7.000t. The different sources differ only by a few hundred tons.

Depending on the source the largest contributor to PM emissions are either passenger cars or HDV's & buses. The emission calculations stemming from passenger cars start with 3.100t (Gains) and go up to 4.900t (COPERT). For HDV & buses the COPERT value is again the highest with 3.700t going down to 2.300 according to Gains.

Figure BE.3: Results of the calculations with COPERT 4 and the updated fleets compared to other sources



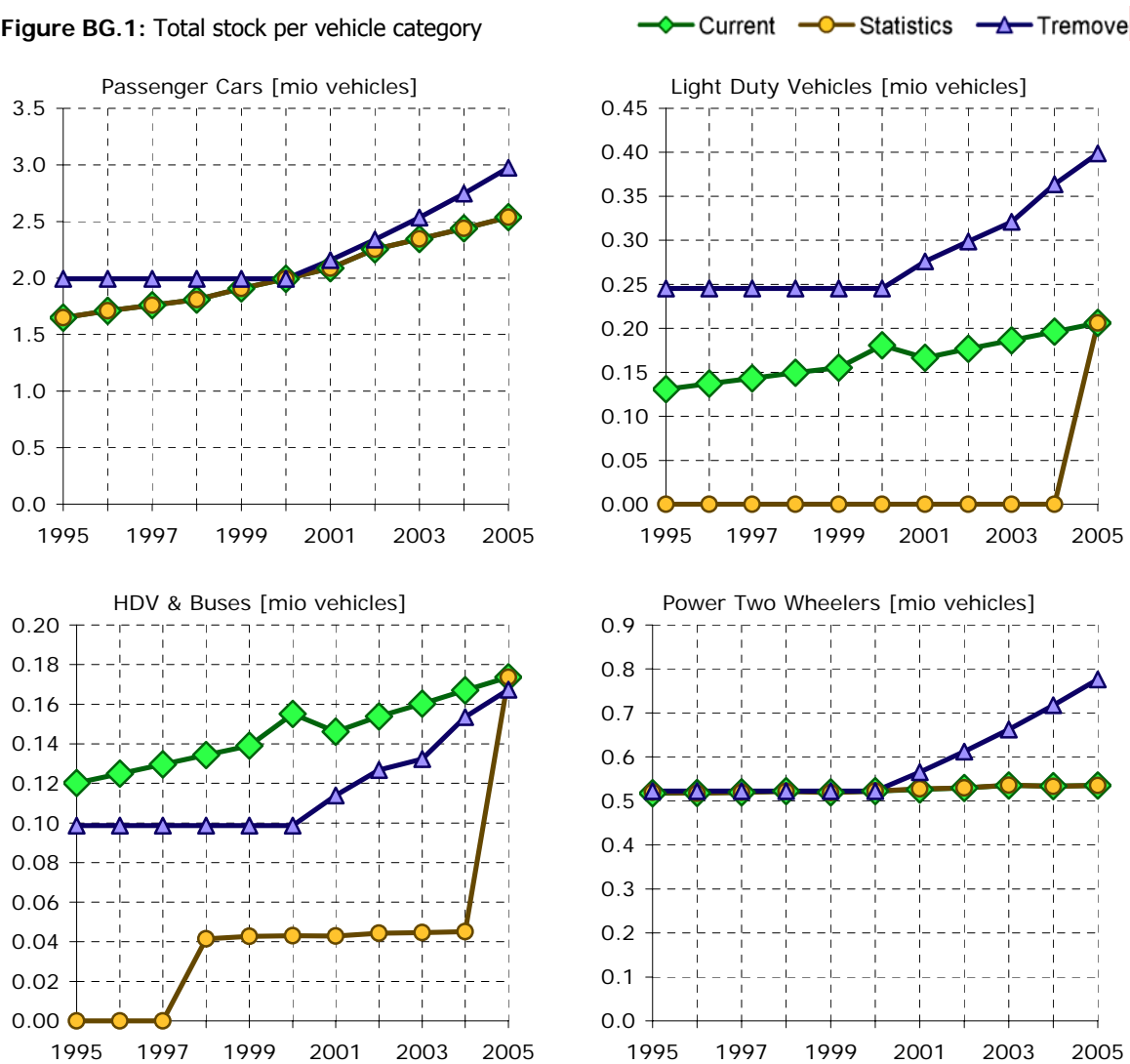
The following were the main sources of information:

- Total fleets per category: IRF World Road Statistics (1990-2006)
- Split in types: IRF World Road Statistics (2005)
- New registrations: IRF World Road Statistics (1990-2005)
- Age/technology distribution of vehicles: no data available

Bulgaria was one of the two countries that provided no official national data. Hence, a large share of the information was missing. In fact, 49% of the total population values had to be calculated. In principle, apart from total numbers for the main vehicle categories, no other information was available. In the absence of any other data, information from the Romanian fleet was used for the distribution into fuel, weight and technology classes for the year 2005. The total fleet should be considered reliable as it originates from updated official databases. However, the distinction to categories and types should be treated with caution as it is based on assumptions, as explained above.

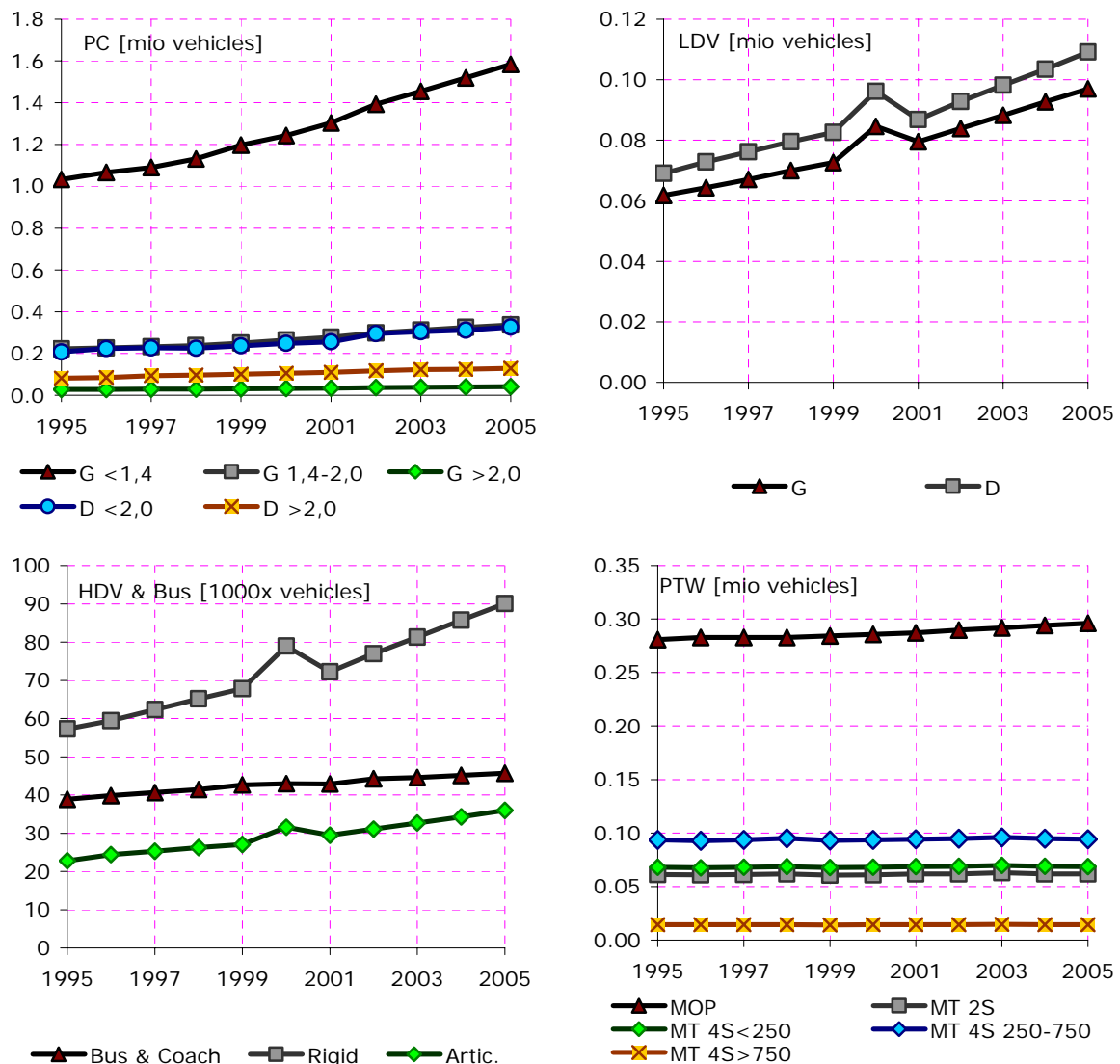
The number of passenger cars in Bulgaria increased by almost 1 mio vehicles over the period 1995-2005, reaching 2.5 mio in 2005. A similar increase was recorded also for LDVs and HDVs, while the number of PTWs remained rather stable over the same period.

Figure BG.1: Total stock per vehicle category



As mentioned above, information from the Romanian fleet was used for the distribution of the main categories of the Bulgarian vehicle fleet into fuel and weight classes for the year 2005. Hence, the results shown in figure BG.2 are only indicative and any assessment on the main trends per category should be treated with caution.

Figure BG.2: Evolution of vehicle type population per subsector



Country: **BULGARIA**

BG3/4

As mentioned above, information from the Romanian fleet was used for the distribution of the main categories of the Bulgarian vehicle fleet into technology classes for the year 2005. Hence, the implementation matrix and technology mix shown in tables BG.1 and BG.2 are only indicative and should be treated with caution.

Table BG.1: Implementation matrix (introduction of technologies per year)

Cat.	G-PC			D-PC			G-LDV				D-LDV				BUS			HDT			PTW	
	2	3	4	2	3	4	1	2	3	4	1	2	3	4	II	III	IV	II	III	IV	I	II
2000	100	0	0	100	0	0									100	0	0	100	0	0	100	0
2001	100	0	0	100	0	0	0	100	0	0	0	100	0	0	0	100	0	0	100	0	100	0
2002	0	100	0	0	100	0	0	99	1	0	0	36	64	0	0	100	0	0	100	0	10	90
2003	0	100	0	0	100	0	0	99	1	0	0	36	64	0	0	100	0	0	100	0	10	90
2004	0	100	0	0	100	0	0	99	1	0	0	36	64	0	0	100	0	0	100	0	10	90
2005	0	37	63	0	81	19	0	96	1	3	0	37	63	0	0	100	0	0	99	1	11	89

Table BG.2: Technology mix of the stock per subsector per year

Cat.	G-PC					D-PC					G-LDV					D-LDV					BUS					HDT					PTW		
	C	1	2	3	4	C	1	2	3	4	C	1	2	3	4	C	1	2	3	4	C	I	II	III	IV	C	I	II	III	IV	C	I	II
2000	88	0	12	0	0	91	0	9	0	0	100	0	0	0	0	100	0	0	0	0	96	0	4	0	0	87	0	13	0	0	96	4	0
2001	83	0	17	0	0	86	0	14	0	0	93	0	7	0	0	94	0	6	0	0	95	0	4	2	0	83	0	13	4	0	94	6	0
2002	82	0	16	2	0	75	0	12	13	0	88	0	12	0	0	79	0	11	10	0	93	0	3	4	0	80	0	12	8	0	83	7	10
2003	81	0	15	4	0	63	0	12	25	0	82	0	18	0	0	65	0	16	19	0	92	0	3	5	0	77	0	11	12	0	73	8	20
2004	80	0	14	6	0	51	0	11	38	0	77	0	22	0	0	53	0	20	27	0	90	0	3	7	0	75	0	10	15	0	62	9	29
2005	75	0	13	8	4	39	0	10	48	3	73	0	26	0	0	42	0	24	34	0	88	0	3	9	0	73	0	9	18	0	52	9	39

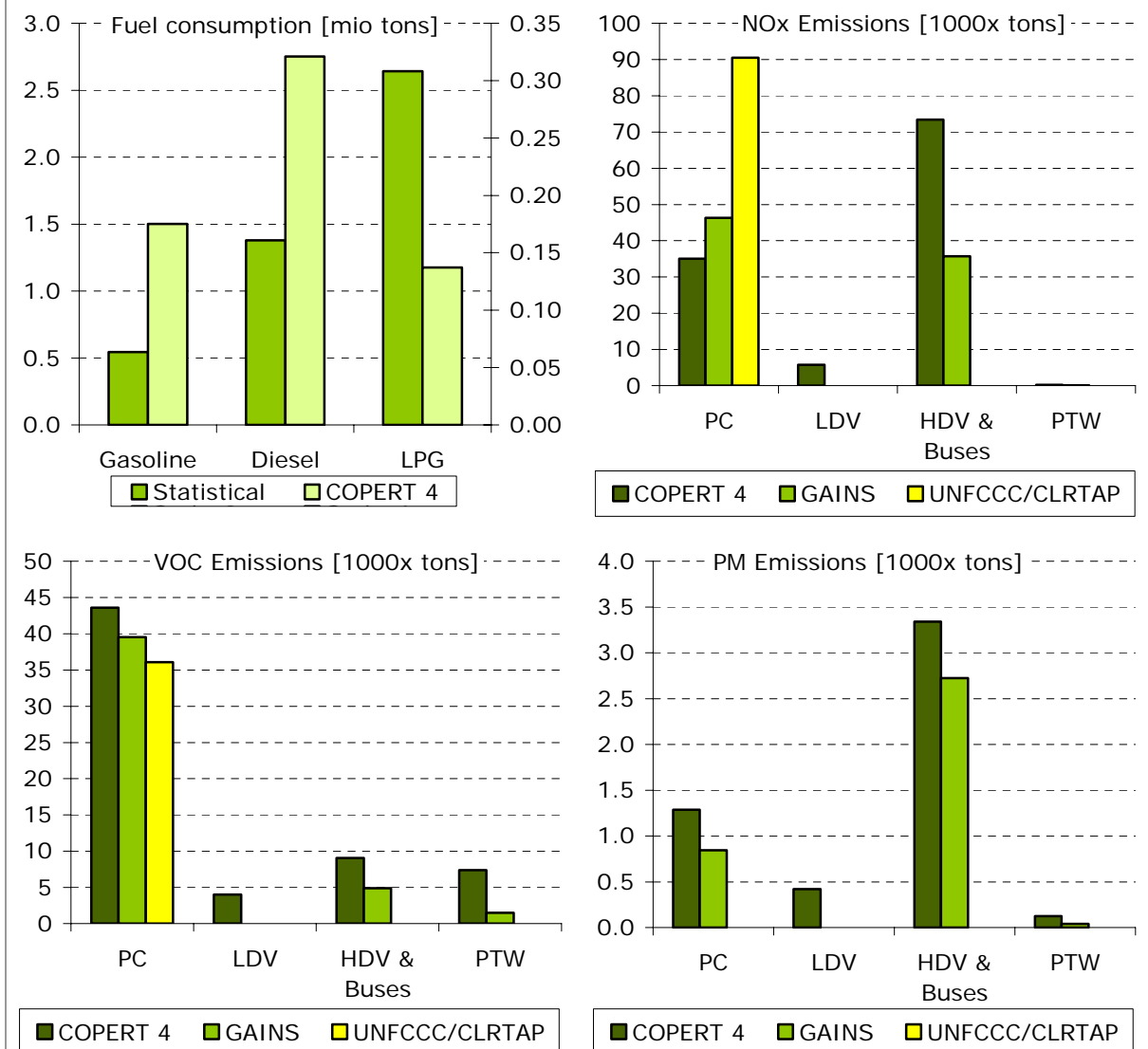
Gasoline and diesel consumption calculated with COPERT 4 are significantly above the statistical figures. The picture regarding LPG is opposite. One can assume that statistics related both to total fuel consumption but also the total vehicle fleet are quite weak and hence, the different reported should be expected. However, the much higher calculated fuel consumption than the statistical one, although the total fleet number is rather reliable, can only be explained by two factors. Either the vehicles are driven for very short distances over the year (3000-4000 km on average) or there is a significant part of energy consumption which is not reported.

The national submissions to UNFCCC and the GAINS calculations do not include all pollutants and/or vehicle categories, due to the general lack of data that is observed in Bulgaria.

For the reasons mentioned in previous sections, the following assessment is based on the total number of vehicles in each category.

PC and in particular G-PC dominate VOC emissions, while HDV & Buses are the dominant source of NOx and PM emissions.

Figure BG.3: Results of the calculations with COPERT 4 and the updated fleets compared to other sources



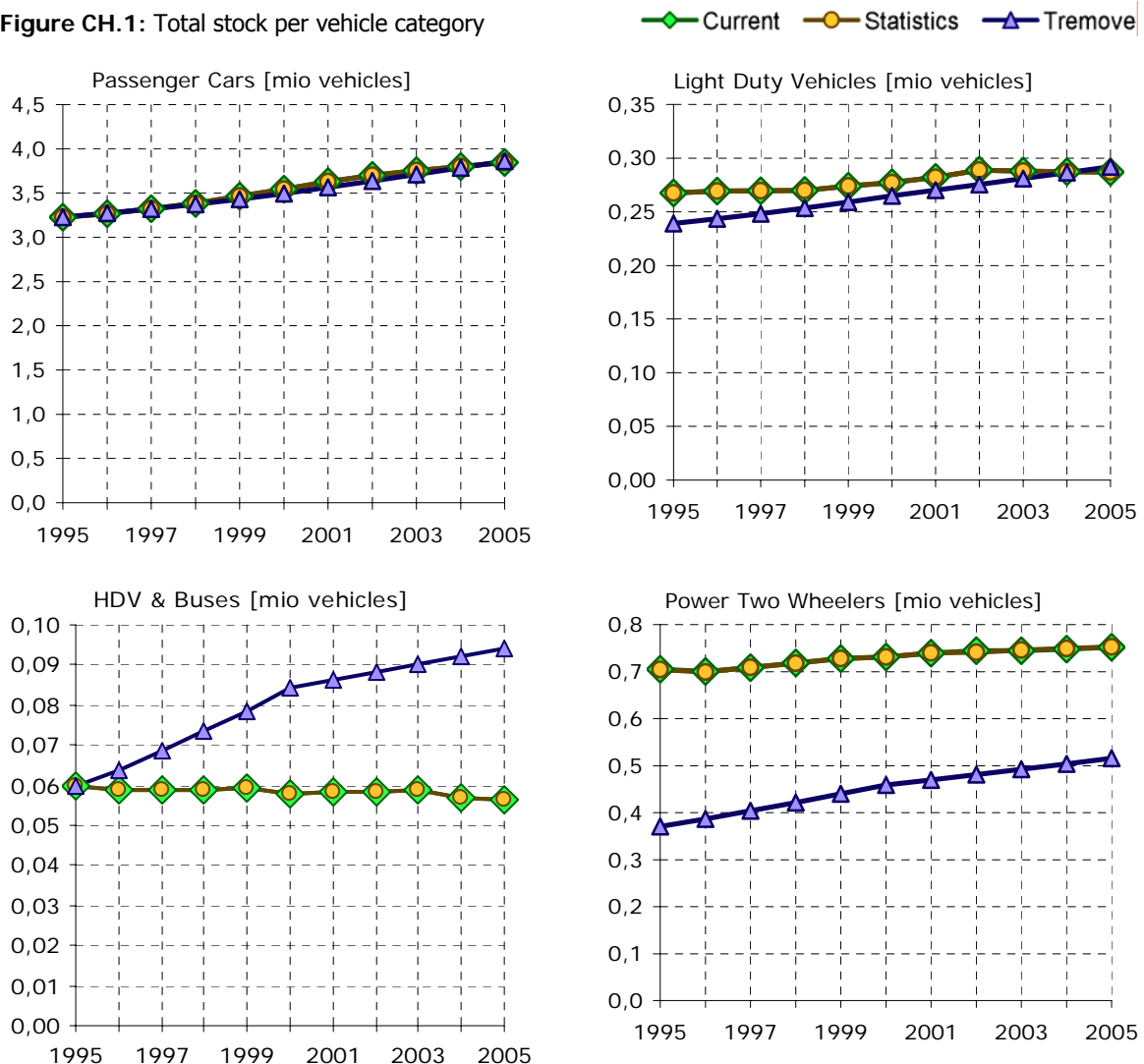
The following were the main sources of information:

- INFRAS on behalf of the Swiss Federal Office for the Environment all data (1990-2006) except de- & new deregistrations, fuel injection & evap. canisters
- Eurostat: new registrations of passenger cars (1989-2003)
- ACEA: new registrations commercial vehicles, buses, passenger cars (2001-2006)

The missing information was only 26% while the missing information of total fleet was less than 1%. The main data missing were the same ECE technology classes and the deregistrations. Differences with the classification system between COPERT/Tremove and the Swiss national system demanded extensive conversion to the template classifications. The total fleet and the distinction to categories and types should be considered reliable as it originates from updated official databases.

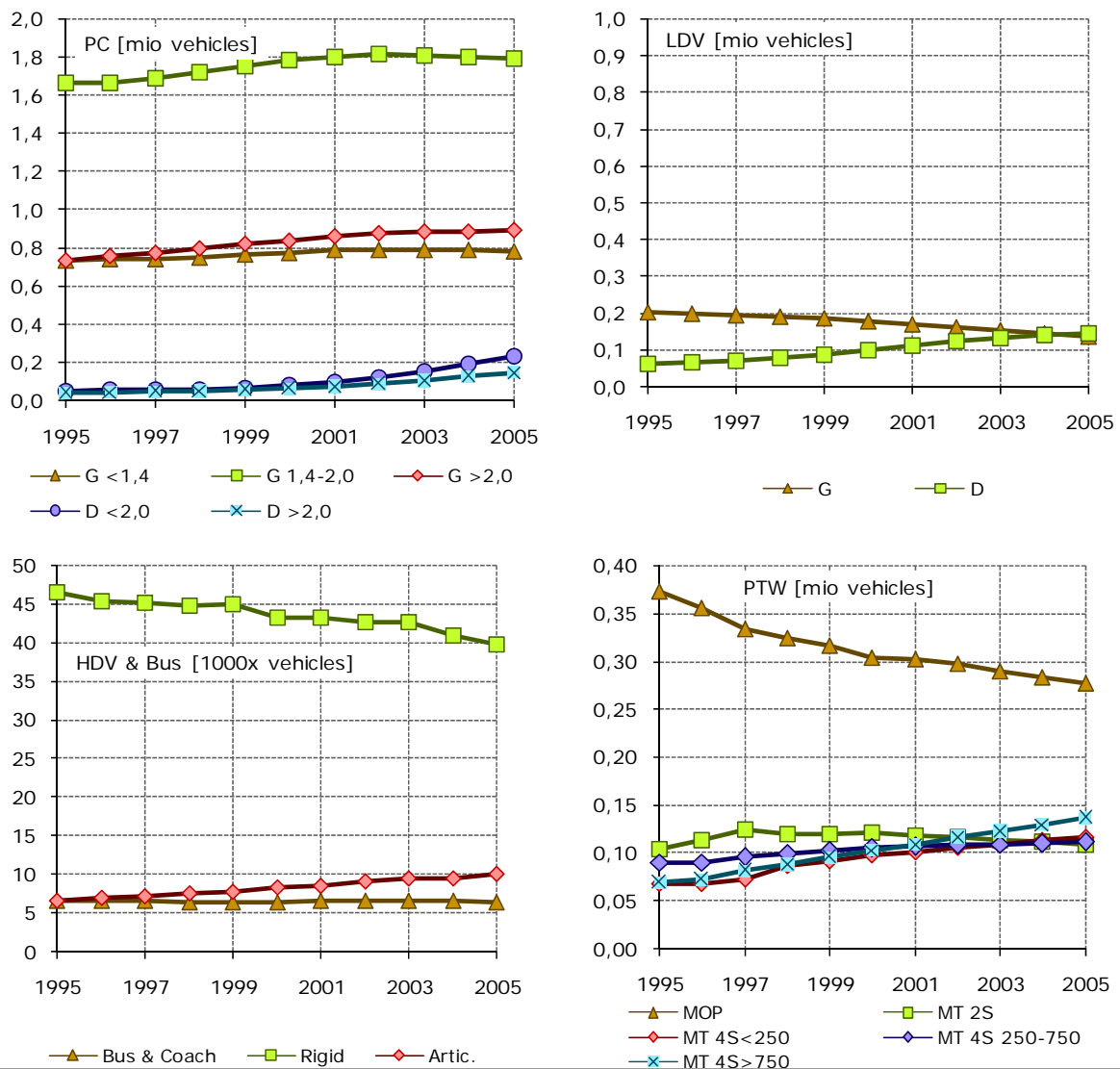
The Swiss passenger fleet size by 19% between 1995 and 2005 increasing its share by 2,5%. The growth rate of the LDV amount to 7% and is considerably low. In addition, the LDV share was reduced slightly if compared to the total fleet. The number of HDV & Buses decreased by about 6% leaving their share with 1% compared to the total Swiss vehicle fleet. The number of PTW increased slightly its share being ~13% in 2005.

Figure CH.1: Total stock per vehicle category



The growth rate of G-PC was 11% between 1995-2005. The largest growth rates could be observed for G-PC >2,0. They increased their share slightly while all other capacity classes experienced a reduction. The number of D-PC has quadrupled, increasing their share from 3% in 1995 to 10% in 2005. This development was mainly driven by D-PC <2,0l. The number of D-LDV doubled within the mentioned period and increased their share from 24% in 1995 to 51% in 2005. The number and share of G-LDV decreased to the same extend. The number of busses & coaches is slightly declining. The fleet of HDV, buses and coaches is dominated by a decline of rigid vehicles. At the same time articulated vehicles increase but their overall effect is only small due to their low share. The number of mopeds has decreased by 25% if compared to 1995 while all motorcycles showed increasing number. In particular those having an engine capacity >750cm³ and < 250 raised their share.

Figure CH.2: Evolution of vehicle type population per subsector



Country: **SWITZERLAND**

CH3/4

Early introduction schemes for G/D-PC and G-LDV fulfilling Euro 4 can be identified, leading to high shares in 2005 at least for those vehicles.

Regarding the technology mix (see table CH.2) a high share of Euro 3 vehicles in D-PC and D-LDV can be observed (52% resp. 40%). The high share (64%) of non-catalyst and Euro 1 G-LDV is also remarkable keeping in mind that the Euro 4 standard was introduced ahead of the time.

Table CH.1: Implementation matrix (introduction of technologies per year)

Cat.	G-PC			D-PC			G-LDV				D-LDV				BUS			HDT			PTW	
	2	3	4	2	3	4	1	2	3	4	1	2	3	4	II	III	IV	II	III	IV	I	II
2000	77	18	5	69	31	0	0	94	6	0	0	97	3	0	98	2	0	60	40	0	100	0
2001	27	53	20	22	78	0	0	65	35	0	0	63	37	0	88	12	0	38	62	0	100	0
2002	0	69	31	1	99	0	0	50	48	2	0	28	72	0	41	59	0	18	82	0	100	0
2003	0	58	42	0	98	2	0	0	83	17	0	0	100	0	27	73	0	0	100	0	0	100
2004	0	36	64	0	70	30	0	0	73	27	0	0	100	0	0	100	0	0	100	0	0	100
2005	0	19	81	0	24	76	0	0	65	35	0	0	100	0	0	72	28	0	61	39	0	100

Table CH.2: Technology mix of the stock per subsector per year

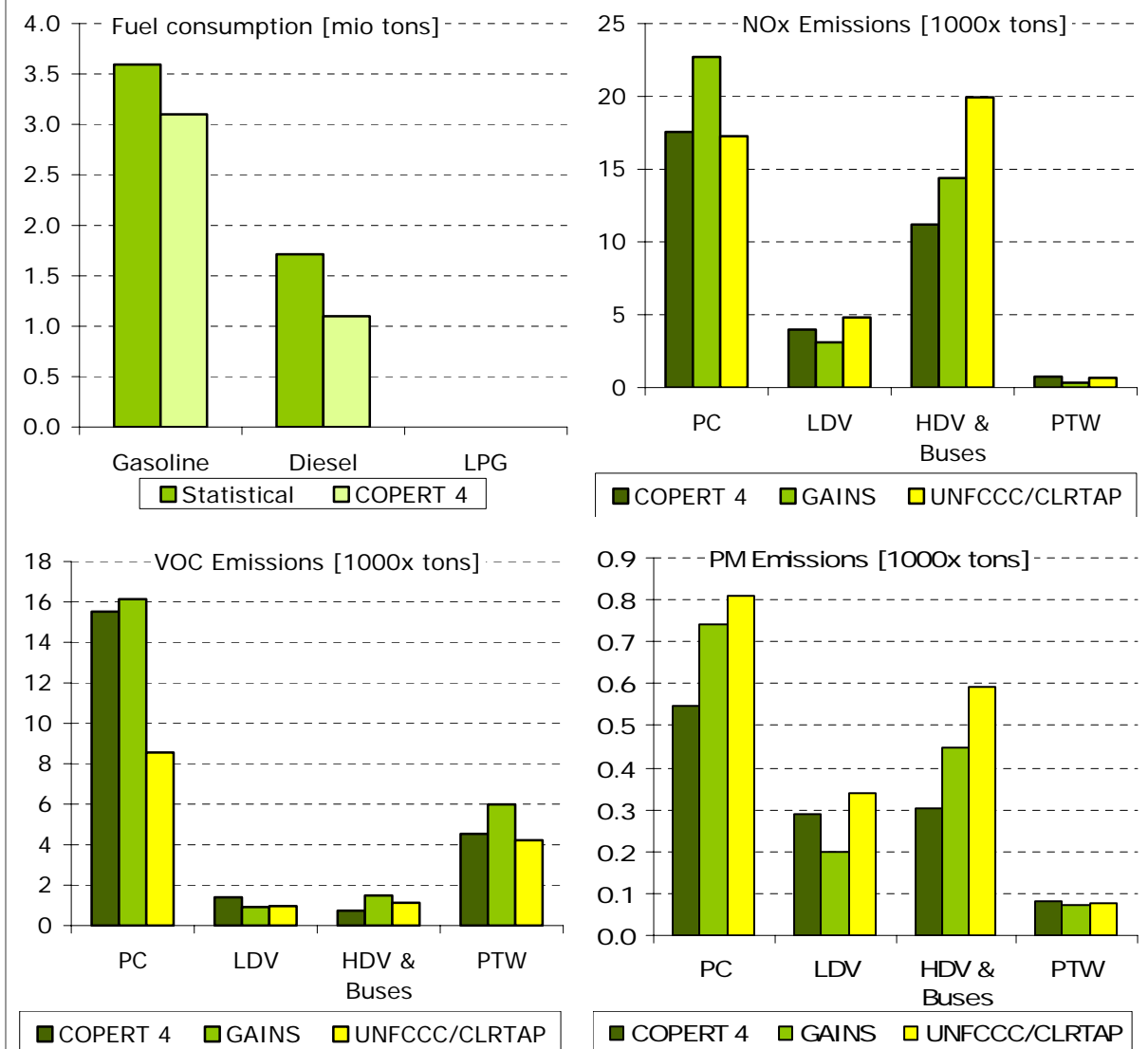
Cat.	G-PC					D-PC					G-LDV					D-LDV					BUS					HDT					PTW		
	C	1	2	3	4	C	1	2	3	4	C	1	2	3	4	C	1	2	3	4	C	I	II	III	IV	C	I	II	III	IV	C	I	II
2000	9	57	32	2	0	15	36	43	6	0	38	49	13	0	0	7	60	33	0	0	63	16	21	0	0	59	18	20	3	0	31	69	0
2001	8	52	33	6	2	10	28	40	22	0	34	48	16	2	0	5	49	39	7	0	55	15	29	1	0	50	17	23	10	0	27	73	0
2002	6	47	32	11	4	7	21	32	40	0	31	47	18	4	0	4	41	38	17	0	48	15	31	6	0	43	16	23	18	0	24	76	0
2003	5	42	31	14	7	5	16	25	54	0	28	45	19	7	1	3	36	35	26	0	42	14	32	11	0	38	15	22	25	0	22	72	5
2004	5	38	31	16	11	3	12	20	58	7	25	43	19	10	2	3	31	33	33	0	37	14	31	18	0	32	14	22	32	0	21	68	11
2005	4	33	30	17	15	2	9	17	52	20	23	41	20	13	4	2	27	31	40	0	32	13	31	22	2	27	13	20	36	3	19	64	17

The fuel consumption value calculated by COPERT is lower than the statistical one by 13% for Gasoline and 36% for diesel. Tank tourism is an important component of this deviation, as fuel tax in Switzerland is much less than in neighbouring countries (Austria, Italy, Germany).

Depending on the source, the main contributor of NOx emissions are either HDV & buses or PC. The data gap for HDV & buses is quite remarkable, the COPERT value indicates ~11.000tons while the UNFCCC/CLRTAP almost doubles this value with ~20.000t. In case of the passenger cars the COPERT and UNFCCC/CLRTAP correspond with each other around 17.000t while Gains indicates 5.000t of higher NOx emissions. The LDV emission of NOx are between 3.000t (Gains) and 5.000 t (UNFCCC/CLRTAP).

The highest contributor of VOC's are passenger cars with an approximate value of 16.000t according to COPERT & Gains and about half according to UNFCCC/CLRTAP. The second largest emitter are PTW's having emissions between ~4.350t (UNFCCC/CLRTAP and COPERT) and 6.000t (Gains). LDV, HDV and Bus emissions of VOC remain largely below 2.000t. Depending on the source most PM is emitted either by passenger cars or HDV's & buses. The gap between the sources is similar for these vehicles types. COPERT always indicates the lowest emission and UNFCCC/CLRTAP always the highest. The latter is also true for LDV. For PTW the sources match almost completely.

Figure CH.3: Results of the calculations with COPERT 4 and the updated fleets compared to other sources



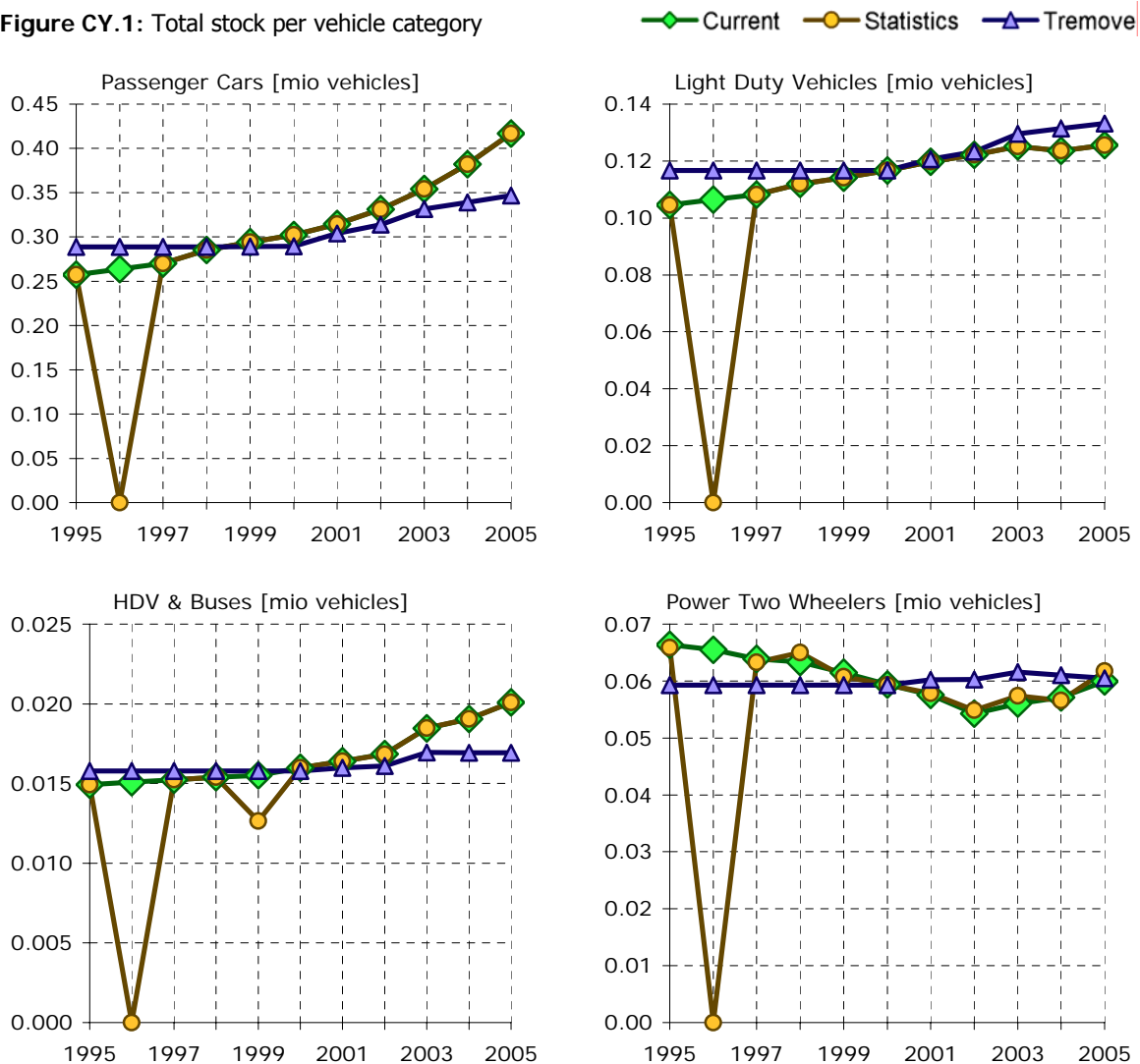
The following were the main sources of information:

- Total fleets per category: Statistical Service of Cyprus (1985, 1990, 1995-2006)
- Split in types: Statistical Service (2000-2006)
- New registrations: Statistical Service (1998-2005)
- Age/technology distribution of vehicles: Statistical Service (2000)
- Other sources included UITP

The information that had to be calculated reached 38% and, actually, 42% of the total stock values had to be calculated. The main information missing was technology distinction for many years. The total fleet and the distinction to categories and types should be considered reliable as it originates from updated official databases.

The number of passenger cars in Cyprus has increased considerably by 60% over the period 1995-2005. A lower increase was recorded for LDVs and HDVs. On the other hand, PTWs decreased slightly, mainly because of the 25% drop in the number of mopeds, although the number of motorcycles increased by 30%.

Figure CY.1: Total stock per vehicle category



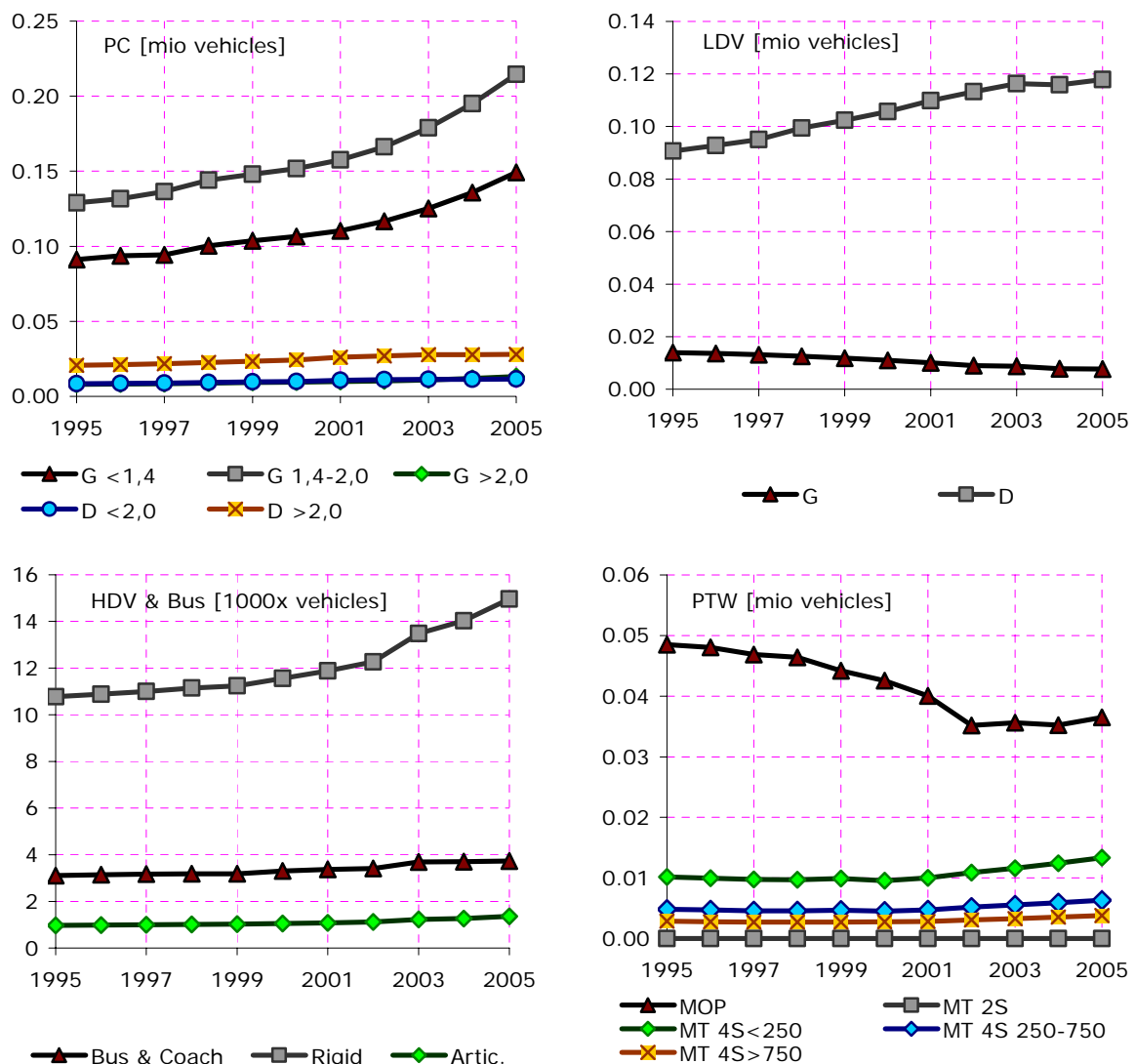
G-PC falling in the medium class (1,4-2,0 l) have the highest share in the passenger car fleet, accounting for more than 50%. The fleet of all G-PC increased by more than 60% over the period 1995-2005. Large (>2.0 l) G-PC have a low share of about 4% of the total G-PC fleet. The share of D-PC has decreased slightly over the period 1995-2005, being lower than 10% of the PC fleet in 2005.

Contrarily to D-PC, D-LDVs, with a share of almost 95%, clearly dominate the LDV fleet. Their fleet increased consistently over the period 1995-2005, while the fleet of G-LDV in 2005 is reduced to almost half compared to 1995.

The bus and HDV stock increase is mainly due to the increase of rigid trucks, which account for more than 90% of the HDV fleet. The fleet of buses & coaches increased by about 20% over the above period.

The fleet of mopeds, accounting for about 60% of the PTW stock, decreased by 25% over the period 1995-2005, while the population of motorcycles (all size classes) increased by about 30%.

Figure CY.2: Evolution of vehicle type population per subsector



Country: **CYPRUS**

CY3/4

The information on the technology of vehicles was quite scarce for Cyprus. As explained above, a distribution into technology classes was only available for one year (2000). On the other hand, there is consistent information on the registration of new and used vehicles. An important fraction of the second-hand imports are from Japan and the average age of the cars imported is estimated in about three years. Therefore, the implementation matrix is considered to be reliable (Table CY.1).

The technology mix in Cyprus (Table CY.2) shows that there is a significant fraction of pre-Euro cars. The G-PC fleet is an exception due to its large expansion over the period 1995-2005, which has led to a fast fleet renewal. On the contrary, new registrations of D-PC have decreased over the same period, resulting in a slow technology replacement. The adoption of EU emission regulations after joining the EU may bring significant improvements in the mean vehicle age.

Table CY.1: Implementation matrix (introduction of technologies per year)

Cat.	G-PC			D-PC			G-LDV				D-LDV				BUS			HDT			PTW	
	2	3	4	2	3	4	1	2	3	4	1	2	3	4	II	III	IV	II	III	IV	I	II
2000	100	0	0	100	0	0	0	100	0	0	0	100	0	0	100	0	0	100	0	0	100	0
2001	55	45	0	0	100	0	0	100	0	0	0	100	0	0	100	0	0	100	0	0	100	0
2002	41	59	0	0	100	0	0	4	96	0	0	28	72	0	69	31	0	71	29	0	36	64
2003	69	31	0	0	100	0	0	14	86	0	0	0	100	0	0	100	0	54	46	0	3	97
2004	0	100	0	0	100	0	0	0	100	0	0	0	100	0	0	100	0	0	100	0	0	100
2005	0	100	0	0	100	0	0	0	100	0	0	0	100	0	0	100	0	0	100	0	0	100

Table CY.2: Technology mix of the stock per subsector per year

Cat.	G-PC					D-PC					G-LDV					D-LDV					BUS					HDT					PTW		
	C	1	2	3	4	C	1	2	3	4	C	1	2	3	4	C	1	2	3	4	C	I	II	III	IV	C	I	II	III	IV	C	I	II
2000	22	47	31	0	0	43	34	22	0	0	87	7	6	0	0	60	13	27	0	0	81	13	7	0	0	63	12	25	0	0	71	29	0
2001	20	43	33	3	0	46	31	20	3	0	85	7	8	0	0	59	12	30	0	0	77	12	12	0	0	58	11	31	0	0	61	39	0
2002	18	42	34	6	0	48	28	19	5	0	83	6	9	2	0	55	10	30	5	0	73	11	15	2	0	53	10	35	2	0	53	43	4
2003	16	37	38	9	0	50	26	18	6	0	82	6	9	3	0	55	10	29	7	0	67	10	14	9	0	51	8	35	5	0	46	42	12
2004	14	31	35	20	0	51	24	17	7	0	80	5	9	6	0	54	9	28	10	0	65	9	13	12	0	47	7	32	13	0	39	40	21
2005	12	26	31	31	0	53	22	16	8	0	78	4	8	9	0	53	9	27	12	0	63	8	12	16	0	46	6	29	19	0	37	37	25

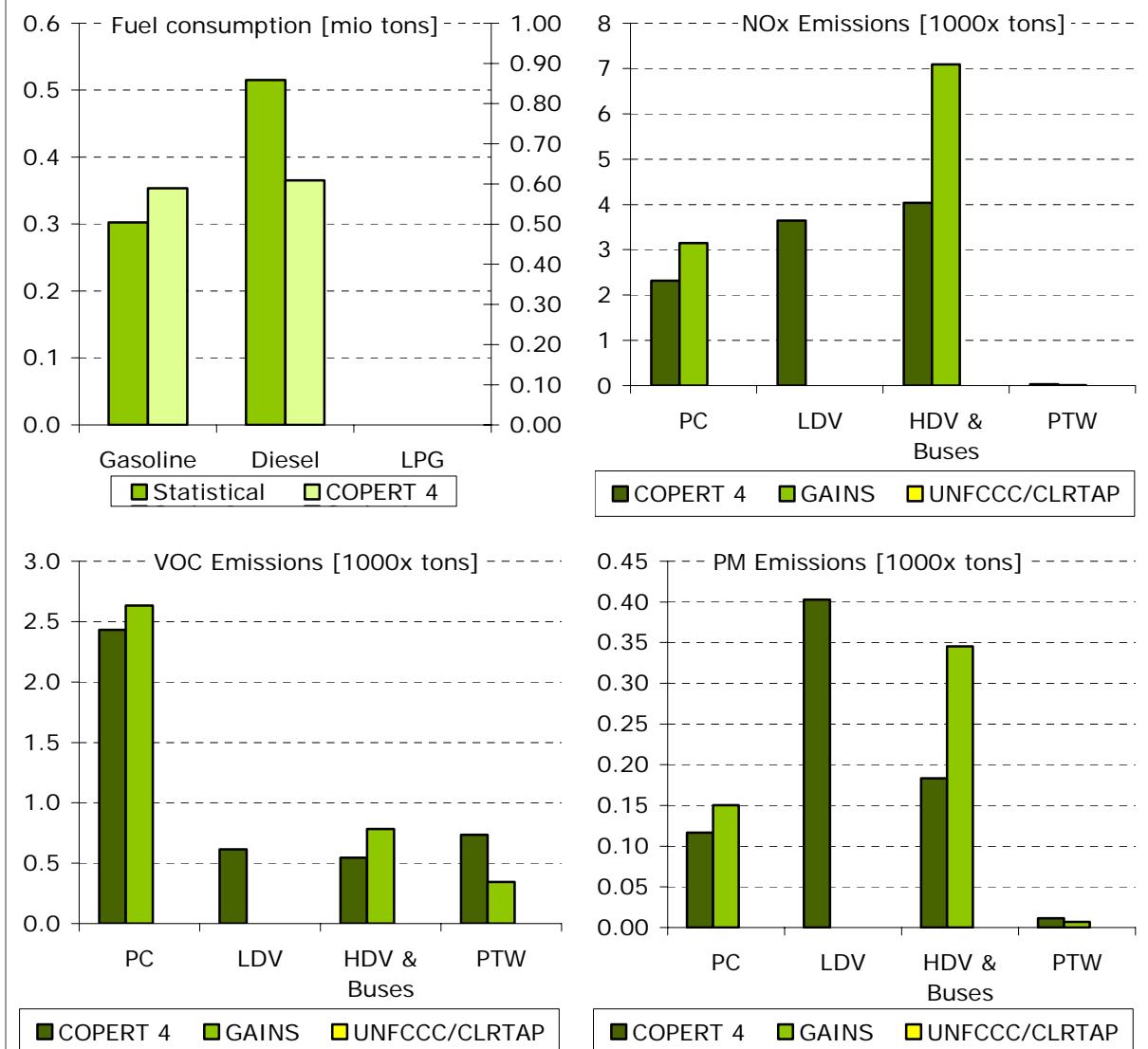
Gasoline consumption calculated with COPERT 4 is about 17% higher compared to the respective statistical value reported by Eurostat, while diesel consumption is almost 30% lower. These deviations may be explained by the difference in the use of gasoline, diesel and LPG vehicles (mainly annual mileage) considered for the calculations and the real-world vehicle use.

Emissions reported under UNFCCC/CLRTAP were not available, while relevant information from GAINS was rather scarce.

Due to the high number of D-LDV in the fleet (practically all LDV are diesel vehicles), NOx emissions from LDV are of the same order of magnitude as from HDV & Buses.

PC and in particular G-PC dominate VOC emissions, while LDV are the dominant source of PM emissions, contributing more than twice as much as all other vehicle categories.

Figure CY.3: Results of the calculations with COPERT 4 and the updated fleets compared to other sources



For the Czech road vehicle population and mileage there was no available database according to COPERT distribution. In this way, primary input data were the Eurostat database the Czech statistics and the Slovak tables produced by us, from point of view of the emission technology distribution. In line with this, the age distribution of vehicles per vehicle classes from Eurostat can offer a good comparison opportunity to the Slovak stock which was taken into account in this task.

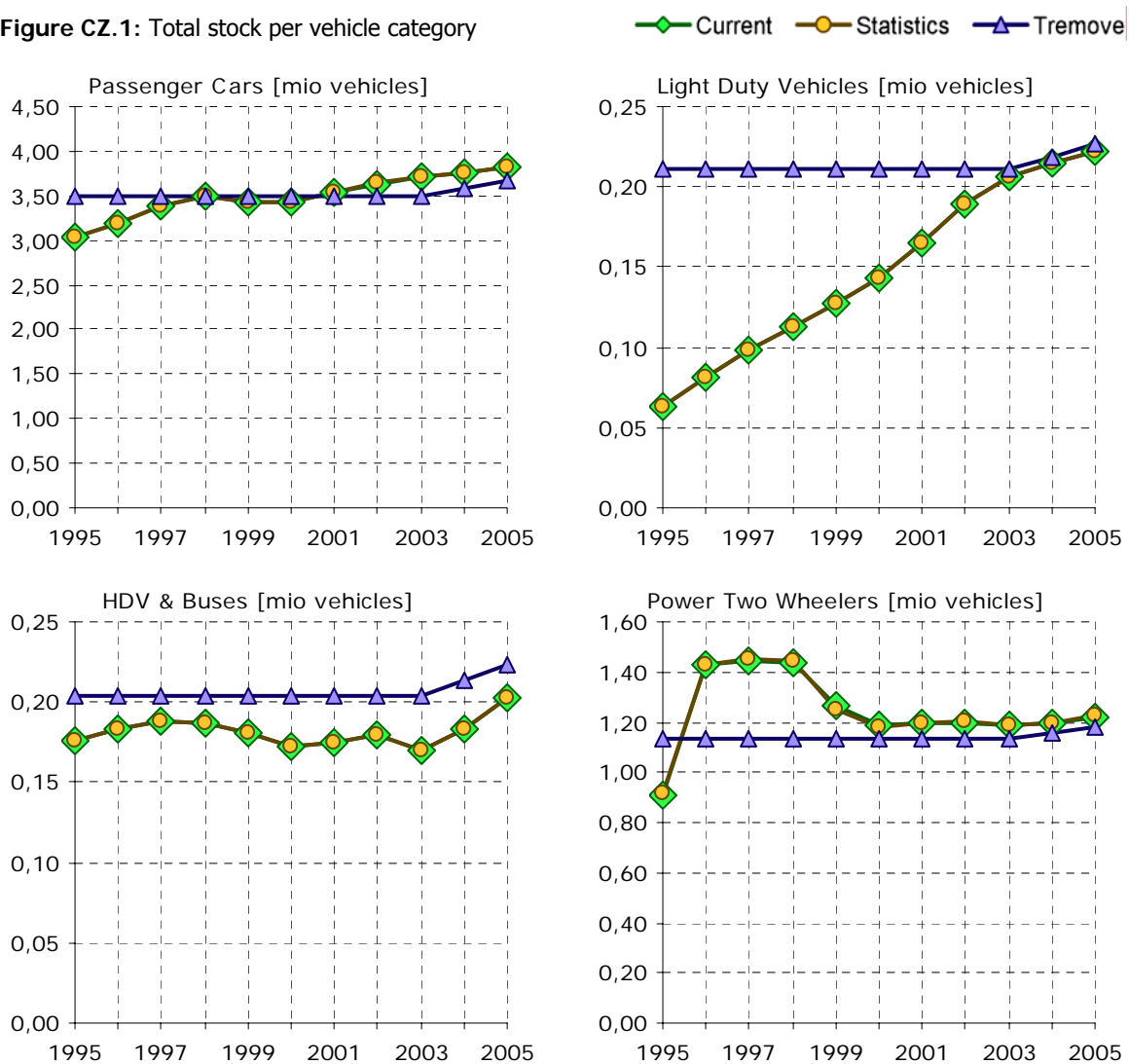
As basic the national statistical yearbook "Study on Transport Trends from Environmental Viewpoints in the Czech Republic 2006" was used for this work, it contains further basic stock data for years 2005 and 2006. Also there are the total mileage data on motorways per vehicle classes.

In total, 38% of the total information had to be calculated, which was split to 26% of the total stock, 39% of new registrations and 48% of deregistration. The passenger car fleet increased moderately during the period 1995–2005, this is in connection with the economic development in this country with growing travel demand.

The light duty vehicles' fleet show and extreme strong growth in the studied period. This is opposite to the near unchanged character of heavy duty vehicle stock – it would be worthy to analyse that, because the Czech Republic lies in an important transit way.

The stock of two-wheelers shows a similar fall at the end of the nineties to the Slovak one.

Figure CZ.1: Total stock per vehicle category



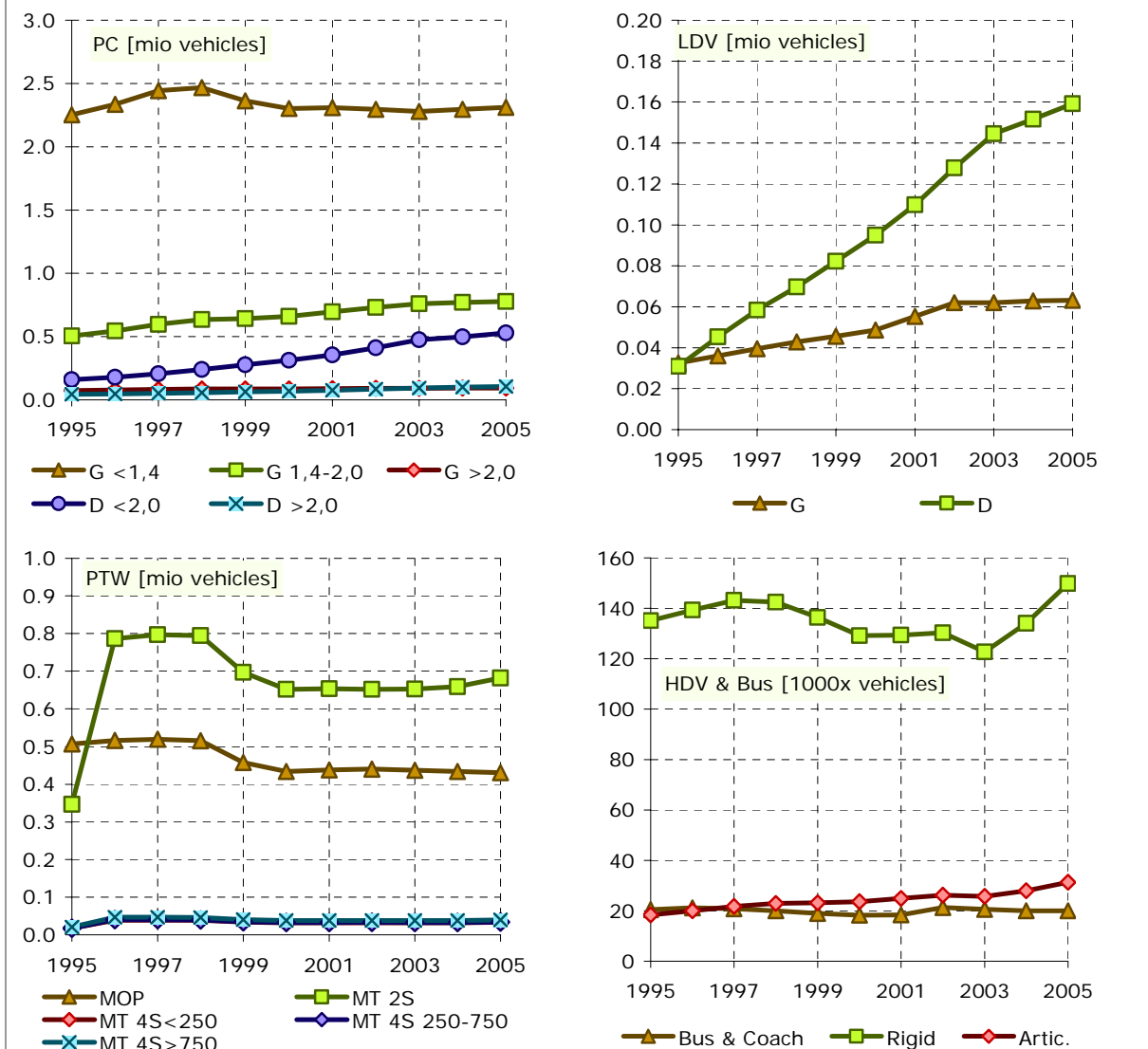
There are very precise Eurostat data for composition of passenger car stock per engine type and piston displacement. Most of the cars have an engine of smaller than 2 litres displacement. As the share of less than 1,4 l petrol fuelled cars slightly decreases from 1998, the 1,4...2 l petrol cars and even more the diesel cars have a growing share in the stock.

The mentioned national issue provides the common amount of PC-s and LDV-s up to 3,5 t, so the amount of LDV-s is known for the years of the period. As it is common in Middle Europe, the share of diesel LDV-s grows in a much more intensive tendency than the share of petrol fuelled ones.

The weight distribution of heavy duty trucks (solo lorries and articulated road tractor–semitrailer couples) could be calculated in the similar way as the other countries where no exact data were available from a COPERT table – from load capacity distribution it can be evolved. Within the heavy duty vehicle stock there is a slightly growing share for articulated trucks (road tractors). The amount of buses didn't change considerably in this period.

In the Czech Republic – similar to Slovakia – the mopeds and two-stroke engined motorcycles form the main part of the powered two-wheelers' stock. There is a relatively large amount of motorcycles in the country.

Figure CZ.2: Evolution of vehicle type population per subsector



These tables show not more relevant trends than the same for the Slovak Republic, since as mentioned the environmental technology distribution rates were copied from there.

Table CZ.1: Implementation matrix (introduction of technologies per year)

Cat.	G-PC			D-PC			G-LDV				D-LDV				BUS			HDT			PTW	
	2	3	4	2	3	4	1	2	3	4	1	2	3	4	II	III	IV	II	III	IV	I	II
2000	25	75	0	53	47	0	0	48	52	0	21	45	34	0	100	0	0	79	21	0	100	0
2001	25	75	0	53	47	0	0	49	51	0	22	44	33	0	100	0	0	62	38	0	100	0
2002	25	75	0	52	48	0	0	46	54	0	23	44	33	0	81	19	0	48	52	0	100	0
2003	3	97	0	14	86	0	0	0	100	0	24	44	32	0	25	75	0	26	74	0	62	38
2004	0	100	0	3	97	0	0	0	100	0	3	2	95	0	1	99	0	27	73	0	68	32
2005	6	94	0	8	92	0	0	0	100	0	5	6	88	0	13	87	0	16	84	0	76	24

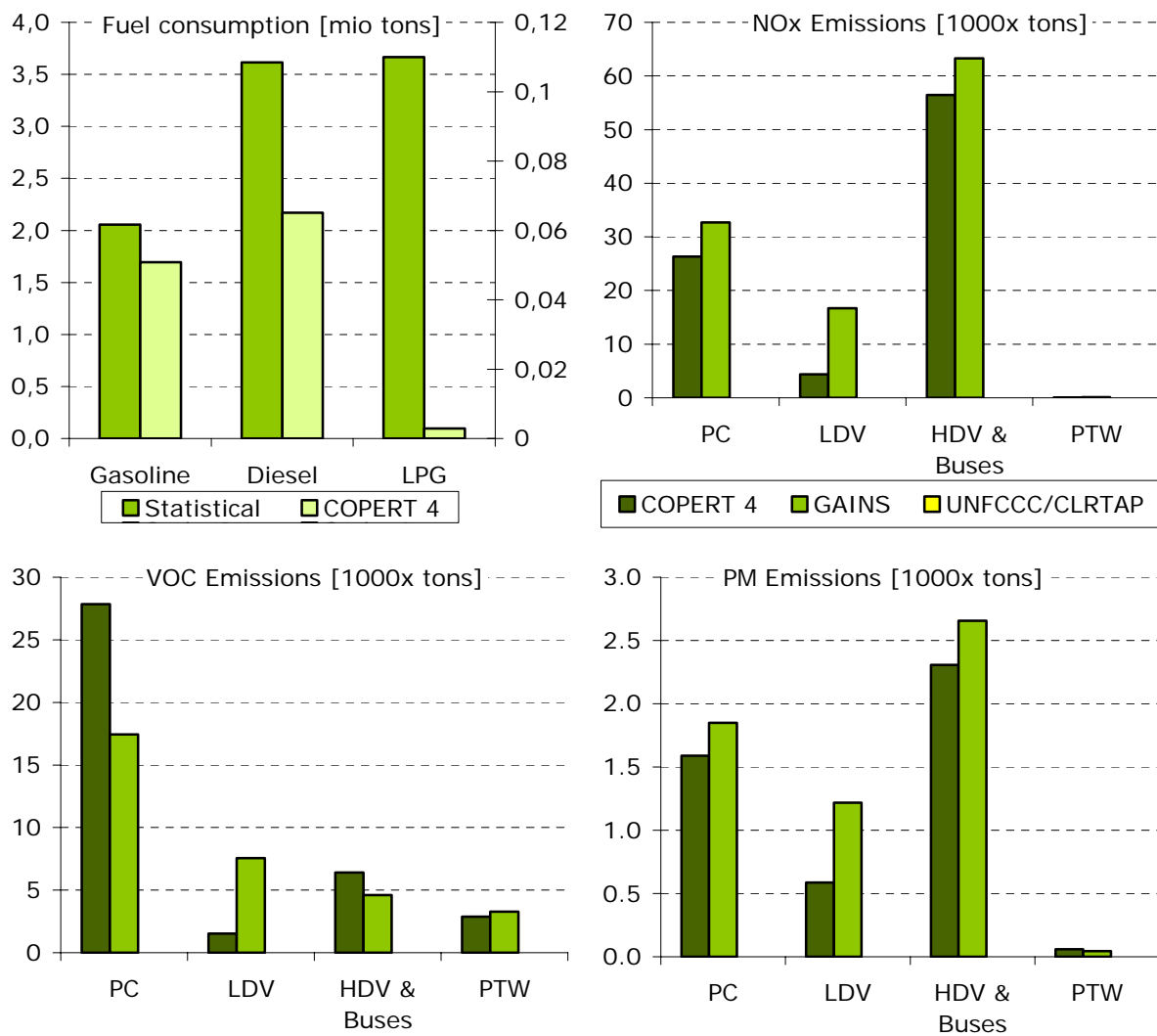
Table CZ.2: Technology mix of the stock per subsector per year

Cat.	G-PC					D-PC					G-LDV					D-LDV					BUS					HDT					PTW		
	C	1	2	3	4	C	1	2	3	4	C	1	2	3	4	C	1	2	3	4	C	I	II	III	IV	C	I	II	III	IV	C	I	II
2000	71	22	3	4	0	79	12	6	3	0	68	13	12	7	0	92	4	3	1	0	89	8	2	0	0	96	2	2	0	0	98	2	0
2001	63	25	4	8	0	75	13	8	5	0	61	11	16	12	0	91	4	4	2	0	87	10	3	0	0	96	2	2	0	0	97	3	0
2002	55	28	5	11	0	72	12	9	6	0	56	9	19	16	0	90	3	4	2	0	87	10	3	0	0	95	2	3	1	0	96	4	0
2003	51	28	5	17	0	67	12	9	11	0	48	9	18	25	0	89	3	5	3	0	83	10	4	2	0	89	4	4	4	0	93	6	1
2004	47	27	5	21	0	63	12	9	16	0	40	8	17	34	0	79	3	5	13	0	80	10	4	6	0	80	4	6	10	0	90	8	2
2005	38	29	5	28	0	59	12	9	21	0	35	8	16	42	0	67	3	5	24	0	75	11	4	9	0	74	4	6	15	0	86	11	3

In connection to the *Fuel consumption* chart, apart from the deviation between statistical (Eurostat) data and computation results from recent COPERT method (for which there is the explanation stated in case of several other countries in our competence), the main problem is the notable difference in the road transportation purpose LPG consumption by the two methods. The problem can be that also in this region lots of old petrol fuelled car were retrofitted for LPG fuelling, and while these cars were not declared as retrofitted, the measurement of LPG consumption at filling stations throughout the country still show the notable demand.

In relation to the further diagrams it is not possible to draw any exact conclusion, because the emission technology distribution was not really available. So the rates are very similar to the Slovak ones, apart from the somewhat differing stock and mileage data per vehicle classes.

Figure CZ.3: Results of the calculations with COPERT 4 and the updated fleets compared to other sources

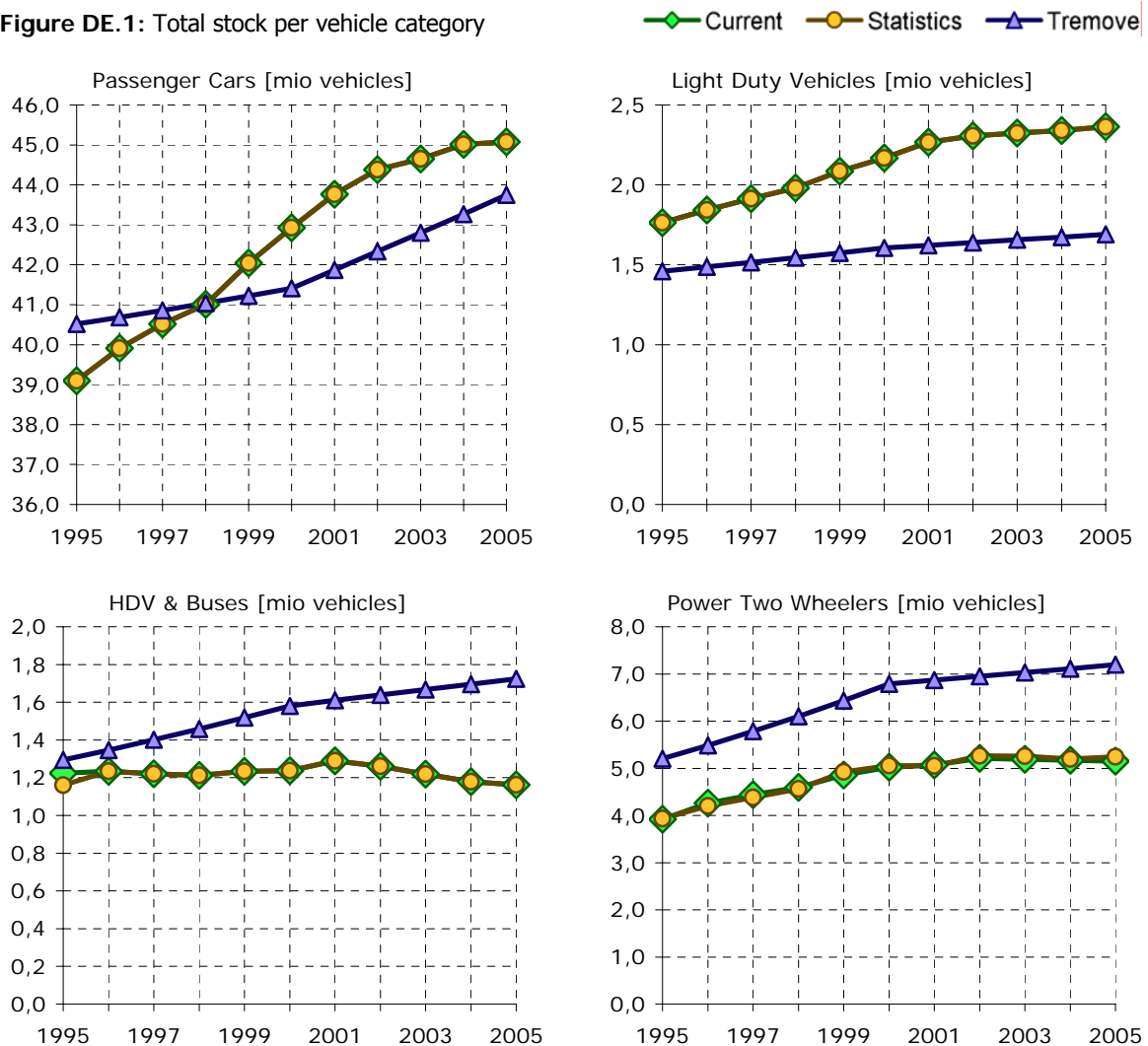


The following were the main sources of information:

- Institute for Energy and Environmental Research on behalf of the German Federal Environment Agency: population, total veh. km, annual mileage, road share, fuel data (1995-2005)
- Eurostat: fuel data (1985-1994), pop. by age for mopeds (95-99) & bikes (95-03)
- German vehicle agency (Kraftfahrt-Bundesamt): population & new registrations (1994-2005), population by age (1995-2005), Deregistrations (mainly 1997-2005)
- Other sources included UITP, the German traffic publishing house (Deutscher Verkehrsverlag), ANFAC Car Park Report, ACEA, Central database of the European Commission for new M1's

The missing information was 29,5%, with only 8% of the total stock missing. The main information missing was the exact technology distinction for PTW. Differences with the classification system demanded extensive conversion to the template classifications and was not possible in all cases. The total fleet and the distinction to categories and types should be considered reliable as it originates from updated official databases. The number of passenger cars increased by 15% between 1995 and 2005 leaving their share at 84% of the total vehicle fleet in 2005. The share of LDV's remained at a constant 4% although their number increased by 34%. The number of HDV's and buses is quite constant but shows a slight decline in recent years. The number of PTW increased by 32% resulting in a share of 10% in comparison to the total vehicle fleet.

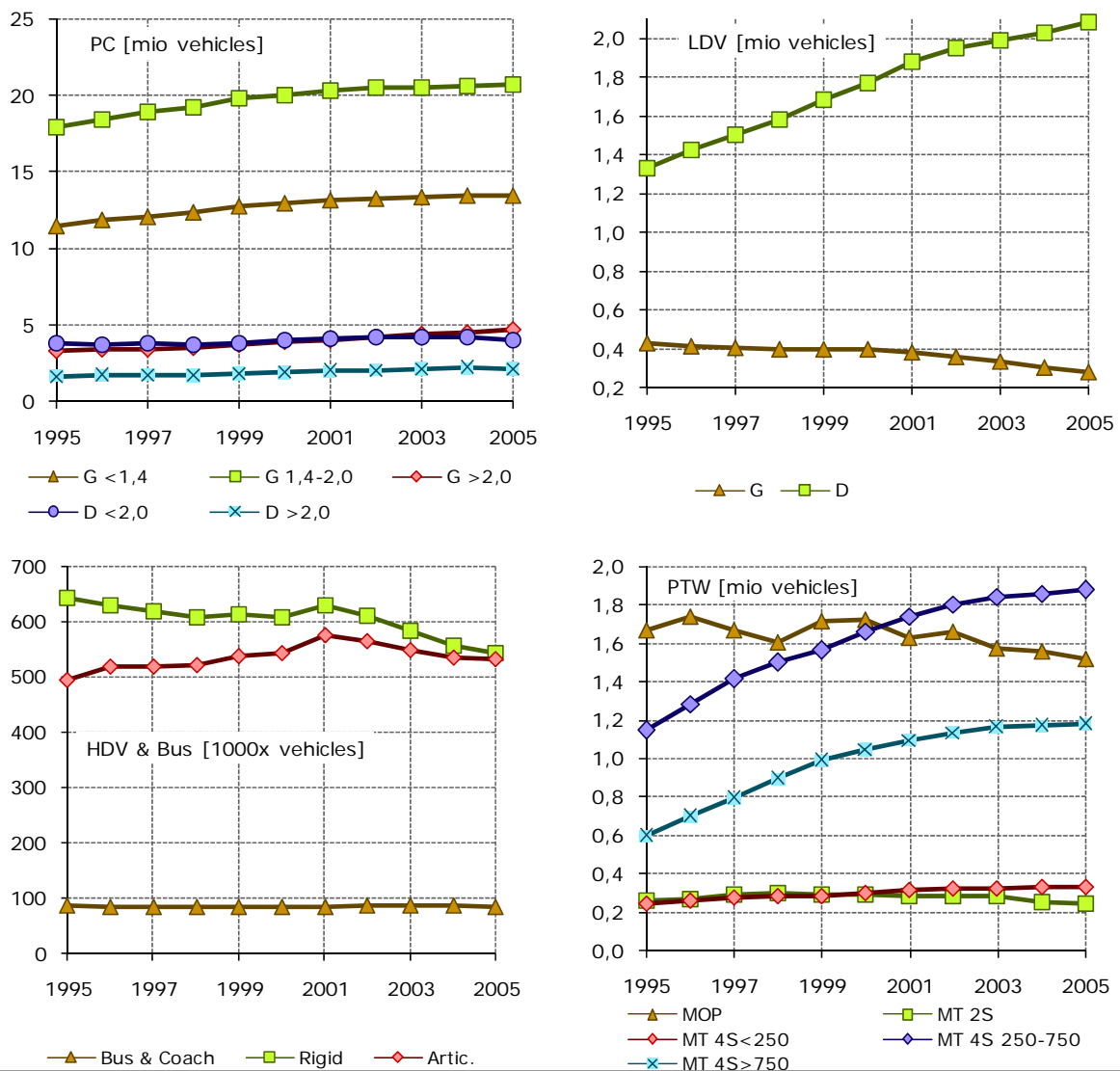
Figure DE.1: Total stock per vehicle category



Among the passenger cars no drastic trends are identifiable. G-PC dominates the fleet due to their share and slightly higher growth rates if compared to D-PC. An increase in share can be observed for G-PC of the lowest and highest category. For the LDV a dieselisation of the fleet is noticeable which reduces the number of G-LDV by half resulting in a share of 12% in 2005.

The number of buses & coaches remains constant over the years. A slight increase can be observed for articulated vehicles, while the number of rigid vehicles decreases significantly. The number of mopeds and small motorcycles decreases considerably. This trend is absorbed by an augmentation of large motorcycles having a share of 59% among all PTW's in 2005.

Figure DE.2: Evolution of vehicle type population per subsector



Country: **GERMANY**

DE3/4

Early introduction schemes for G/D-PC and G/D-LDV fulfilling Euro 4 can be identified, This development lead to an early disappearance of Euro 2 or earlier technologies for new registrations. For G/D-LDV earlier Euro 2 standard vehicles have been registered with relatively high rates until 2004. In addition the opposing development of Euro 1/2 vehicles in 2000 and 2001 is remarkable.

The technology mix in Germany (Table DE.2) shows that the majority of passenger cars fulfil the Euro 3 or 4 standard. The share of conventional vehicles is 4% for G-PC and 2% for D-PC. Nevertheless in absolute values the number of those vehicles is ~ 1,7 million. This is still considerably more than the number of LDV's fulfilling the only Euro 1 standard or lower although their share is 55% to 67% (D-LDV resp. G-LDV).

Table DE.1: Implementation matrix (introduction of technologies per year)

Cat.	G-PC			D-PC			G-LDV				D-LDV				BUS			HDT			PTW	
	2	3	4	2	3	4	1	2	3	4	1	2	3	4	II	III	IV	II	III	IV	I	II
2000	0	59	41	48	52	0	13	87	0	0	35	65	0	0	98	2	0	96	4	0	100	0
2001	0	35	65	6	93	2	58	42	0	0	31	47	22	0	82	18	0	83	17	0	100	0
2002	0	30	70	0	93	7	0	76	24	0	0	52	48	0	38	62	0	0	100	0	100	0
2003	0	20	80	0	83	17	0	28	39	33	0	47	53	0	0	100	0	0	100	0	67	33
2004	0	17	83	0	47	53	0	28	29	44	0	24	50	25	0	100	0	0	100	0	20	80
2005	0	14	86	0	23	77	0	0	5	95	0	0	37	63	0	93	7	0	97	3	0	100

Table DE.2: Technology mix of the stock per subsector per year

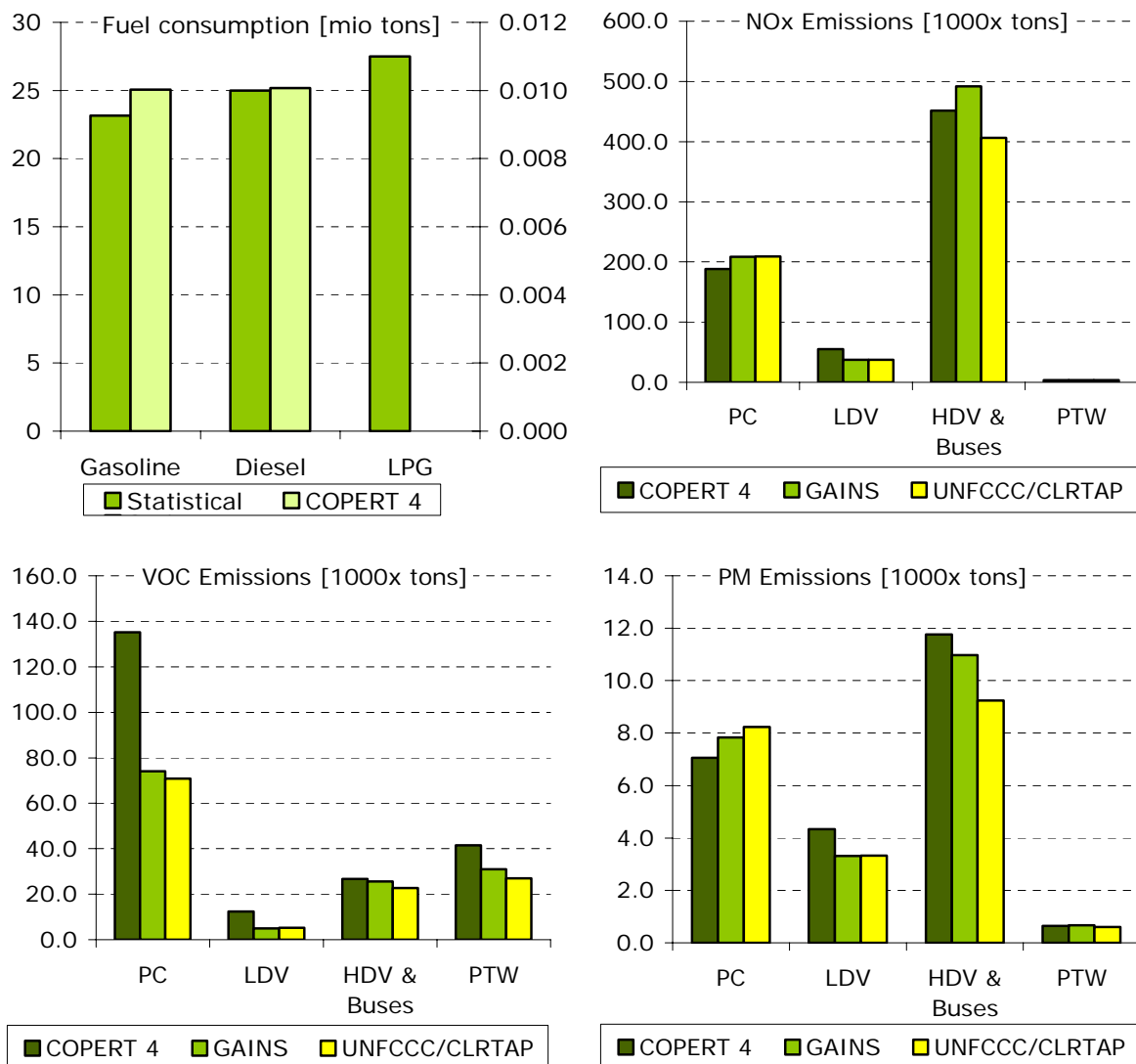
Cat.	G-PC					D-PC					G-LDV					D-LDV					BUS					HDT					PTW		
	C	1	2	3	4	C	1	2	3	4	C	1	2	3	4	C	1	2	3	4	C	I	II	III	IV	C	I	II	III	IV	C	I	II
2000	14	45	19	18	5	11	43	32	14	0	73	8	19	0	0	8	79	14	0	0	57	18	24	0	0	49	14	37	0	0	85	15	0
2001	11	41	18	20	10	8	36	31	24	0	70	10	21	0	0	7	74	17	2	0	51	18	30	1	0	43	13	41	4	0	78	22	0
2002	9	38	17	22	15	6	29	29	35	1	66	10	23	1	0	7	68	19	6	0	45	18	31	6	0	39	12	39	10	0	73	27	0
2003	7	35	16	22	20	4	23	26	44	3	63	10	24	2	1	6	61	22	10	0	40	17	31	12	0	34	11	37	18	0	69	30	1
2004	5	32	15	22	26	3	17	24	47	9	60	10	24	3	2	5	56	23	14	2	35	16	30	19	0	30	10	35	26	0	65	30	5
2005	4	29	14	22	31	2	13	22	49	15	57	10	25	3	5	5	50	21	17	8	30	16	29	25	0	27	9	31	33	1	61	29	10

The fuel consumption value for diesel fuel is 25 mio tons, differing by only 200 ktons between the statistical and the calculated estimate. The gasoline value differs by 1.9 mio tons and the calculated one is 8.2% higher than the statistical. The difference obviously comes from slightly different emission factors used between the TREMOD and COPERT emission models. The LPG consumption in Germany is in any case very small to comment upon.

With regard to all emissions, the national data correspond very well with the COPERT ones in all vehicle categories. It should be repeated that VOC in the COPERT approach includes evaporation emissions and it is therefore natural that they exceed by far the national submissions. Also, LDV seem a bit higher than national submissions. The total activity for LDVs might have to be adjusted to better match the national estimates.

There is also a characteristic difference in the PM emissions from HDVs. Several of the busses in Germany are retrofitted with emission control devices which is not taken into account in the COPERT approach. In order to further replicate this information, DPF-specific emission factors will have to be used. In order to keep the consistency with all other countries, we did not use such specific emission factors for Germany, a fact that promotes the deviation.

Figure DE.3: Results of the calculations with COPERT 4 and the updated fleets compared to other sources



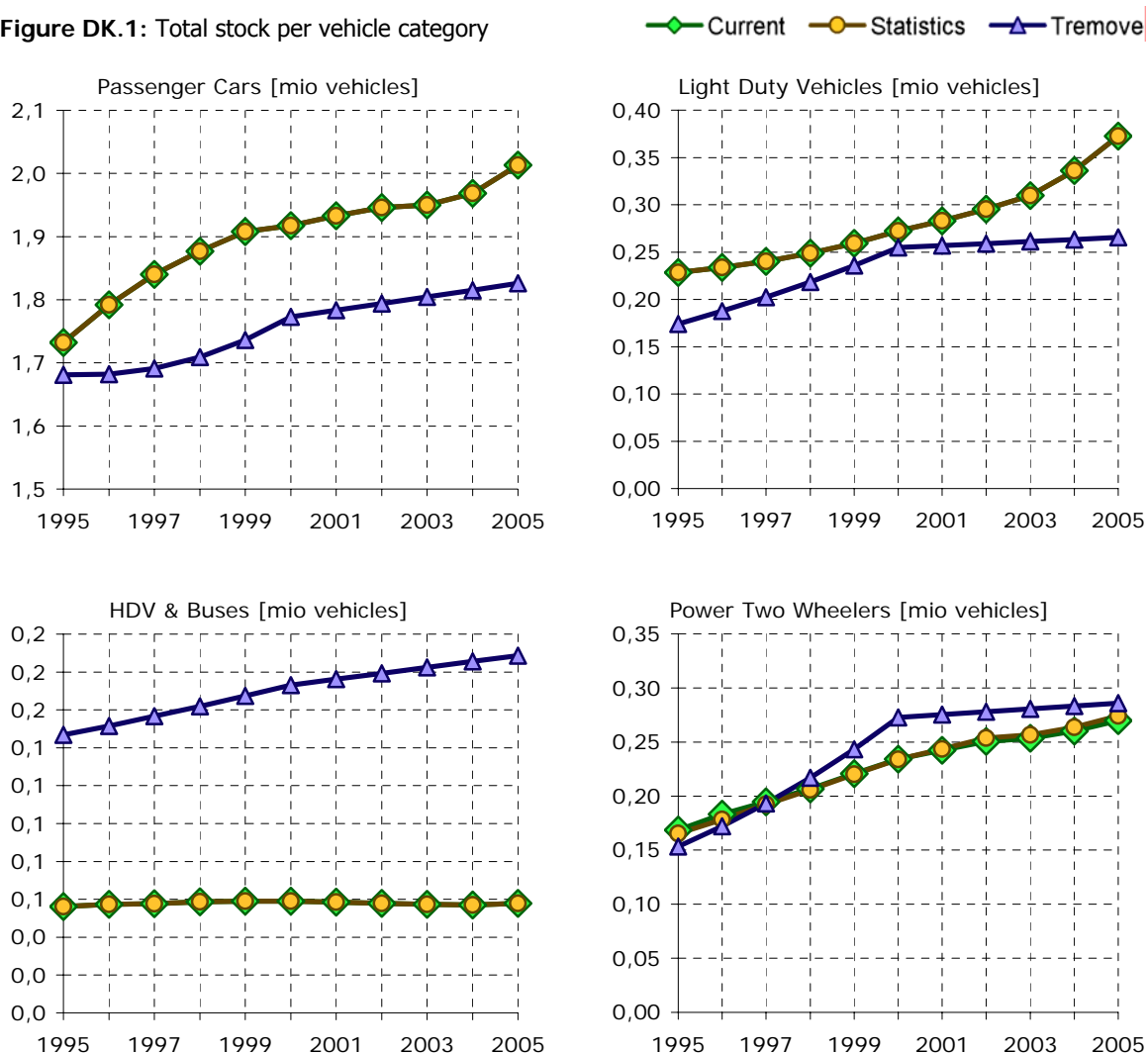
The following were the main sources of information:

- Danish National Environmental Research Institute: all (1985-2005) except population by age, new registrations & deregistrations
- Eurostat: population busses (79-84) and motorcycles (79-02), new registrations (mainly 1979-2002), total veh. km (92-02)
- Central database of the European Commission: new registrations of passenger cars (2002-2006)
- ACEA: population by age (1996-2005) & deregistrations (2001-2005) of passenger cars and UITP

The missing information was 25% which is split to less than 1% of total population, 26% of new registrations and 49% of deregistrations. The total fleet and the distinction to categories and types should be considered reliable as it originates from updated official databases. The main information missing was the weight classification for Buses and Coaches and the distinction to categories and types for the data not provided by the Danish National Environmental Research Institute.

The vehicle stock of passenger cars increases by 16% between 1995-2005 while the stock of LDV increases by 63%. This steep increase of LDV could be explained by the fact that the registration tax for LDV used to be significantly lower than for passenger cars in Denmark. The other remarkable increase is the development of PTW having an increase in stock of 60% between 1995 and 2005. The stock of Buses and Coaches is slightly decreasing while the HDV's are slowly increasing. Due to this the overall fleet of Buses, Coaches and HDV's stays constant over the years.

Figure DK.1: Total stock per vehicle category

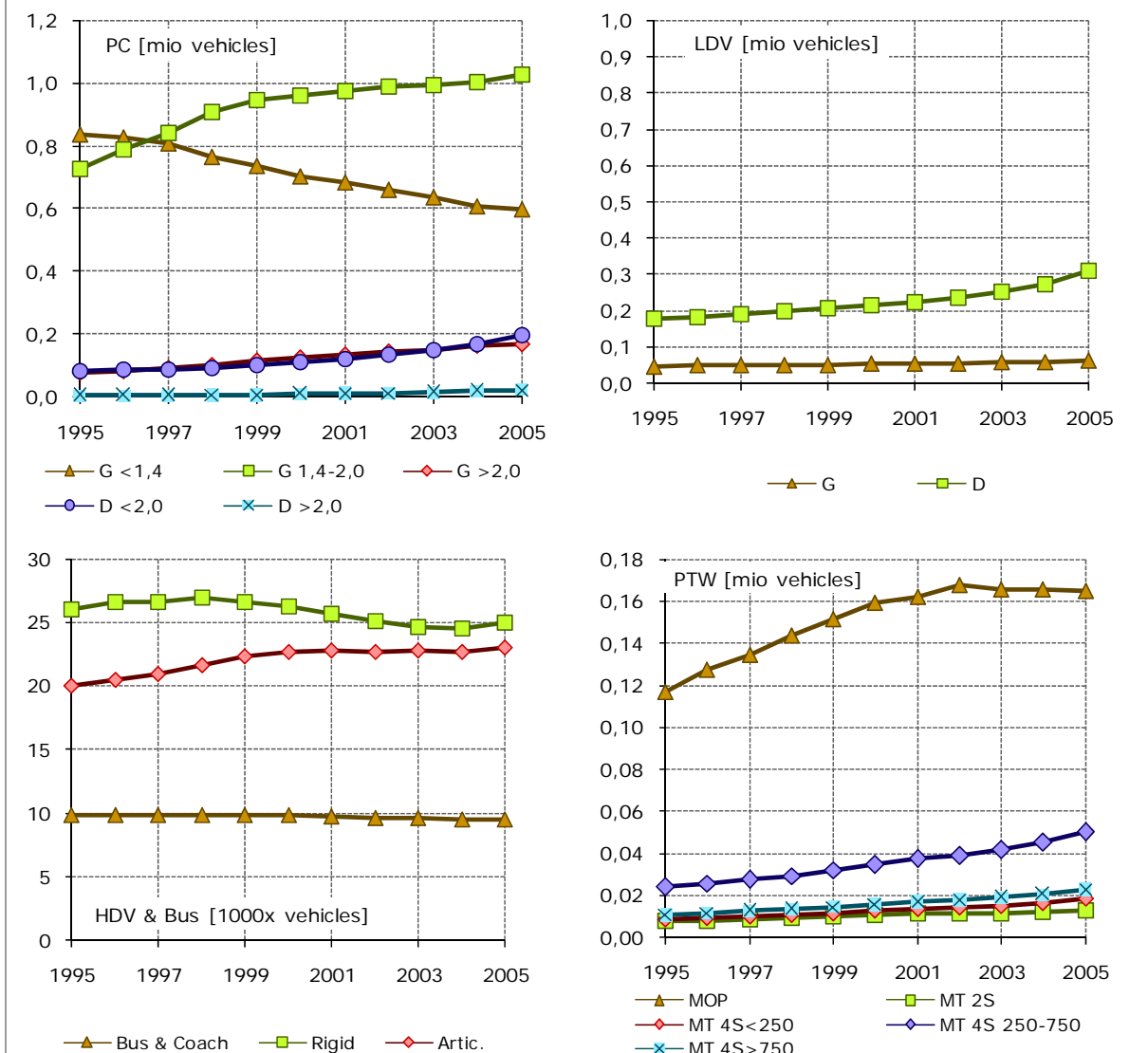


The passenger car fleet is dominated by G-PC falling in the <1.4 l class and an increase of registration for about the same rate for the G-PC 1,4-2,0 class. The fraction of large (>2.0 l) G-PC amounts to only 8% of the total passenger cars in 2005 and the share of diesel passenger cars is also quite small with 11% of the total. Among the diesel fuelled vehicles the share of D-PC >2,0 has a share of 1% in comparison with the total passenger cars.

The share of diesel fuelled LDV's is higher than for G-LDV and is also constantly rising while the share of G-LDV remains constant.

The bus and HDV stock shows only slight increase, which is mainly due to the increase of articulated HDV's. PTW's increase was mainly made by mopeds although their number is slightly decreasing in recent years. All motorcycles show constant increase. The highest increase can be observed for motorcycles < 250 cm³ and between 250-750cm³ both doubled between 1995-2005 having a share of 26% if compared to all PTW in 2005.

Figure DK.2: Evolution of vehicle type population per subsector



Country: **DENMARK**

DK3/4

The implementation matrix reveals that no passenger car with an Euro 4 technology entered the Danish market in 2005. In general, the implementation matrix largely follows the implementation dates considered by the regulations.

The technology mix in Denmark (Table DK.2) shows that there is a large fraction of old (even non-catalyst) cars which amount to one fifth of the passenger cars in 2005. For passenger cars the other technologies are evenly distributed. Within the LDV sector the Euro 3 technology is quite dominant, while Euro1 is negligible.

Table DK.1: Implementation matrix (introduction of technologies per year)

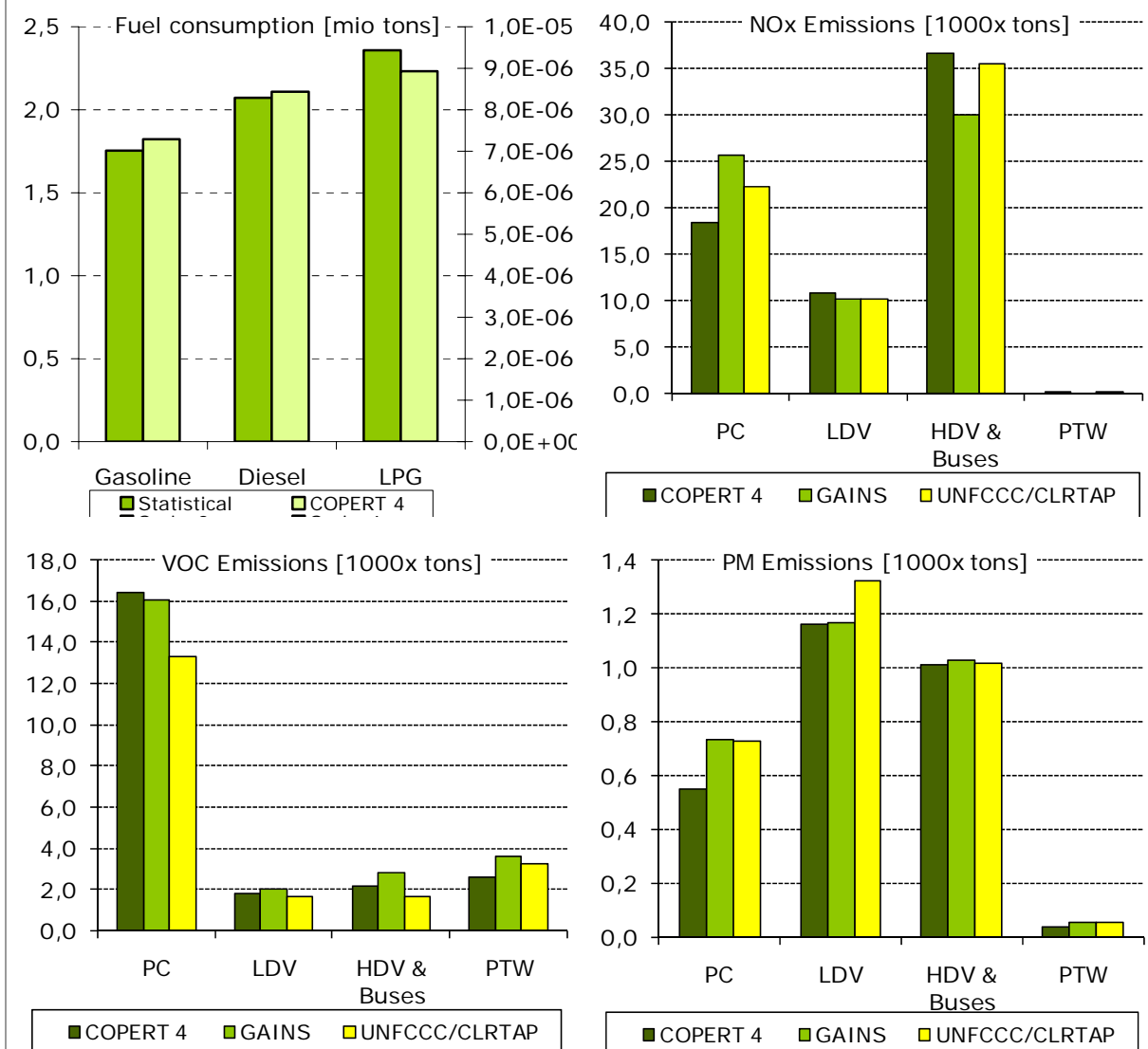
Cat.	G-PC			D-PC			G-LDV				D-LDV				BUS			HDT			PTW		
	Euro	2	3	4	2	3	4	1	2	3	4	1	2	3	4	II	III	IV	II	III	IV	I	II
2000	100	0	0	100	0	0	0	100	0	0	0	0	100	0	0	100	0	0	100	0	0	100	0
2001	0	100	0	35	65	0	0	100	0	0	0	0	100	0	0	100	0	0	100	0	0	100	0
2002	0	100	0	32	68	0	0	0	100	0	0	0	0	100	0	0	100	0	0	100	0	41	59
2003	0	100	0	33	67	0	0	0	100	0	0	0	0	100	0	0	100	0	0	100	0	0	100
2004	0	100	0	29	71	0	0	0	100	0	0	0	0	100	0	0	100	0	0	100	0	0	100
2005	26	74	0	39	61	0	0	0	100	0	0	0	0	100	0	0	100	0	0	100	0	0	100

Table DK.2: Technology mix of the stock per subsector per year

Cat.	G-PC					D-PC					G-LDV					D-LDV					BUS					HDT					PTW		
	Euro	C	1	2	3	4	C	1	2	3	4	C	1	2	3	4	C	1	2	3	4	C	I	II	III	IV	C	I	II	III	IV	C	I
2000	35	34	31	0	0	37	32	31	0	0	52	13	35	0	0	53	13	34	0	0	42	28	30	0	0	47	20	33	0	0	73	27	0
2001	32	33	30	5	0	33	31	31	5	0	44	11	45	0	0	46	12	42	0	0	40	26	34	0	0	41	19	40	0	0	67	33	0
2002	28	32	29	11	0	29	30	30	11	0	37	9	43	10	0	39	11	38	12	0	37	23	33	8	0	34	18	39	9	0	62	34	4
2003	25	31	29	15	0	25	29	29	16	0	32	8	40	20	0	32	10	35	23	0	34	21	31	14	0	28	16	37	18	0	58	33	9
2004	20	29	28	22	0	21	28	28	22	0	25	6	37	32	0	25	8	31	36	0	32	19	29	20	0	20	16	36	28	0	54	32	15
2005	17	27	28	27	0	18	24	29	28	0	20	5	31	44	0	19	7	25	48	0	30	17	28	25	0	15	14	34	37	0	49	30	21

The fuel consumption differs only slightly between the sources. This is also true for LPG. The main contributor for NOx emissions are HDV & Buses. COPERT and UNFCCC/CLRTAP show similar emissions while Gains indicates a value lower by ~ 5.000tons. For passenger cars the differences between the sources are similar only that COPERT and Gains are farther apart. The values for LDV match almost completely. The largest contributor for VOC emissions are passenger cars by far. While COPERT & Gains indicate similar emissions around 16.000t, UNFCCC/CLRTAP indicates ~13.000t. The VOC emission for LDV, HDV & Buses differ only by a few hundred tons. For PTW only the COPERT value shows a larger difference. For those vehicle categories Gains provides the highest emissions in all cases. The largest contributor for PM emissions are LDV's followed by HDV's and passenger cars. The emissions indicated by the different sources differ only by a few hundred tons. For all vehicle categories COPERT indicated the lowest PM emissions.

Figure DK.3: Results of the calculations with COPERT 4 and the updated fleets compared to other sources



The data sources for the road vehicle stock in Estonia were

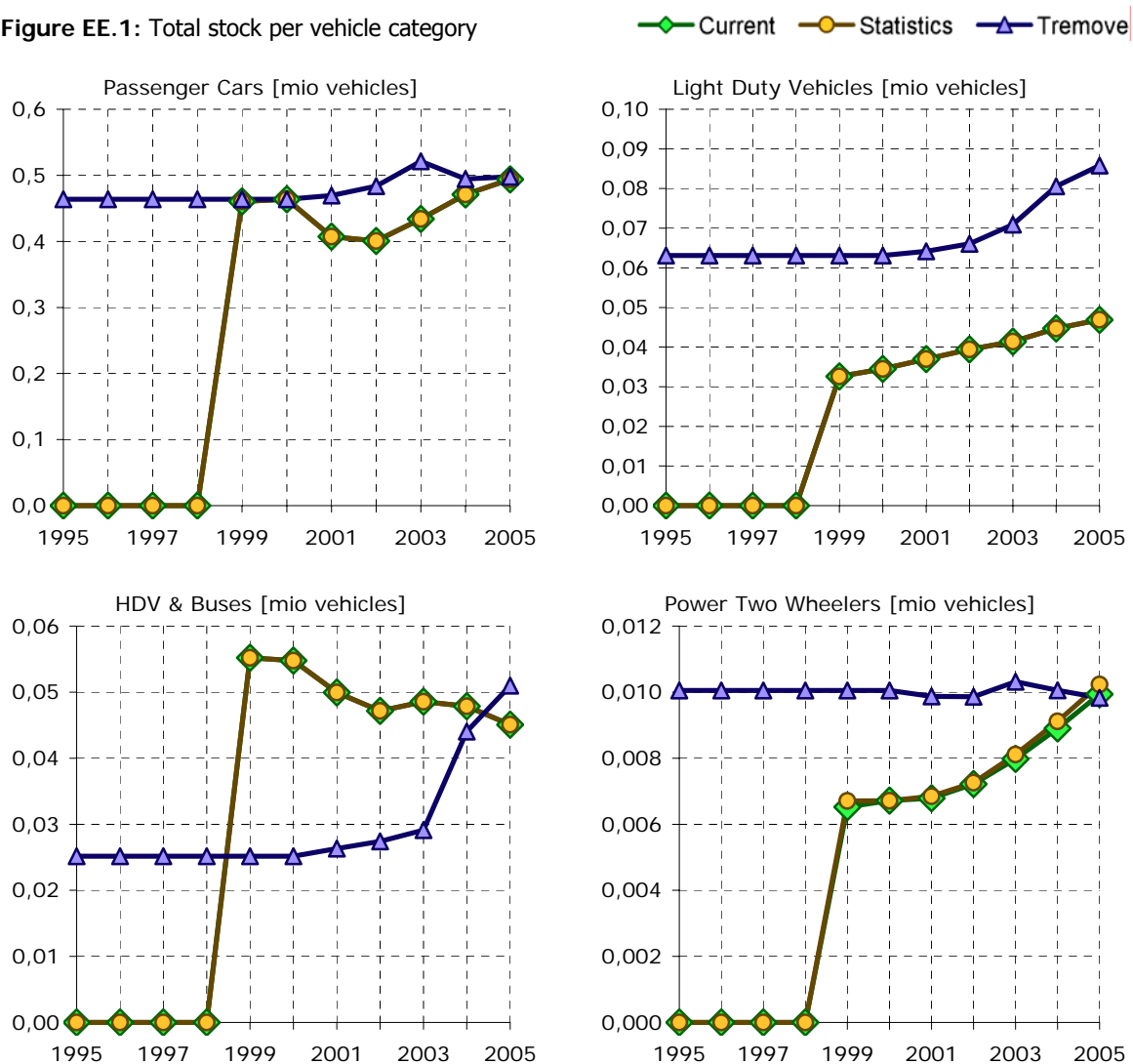
- COPERT III database delivered by the national expert of Estonia
- Eurostat database.

COPERT III scheme was filled in practically fully for 2000-2005 (but no data for 2-stroke cars). Eurostat shows that there are in practice neither LPG nor hybrid cars in the studied period. Since COPERT III contains a much simpler distribution for HDT-s than recently required, on the basis of available data the following method was applied:

- on the strength of gained data a distribution curve (by maximal gross weight) can be produced;
- so the amount of HDT-s within a weight class can be estimated (the total amount must accord);
- a further distribution into rigid lorries and articulated road tractors can be produced on the basis of other countries' data (it seems, also in Eurostat there are just aggregated data for this) – but in regard of emission this latter hasn't got any great importance.

In total, only 29% of the information was missing, which is distinguished to 0% of total fleet, 36% of new registrations and 50% of deregistrations. For buses there were just aggregated amounts for all city buses and coaches together, so on the basis of the purchased Latvian stock the urban-coach ratio could be estimated. There aren't any data for mopeds and also the motorcycles' distribution seems too plain. The database was extended with the year 1999, for this the stock data were produced from the registration and fleet data and the main trends of a subsector where there are no Eurostat data. Registered cars were considered as of the latest Euro-norm, and deregistered cars as of the oldest ones. A split into emission levels was based on the proportions in Latvia as neighboring country. Any other data (mileage, speed, load etc.) are given in COPERT III and they look to be worked out fairly precise.

Figure EE.1: Total stock per vehicle category



Regarding the passenger car fleet the gasoline fuelled cars are dominating.

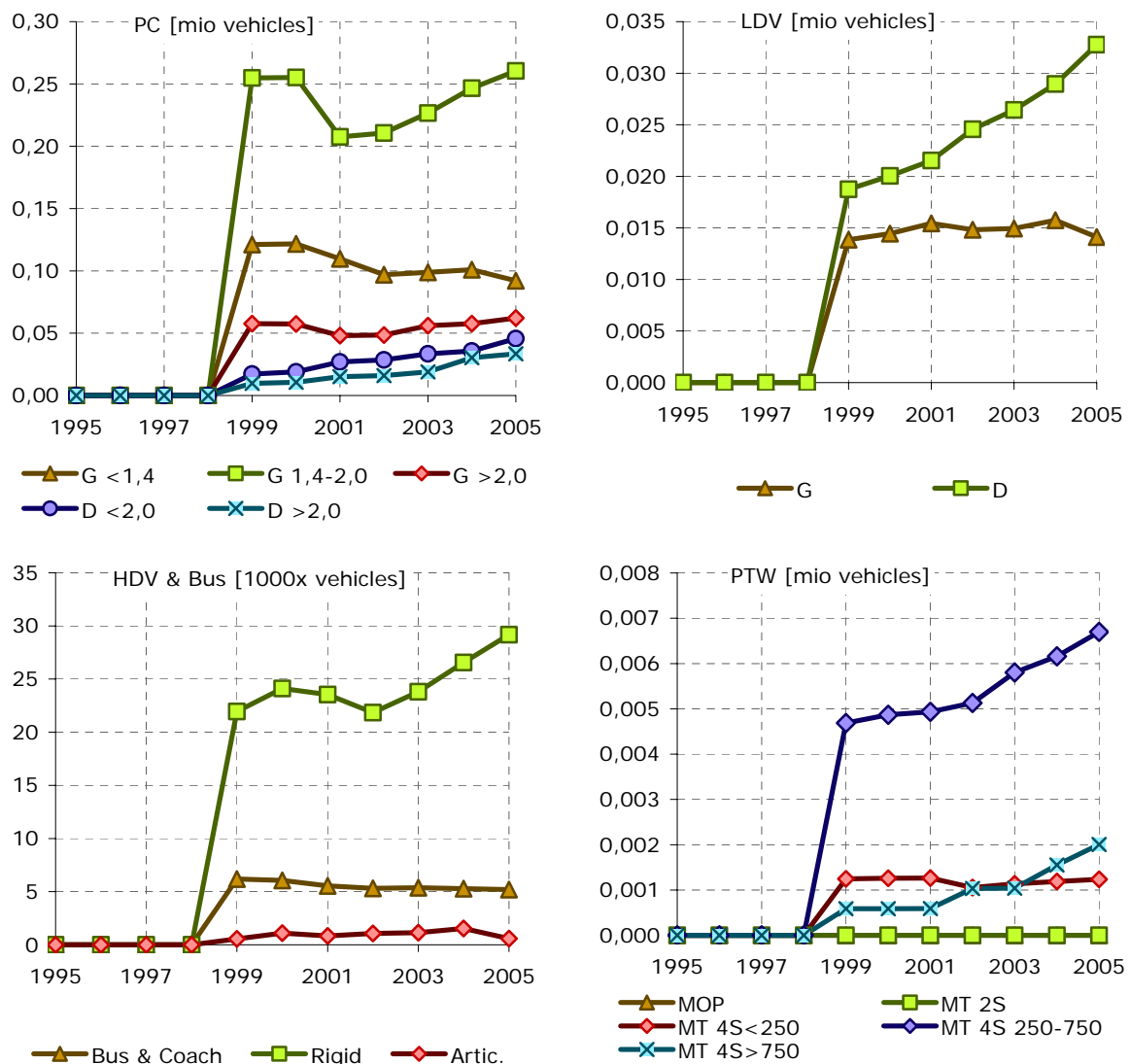
There is a special tendency in medium-size petrol fuelled passenger cars' stock as well in large diesel cars, which can be attributable to an economic development in the country.

The rising tendency of diesel share in the PC and LDV stock in the period 2000-2005 is due to the worldwide spreading of diesel vehicles due to their better fuel economy.

One can notice a decreasing tendency of buses, which is due to the decrease of public transport.

It can be seen that larger motorcycles became preferred during these years.

Figure EE.2: Evolution of vehicle type population per category



Country: **ESTONIA**

EE3/4

Table EE.1 below informs you of the environmental technology distribution of registered vehicles during the years. It is not informative enough yet, because some environmental technology classes aren't present here, but the amount of registered vehicles within them was of great importance (e.g. in case of buses you may think from the table that in 2000-2001 only new buses were registered, but there was a considerable amount of registered buses of pre Euro technologies).

From these data one can draw the conclusion that imported used cars might be registered in Estonia up to a rather high age.

It can be seen that as long as passenger car market preferred mostly not too old vehicles, on the area of heavy duty vehicles' market of old vehicles had a rather serious weight in the studied period.

In Table EE.2 you can see the environmental technology distribution of the vehicle stock at the end of the years. This distribution matches well to the general tendencies of the Central and Eastern European Countries.

The renewal of PC and LDV vehicle stock is obvious in the period 2000-2005, especially in case of diesel fuelled vehicles. But regarding the HDTs there isn't such a big fluctuation, and in the year 2005 the buses were yet older than they were in 2000.

In case of motorcycles there are not too many emission classes, and you can't see an exact age distribution from these data, but in Estonia there is such a low mileage of motorcycles that they have no importance in emissions' aspect.

Table EE.1: Implementation matrix (introduction of technologies per year)

Cat.	G-PC			D-PC			G-LDV				D-LDV				BUS			HDT			PTW	
	2	3	4	2	3	4	1	2	3	4	1	2	3	4	II	III	IV	II	III	IV	I	II
2000	100	0	0	100	0	0	1	99	0	0	6	94	0	0	100	0	0	100	0	0	100	0
2001	21	79	0	68	32	0	75	25	0	0	50	50	0	0	0	100	0	57	43	0	100	0
2002	15	85	0	15	85	0	3	24	73	0	28	29	44	0	8	92	0	16	84	0	100	0
2003	27	73	0	45	55	0	0	33	67	0	10	14	76	0	4	96	0	48	52	0	100	0
2004	7	93	0	0	100	0	0	71	29	0	3	38	59	0	31	69	0	45	55	0	100	0
2005	16	84	0	36	64	0	0	0	100	0	15	32	53	0	70	30	0	54	46	0	100	0

Table EE.2: Technology mix of the stock per subsector per year

Cat.	G-PC					D-PC					G-LDV					D-LDV					BUS					HDT					PTW		
	C	1	2	3	4	C	1	2	3	4	C	1	2	3	4	C	1	2	3	4	C	I	II	III	IV	C	I	II	III	IV	C	I	II
2000	90	3	8	0	0	84	6	11	0	0	87	6	7	0	0	87	6	7	0	0	78	4	18	0	0	92	3	6	0	0	96	4	0
2001	81	7	10	3	0	69	13	15	3	0	71	18	11	0	0	54	22	24	0	0	85	6	6	3	0	81	7	9	3	0	95	5	0
2002	75	9	10	6	0	64	12	15	9	0	65	19	12	4	0	49	23	24	5	0	81	8	7	5	0	80	7	8	5	0	94	6	0
2003	69	11	11	9	0	53	17	17	13	0	59	18	14	9	0	44	22	23	12	0	79	8	6	7	0	77	8	9	6	0	94	6	0
2004	65	12	10	13	0	57	14	13	15	0	54	17	19	10	0	39	20	24	17	0	76	9	7	8	0	71	10	11	9	0	94	6	0
2005	58	14	11	17	0	42	18	17	23	0	47	17	19	16	0	34	19	25	22	0	68	12	10	10	0	63	10	15	11	0	94	6	0

As *Fuel consumption* chart shows, there was no countable LPG consumption for road transport purposes in Estonia in 2005 (perhaps there was also no distributor network).

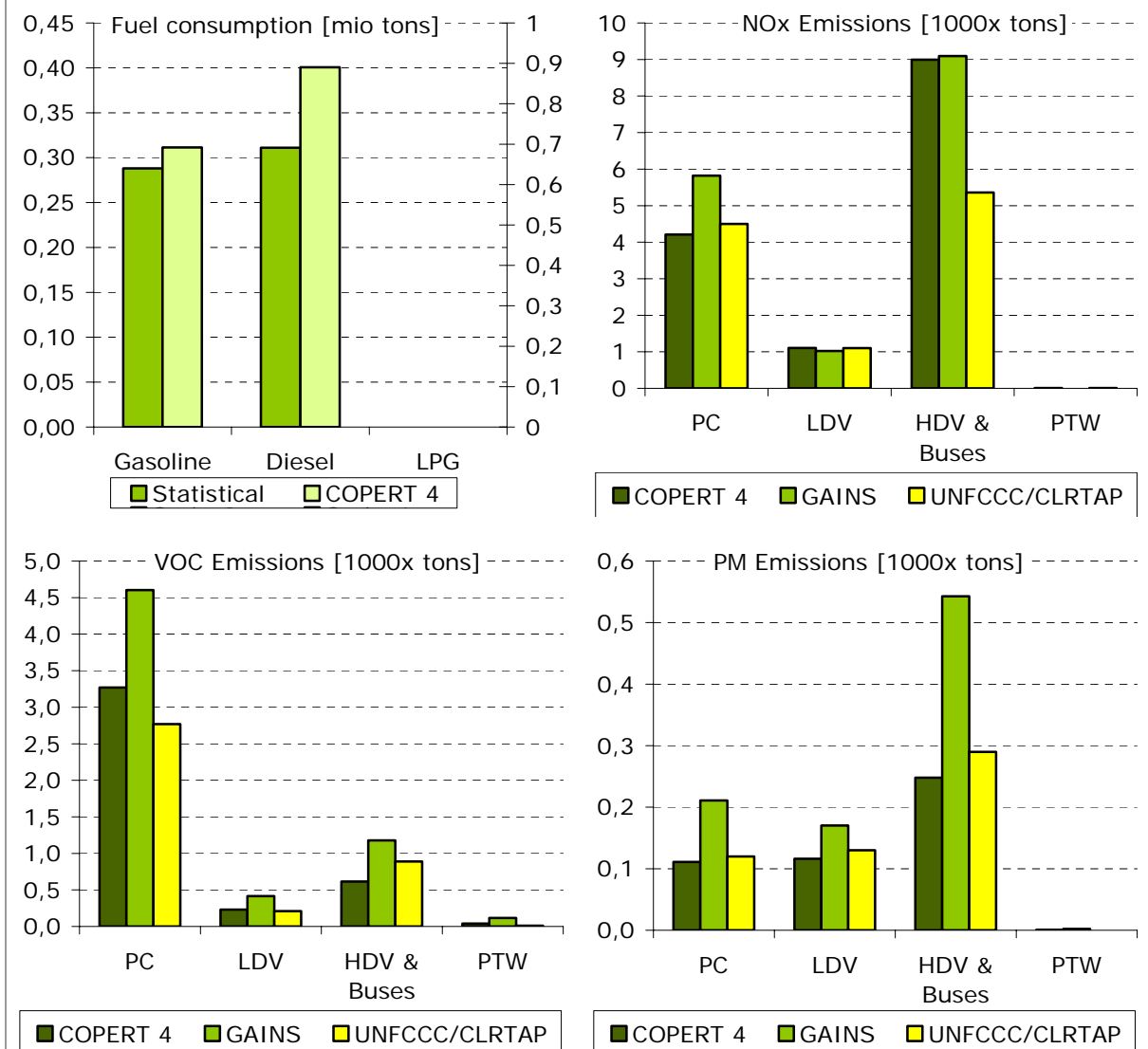
There is a small difference in petrol and diesel fuel consumption between the Eurostat road transport fuel consumption data and the COPERT IV calculation. It can originate whether the method of Eurostat (but it can likely effect only a minor error) or the input data for recent calculation (mostly in mileage, speed and load) or the COPERT method to gain fuel consumption data (nominal fuel consumption factors and taking into consideration the affects of other parameters in real traffic like unsteady running, acceleration, but e.g. the truck haulage is also not taken into account).

The difference in air pollutant (NO_x, VOC, PM) emissions among several methods can be also under a similar judgment.

Petrol fuelled vehicles together take a greater annual total mileage than diesel vehicles, but among latter ones there are the HDT-s and buses with about twice-thrice larger engines. Taking further into consideration the total mileage data and the usual engine power for vehicle classes, you can find:

- since diesel vehicles have a rather higher NO_x emission factor than petrol ones, the share of LDV-s in total NO_x emission is positively low, due to the fairly young LDV stock in 2005;
- VOC emission of (mainly diesel!) HDT-s and buses is a bit too high by reason of the old HDT and bus fleet.

Figure EE.3: Results of the calculations with COPERT 4 and the updated fleets compared to other sources



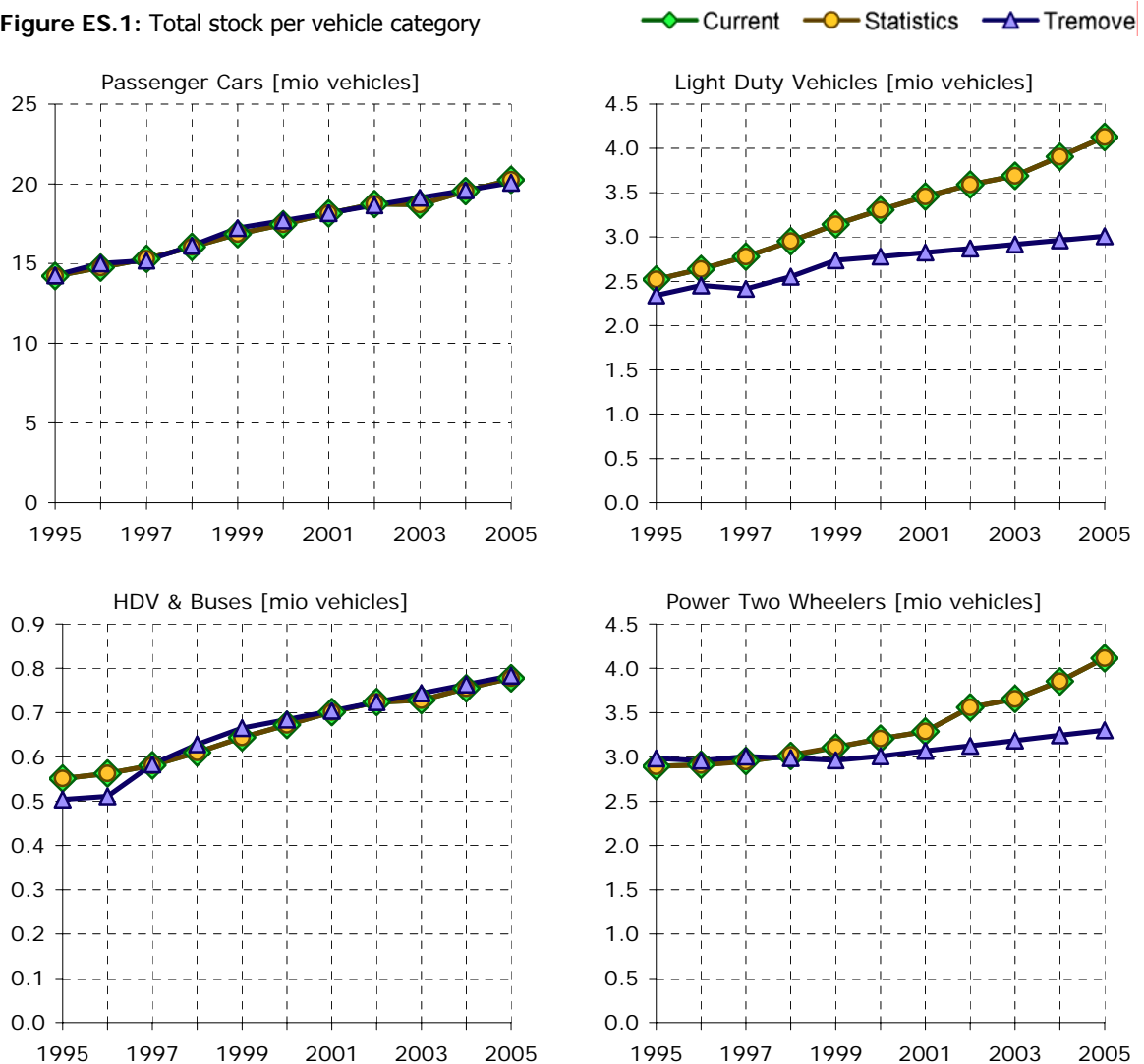
The following were the main sources of information:

- Total fleets per category: Eurostat (1970-1989), Ministry of Environment (1990-2005)
- Split in types: Ministry of Environment (1990-2005)
- New registrations: Eurostat (1970-2001), ACEA (2002-2006)
- Age/technology distribution of vehicles: Ministry of Environment (1990-2005)
- Other sources included UITP

The information missing was only 25%, distinguished into 1,75% of the total fleet, 28% of new registrations and 44% of deregistration. The total fleet and the distinction to categories and types should be considered reliable as it originates from updated official databases.

The vehicle stock of Spain develops significantly over the period 1995-2005, with passenger cars reaching 20 mio vehicles in 2005 compared to 14 mio in 1995. The number of LDVs, HDVs, buses & coaches also increased considerably by more than 40%. The number of PTWs increased by more than 1 mio over the same period, reaching 4,1 mio in 2005.

Figure ES.1: Total stock per vehicle category



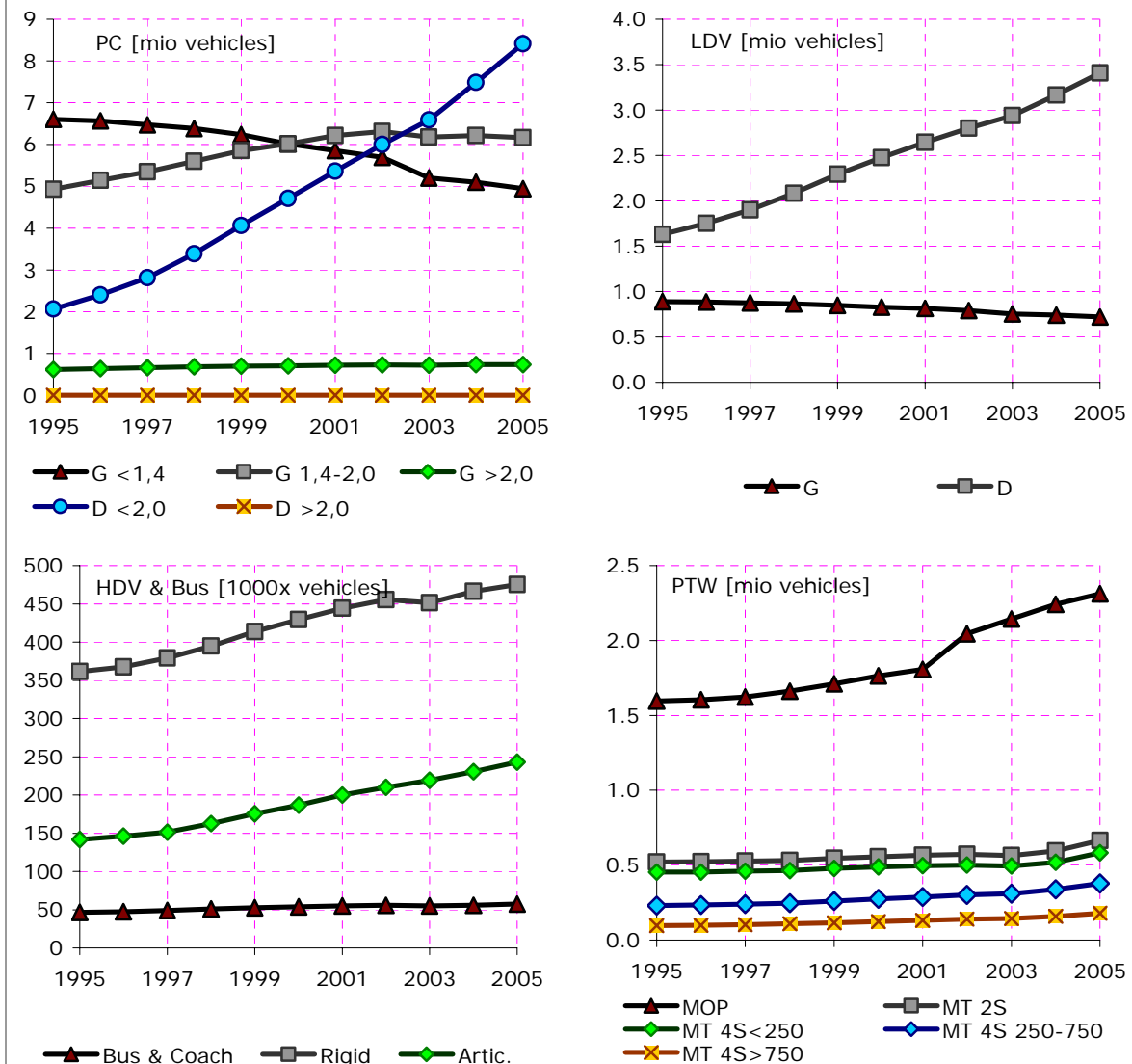
The population of D-PC has quadrupled over the period 1995-2005, increasing its share to 42%, which is one of the biggest in the EU. The G-PC fleet has decreased over the same period, due to the considerable decrease by 25% in the small class (<1,4 l). G-PC falling in the medium and large class (1,4-2,0 & >2,0 l) have increased over the same period, with large (>2.0 l) G-PC having an important share in the G-PC fleet, exceeding 6%.

The population of D-LDV has increased considerably over the years and has doubled in the period 1995-2005 with their share exceeding 82% in 2005. The number of G-LDV in 2005 is reduced by almost 20% compared to 1995.

The bus and HDV stock has recorded an important increase over the years. The population of rigid HDVs has increased by more than 30%, while articulated HDVs have one of the highest shares in the EU, accounting for one third of the HDV fleet. The fleet of buses and coaches has increases by about 25%.

The fleet of mopeds has increased by almost 50% reaching 2,3 mio vehicles. The fleet of motorcycles has also increased, with the fleet of medium and large motorcycles (MT 4S 250-750 & >750) recording the highest increases over the period 1995-2005.

Figure ES.2: Evolution of vehicle type population per subsector



Country: **SPAIN**

ES3/4

The implementation matrix (Table ES.1) is based on a complete and consistent dataset and therefore it can be considered as reliable. Euro 4 PCs are already introduced in 2005, one year ahead of the official implementation date. A significant fraction of Euro 3 LDVs are already introduced in 2001, while a large fraction of HDTs and buses were introduced in 2000, two years earlier than the official implementation date.

The technology mix in Spain (Table ES.2) shows that there is a significant fraction of pre-Euro cars, especially for gasoline vehicles (G-PC and G-LDV). Due to the dieselization trend, this fraction is considerably lower for diesel vehicles, with the D-PC fleet being dominated by Euro 2 and 3 vehicles. As a result, Spain has one of the oldest fleets in the EU, with a mean age of more than 10 years for PCs. The technology replacement is equally slow for LDVs, HDTs and PTWs.

Table ES.1: Implementation matrix (introduction of technologies per year)

Cat.	G-PC			D-PC			G-LDV				D-LDV				BUS			HDT			PTW	
	2	3	4	2	3	4	1	2	3	4	1	2	3	4	II	III	IV	II	III	IV	I	II
2000	0	100	0	0	100	0	0	100	0	0	0	100	0	0	5	95	0	1	99	0	22	78
2001	0	100	0	0	100	0	0	26	74	0	0	12	88	0	10	90	0	13	87	0	20	80
2002	0	100	0	0	100	0	0	0	100	0	0	0	100	0	0	100	0	0	100	0	12	88
2003	0	100	0	0	100	0	0	0	100	0	0	0	100	0	0	100	0	0	100	0	20	80
2004	0	100	0	0	100	0	0	0	100	0	0	0	100	0	0	100	0	0	100	0	31	69
2005	0	0	100	0	0	100	0	0	100	0	0	0	100	0	0	25	75	0	8	92	51	49

Table ES.2: Technology mix of the stock per subsector per year

Cat.	G-PC					D-PC					G-LDV					D-LDV					BUS					HDT					PTW		
	C	1	2	3	4	C	1	2	3	4	C	1	2	3	4	C	1	2	3	4	C	I	II	III	IV	C	I	II	III	IV	C	I	II
2000	60	20	15	5	0	23	22	39	16	0	76	14	10	0	0	42	21	38	0	0	54	11	29	6	0	53	10	29	9	0	80	12	8
2001	55	19	15	11	0	19	19	34	28	0	73	14	11	3	0	37	19	35	9	0	49	10	29	12	0	47	9	28	16	0	71	14	16
2002	51	19	15	15	0	16	17	30	38	0	71	13	11	5	0	33	17	33	17	0	43	10	27	20	0	43	8	26	23	0	59	14	27
2003	47	18	15	20	0	13	14	27	46	0	68	14	11	7	0	29	16	30	25	0	40	10	27	24	0	37	7	25	30	0	51	16	34
2004	44	17	15	24	0	10	12	23	54	0	66	13	11	10	0	26	14	27	32	0	34	9	25	32	0	34	7	23	36	0	44	18	39
2005	40	17	15	24	4	8	11	20	48	13	64	13	10	12	0	23	13	25	40	0	29	9	23	32	7	31	6	20	35	8	37	22	41

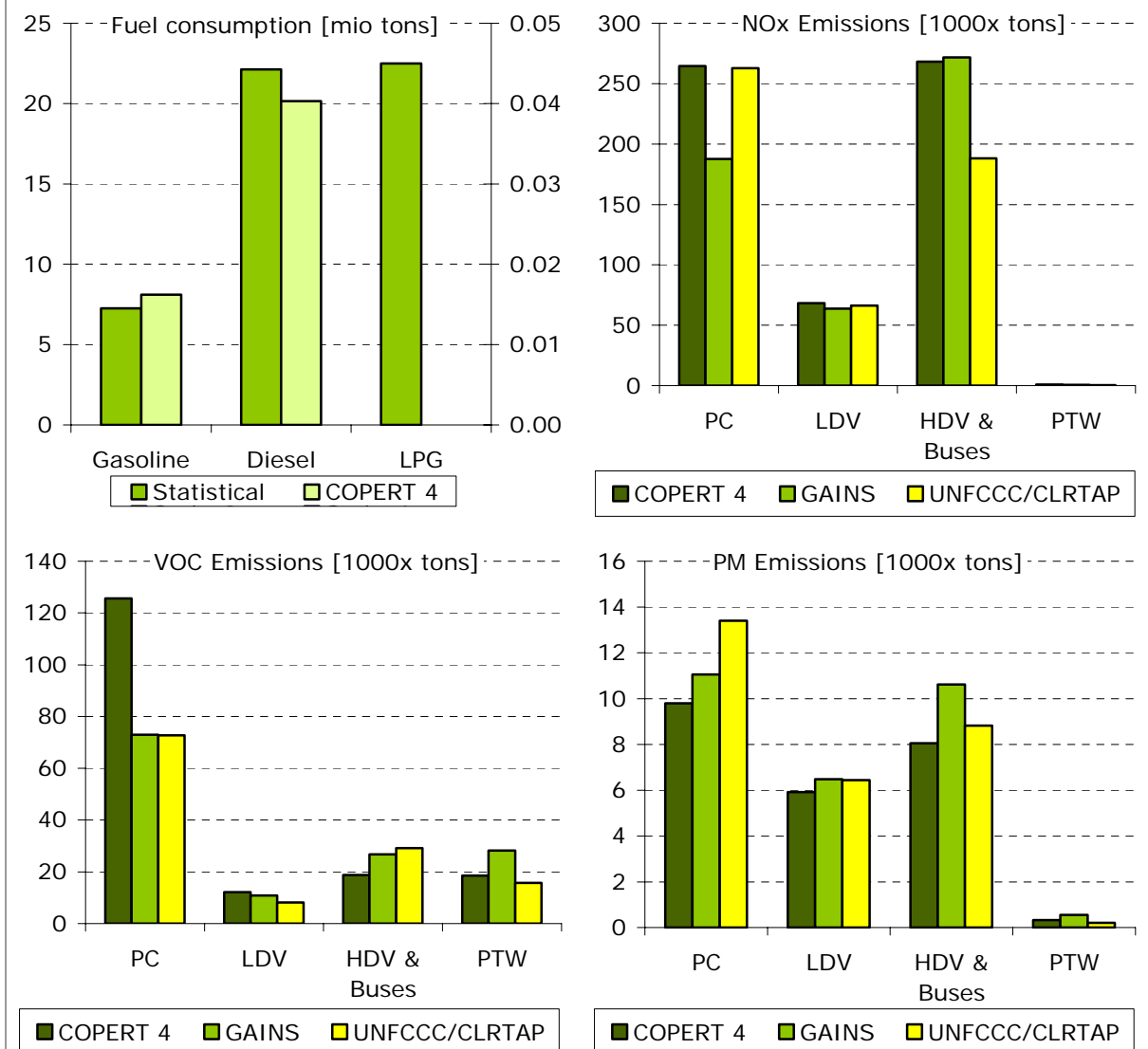
Small differences on the order of 10% may be observed when comparing fuel consumption calculated with COPERT 4 with the respective statistical values reported by Eurostat. These deviations may be explained by the difference in the use of gasoline and diesel vehicles (mainly annual mileage) considered for the calculations and the real-world vehicle use. LPG consumption could not be calculated with COPERT 4, because no LPG vehicles were reported.

It is known that emissions for Spain reported under UNFCCC/CLRTAP are calculated with COPERT 3. Due to the high number of D-PC in the Spanish fleet, NOx emissions from PC are of the same order of magnitude as from HDV & Buses. The higher NOx emissions calculated with COPERT 4 for HDV & Buses may be explained by the difference in emission factors between COPERT 3 and 4 (HDV EF were underestimated in COPERT 3).

PC and in particular G-PC dominate VOC emissions. Emissions from PC reported under UNFCCC/CLRTAP are about 40% lower than calculated with COPERT 4 due to the fact that evaporative emissions from gasoline vehicles in the UNFCCC submissions are reported as a whole and not allocated into vehicle categories. When comparing total VOC emissions of the entire fleet, differences are lower than 10%.

Due to the high number of D-PC in the Spanish fleet, PC are the main source of PM emissions, followed by HDV & Buses. PM emissions calculated with COPERT 4 for the main vehicle categories compare reasonably well with emissions reported by GAINS and UNFCCC/CLRTAP.

Figure ES.3: Results of the calculations with COPERT 4 and the updated fleets compared to other sources



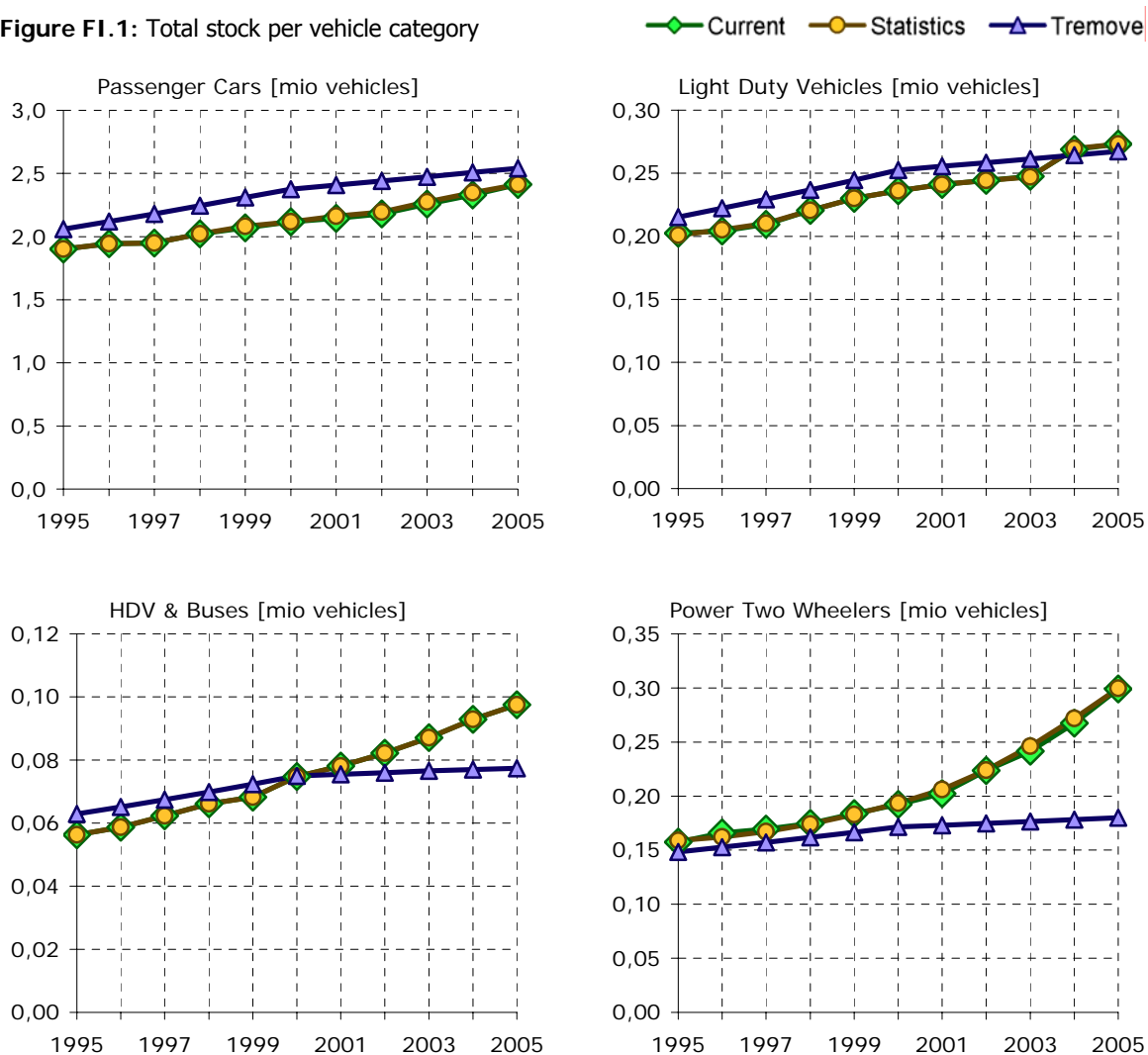
The following were the main sources of information:

- Technical Research Centre of Finland on behalf of the Environmental Administration of Finland all (1990, 2001, 2005) except population by age, deregistration, new registrations
- Eurostat: fuel data (1985-2004), population cars (99-04), buses and motorcycles (89-04) new registrations passenger cars (1990-2004), motorbikes (1989-2004)
- Other sources included UITP, ANFAC Car Park Report, ACEA and the Central database of the European Commission for new M1's

The ratio missing information was 41%, which is distinguished into 40% of the total stock, 34% of new registrations and 49% of deregistrations. Only a very limited number of years was made available. In addition The total fleet and the distinction to categories and types should be considered reliable as it originates from updated official databases.

The vehicle stock increases slightly for all categories (Figure FI.1) over the period 1995-2005, with the exception of a very high increase in PTW's. The other remarkable element is the increase of HDV & Buses stemming mainly from the increase of HDV registrations from ~65.000 in 2000 vehicles to ~87.000 in 2005. Among those the highest share can be observed for the smallest and largest HDV's ($\leq 7,5$ t and 50-60t).

Figure FI.1: Total stock per vehicle category



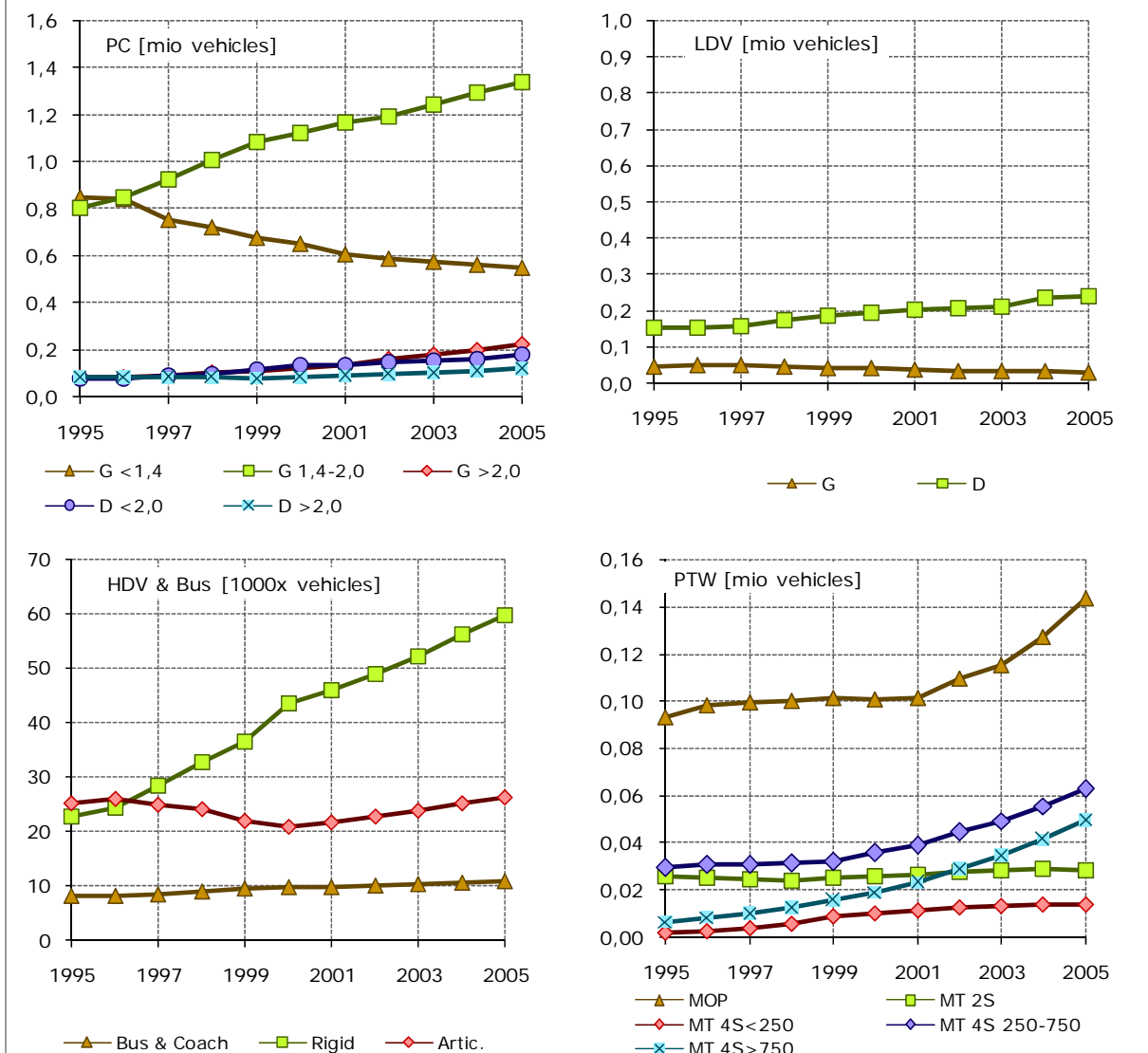
The passenger car fleet is dominated by G-PC falling in the <1.4 l class and an increase of registration for about the same rate for the G-PC 1,4-2,0 class. The fraction of large (>2.0 l) G-PC amount to only 9% of the total and the share of diesel passenger cars is also quite small with 12% of the total.

The share of diesel fuelled LDV's is higher than for G-LDV and also constantly rising while the share of G-LDV is decreasing by the same rate.

The bus and HDV stock increase is mainly due to the increase of rigid trucks. The urban bus and coach fleet increases only slightly over the years. The number of articulated HDV's fluctuated between 1995 and 2000, but is increasing since 2000.

Although the share of mopeds and motorcycles is almost the same, the increase in motorcycles is higher than for mopeds in particular for those having an engine capacity above 750cm³ followed by motorcycles with an engine capacity between 250-750cm³.

Figure FI.2: Evolution of vehicle type population per subsector



Country: **FINLAND**

FI3/4

For gasoline and diesel passenger cars and light duty vehicles a very high number of Euro 4 vehicles have been introduced in 2005.

The technology mix in Finland (Table GR.2) shows that there is a large fraction of old (even non-catalyst) cars in particular for Gasoline light duty vehicles. This can be due to imports of used cars in particular through the Baltic countries where a high number of used vehicles can entered the market. A high number of D-LDV and D-PC is equipped with Euro 3 in 2005.

Table FI.1: Implementation matrix (introduction of technologies per year)

Cat.	G-PC			D-PC			G-LDV				D-LDV				BUS			HDT			PTW	
	2	3	4	2	3	4	1	2	3	4	1	2	3	4	II	III	IV	II	III	IV	I	II
2000	100	0	0	47	53	0	0	28	72	0	4	17	79	0	70	30	0	45	55	0	100	0
2001	15	85	0	26	74	0	0	14	86	0	5	35	61	0	16	84	0	17	83	0	100	0
2002	17	83	0	25	75	0	0	0	100	0	6	0	94	0	15	85	0	9	91	0	55	45
2003	15	85	0	15	85	0	0	0	100	0	5	0	95	0	0	100	0	11	89	0	32	68
2004	14	86	0	7	93	0	0	0	100	0	3	0	97	0	0	100	0	8	92	0	30	70
2005	4	5	91	6	40	54	0	0	17	83	0	0	30	70	0	100	0	3	97	0	28	72

Table FI.2: Technology mix of the stock per subsector per year

Cat.	G-PC					D-PC					G-LDV					D-LDV					BUS					HDT					PTW		
	C	1	2	3	4	C	1	2	3	4	C	1	2	3	4	C	1	2	3	4	C	I	II	III	IV	C	I	II	III	IV	C	I	II
2000	63	18	19	0	0	48	10	29	12	0	90	2	2	5	0	63	3	7	27	0	59	13	22	6	0	48	14	31	8	0	88	12	0
2001	52	18	20	10	0	40	10	31	19	0	89	2	3	7	0	56	3	10	31	0	54	13	23	10	0	43	13	30	14	0	82	18	0
2002	42	18	22	18	0	33	10	31	26	0	87	2	3	8	0	52	3	9	36	0	50	13	23	14	0	40	12	28	19	0	74	21	4
2003	38	17	22	23	0	28	10	30	32	0	86	2	3	9	0	48	3	8	40	0	46	13	22	19	0	36	11	27	25	0	68	22	10
2004	35	17	21	27	0	24	10	29	37	0	85	2	2	10	0	44	3	8	45	0	42	12	21	24	0	33	11	25	31	0	60	23	17
2005	32	17	20	26	6	18	9	25	39	8	84	2	2	10	1	40	3	7	45	6	39	12	21	28	0	29	10	24	37	0	54	23	23

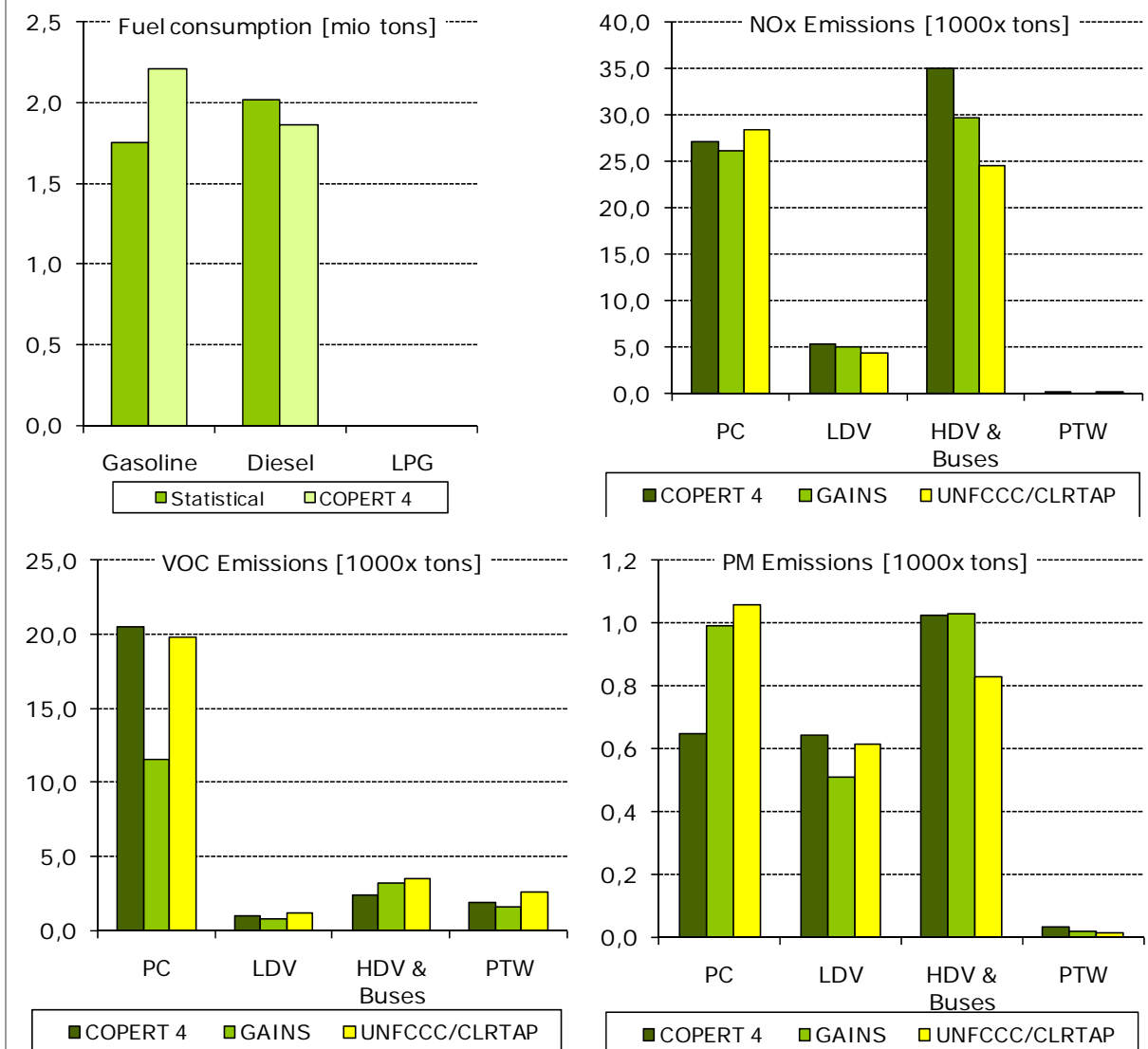
The fuel consumption value of diesel stemming from COPERT is about 100.000t lower than of the current model input. For gasoline the COPERT indicates ~500.000 tons more than the current model. No fuel consumption for LPG was indicated.

The NO_x emissions are in the same range for PC, LDV's & PTW's. Only for HDV and Buses the differences are relevant on a quantitative basis. The difference is that the new calculation has been based on updated NO_x emission factors for HDVs. The main contributor for NO_x are HDV & Buses according to COPERT & Gains and passenger cars according to UNFCCC/CLTRAP.

For VOC emissions the main contributor are clearly passenger cars. Large differences exist between the sources for this vehicle type. While COPERT and UNFCCC/CLTRAP show similar values, the value stemming from Gains indicates only half of those emissions. For the other vehicle types the emissions are comparably low and the differences between the sources as well. Only UNFCCC/CLTRAP displays the highest value.

For the PM emissions the highest emitter are passenger cars according to UNFCCC/CLTRAP or HDV & Buses according to Gains. The emissions values between the sources differ largely for emissions from passenger cars indicated by COPERT in comparisons those emissions indicated by Gains & UNFCCC/CLTRAP. One should consider that a large part of PM may originate from studded tyres which have not been considered in our analysis.

Figure FI.3: Results of the calculations with COPERT 4 and the updated fleets compared to other sources



The following were the main sources of information

- Total fleet per category : EUROSTAT (1970 – 2006)
- Total population, population in subsector, Split in the type, Age technology Distribution of vehicles was given by CITEPA (1990 – 2006)

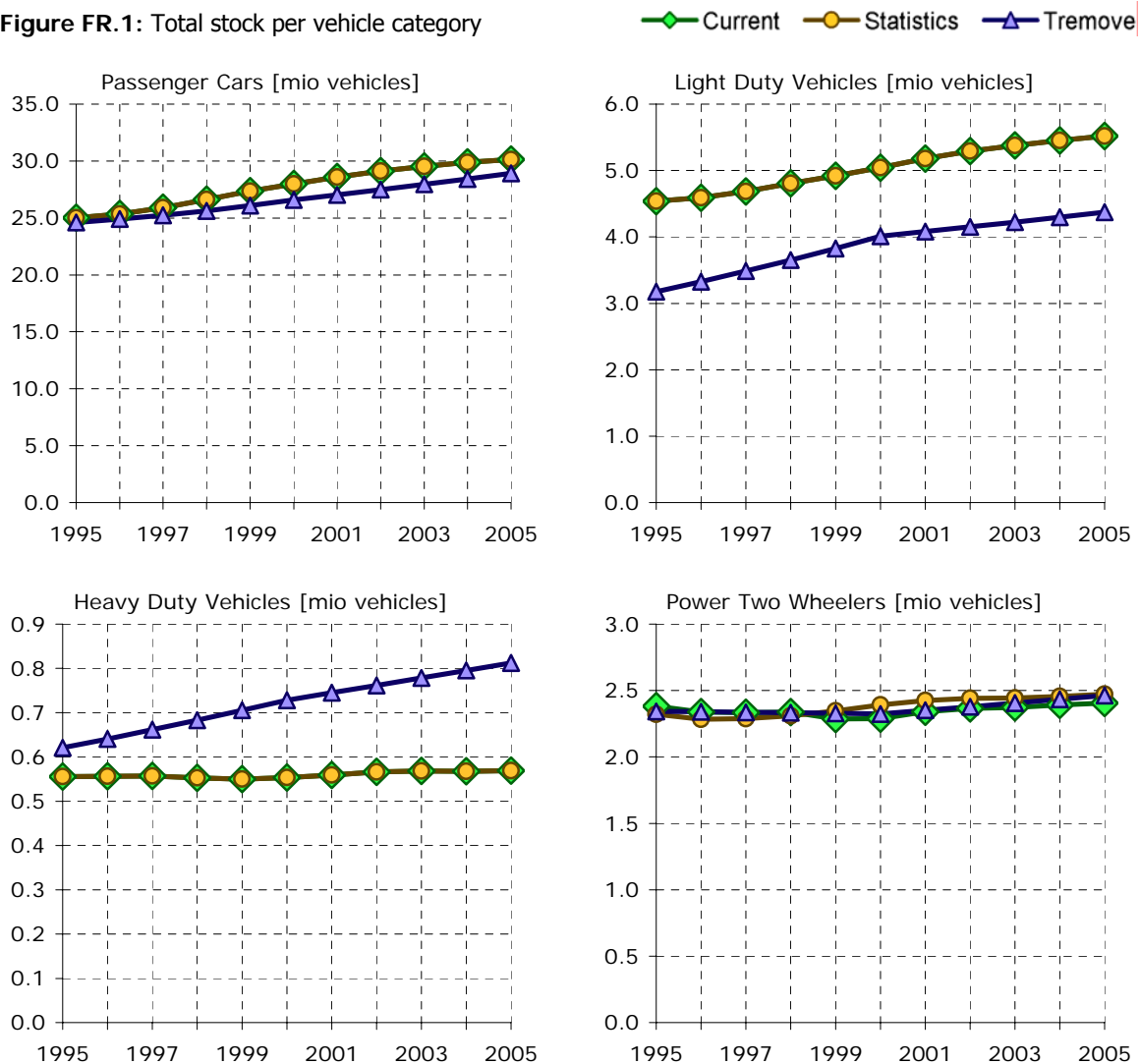
For France, 27% of the total information had to be calculated, which meant 3% of the total fleet, 29% of new registrations and 49% of deregistrations.

There is a linear increase in the population of passenger cars, reaching 30 Mo in 2005. Considering the French new registrations, we can notice that sales are constant (about 2 Mo/year), so the linear increase is not due to an excess in new registrations of passenger cars but due to the ageing of the car population. There is a big gap between Tremove & the current data for light duty vehicles. Time series for Tremove were inconsistent for 1990 to 2000 years and more specifically Diesel total population was not taken into account (1 Mo vehicles missing). It explains the offset between the 2 curves today.

HDV: Tremove considered an increasing HDV population while the current data shows a rather constant HDV population. We should consider the constant curve is the correct one with reference to the INRETS Report C02-02 (HUGREL/JOUMARD) – "Transport Routier – Parc, usage & émissions des véhicules en France de 1970 à 2025".

PTW: Consistent data. Nevertheless, we should be cautious in the forecast of this category in France because of City Programs enabling bicycle rental & increased bicycle sales (+35% in France in 2007).

Figure FR.1: Total stock per vehicle category

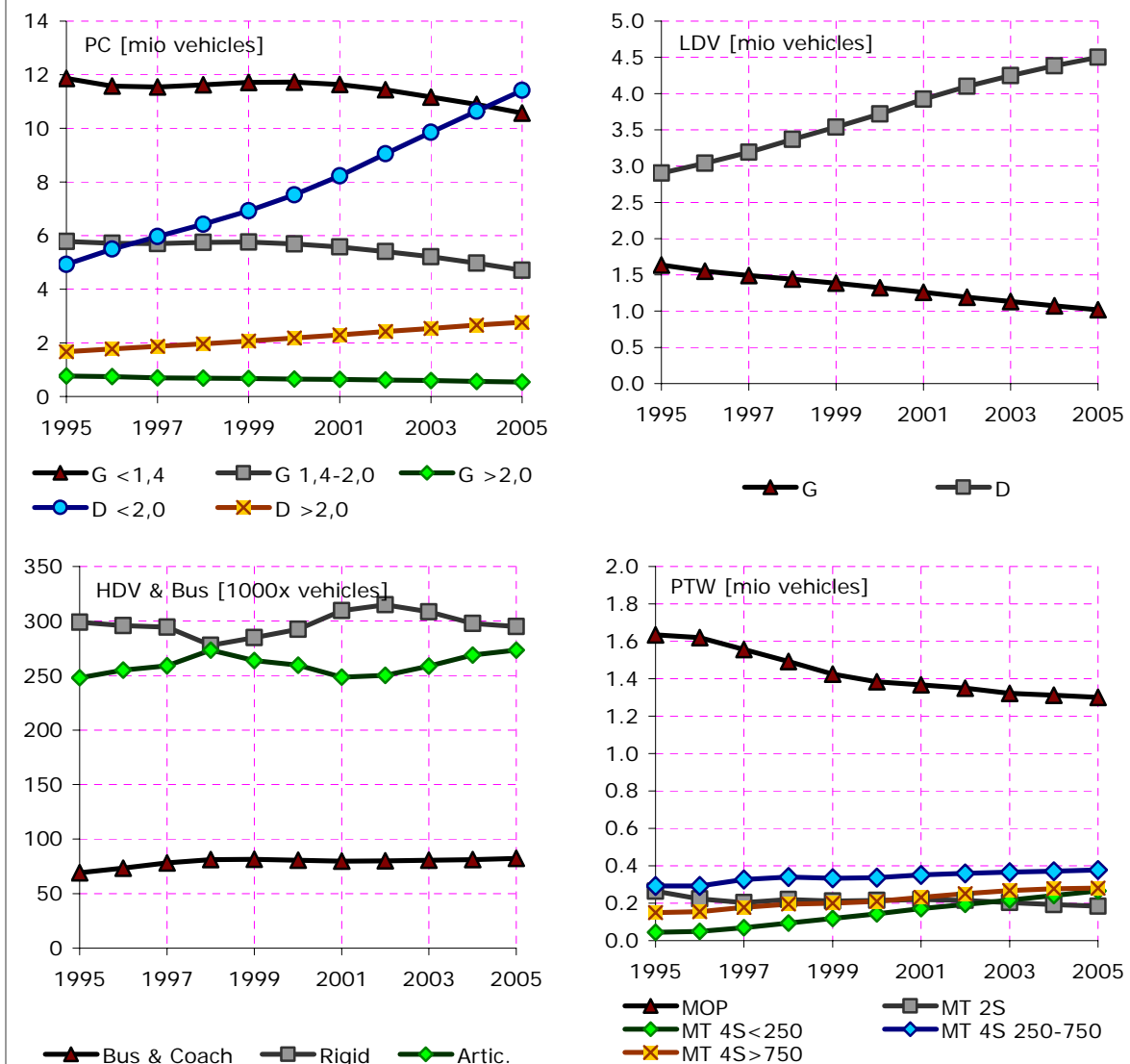


Since 1995, we observe a high increase in diesel < 2 l due to the benefit in fuel consumption for this kind of vehicles. It should also be noted that this trend in the recent years can no more be explained by the difference in price between petrol and diesel fuel. The difference has been reduced drastically. In 2008, typical price differences are in the range of 0.04 to 0.1 euros.

This trend for diesel with range of capacity around 1.5 l is assumed to continue, because of the CO2 bonus/malus in France, especially because the 120 g/km bonus can be achieved by the "1.5 l" category.

The increase of sales for light duty vehicles observed is obviously due to diesel share with a similar reduction of gasoline LD vehicles.

Figure FR.2: Evolution of vehicle type population per subsector



Country: **FRANCE**

FR3/4

The information on the technology of vehicles is not based on observed data.

For a year when Euro X regulation is applied for first time, one major difficulty is to deal with the new type implementation date. For instance, from 1st January 2000, Euro 3 has been implemented for new types of vehicles, such as a very new car sold for the first time, and Euro 2 was still valid for the other cars. Therefore, in the absence of data, it is very difficult to allocate in this transient year the percentages of Euro 2 vehicles and Euro 3 sold. A conservative figure of 50 % of each category is generally used to take into account this implementation schedule.

Table FR.1: Implementation matrix (introduction of technologies per year)

Cat.	G-PC			D-PC			G-LDV				D-LDV				BUS			HDT			PTW	
	2	3	4	2	3	4	1	2	3	4	1	2	3	4	II	III	IV	II	III	IV	I	II
2000	55	45	0	50	50	0	13	87	0	0	0	100	0	0	100	0	0	100	0	0	100	0
2001	0	100	0	0	100	0	17	54	30	0	0	53	47	0	100	0	0	100	0	0	89	11
2002	0	100	0	0	100	0	28	6	66	0	0	0	100	0	47	53	0	49	51	0	75	25
2003	0	100	0	0	100	0	38	10	52	0	0	1	99	0	0	100	0	6	94	0	76	24
2004	0	100	0	0	100	0	44	12	44	0	0	0	100	0	2	98	0	5	95	0	57	43
2005	0	55	45	0	54	46	49	13	38	0	0	0	100	0	0	100	0	6	94	0	18	82

Table FR.2: Technology mix of the stock per subsector per year

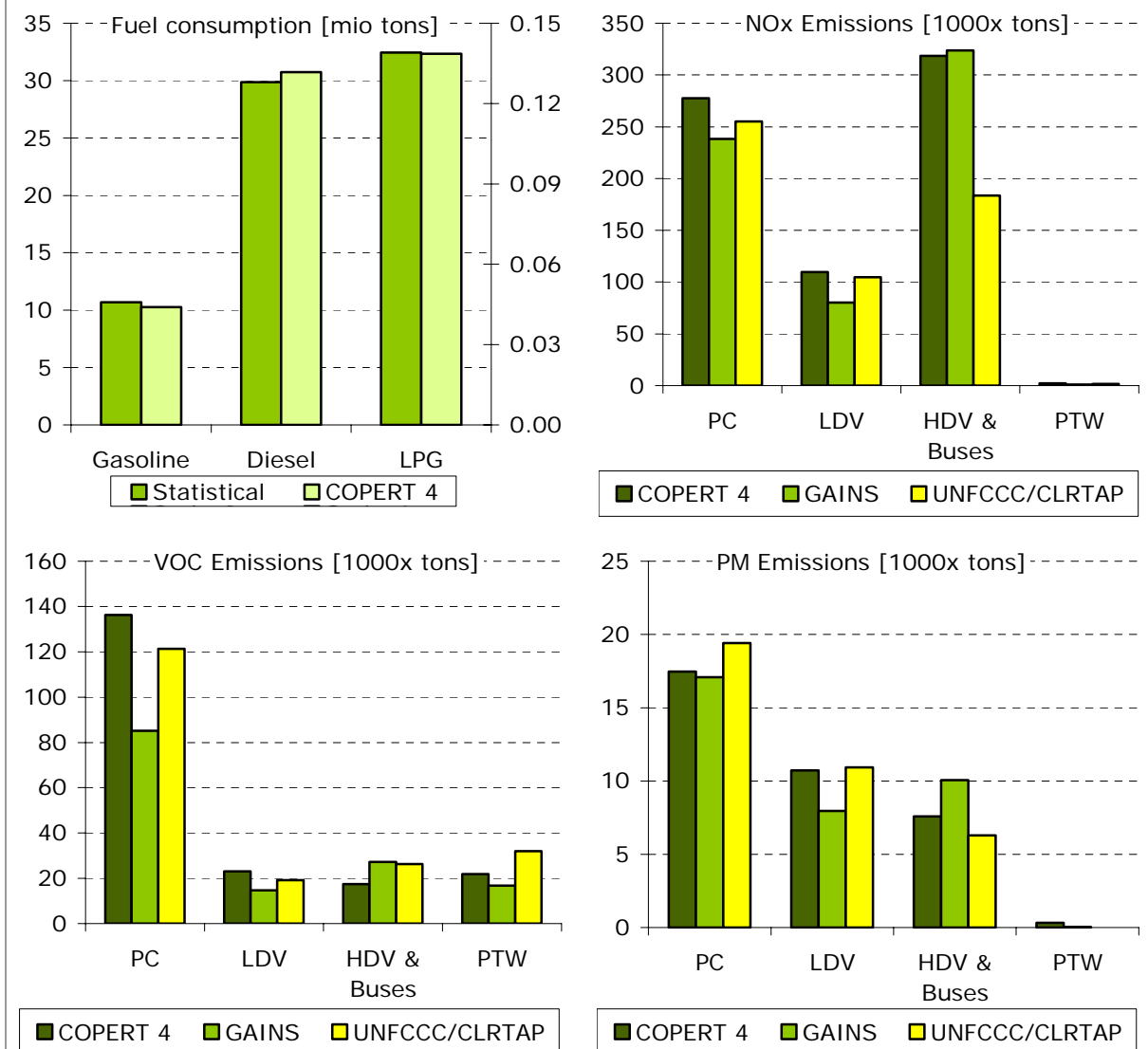
Cat.	G-PC					D-PC					G-LDV					D-LDV					BUS					HDT					PTW		
	C	1	2	3	4	C	1	2	3	4	C	1	2	3	4	C	1	2	3	4	C	I	II	III	IV	C	I	II	III	IV	C	I	II
2000	53	24	19	3	0	35	33	26	6	0	91	7	2	0	0	55	30	14	0	0	64	14	22	0	0	50	20	30	0	0	95	5	0
2001	47	24	19	9	0	29	30	24	17	0	89	8	3	0	0	47	28	19	5	0	58	14	28	0	0	41	19	40	0	0	86	13	1
2002	42	24	19	15	0	24	27	22	27	0	87	8	3	1	0	41	26	18	15	0	53	13	31	4	0	34	18	43	5	0	77	20	3
2003	37	24	20	20	0	20	24	20	36	0	85	9	3	2	0	35	25	17	23	0	48	13	30	10	0	28	16	42	13	0	68	26	6
2004	32	24	20	24	0	16	22	18	44	0	83	10	4	3	0	29	23	16	31	0	44	12	29	15	0	23	15	41	21	0	57	33	11
2005	27	24	20	27	2	13	19	16	47	5	80	12	4	4	0	24	22	15	39	0	39	11	27	22	0	17	14	39	30	0	43	34	23

The fuel consumption calculated is almost identical to the statistical one for almost all three fuels. This good comparison of energy figures is also reflected to a very good comparability between the national submissions of pollutant emissions and the emissions calculated by the model.

The only significant difference is observed for NO_x HDV and Busses. The calculation in this report have been executed with COPERT 4 which contains updated NO_x emission factors, based on the Artemis results. National data have been calculated with the older COPERT 3 version which does not include the updated emission factors.

VOC and PM emissions are close between national submissions and the calculations in this report while larger differences are observed by the Gains model.

Figure FR.3: Results of the calculations with COPERT 4 and the updated fleets compared to other sources



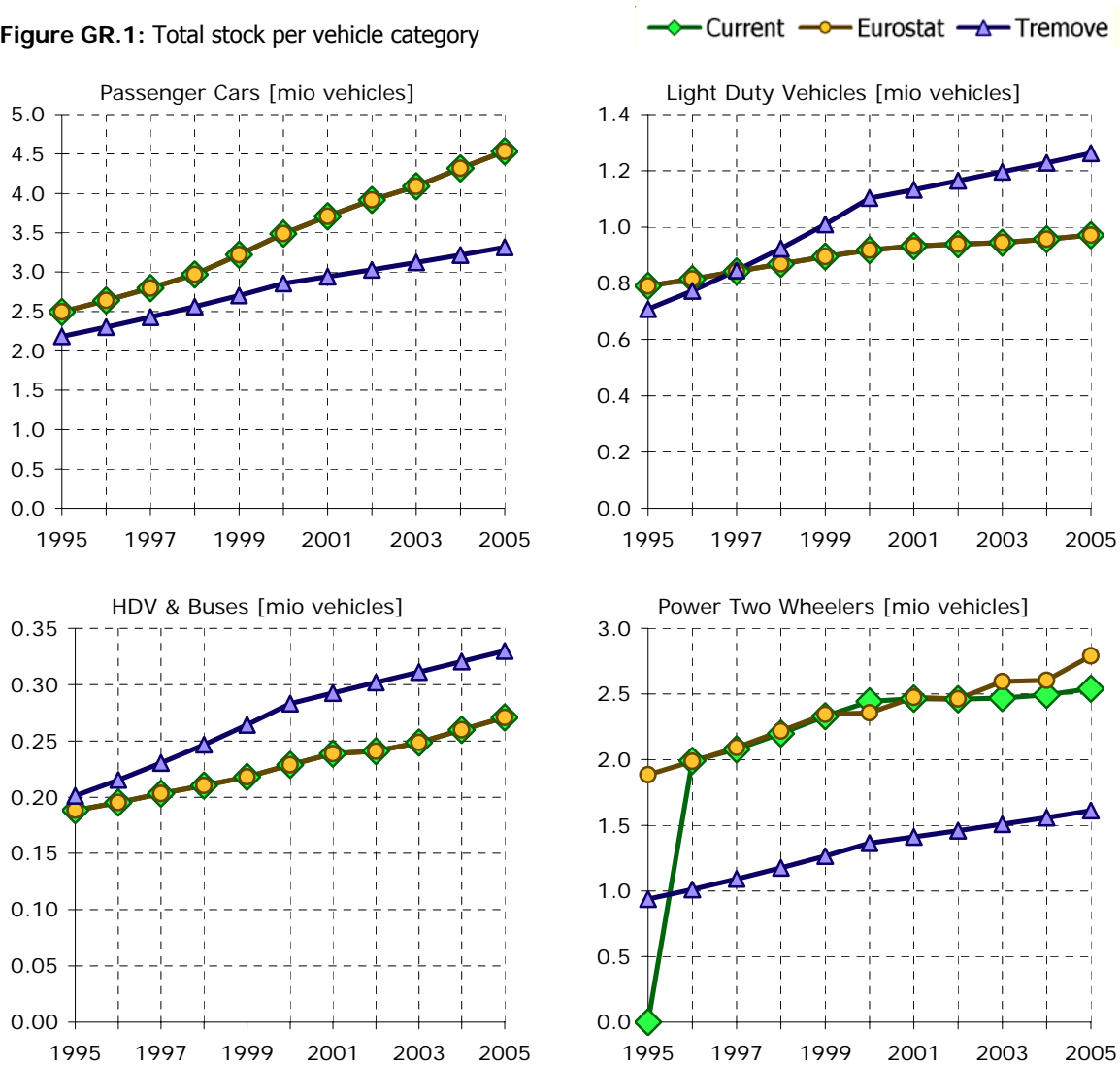
The following were the main sources of information:

- Total fleets per category: EUROSTAT (1970-1999), Ministry of Transport (2000-2006)
- Split in types: Ministry of Transport (2000-2006)
- New registrations split in new and used cars: Statistics Greece (1985-2006)
- Age/technology distribution of vehicles: Ministry of Environment (2000), TRENDS (1995)
- Number of mopeds: Greek Police (1988-2006)
- Other sources included UITP, and the Greek association of tourist coaches

The missing information was 37%, distinguished to 39% of the total fleet, 28% of new registrations and 45% of deregistrations. The main information missing was technology distinction for more years and in particular for HDV. The total fleet and the distinction to categories and types should be considered reliable as it originates from updated official databases.

The vehicle stock of Greece develops significantly over the period 1995-2005, with passenger cars reaching 4,5 mio vehs in 2005 compared to about 2 mio vehs in 1995. An important increase is also reported for HDVs. Road transport is the main freight carrier in Greece and this translates to one of the largest number of HDVs per inhabitant in Europe. The opening of the borders to Bulgaria is also expected to increase transit freight transport. The other important element of the Greek fleet is the high share of PTWs and in particular mopeds, which exceed 1.5 mio vehs. The high share of PTWs is consistent to other countries along the Mediterranean basin (Italy, Spain) as the favorable weather conditions promote their widespread use.

Figure GR.1: Total stock per vehicle category



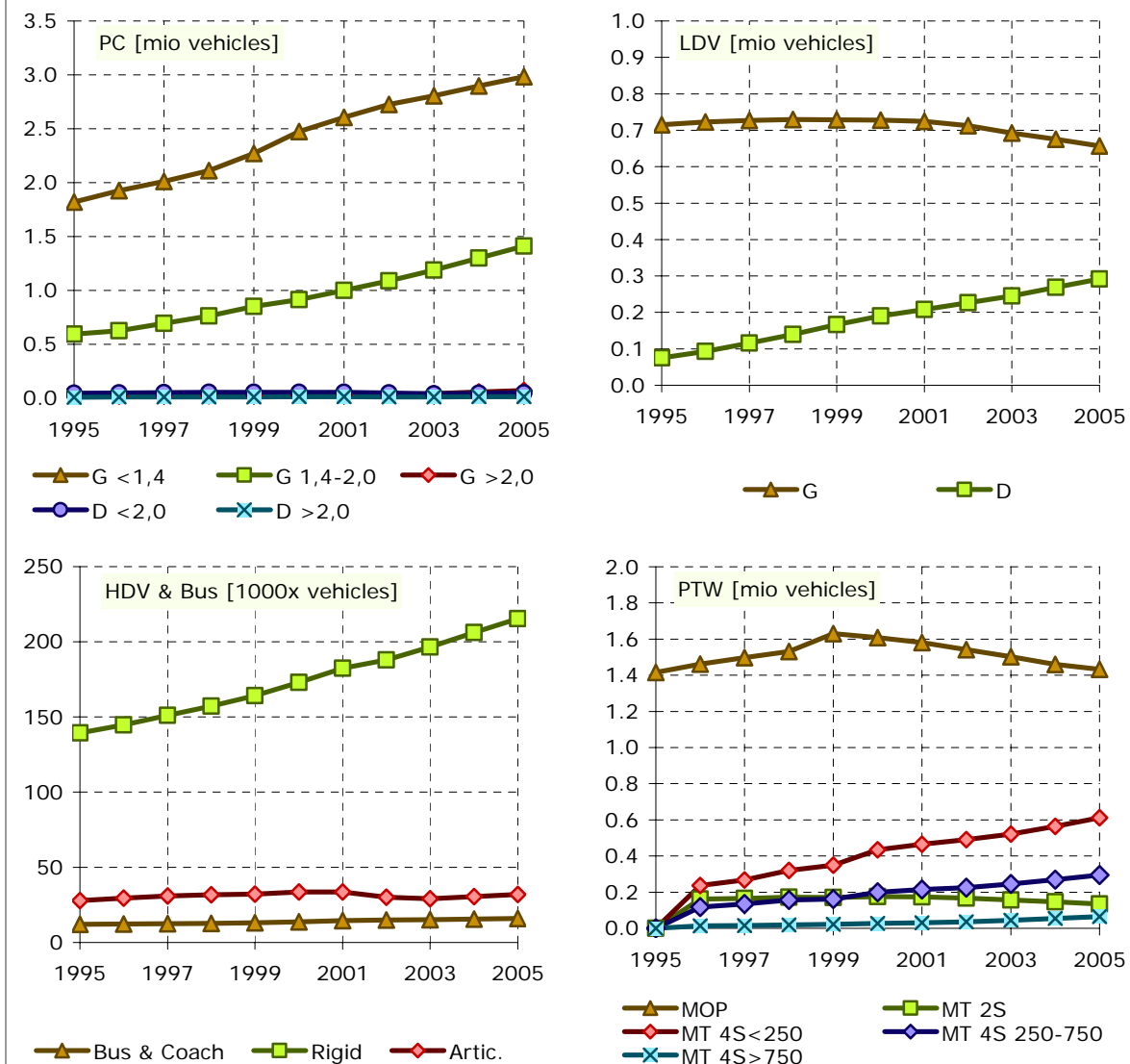
The passenger car fleet is dominated by G-PC falling in the <1.4 l class. Their fleet has almost doubled in the period 1995-2005. The fraction of large (>2.0 l) and diesel passenger cars is very small. Large G-PC are less than 2% of the total G-PC fleet. This has been mainly the effect of high purchase tax on >2.0 l G-PC in Greece. On the other hand, DPC are banned (for environmental reasons) from the two main cities (Athens and Thessaloniki) which correspond to 70% of the Greek market. Hence, the number of D-PC is limited to below 100 th. vehs, corresponding solely to taxis.

Due to the low interest in diesel vehicles, the penetration of D-LDVs (which were not banned) has been also quite small over the years. However, in contrast to G-LDV, the population of D-LDV increases consistently over the years and has tripled in the period 1995-2005. This has been the effect of the much lower diesel cost compared to gasoline fuel.

The bus and HDV stock increase is mainly due to the increase of rigid trucks, followed by articulated, while the urban bus and coach fleet remains rather constant over the years. The increase of rigid trucks may be associated to the rapid expansion of the public and private construction sector over the last years.

The fleet of mopeds stays rather constant over the years but motorcycles (in particular small ones) increase. The 2S motorcycle fleet decreases significantly after 2000.

Figure GR.2: Evolution of vehicle type population per category



Country: GREECE	GR3/4
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The information on the technology of vehicles was quite scarce for Greece. This was one of the major problems of the fleet characteristics estimation for this country. For passenger cars, one can really assume that the new registrations follow the emission standard classes applicable in EU15, as the ratio of second-hand imports has been very low (12% of total registration in year 2006), mainly due to high taxation of second-hand vehicle import. Most of the second-hand imports are from Germany and the average age of the cars imported is estimated to be less than three years. Hence, the implementation matrix for PC in table GR.1 is quite reliable. The same applies to PTW as well, as the range of second hand import is <10% in 2006.

However, the second-hand market of heavy duty vehicles is very strong with many vehicles again imported from Germany. In this category, it is practically the second-hand sales which dominate the market of lorries and tractors with some 75% of new registrations coming from second-hand vehicles. Therefore, the implementation matrix for trucks is shifted to older technologies. The situation looks better for busses, as registration of urban ones follow the Euro standards.

As a result, the technology mix in Greece (Table GR.2) shows that there is a large fraction of old (even non-catalyst) cars. It is known that Greece has one of the fleets with the highest mean age in Europe (ast or more than 10 years). There are new measures considered lately, to introduce accelerated scrappage incentives for cars up to Euro 2 and to base taxation on the Euro-control level. These may bring significant improvements in the mean vehicle age.

Table GR.1: Implementation matrix (introduction of technologies per year)

Cat.	G-PC			D-PC			G-LDV				D-LDV				BUS			HDT			PTW	
	2	3	4	2	3	4	1	2	3	4	1	2	3	4	II	III	IV	II	III	IV	I	II
2000	76	24	0	100	0	0	59	41	0	0	0	100	0	0	100	0	0	100	0	0	100	0
2001	39	61	0	54	46	0	44	38	18	0	0	100	0	0	100	0	0	100	0	0	100	0
2002	18	82	0	0	100	0	0	0	100	0	0	0	100	0	6	94	0	61	39	0	84	16
2003	15	85	0	0	100	0	0	0	100	0	0	0	100	0	46	54	0	28	72	0	11	89
2004	14	86	0	0	100	0	0	0	100	0	0	0	100	0	41	59	0	13	87	0	7	93
2005	15	85	0	0	100	0	0	0	100	0	0	0	100	0	0	100	0	2	98	0	0	100

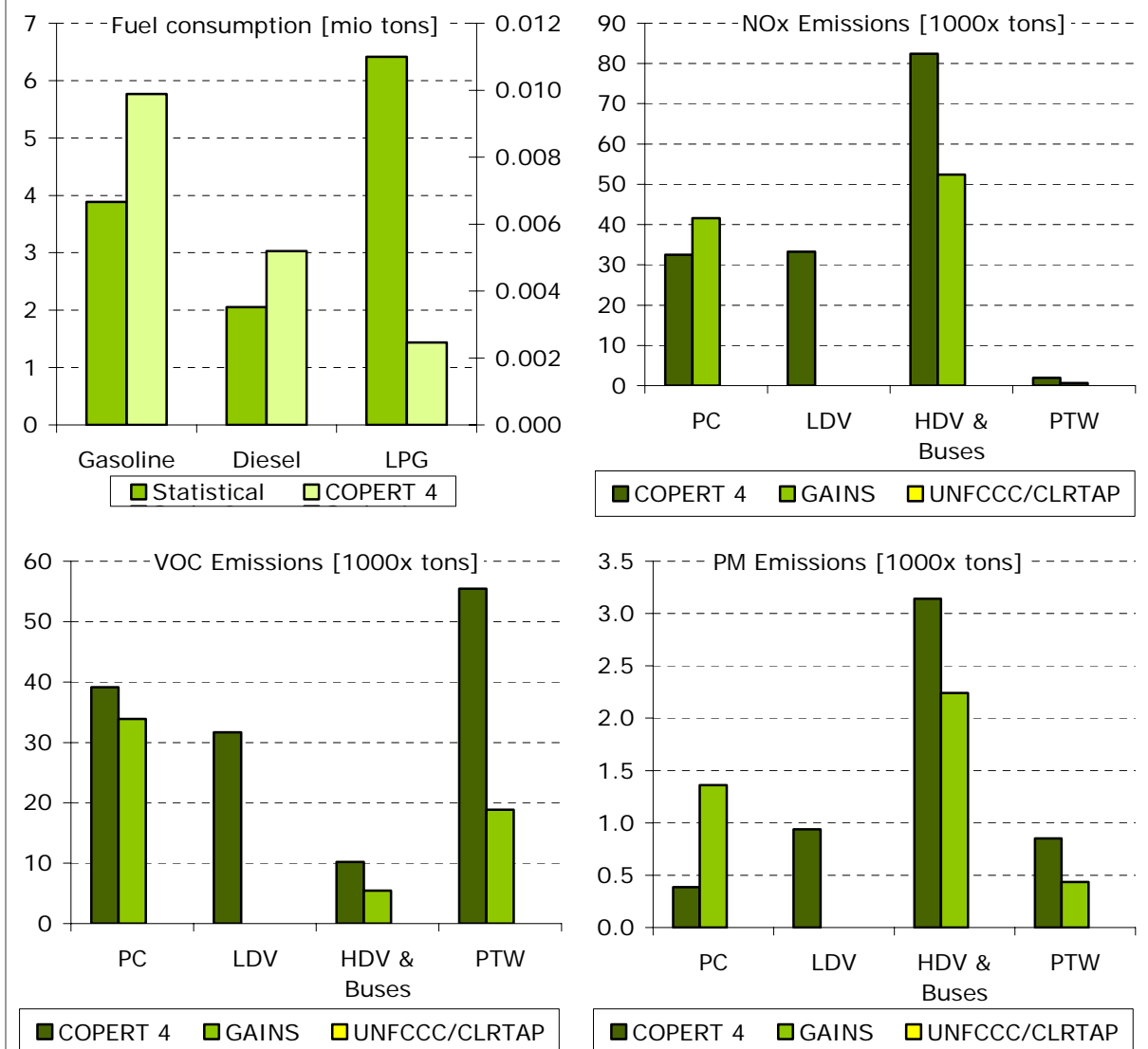
Table GR.2: Technology mix of the stock per subsector per year

Cat.	G-PC					D-PC					G-LDV					D-LDV					BUS					HDT					PTW		
	C	1	2	3	4	C	1	2	3	4	C	1	2	3	4	C	1	2	3	4	C	I	II	III	IV	C	I	II	III	IV	C	I	II
2000	36	32	29	3	0	32	43	25	0	0	79	15	6	0	0	57	11	32	0	0	47	36	17	0	0	67	18	15	0	0	68	32	0
2001	30	28	32	10	0	14	50	31	5	0	75	16	8	1	0	55	10	35	0	0	44	36	20	0	0	62	17	20	0	0	63	37	0
2002	25	27	31	17	0	8	51	33	8	0	74	16	8	2	0	50	9	32	10	0	39	37	20	5	0	58	17	23	2	0	59	41	1
2003	21	25	31	23	0	1	41	40	19	0	72	16	8	4	0	45	8	28	19	0	26	44	20	10	0	54	15	23	7	0	54	41	6
2004	18	24	30	28	0	0	34	34	32	0	71	16	8	5	0	41	7	25	28	0	17	46	19	18	0	52	14	23	11	0	49	40	12
2005	15	23	30	32	0	0	29	30	40	0	71	15	7	7	0	37	6	22	36	0	11	45	18	26	0	52	12	22	15	0	43	38	19

There is significant deviation between the gasoline and the diesel (and LPG) calculated and statistical consumptions in Greece. For Gasoline, the deviation should mostly be attributed to the mileage values that have been used for the passenger car fleet. Although the values used come from statistics, these are rather outdated (~1995). At that time, the PC car stock mainly consisted of one car per family which was largely driven for longer distances. Ever since, the Greek stock has been booming mainly by the addition of a second family car. Naturally, this lead to less mileage per vehicle which is not reflected to the rather old statistics. Therefore, the mileage should be decreased. According to official data, the black market of gasoline is not really important in Greece and there is not significant tank tourism, as the cross-border PC car market is negligible. We have not adjusted the mileage in this report, in order not to hamper the transparency of the calculations.

The reasons for the rather significant diesel deviations are different. First, there is a significant international truck activity of the large road freight transport sector in Greece. Therefore, a large portion of the consumption difference shown in Figure GR.3 occurs outside of Greek borders. The other reason is that, until recently, diesel smuggling has been significant as a different tax was applied on heating oil (red colour) compared to motor oil (green colour). As a result, heating oil was regularly used (after decolorisation) as motor oil. Also, smuggling of maritime oil used to be a common practice also de to the tax difference. According to the Ministry of Finance, such activities resulted to tax evasion of 1.3-1.5 billion Euros in 2006. Given the tax difference of about 70 cents per litre, this results to some 2 mio tones of heating and maritime oil converted to transport fuel. These practices have been stopped from 2008 on, after equating heating and transport oil tax and installing electronic systems to monitor maritime oil transport. Therefore, the diesel oil deviation is, to a large extent, rather reasonable and it is not recommended to adjust the mileage to match the statistical fuel consumption.

Figure GR.3: Results of the calculations with COPERT 4 and the updated fleets compared to other sources



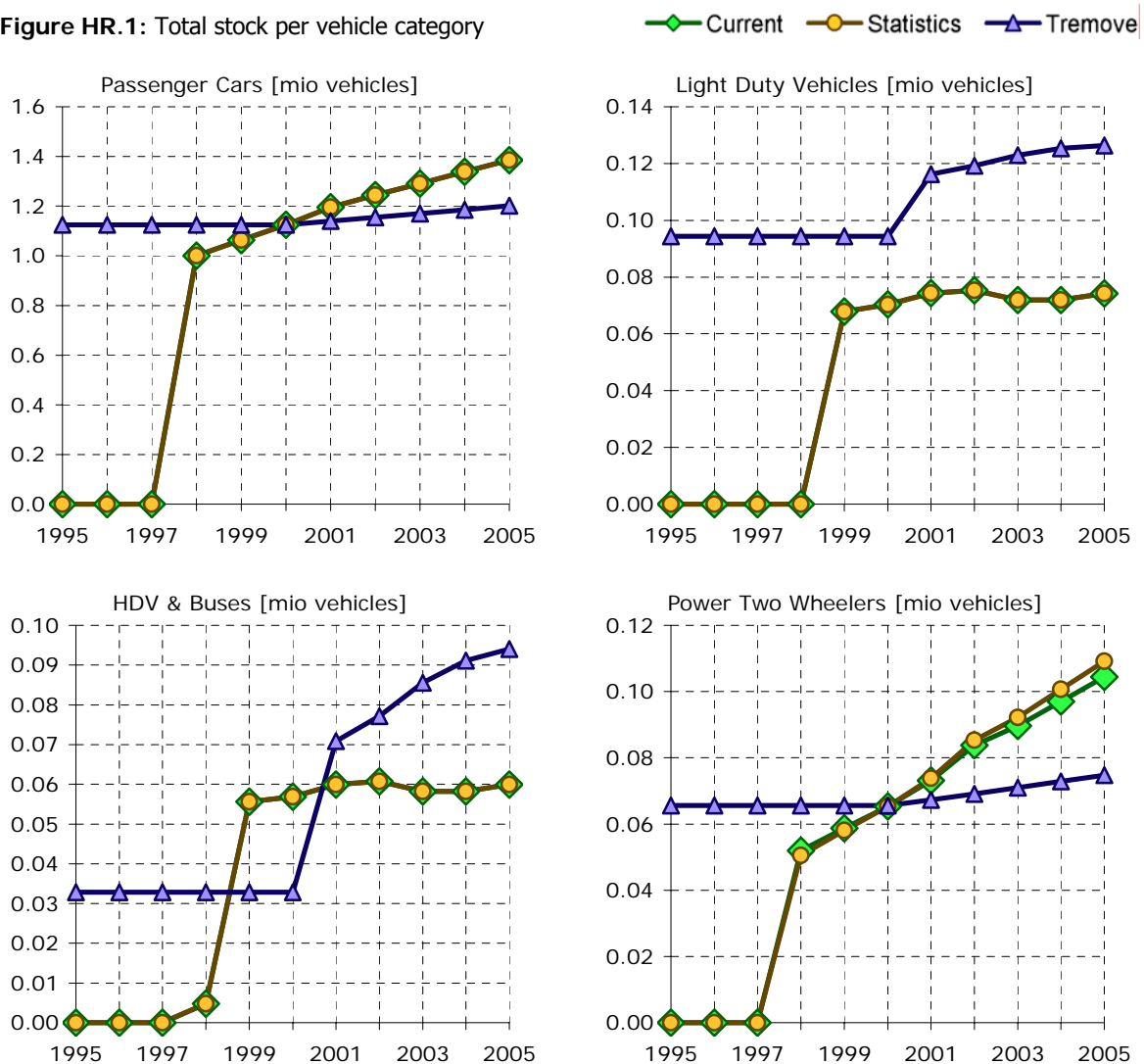
The following were the main sources of information:

- Total fleets per category: IRF World Road Statistics (1998-2004)
- Split in types: IRF World Road Statistics (1999-2000)
- New registrations: IRF World Road Statistics (1998-2004)
- Age/technology distribution of vehicles: no data available

Apart from total numbers for the main vehicle categories, no other information was available. Therefore, 50% of the total information had to be calculated, which is further distinguished to 52% of the total fleet, 35% of new registrations and 61% of deregistrations. In the absence of any other data, information from the Slovakian fleet was used for the distribution into fuel, weight and technology classes for the year 2005. The total fleet should be considered reliable as it originates from updated official databases. However, the distinction to categories and types should be treated with caution as it is based on assumptions, as explained above.

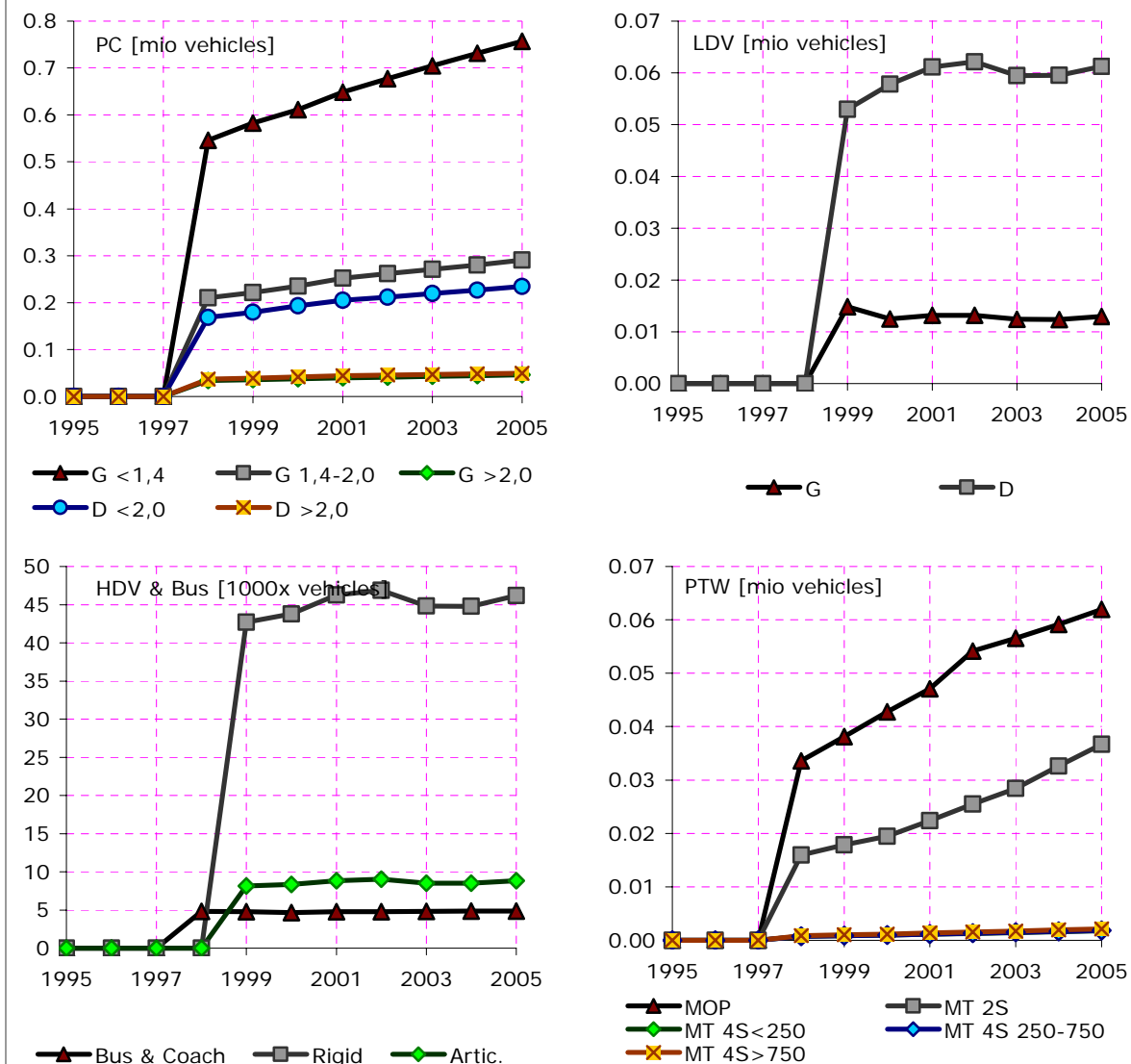
The number of passenger cars in Croatia increased by about 40%, reaching 1,4 mio vehs in 2005 compared to about 1 mio vehs in 1998. A slight increase of less than 10% was recorded for LDVS and HDVs over the period 1999-2005, while the number of PTWs doubled from 1998 to 2005.

Figure HR.1: Total stock per vehicle category



As mentioned above, information from the Slovakian fleet was used for the distribution of the main categories of the Croatian vehicle fleet into fuel and weight classes for the year 2005. Hence, the results shown in figure HR.2 are only indicative and any assessment on the main trends per category should be treated with caution.

Figure HR.2: Evolution of vehicle type population per subsector



As mentioned above, information from the Slovakian fleet was used for the distribution of the main categories of the Croatian vehicle fleet into technology classes for the year 2005. Hence, the implementation matrix and technology mix shown in tables HR.1 and HR.2 are only indicative and should be treated with caution.

Table HR.1: Implementation matrix (introduction of technologies per year)

Cat.	G-PC			D-PC			G-LDV				D-LDV				BUS			HDT			PTW		
	Euro	2	3	4	2	3	4	1	2	3	4	1	2	3	4	II	III	IV	II	III	IV	I	II
2000	13	87	0	0	100	0	0	56	44	0	0	40	60	0	100	0	0	100	0	0	100	0	0
2001	10	90	0	0	100	0	0	0	100	0	0	0	100	0	0	100	0	0	100	0	100	0	0
2002	11	89	0	0	100	0	0	0	100	0	0	0	100	0	0	100	0	0	100	0	41	59	0
2003	11	89	0	0	100	0	0	0	100	0	0	0	100	0	0	100	0	0	100	0	38	62	0
2004	10	90	0	0	100	0	0	0	100	0	0	0	100	0	0	100	0	0	100	0	37	63	0
2005	9	91	0	0	100	0	0	0	100	0	0	0	100	0	0	100	0	0	100	0	37	63	0

Table HR.2: Technology mix of the stock per subsector per year

Cat.	G-PC					D-PC					G-LDV					D-LDV					BUS					HDT					PTW		
	Euro	C	1	2	3	4	C	1	2	3	4	C	1	2	3	4	C	1	2	3	4	C	I	II	III	IV	C	I	II	III	IV	C	I
2000	70	21	3	5	0	65	19	12	4	0	64	10	18	7	0	85	5	6	4	0	82	13	5	0	0	85	7	8	0	0	95	5	0
2001	62	23	4	11	0	63	17	12	8	0	59	9	17	14	0	81	4	6	9	0	80	13	5	2	0	84	6	8	3	0	93	7	0
2002	55	25	4	16	0	61	16	11	12	0	53	9	17	22	0	78	4	5	13	0	79	12	5	4	0	82	5	7	5	0	91	7	2
2003	48	26	5	21	0	60	15	10	15	0	46	9	17	28	0	74	4	5	16	0	77	12	4	6	0	79	5	7	8	0	89	7	3
2004	43	27	5	25	0	59	13	10	18	0	41	8	16	35	0	71	4	5	20	0	76	12	4	8	0	78	4	7	11	0	88	7	5
2005	37	28	5	29	0	58	12	9	21	0	35	7	15	43	0	67	3	5	25	0	75	11	4	10	0	77	4	6	13	0	87	7	6

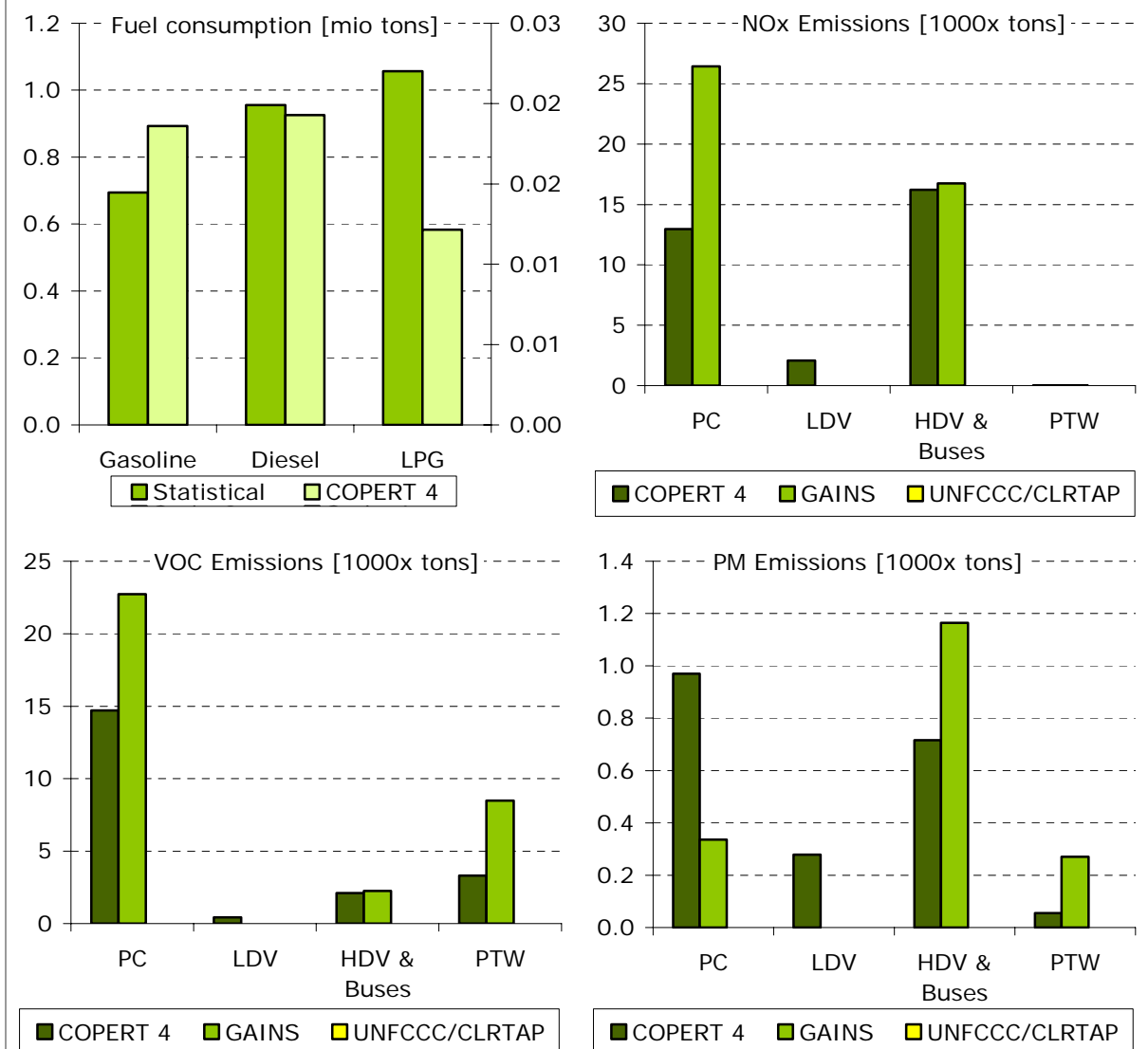
Small difference on the order of 3% may be observed when comparing diesel consumption calculated with COPERT 4 with the respective statistical value reported by Eurostat. Larger deviations from Eurostat values are observed for gasoline (30%) and LPG (45%). These deviations may be explained by the difference in the use of gasoline, diesel and LPG vehicles (mainly annual mileage) considered for the calculations and the real-world vehicle use.

Only total emissions are reported for Croatia under UNFCCC/CLRTAP and therefore emissions from vehicle categories are not shown in Figure HR.3 below. Emissions information from GAINS was rather scarce.

For the reasons mentioned in previous sections, the following assessment is based on the total number of vehicles in each category.

Due to the high number of D-PC considered, NOx emissions from PC are of the same order of magnitude as from HDV & Buses. For the same reason, PC are the main source of PM emissions, followed by HDV & Buses. PC and in particular G-PC dominate VOC emissions.

Figure HR.3: Results of the calculations with COPERT 4 and the updated fleets compared to other sources



The basic sources for data of road vehicle fleets and their operation were as follows:

- Fuel consumption: Gasoline/Diesel: Annual Reports of the Hungarian Petroleum Association, Yearbook for Economy of Energy in Hungary; LPG: Eurostat; RVP: Standards for Motor Fuels
- Population of vehicles, total number per category, yearly first registrations (new and used cars, light/heavy duty vehicles, buses, motorcycles), age distributions: National Statistics of Road Vehicles, Ministry of Transport and Water Management (1990-2001), Ministry of Economy and Transport (2001-2005)
- Split according emission categories: Decrees on introduction of ECE/EU Emission Regulations
- Annual mileage: surveys by KTI (institute for Transport Sciences), calculations based on national traffic counts
- Average speeds, shares/loads in urban/rural/highway traffic: surveys on national road networks/at different transport companies by Hungarian institutions,
- Fuel injection, evaporation canister: distribution according emission technology based on the years of production and first registration.

Only 26% of the information was missing, further distinguished into 13% of total population, 28% of new registrations and 36% of deregistrations. The data on total fleets and the splits according emission regulations (especially after the introduction of EURO1 level) as well as the fuel consumption should be considered as reliable because these data originate from controlled official databases. The main uncertainty is caused by the first registration of used (imported) vehicles belonging to unknown emission categories. There were no official data on the mopeds. The vehicle fleets of Hungary are developing continuously and significantly in the last decade except the buses. The share of cars and HDVs in transport performances significantly increased during the last decade.



In the passenger car fleet (also in the new registration) the gasoline fuelled cars (belonging to the <1,4l class) are dominating, the share of >2,0l is very small (less than 2,5 % of the total PC-fleet). The number of the old (pre ECE category) cars is continuously and significantly decreasing (in the year 2000 their share was 42,3% and in 2005 17,9%); the share of cars powered by 2-stroke engine

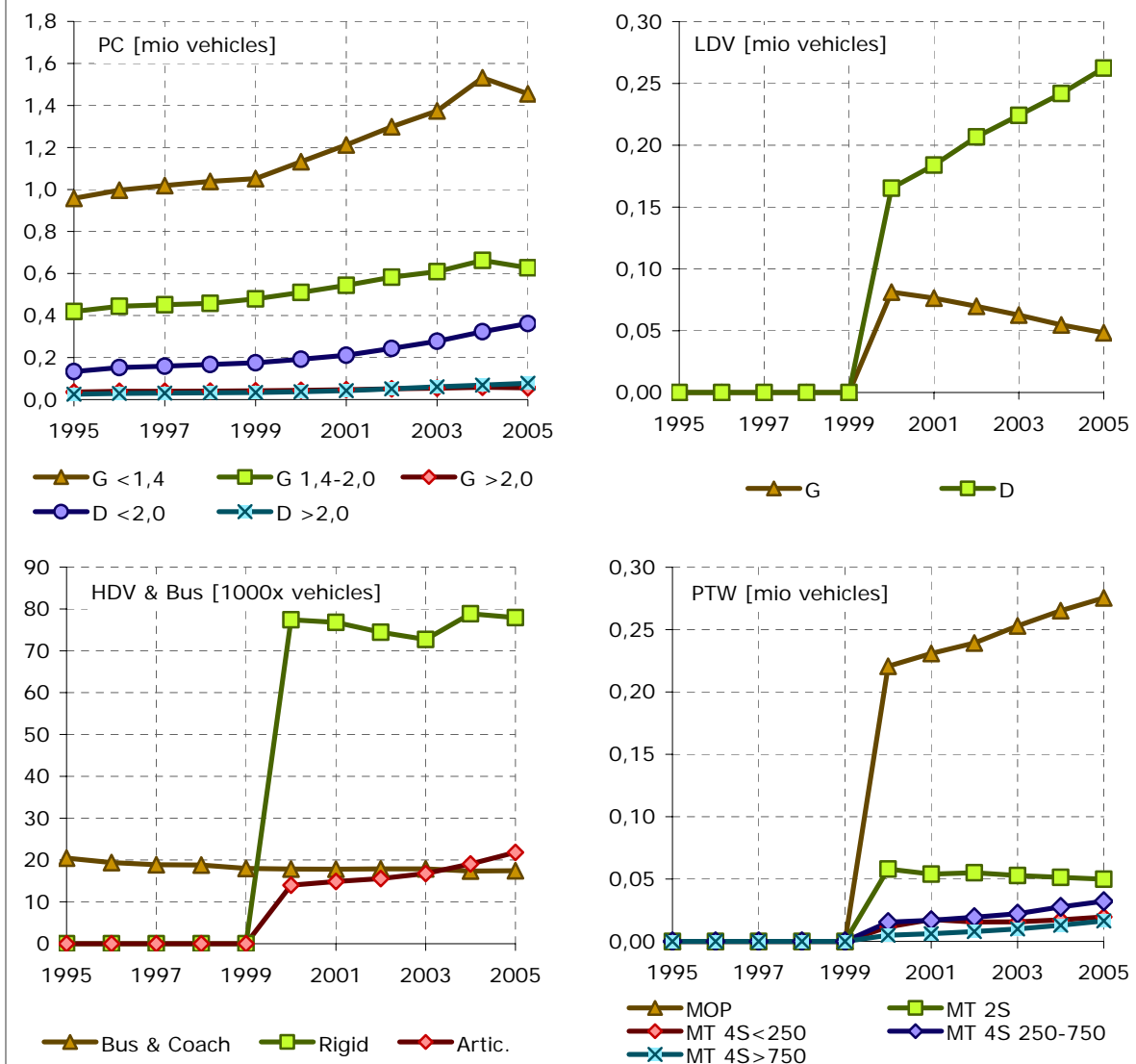
is remarkably decreasing too (year 2000: 15,4%; year 2005: 7,3%). The share of diesel fuelled cars in the total PC-fleet is increasing 12,6% in the year 2005 (but 25,8% in the first registered cars). The share of first registered cars was between 9-10% in the total fleet of late years and within the first registration the share of imported old/used cars was fluctuating between 20-30% (2000-2005). The average age of PC was 11.6 year (2000) and 10,4 year (2005). The share of deregistration was 6,2% of the total passenger car fleet in the year 2005.

The share of LDV in the goods vehicles was 70,7% in 2005. Most of the goods vehicles are diesel fuelled (81 8%) and in case of their first registration the diesel's share is increasing, it was 92,14% in the year 2005. The average age of goods vehicles was 8,99 year (2005). The continuous increase of

articulated trucks is connected with their growing share in the goods transport. The share of first registration in the total goods vehicles was 9,0% (2005), 50 2% of them was brand new the rest was imported used one.

The bus fleet in Hungary is old, its average age was 13,0 year (2005), the share of the buses firstly registered before 1996 was 60,2% (2005).The renewal of the bus fleet is very slow, the share of first registration 5,8%, and within the firstly registered ones 49,9 % was the share of brand new buses.

Figure HU.2: Evolution of vehicle type population per category



Country: **HUNGARY**

HU3/4

The information on introduction of certain emission regulations of vehicle categories in Hungary is available and reliable after the introduction of Euro1 level especially in case of the first registration of new vehicles. There is also reliable information on development regarding the passenger cars powered by two stroke engine. It was not possible to differentiate among the ECE15/01..15/04 levels. Before 2002 different emission regulations had to be applied incase of first registered new and used vehicles. The share of second hand import was fluctuating from year to year and vehicle category to vehicle category due to the change in taxation and economical situation. This uncertainty will decrease in the next years because the scraping of very old vehicles and because the emission level of each vehicles will be recorded due to introduction of low emission zones in big cities.

The share of gasoline cars equipped with three-way catalyst is about 65% and it is continuously increasing. A part of LPG fuelled cars is not registered yet but this uncertainty will diminish due to the control of retrofitting during the periodical technical inspections.

The data on yearly mileage of passenger cars are based on surveys using questionnaires, an important conclusion was that the old cars (age above 10 years) have significantly lower mileage compared to the younger ones (1-5 years old).

A part of cars were retrofitted with uncontrolled three way catalyst in the early 90's (4-5% of the PC fleet).

The data on urban/rural/highway speeds and shares data are based on surveys and represents the country average, the base was the same regarding the average load of trucks and buses.

Table HU.1: Implementation matrix (introduction of technologies per year)

Cat.	G-PC			D-PC			G-LDV				D-LDV				BUS			HDT			PTW	
	2	3	4	2	3	4	1	2	3	4	1	2	3	4	II	III	IV	II	III	IV	I	II
2000	100	0	0	100	0	0	100	0	0	0	100	0	0	0	100	0	0	100	0	0	0	0
2001	100	0	0	100	0	0	0	100	0	0	10	90	0	0	100	0	0	100	0	0	0	0
2002	100	0	0	100	0	0	0	100	0	0	0	100	0	0	40	60	0	33	67	0	100	0
2003	1	99	0	35	65	0	0	4	96	0	0	9	91	0	43	57	0	29	71	0	100	0
2004	18	82	0	29	71	0	0	0	100	0	5	1	95	0	29	71	0	38	62	0	100	0
2005	0	100	0	28	72	0	0	0	100	0	20	4	76	0	48	52	0	30	70	0	100	0

Table HU.2: Technology mix of the stock per subsector per year

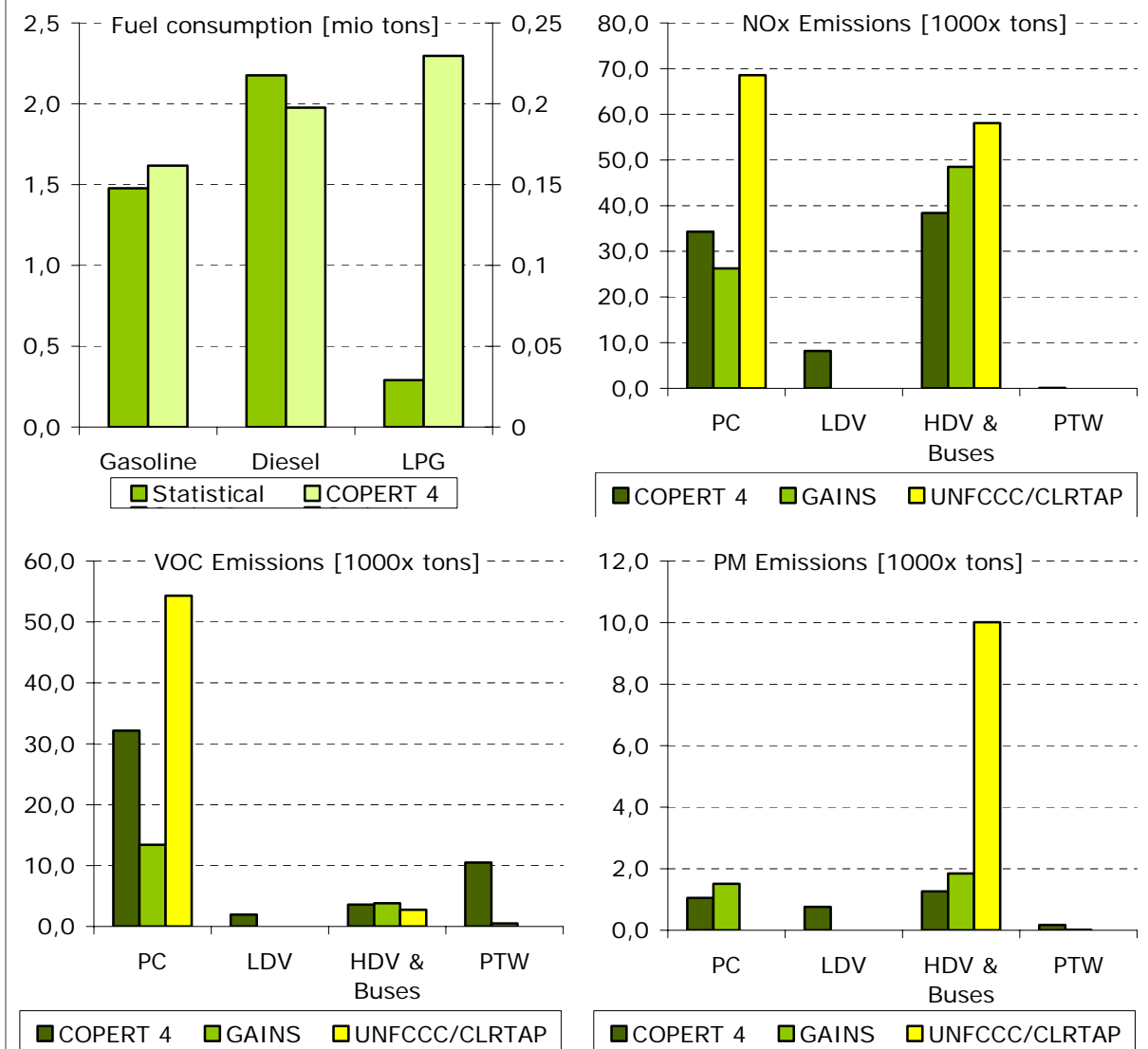
Cat.	G-PC					D-PC					G-LDV					D-LDV					BUS					HDT					PTW		
	C	1	2	3	4	C	1	2	3	4	C	1	2	3	4	C	1	2	3	4	C	I	II	III	IV	C	I	II	III	IV	C	I	II
2000	69	18	14	0	0	86	9	5	0	0	78	22	0	0	0	47	53	0	0	0	81	5	14	0	0	82	5	13	0	0	100	0	0
2001	62	17	21	0	0	80	10	10	0	0	75	23	2	0	0	41	48	11	0	0	76	5	19	0	0	77	6	17	0	0	100	0	0
2002	56	16	27	0	0	72	12	16	0	0	72	24	5	0	0	35	42	23	0	0	71	5	21	3	0	70	7	19	4	0	96	4	0
2003	51	16	26	8	0	62	14	17	6	0	69	25	5	2	0	31	38	22	9	0	66	6	22	6	0	63	8	21	8	0	92	8	0
2004	45	15	25	15	0	52	14	19	15	0	63	27	6	4	0	27	36	20	17	0	60	6	23	11	0	55	8	23	14	0	84	16	0
2005	38	15	24	22	0	43	13	20	24	0	59	29	7	5	0	24	34	19	23	0	56	6	24	14	0	49	8	25	19	0	78	22	0

The discrepancy of gasoline/diesel fuel consumption between statistical and COPERT4 data can be traced back mainly to the "fuel tourism", that is to the big price difference of fuels in Hungary and in the neighboring countries. The total consumption of gasoline from 1996 up to now was unchanged but the diesel consumption is steadily increasing due to the increasing share of diesel fuelled vehicle as well as because the transport volume of goods vehicles is increasing. The sale of leaded gasoline came to an end in the year 1999, the low sulphur-content fuels (S<10ppm) were introduced generally in the year 2005.

The big difference of LPG consumptions between statistical and COPERT data can be traced back to the estimated mileage and number of LPG fuelled cars.

The share of passenger cars in NOx and VOC emissions is acceptable and is keeping with the data of the national emission inventory of road transport. The share of passenger cars in PM emission is overestimated, the determinant role have the LDV and HDV.

Figure HU.3: Results of the calculations with COPERT 4 and the updated fleets compared to other sources



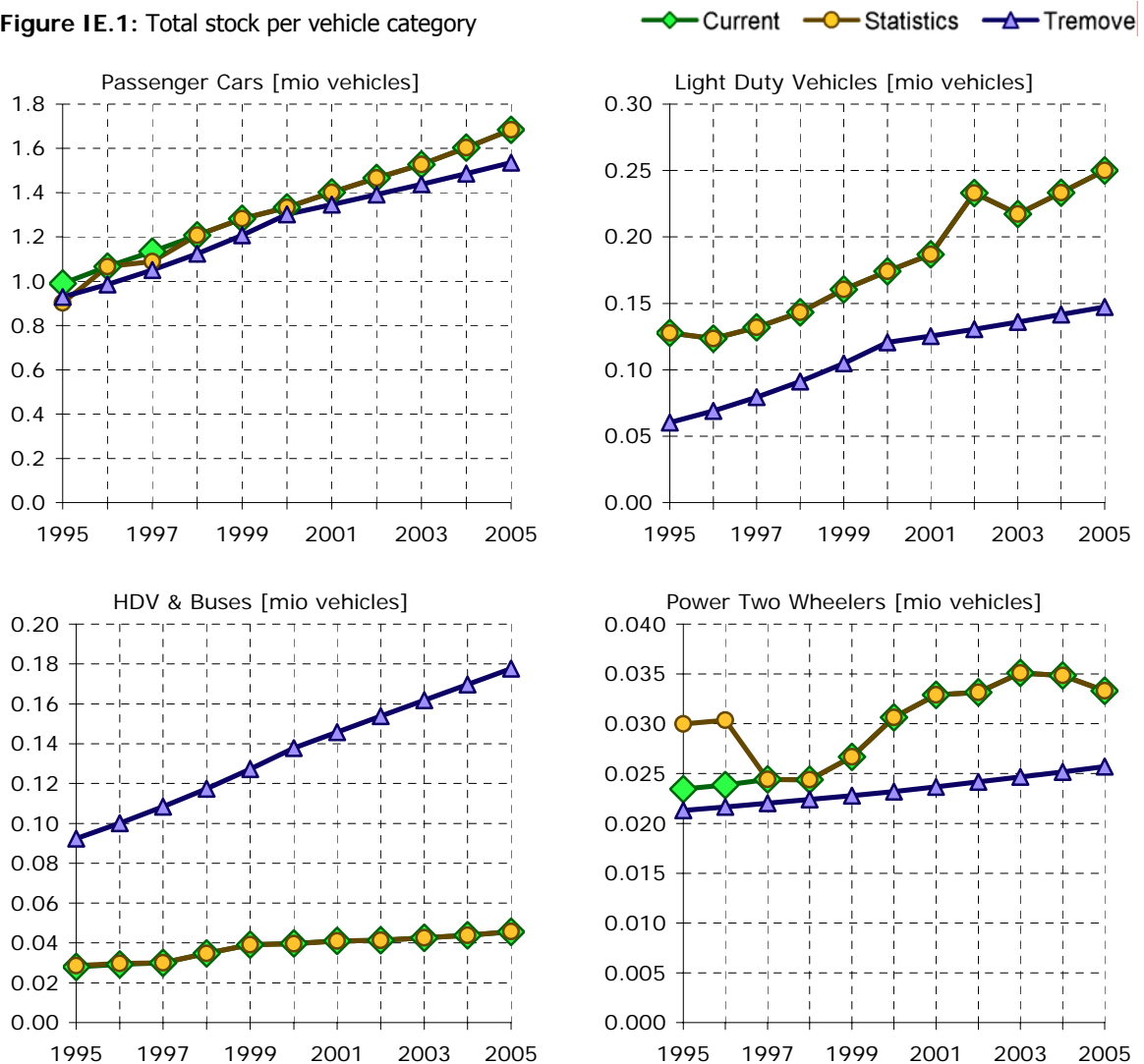
The following were the main sources of information:

- Total fleets per category: Eurostat (1970-1999), Environment Protection Agency (1990-2005)
- Split in types: Environment Protection Agency (1990-2005)
- New registrations: Eurostat (1970-2001), ACEA (2002-2006)
- Age/technology distribution of vehicles: Environment Protection Agency (1990-2005)
- Other sources included UITP

The information that had to be calculated was only 14%, distinguished into 2% of the total stock, 14% of new registrations and 25% of deregistrations. The total fleet and the distinction to categories and types should be considered reliable as it originates from updated official databases.

The vehicle stock of Ireland develops significantly over the period 1995-2005, with passenger cars reaching 1.8 mio vehicles in 2005 compared to 1 mio in 1995. The number of LDVs almost doubled, while HDVs, buses & coaches also increased considerably by about 60%. The number of PTWs increased by about 40%, however, its share remains low relatively to other countries.

Figure IE.1: Total stock per vehicle category



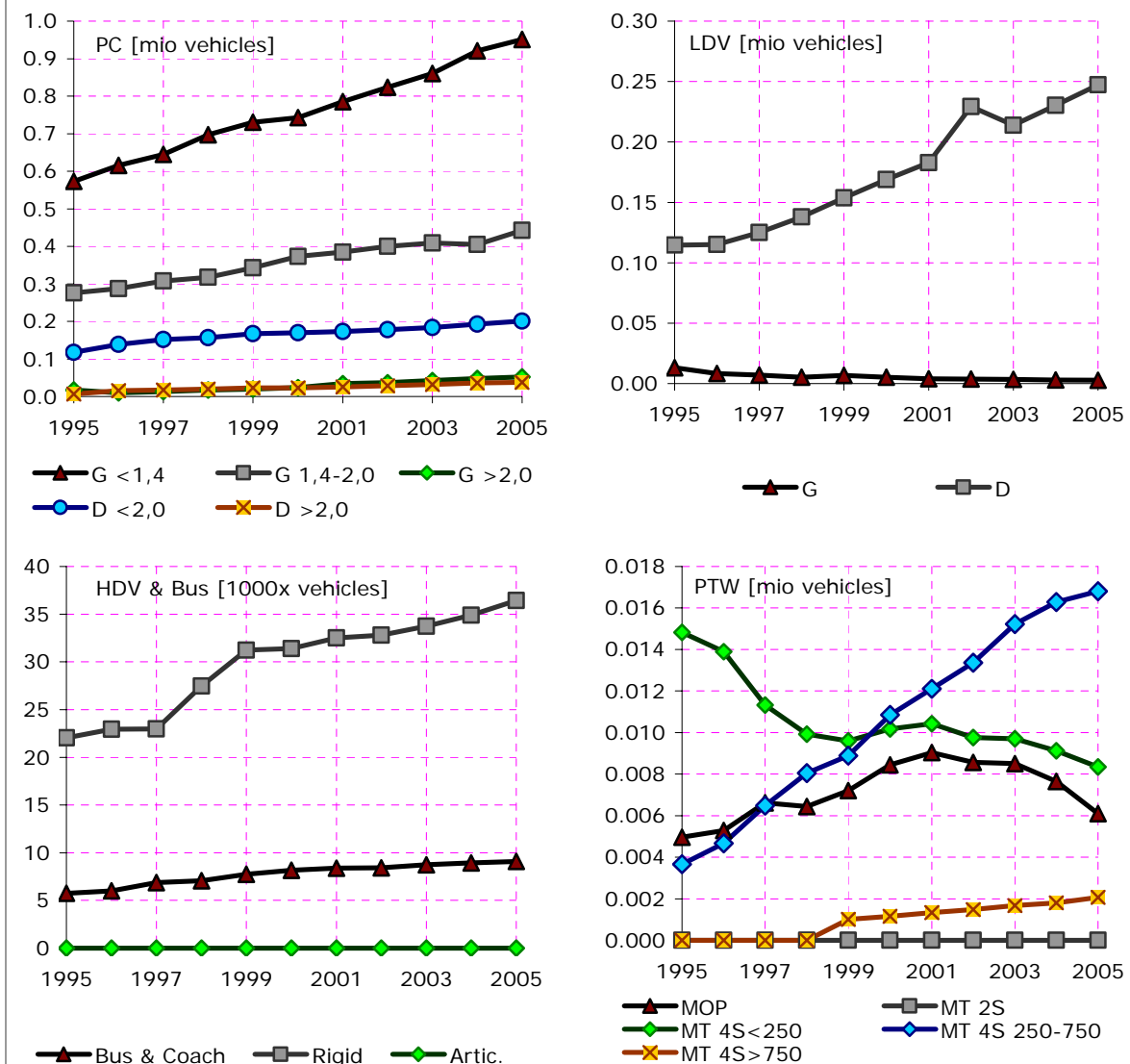
G-PC falling in the small and medium class (<1,4 & 1,4-2,0 l) dominate the passenger car fleet, accounting for almost 85% of the PC fleet. The G-PC fleet increased by more about 60% over the period 1995-2005. The population of large (>2,0 l) G-PC increases consistently over the years and has tripled in the period 1995-2005; however, they still have a low share of less than 4% of the total G-PC fleet. The D-PC fleet has doubled over the same period, accounting for about 15% of the PC fleet in 2005. Large (>2,0 l) D-PC have tripled their share in the D-PC fleet from 5% to 16% over the above period.

D-LDVs dominate the LDV fleet, with their share increasing further to 99% in 2005 compared to 90% in 1995. The population of G-LDV in 2005 is reduced consistently, accounting for only 1% of the total LDV fleet.

The bus and HDV stock has increased by more than 60% over the 1995-2005 period, mainly due to the increase of rigid trucks. Due to the relatively small size of the island, there are no articulated trucks in the Irish HDV fleet.

The population of medium class motorcycles (MT 4S 250-750) has recorded a considerable increase, accounting for 50% of the PTW fleet. Mopeds also increased, by about 25%; however, their share in the PTW fleet remains relatively low (less than 20%).

Figure IE.2: Evolution of vehicle type population per subsector



Country: IRELAND	IE3/4
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The implementation matrix is based on a complete and consistent dataset and therefore it can be considered as reliable. The import of second-hand vehicles, especially D-PC and D-LDV contributes to the fleet development as shown in table IE.1 (e.g. Euro 1 vehicles registered for the first time in 2005). Although Euro 3 PCs are introduced a year later than their implementation date, Euro 4 PCs are introduced already in 2005, a year earlier than their implementation date.

For HDTs the data also suggest that second-hand vehicles are introduced in the market (e.g. a few Euro I and a larger fraction of Euro II HDTs are registered for the first time even in 2005).

Most pre-Euro vehicles are phased-out in 2005, with Euro 2 and 3 PCs and LDVs and Euro II and III buses and HDVs dominating the fleet. This, together with the significant development of the entire fleet has resulted in a fast technology replacement. For the PTWs there is still an important share of conventional vehicles.

Table IE.1: Implementation matrix (introduction of technologies per year)

Cat.	G-PC			D-PC			G-LDV				D-LDV				BUS			HDT			PTW	
	2	3	4	2	3	4	1	2	3	4	1	2	3	4	II	III	IV	II	III	IV	I	II
2000	100	0	0	100	0	0	100	0	0	0	100	0	0	0	100	0	0	100	0	0		
2001	100	0	0	100	0	0	0	100	0	0	0	100	0	0	100	0	0	100	0	0		
2002	3	97	0	8	92	0	0	0	100	0	13	28	59	0	0	100	0	0	100	0		
2003	2	98	0	5	95	0	0	0	100	0	0	0	100	0	0	100	0	1	99	0		
2004	3	97	0	11	89	0	0	0	100	0	0	1	99	0	0	100	0	0	100	0		
2005	1	20	79	14	0	86	0	0	0	100	0	0	14	86	0	0	100	6	30	64	100	0

Table IE.2: Technology mix of the stock per subsector per year

Cat.	G-PC					D-PC					G-LDV					D-LDV					BUS					HDT					PTW		
	C	1	2	3	4	C	1	2	3	4	C	1	2	3	4	C	1	2	3	4	C	I	II	III	IV	C	I	II	III	IV	C	I	II
2000	25	37	38	0	0	27	40	34	0	0	41	59	0	0	0	44	56	0	0	0	25	38	38	0	0	26	38	36	0	0	100	0	0
2001	20	34	46	0	0	21	37	42	0	0	34	31	35	0	0	31	48	21	0	0	18	33	49	0	0	20	33	47	0	0	100	0	0
2002	15	30	44	11	0	15	34	40	10	0	25	29	36	10	0	23	40	23	13	0	16	31	48	5	0	14	27	44	14	0	100	0	0
2003	11	27	41	20	0	11	30	38	21	0	18	25	39	18	0	21	27	24	28	0	12	28	45	16	0	11	25	42	22	0	100	0	0
2004	8	24	38	29	0	7	25	36	31	0	13	20	43	25	0	18	22	22	38	0	8	24	42	26	0	8	21	38	33	0	100	0	0
2005	5	21	35	29	9	5	21	35	29	10	8	11	44	26	10	15	16	19	37	13	5	19	38	25	13	5	16	33	33	13	80	20	0

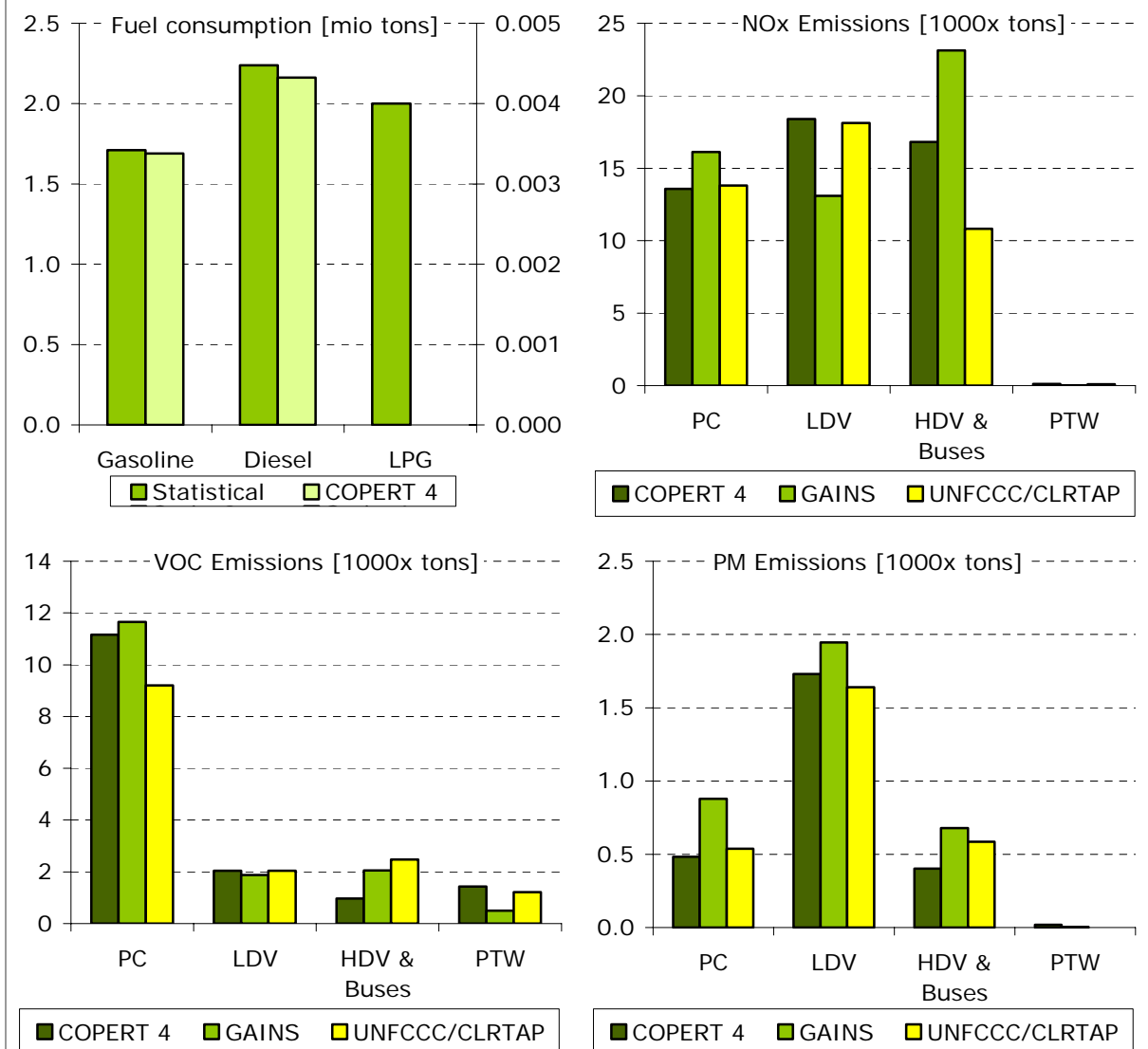
Small differences on the order of 1% for gasoline and 3% for diesel may be observed when comparing fuel consumption calculated with COPERT 4 with the respective statistical values reported by Eurostat. These deviations may be explained by the difference in the use of gasoline and diesel vehicles (mainly annual mileage) considered for the calculations and the real-world vehicle use. LPG consumption could not be calculated with COPERT 4, because no LPG vehicles were reported.

It is known that emissions for Ireland reported under UNFCCC/CLRTAP are calculated with COPERT 3. Due to the high number of D-LDV in the Irish fleet (practically all LDV are diesel vehicles), NOx emissions from LDV are of the same order of magnitude as from HDV & Buses. Emissions calculated with COPERT 4 are almost identical with those reported under UNFCCC/CLRTAP for all vehicle categories except for HDV & Buses. The higher NOx emissions calculated with COPERT 4 for HDV & Buses may be explained by the difference in emission factors between COPERT 3 and 4 (HDV EF were underestimated in COPERT 3).

PC and in particular G-PC dominate VOC emissions. Total emissions calculated with COPERT 4 compare reasonably well with emissions reported by GAINS and UNFCCC/CLRTAP.

LDV are the dominant source of PM emissions, contributing almost twice as much as PC, HDV & Buses and PTW together.

Figure IE.3: Results of the calculations with COPERT 4 and the updated fleets compared to other sources



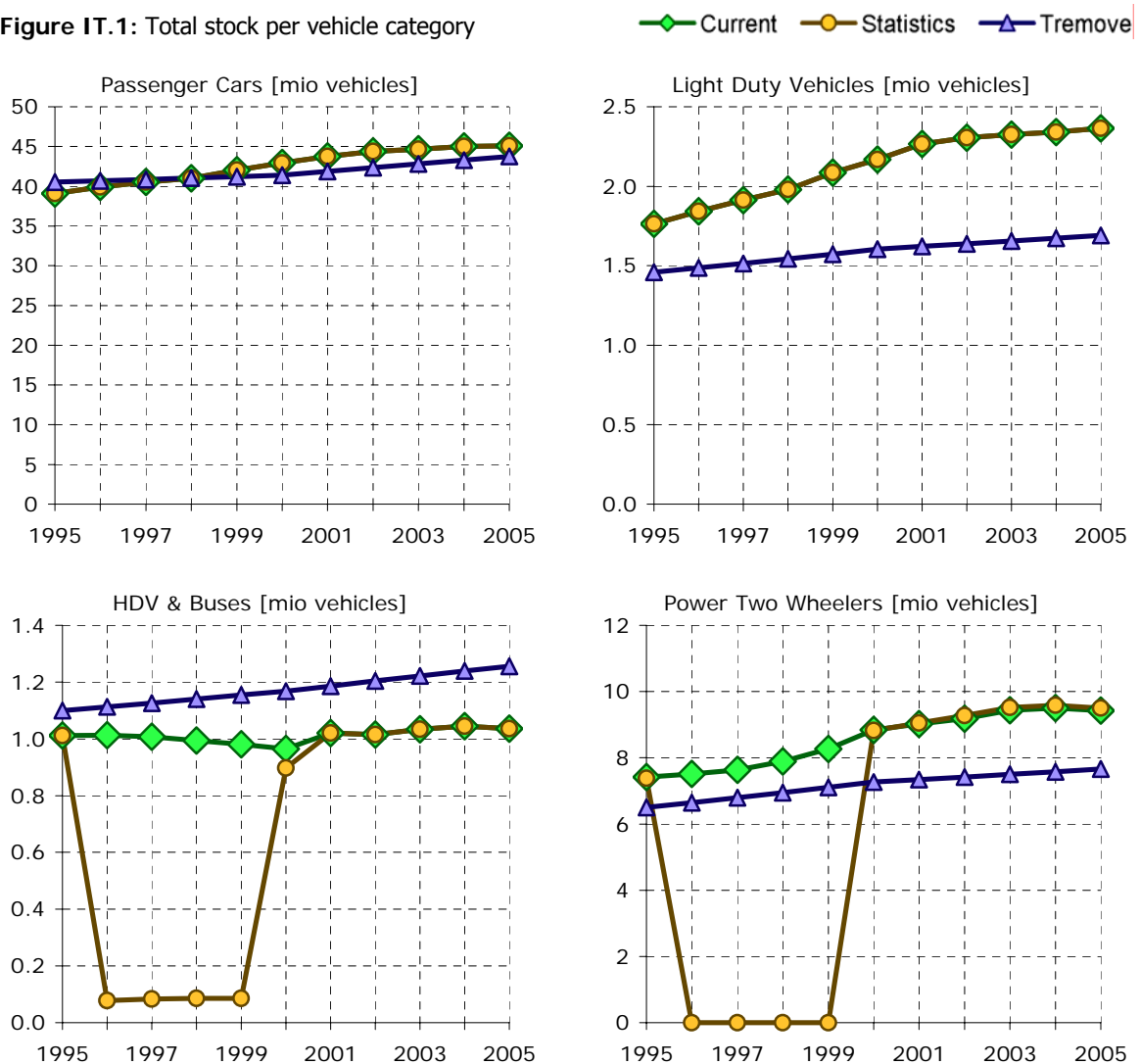
The following were the main sources of information:

- Total fleets per category: Eurostat (1970-1994, 1996-1999), Environment Protection and Technical Services Agency (1995, 2000-2005)
- Split in types: Environment Protection and Technical Services Agency (1995, 2000-2005)
- New registrations: Eurostat (1970-2000), ACEA (2001-2006)
- Age/technology distribution of vehicles: Environment Protection and Technical Services Agency (1995, 2000-2005)
- Other sources included UITP

The information missing was 31,5%, allocated to 22% of the total stock, 28% of new registrations, and 44% of deregistrations. The total fleet and the distinction to categories and types should be considered reliable as it originates from updated official databases.

A moderate increase of the Italian vehicle stock is observed for the period 1995-2005, with the number of passenger cars increasing by 14% from 30 mio vehicles in 1995 to 34 mio in 2005. The number of LDVs recorded a considerable increase of 70%, while the number of HDVs remained almost stable over the same period. Italy has the largest PTW stock in Europe, with its number increasing from 7.5 mio in 1995 to 9.5 mio in 2005, mainly due to the increase in the number of motorcycles by almost 2 mio vehicles.

Figure IT.1: Total stock per vehicle category



A trend towards dieselization is obvious for both the PC and the LDV fleet.

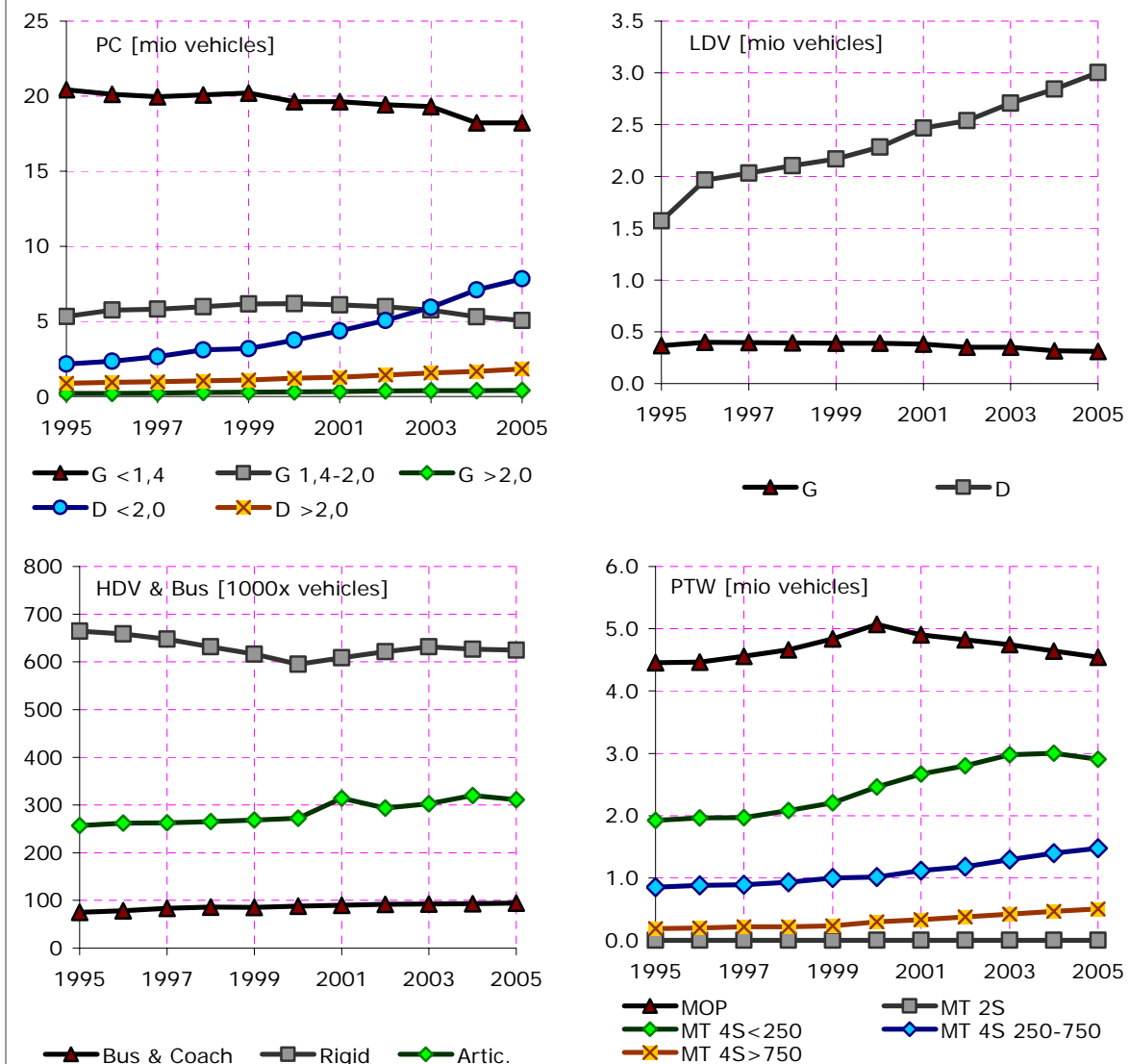
G-PC falling in the small and medium class (<1,4 & 1,4-2,0 l) have decreased over the period 1995-2005. The G-PC fleet increased by more about 20% over the period 1995-2005. Large (>2.0 l) G-PC increased considerably, however their share in the G-PC fleet remains low (less than 2%). The D-PC fleet has increased by more than 2.5 times over the same period, accounting for about 20% of the PC fleet in 2005.

The population of D-LDV has increased considerably over the years and has doubled in the period 1995-2005 with their share exceeding 92% in 2005. The number of G-LDV in 2005 is reduced by 15% compared to 1995.

The bus and HDV stock remained almost constant over the years. The population of rigid HDVs has decreased slightly, while articulated HDVs have one of the highest shares in the EU, accounting for one third of the HDV fleet. The fleet of buses and coaches has increases by about 25%.

The fleet of mopeds stays rather constant, however it remains the biggest in the EU with about 4,5 mio vehicles. The fleet of motorcycles has increased considerably by 2 mio, with the fleet of large motorcycles (MT 4S >750) more than doubling over the period 1995-2005.

Figure IT.2: Evolution of vehicle type population per subsector



Country: **ITALY**

IT3/4

The implementation matrix (Table IT.1) is based on a complete and consistent dataset and therefore it can be considered as reliable. A large fraction of Euro 4 PCs is already introduced in 2005, one year ahead of the official implementation date. A smaller fraction of Euro4 LDVs is already introduced in 2005, two years ahead of the official implementation date. For HDTs the data suggest that second-hand vehicles are introduced in the market (e.g. Euro II HDTs are still registered in 2002). Therefore, the technology replacement is slower than for PCs and LDVs.

The technology mix in Italy (Table IT.2) shows that there is a significant fraction of pre-Euro cars, with the exception of diesel vehicles. The D-PC fleet is dominated by Euro 2 and 3 vehicles. On the contrary, there is an important share of pre-Euro D-LDV, despite the significant increase in their population over the period 1995-2005. As a result, Italy has one of the oldest fleets in the EU, with a mean age of more than 10 years for PC. For the PTWs there is also an important share of conventional vehicles.

Table IT.1: Implementation matrix (introduction of technologies per year)

Cat.	G-PC			D-PC			G-LDV				D-LDV				BUS			HDT			PTW	
	2	3	4	2	3	4	1	2	3	4	1	2	3	4	II	III	IV	II	III	IV	I	II
2000	100	0	0	100	0	0	0	100	0	0	0	100	0	0	100	0	0	100	0	0	100	0
2001	8	92	0	10	90	0	0	20	80	0	0	58	42	0	0	100	0	94	6	0	97	3
2002	0	100	0	0	100	0	0	0	100	0	0	0	100	0	0	100	0	55	45	0	87	13
2003	0	100	0	0	100	0	0	0	100	0	0	0	100	0	100	0	0	0	100	0	80	20
2004	0	100	0	0	100	0	0	0	100	0	0	0	100	0	1	99	0	19	81	0	79	21
2005	0	0	100	0	14	86	0	0	65	35	0	1	86	13	0	100	0	0	100	0	79	21

Table IT.2: Technology mix of the stock per subsector per year

Cat.	G-PC					D-PC					G-LDV					D-LDV					BUS					HDT					PTW		
	C	1	2	3	4	C	1	2	3	4	C	1	2	3	4	C	1	2	3	4	C	I	II	III	IV	C	I	II	III	IV	C	I	II
2000	49	21	29	0	0	36	11	53	0	0	69	19	12	0	0	60	22	18	0	0	73	6	21	0	0	77	10	13	0	0	86	14	0
2001	44	20	29	6	0	28	9	47	15	0	65	19	13	4	0	54	20	22	4	0	69	6	20	6	0	70	8	21	1	0	81	19	0
2002	40	19	29	12	0	22	8	40	30	0	57	19	13	11	0	48	19	20	12	0	63	6	19	12	0	67	8	21	4	0	76	24	1
2003	36	18	28	17	0	17	6	33	44	0	53	18	13	16	0	45	17	19	20	0	55	8	27	10	0	63	8	20	9	0	70	28	2
2004	32	17	28	22	0	12	5	27	56	0	47	18	13	21	0	40	16	17	27	0	49	8	27	16	0	58	7	21	14	0	64	32	3
2005	30	16	27	22	6	10	4	23	52	11	45	18	13	23	1	37	14	16	32	1	45	8	27	21	0	55	7	19	19	0	58	37	5

Small differences on the order of 5% may be observed when comparing fuel consumption calculated with COPERT 4 with the respective statistical values reported by Eurostat. These deviations may be explained by the difference in the use of gasoline, diesel and LPG vehicles (mainly annual mileage) considered for the calculations and the real-world vehicle use.

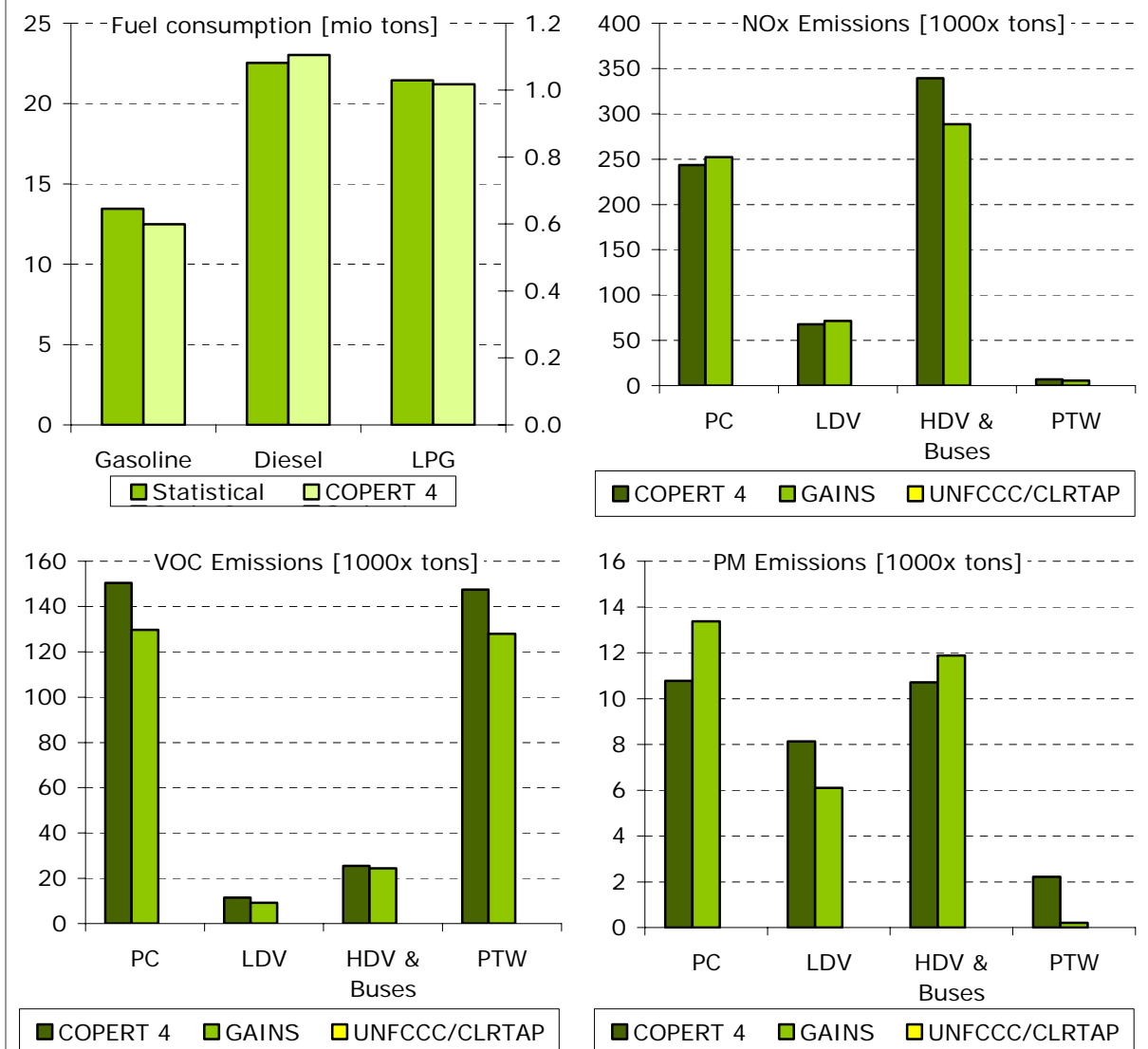
Only total emissions are reported for Italy under UNFCCC/CLRTAP and therefore emissions from vehicle categories are not shown in Figure IT.3 below. It is known that these emissions are calculated with COPERT 3.

Despite the considerable increase in D-PC over the last years, HDV & Buses remain the main source of NOx emissions. Total emissions reported under UNFCCC/CLRTAP are 25% lower than calculated with COPERT 4. This may be explained by the difference in emission factors between COPERT 3 and 4 (an in particular due to HDV EF that were underestimated in COPERT 3).

VOC emissions from PC and in particular G-PC dominate VOC emissions. When comparing total VOC emissions of the entire fleet, differences are lower than 10%.

Due to the high share of D-PC in the Italian fleet, PM emissions from PC are of the same order of magnitude as from HDV & Buses. Small differences between PM emissions calculated with COPERT 4 and those reported by GAINS may be observed for the main vehicle categories; however, total PM emissions are almost identical.

Figure IT.3: Results of the calculations with COPERT 4 and the updated fleets compared to other sources



Our main data source for compiling the road transport tables for Lithuania was the COPERT III database sent us by the national expert of the country. The referring year of these data aren't included in the document – the numerical values (in comparison with Eurostat) show that it is the database of 2006.

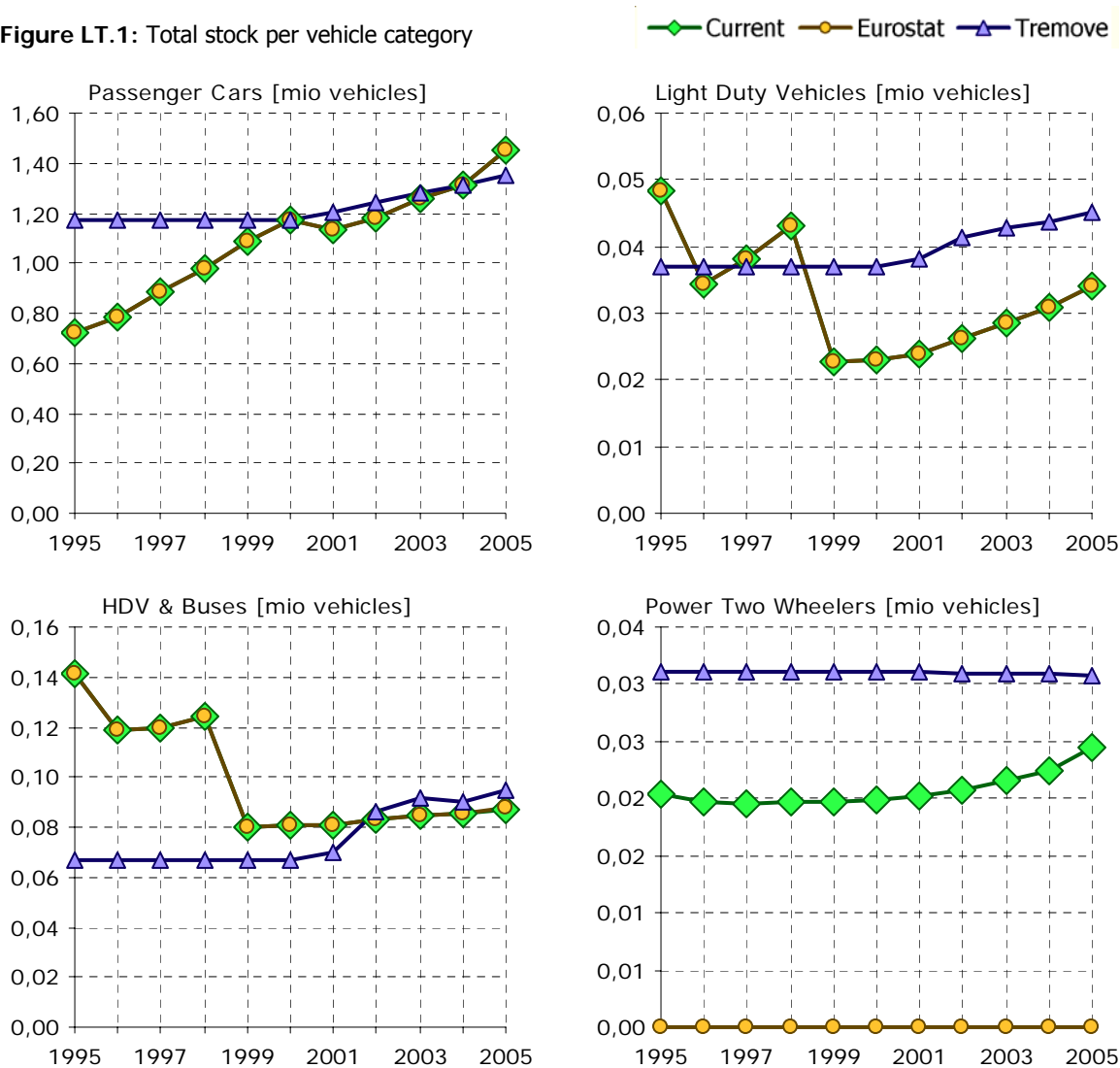
This national document contains data about the road vehicle stock, the characteristic speed and annual mileage values on urban, rural roads and motorways for each vehicle class in COPERT III. However, 40% of the total information had to be calculated, split as 41% of total population, 33% of new registrations and 45% of deregistrations.

The amount of heavy duty lorries and road tractors by the weight class distribution required in COPERT IV is produced by the method described also in the case of Estonia or Slovakia. Eurostat provides load capacity data classes for Lithuania, also on the basis of these amounts the classification into the required weight classes can be made more precious (but there are in some cases serious gaps, e. g. in case of classification into light and heavy duty vehicles).

The data sources available for us don't show any data about the amount of mopeds or two-stroke cars.

Since in the COPERT III database there are no data about weights class of buses, so this needed some approximation: knowing the seat capacity of an average solo and articulated bus, the quotient of total bus seat capacity and bus stock (Eurostat data, from them you get the seat capacity of an average bus), and the same data for a country where the exact solo-articulated ratio is also given, like Hungary, then one can estimate this ratio also for Lithuania.

Figure LT.1: Total stock per vehicle category

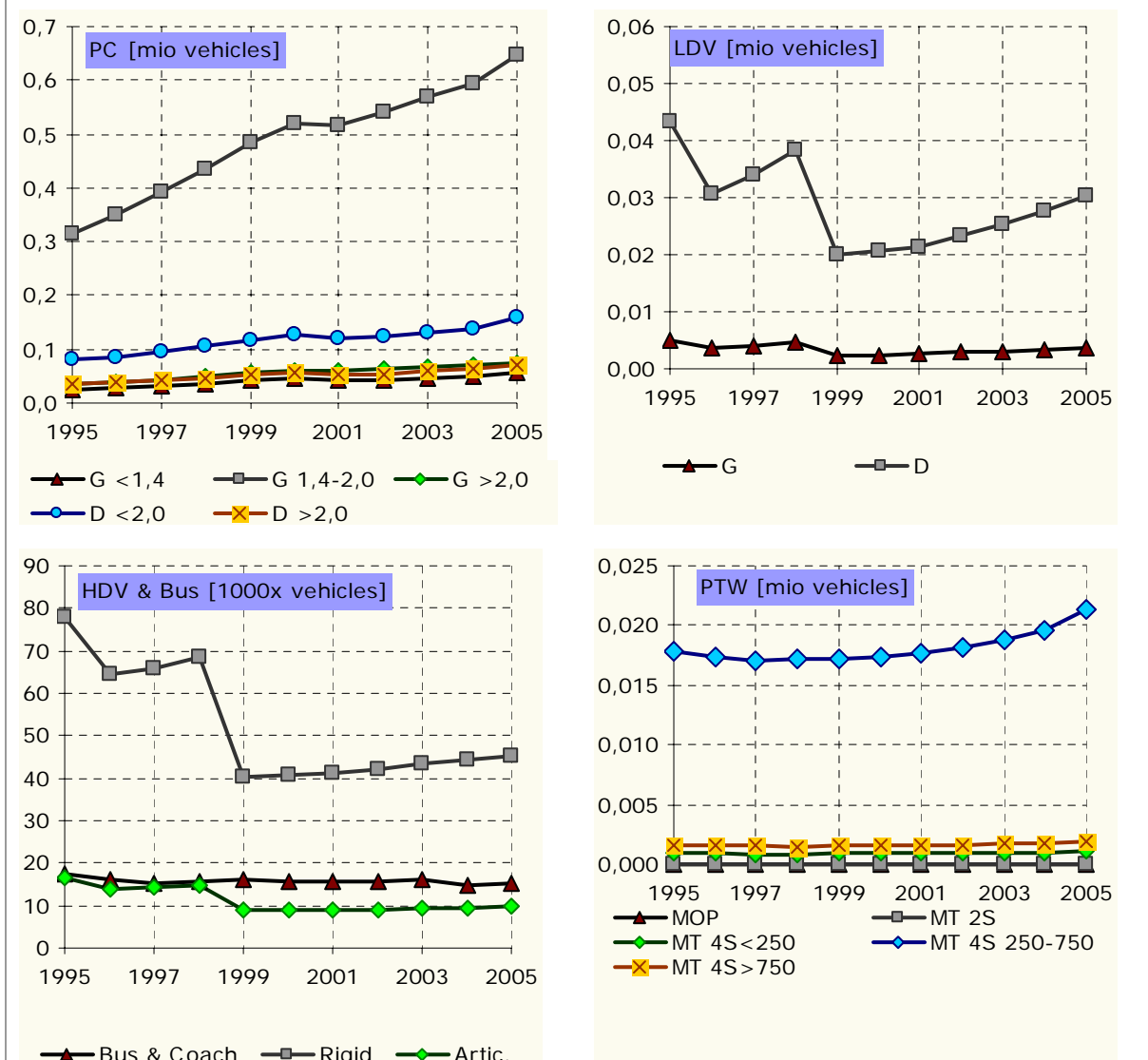


It is unclarified, where the exact passenger car subclass data for the years before 2006 derive from. Such data are not provided by the Eurostat nor other international available sources. I gave the fleet data for the previous year 2005, with the available vehicle class data (Eurostat and so on) and the same subclass distribution as in 2006. The environmental technology classification was taken into account as if all new vehicles would have been of the newest operative Euro-class and all deleted cars of the oldest one. The previous years' data (before 2005) also seem to be a very schematic extrapolation of these ones; but in this way, any exact conclusion for tendency can't be taken.

On the basis of the ratios in 2005 (they are nearest to the exact data of 2006) you can take some relevant conclusions:

- the main part of passenger cars' stock is petrol fuelled and has a displacement of 1,4...2 litres;
- also the diesel passenger cars have an important part in the stock, mainly under 2 litres (but this stock is much smaller than the previous one);
- the light duty lorries are far mostly diesel fuelled.
- The most frequent motorcycles are of a displacement of 250...750 cm³, only a very small fraction have a smaller engine than 250 cm³ or a two-stroke engine. There is no data for mopeds in Lithuania.

Figure LT.2: Evolution of vehicle type population per subsector



Country: **LITHUANIA**

LT3/4

Since the method for years before 2006 for which we didn't have any environmental technology classification data for vehicles, these tables don't show any certain information on the trends in road transportation in Lithuania.

The main thing you can observe in *Table LT.2* in case of 2005 (it is nearest to 2006) is the high average age of the most vehicle categories. Light duty lorries and especially diesel passenger cars have a relative lower age, so they conduce in this respect less to the air pollution.

Table LT.1: Implementation matrix (introduction of technologies per year)

Cat.	G-PC			D-PC			G-LDV				D-LDV				BUS			HDT			PTW		
	Euro	2	3	4	2	3	4	1	2	3	4	1	2	3	4	II	III	IV	II	III	IV	I	II
2000	100	0	0	100	0	0	47	53	0	0	58	42	0	0	100	0	0	100	0	0	100	0	0
2001	96	4	0	67	33	0	22	24	54	0	32	30	38	0	0	100	0	0	100	0	100	0	0
2002	97	3	0	73	27	0	23	24	53	0	51	23	26	0	0	100	0	0	100	0	100	0	0
2003	97	3	0	75	25	0	27	23	50	0	59	21	20	0	0	100	0	0	100	0	100	0	0
2004	97	3	0	74	26	0	29	24	48	0	69	14	17	0	0	100	0	0	100	0	100	0	0
2005	98	2	0	78	22	0	21	26	53	0	40	28	30	2	0	86	14	0	81	19	100	0	0

Table LT.2: Technology mix of the stock per subsector per year

Cat.	G-PC					D-PC					G-LDV					D-LDV					BUS					HDT					PTW		
	Euro	C	1	2	3	4	C	1	2	3	4	C	1	2	3	4	C	1	2	3	4	C	I	II	III	IV	C	I	II	III	IV	C	I
2000	88	11	1	0	0	67	23	10	0	0	87	9	4	0	0	81	14	5	0	0	80	9	11	0	0	79	10	11	0	0	98	2	0
2001	86	12	1	0	0	59	27	12	1	0	79	10	6	5	0	75	15	7	3	0	79	8	11	1	0	78	9	11	1	0	97	3	0
2002	85	14	1	0	0	54	30	14	2	0	73	11	8	9	0	70	16	8	5	0	79	8	11	3	0	79	8	10	3	0	96	4	0
2003	84	15	2	0	0	50	32	15	3	0	68	11	9	12	0	66	17	10	7	0	78	8	10	4	0	79	7	10	4	0	95	5	0
2004	83	16	2	0	0	47	34	16	3	0	64	12	10	15	0	63	17	11	9	0	76	8	11	5	0	80	6	9	5	0	94	6	0
2005	81	17	2	0	0	45	34	17	4	0	60	12	10	18	0	61	17	11	10	0	74	8	10	7	1	80	5	8	6	0	94	6	0

The fuel consumption data by several sources show such differences as in case of other countries. Also the occurring problems are discussed in the report of other countries in our responsibility, which can cause the discrepancies (uncertainties in approximation of vehicle movements and stock compound, errors in the applied model). Also the international traffic has an important effect in case of such a small country as Lithuania.

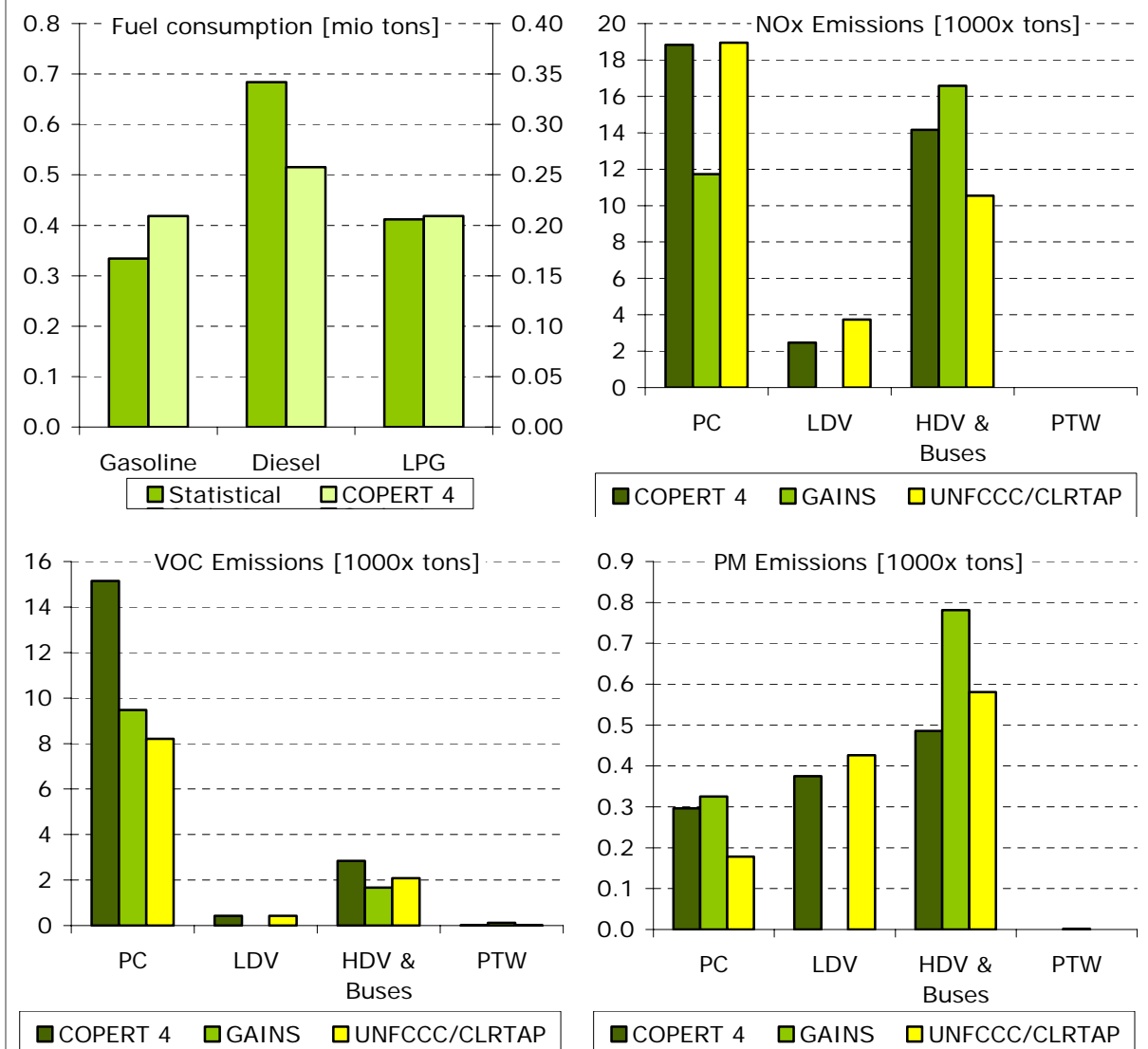
Th LPG consumption measured by filling stations checks up with the one computed from the COPERT model. It can be a result of the exact calculation but it can be also an accidental coincidence.

Unfortunately, the air pollutant gases' emission can't be evaluated very exactly since the assumption for the vehicle fleet in 2005 by environmental technology aspect detailed previously.

On the whole, the main polluting sources can be seen also in the charts below, and they show a similar figure as in case of other countries. The most problematic vehicles are the petrol fuelled passenger cars (VOC, NO_x) and especially the heavy duty lorries (NO_x, PM). There are also many petrol fuelled big Russian lorries, also they take a part in emissions. Motorcycles have practically no role in national pollutant emissions.

Naturally, when one have to make decisions and to set the main courses related to reducing air pollution from road traffic, you have also take the local emission–immission effects into consideration.

Figure LT.3: Results of the calculations with COPERT 4 and the updated fleets compared to other sources



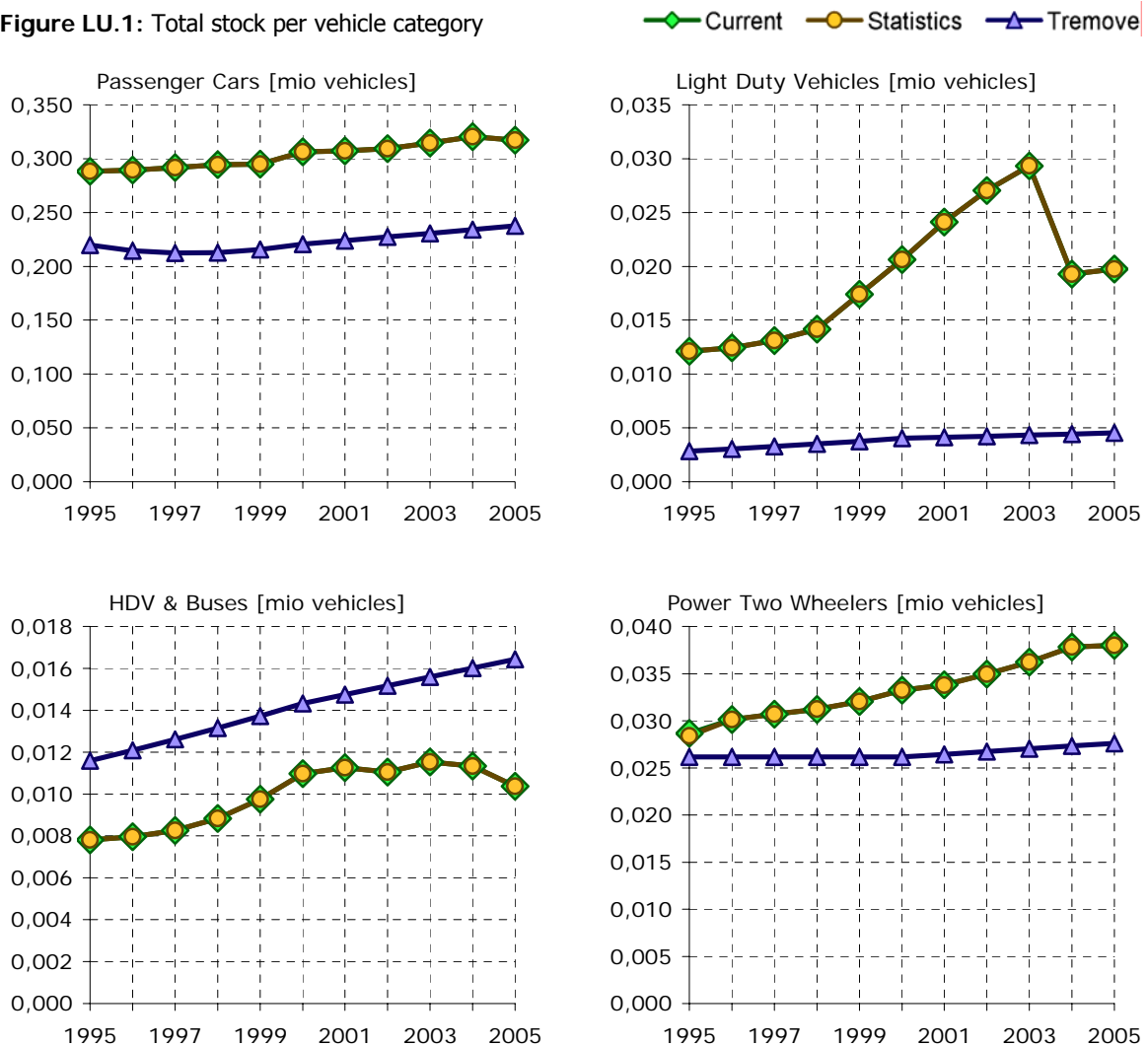
The following were the main sources of information:

- Ministry of environment: Population (1990-2005)
- Eurostat: fuel data 1985-2004, new registrations, passenger cars, motorbikes (1979-2004)
- Central database of the European Commission: new registrations of passenger cars (2002-2006)
- ANFAC Car Park Report: passenger cars, commercial vehicles, buses (2001/02-2006)

The total fleet and the distinction to categories and types should be considered reliable as it originates from updated official databases. The total missing data were 26% split into 3% of the total stock, 29% of new registrations and 47% of deregistrations

The main data missing were the subsectors, data on small urban buses and 2 stroke motorcycles. Only a very limited number of years was made available. The number of passenger cars increased by 10% between 1995 and 2005. A remarkable growth rate can be observed for the LDV's peaking with almost 300.000 vehicles in 2003 having due to this almost the same fleet size as the passenger cars. After 2003 the LDV fleet decreases by 100.000 vehicles. Among other reasons the scarcely available number of years and the overall small fleet could be the reason for this development although it is likely that basic taxation or statistic issues changed in Luxembourg and lead to this development. The number of HDV & Buses and PTW's increased by 33% between 1995 to 2005.

Figure LU.1: Total stock per vehicle category



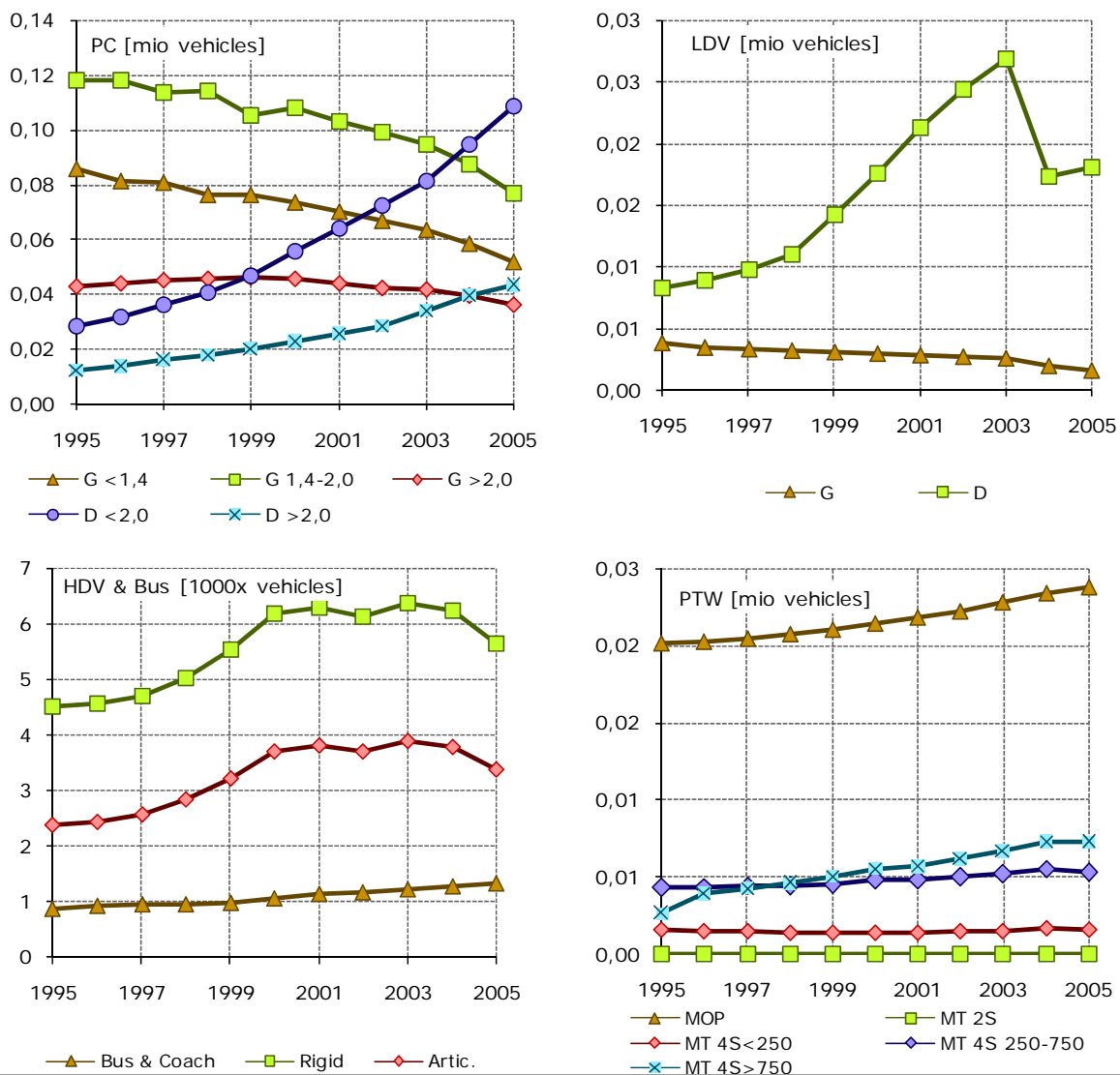
The passenger car fleet is dominated by G-PC falling in all engine capacity classes while the D-PC increased largely between 1995-2005. The share of G-PC diminished from 86% in 1995 to 52% while the D-PC augmented from 14% in 1995 to 48%.

The number of G-LDV's decreased constantly and accounts for 8% in 2005. The D-LDV development mirrors the development shown in Figure LU.1.

The development of rigid and articulated vehicles mirror each other and are showing a growth rate of 33% but still having a very low share (3% in 2005). Buses & coaches increased by 52% at very low share (<1%) in comparison with the total vehicle stock.

Within the PTW category the highest share is with mopeds (63% in 2005) having a intermediate growth rate of 18%. Data on 2stroke motorcycles is not available. The highest growth rates can be observed for large motorcycles in particular for the one with an engine capacity >750cm³.

Figure LU.2: Evolution of vehicle type population per subsector



Country: **LUXEMBOURG**

LU3/4

The implementation matrix reveals that no passenger car with the Euro 4 technology entered the Luxembourg market in 2005. In general, the implementation matrix largely follows the implementation dates considered by the regulations. A remarkable development can be identified within the LDV vehicles. Euro 1 or earlier technologies are introduced over a longer period of time if compared to other countries. In addition Euro 2 new registrations disappear completely in 2003 leaving only the Euro 1 and Euro 3 technology for LDV's.

The technology mix in Luxembourg (Table LU.2) shows that half of the G-LDV is comprised of non-catalyst cars, followed by Euro 3/2 G-LDV accounting together for 39%. The development of D-LDV shows almost a reversed technology mix. Here the majority of the fleet fulfils Euro 3 and 24% Euro 2 standards. Within the passenger cars the relatively high share (14%) of non catalyst G-PC is remarkable as well as the high share (72%) of Euro 3 D-PC.

Table LU.1: Implementation matrix (introduction of technologies per year)

Cat.	G-PC			D-PC			G-LDV				D-LDV				BUS			HDT			PTW	
	2	3	4	2	3	4	1	2	3	4	1	2	3	4	II	III	IV	II	III	IV	I	II
2000	100	0	0	100	0	0	49	51	0	0	45	55	0	0	100	0	0	100	0	0	100	0
2001	100	0	0	100	0	0	43	57	0	0	43	57	0	0	100	0	0	100	0	0	100	0
2002	100	0	0	100	0	0	46	54	0	0	46	54	0	0	100	0	0	100	0	0	47	53
2003	0	100	0	0	100	0	21	0	79	0	20	0	80	0	0	100	0	0	100	0	0	100
2004	0	100	0	0	100	0	0	0	100	0	0	0	100	0	0	100	0	0	100	0	0	100
2005	0	100	0	0	100	0	0	0	100	0	0	0	100	0	0	100	0	0	100	0	0	100

Table LU.2: Technology mix of the stock per subsector per year

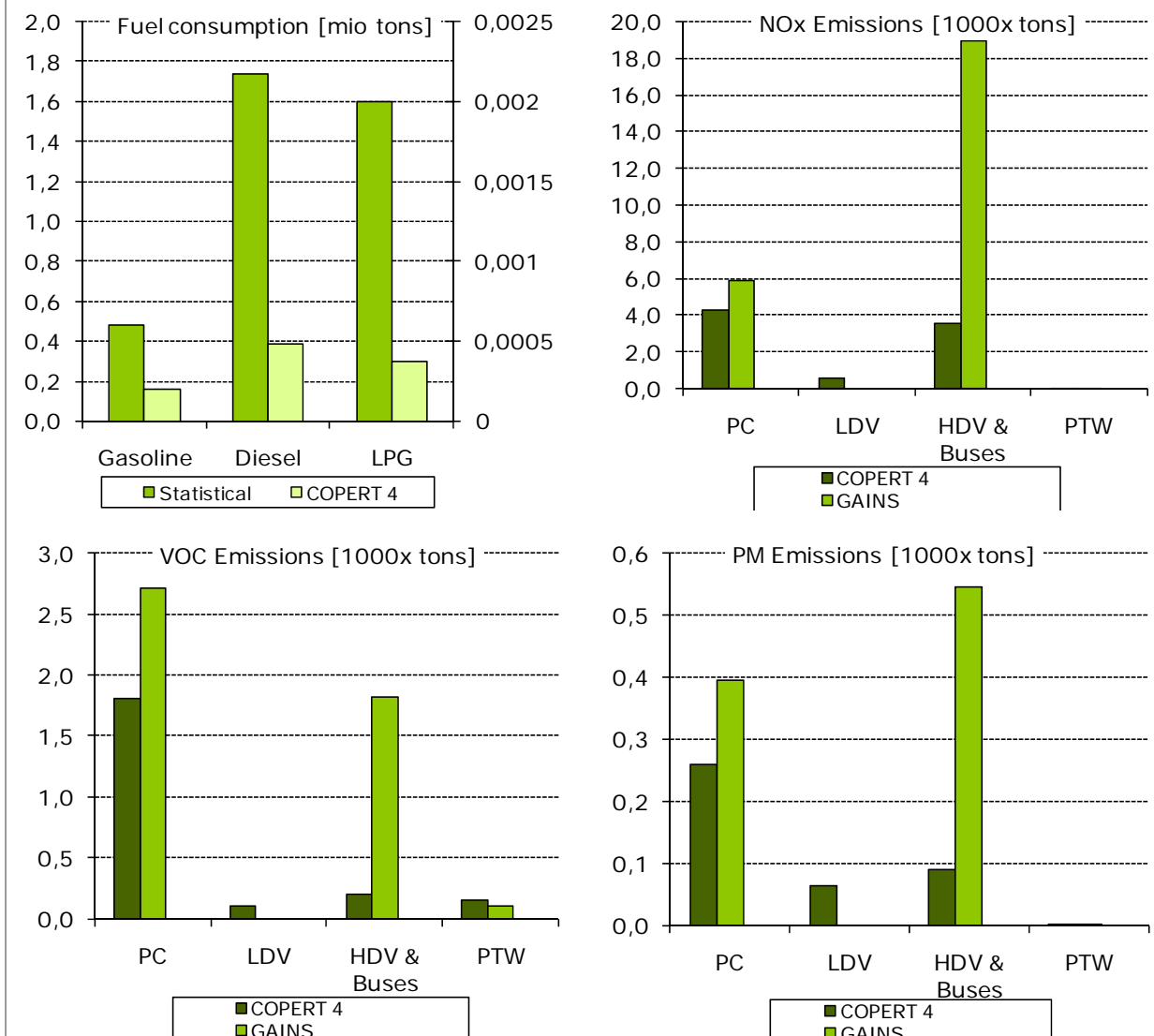
Cat.	G-PC					D-PC					G-LDV					D-LDV					BUS					HDT					PTW		
	C	1	2	3	4	C	1	2	3	4	C	1	2	3	4	C	1	2	3	4	C	I	II	III	IV	C	I	II	III	IV	C	I	II
2000	29	37	34	0	0	14	20	65	0	0	66	25	9	0	0	24	50	26	0	0	37	19	45	0	0	32	13	55	0	0	75	25	0
2001	25	35	40	0	0	11	15	74	0	0	61	28	11	0	0	17	50	33	0	0	29	17	55	0	0	27	11	62	0	0	68	32	0
2002	22	33	45	0	0	8	12	80	0	0	56	31	13	0	0	14	50	36	0	0	25	15	60	0	0	26	10	64	0	0	59	35	6
2003	19	29	37	15	0	6	9	41	44	0	50	33	12	5	0	11	50	21	19	0	19	13	49	19	0	22	9	44	26	0	51	33	16
2004	16	26	35	23	0	4	6	30	60	0	54	23	15	8	0	13	18	29	40	0	15	11	44	29	0	19	7	36	38	0	44	29	27
2005	14	23	32	31	0	3	5	21	72	0	50	22	17	12	0	10	14	24	52	0	11	9	39	41	0	18	7	31	45	0	38	27	34

Regarding fuel consumption values, the COPERT and Eurostat data show large differences in particular for diesel vehicles differing by about 1,1 mio. tons. The fuel consumption of LPG differs by one order of magnitude. This is a well known problem for Luxembourg where tank tourism is a very significant issue regarding the fuel balance. Therefore, the large differences should not be considered an issue that needs to be resolved.

For the emissions no data from UNFCCC/CLRTAP is available for Luxembourg. Depending on the sources the largest emitter in Luxembourg are either HDV's or passenger cars. For HDV and busses the Gains value shows a high difference if compared to the COPERT value. This large gap between the sources is because Gains is based on the statistical fuel consumption to estimate emissions while our results are based on the calculated fuel consumption.

The values for passenger cars differ as well but not to the same extent as the values for HDV's & Buses. This could be due to the size of the country as small data sets are more vulnerable to show large differences due to the different assumptions made by COPERT and Gains.

Figure LU.3: Results of the calculations with COPERT 4 and the updated fleets compared to other sources



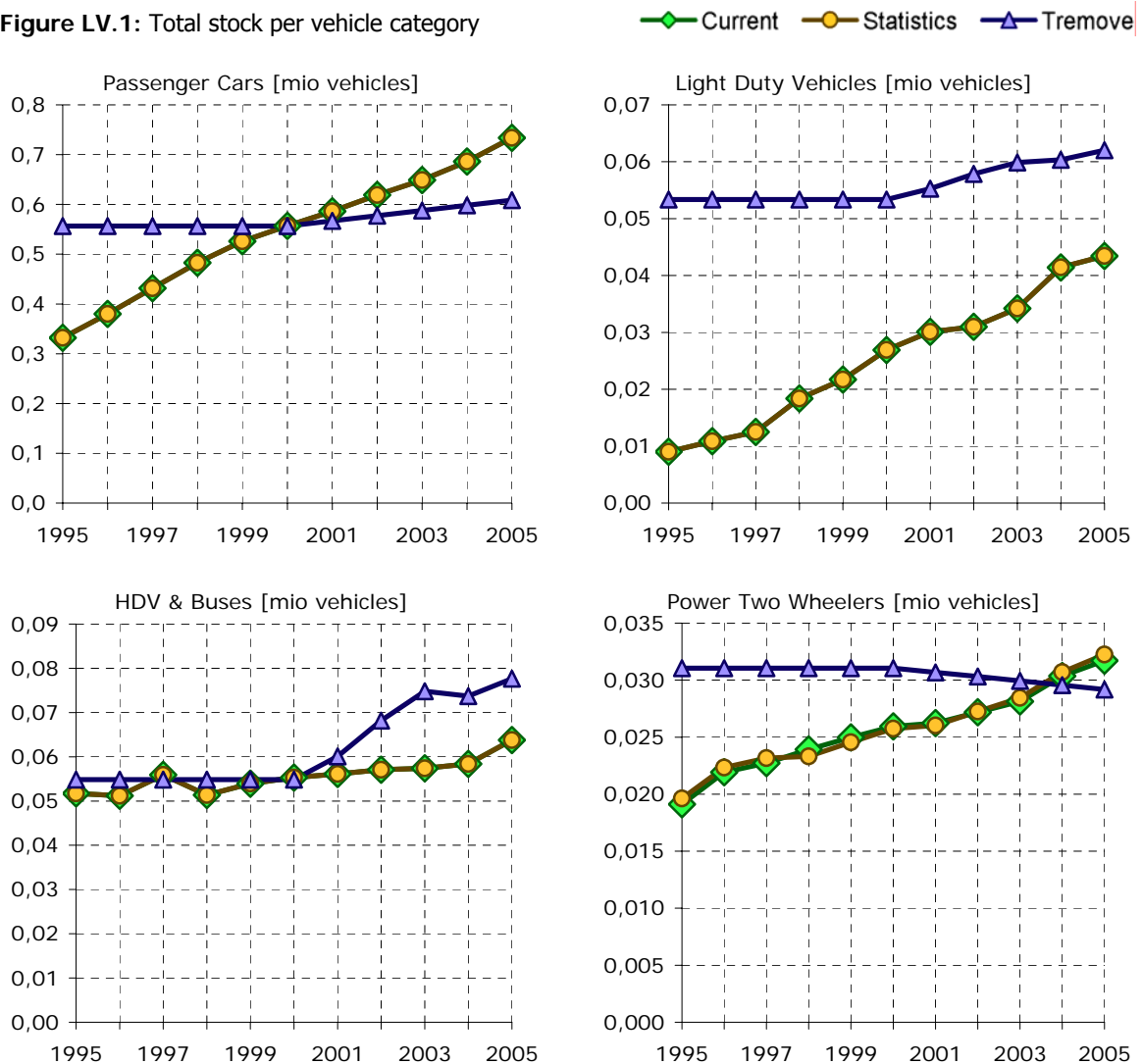
The Latvian road transport database was produced by the national expert, these tables can be transmitted in an unchanged form. The expert had to choose a method to systematize the available data for Latvia, since there are many gaps in the official dataset, mainly for the older periods (e.g. piston displacement, weight class distributions miss from the prior official datasets). These official datasets were namely during the former years under formation.

This is the reason that many of the COPERT data are based on a very strong assumption. As a result, only 19% of the total information had to be calculated, allocated to 0% of the total fleet, 25% of new registrations to 32% of deregistrations.

The further speciality for this COPERT database is that the amount of vehicles mean always the amount of vehicles in technical use – there are much more registered vehicles in the country (approximate ratio for vehicles in technical use compared to registered ones is in case of passenger cars 50...60%, goods vehicles 40...50%, buses 20...30%, motorcycles 80...90%, and these ratios don't show any regular tendency in function of years). It can be also a consequence of inadequate registry in the former periods on the score of registration and cancellation of vehicles.

The database reported by the Latvian expert contains also all of the other required data for mileage shares, speeds, loads and some technical solutions related to evaporation emissions.

Figure LV.1: Total stock per vehicle category



As mentioned above, some of the information detailing the vehicle classes into subclasses are based on approaches, but the main tendencies are naturally known by the national experts, so the charts are appropriate to draw conclusions.

According to the first chart below, the amount of passenger cars climbed first of all by growing of medium-sized petrol car stock in the period 1995-2005. Also growing of large category gasoline cars was notable. There is a certain part of diesel vehicles in passenger cars' fleet, their share is about 20%, and it shows a slight increase during the studied years.

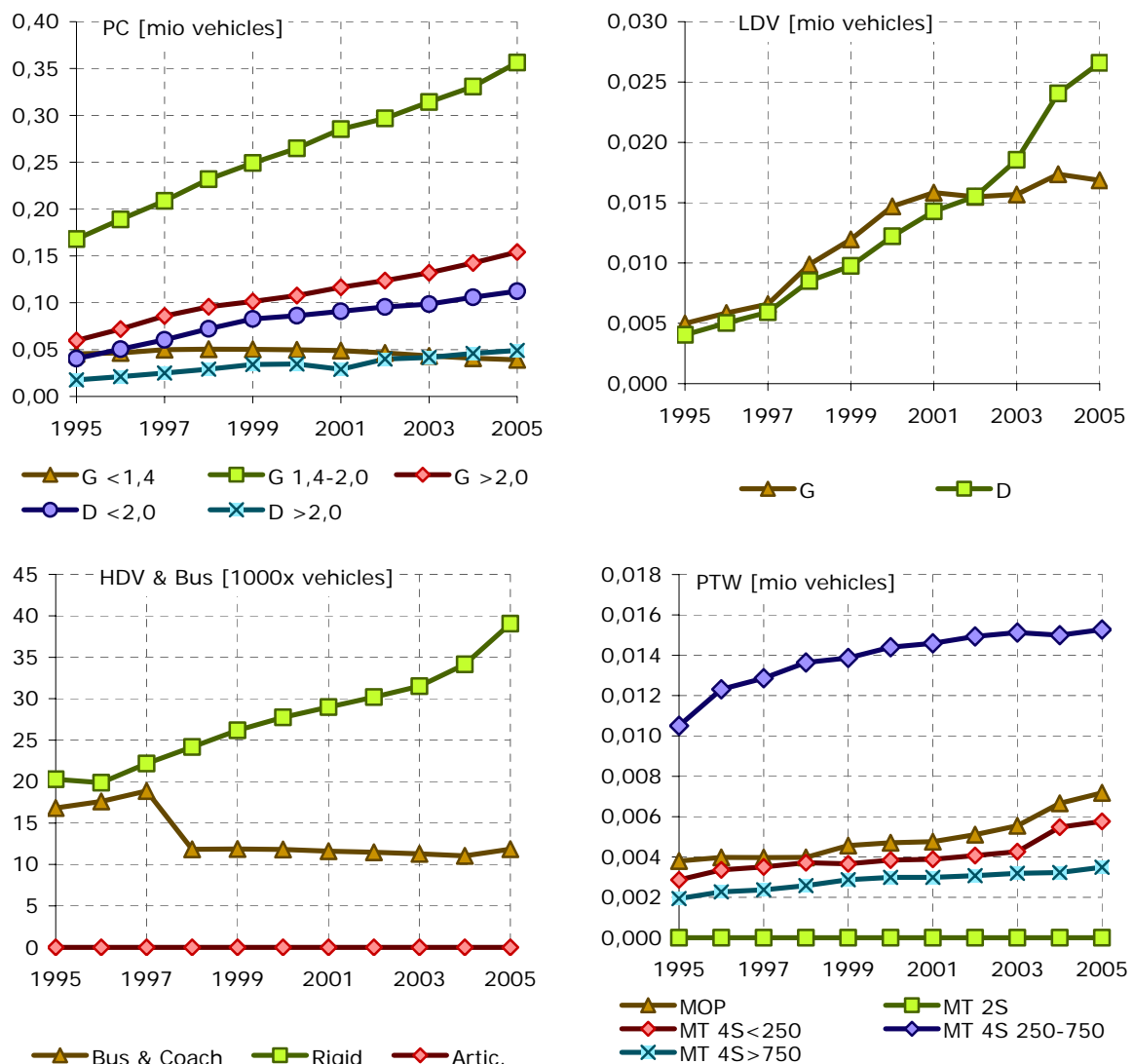
In contrast to this, in case of light duty vehicles, from the beginning of the III. millennium, the share of diesel engined vehicles shows an intensive rising tendency while gasoline fuelled light duty lorries remain at an approximately constant level.

Also the amount of heavy duty trucks climbed up at a similar rate as previous vehicles.

In contrast to these, in the period 1997-98 the buses fell off in a large measure then the bus fleet remained nearly constant probably due to the stabilized public transport demand.

In Latvia the medium-sized motorcycles are far the most preferred under the two-wheelers, and the biggest motorcycles have a notable share, while there are relatively much fewer mopeds than in general in Europe (it is caused probably by the climatic conditions).

Figure LV.2: Evolution of vehicle type population per category



Country: **LATVIA**

LV3/4

Table LV.1 below informs you of the environmental technology distribution of vehicles registered during the years. In order to see the complete Euro-category distribution for vehicles registered in the period, one should give a look over the whole stock table in the Excel file in order to see that basically there was no remarkable amount of registrations among very old used vehicles as Euro 0 or 1 (or the table should be completed with these categories).

From these data one can conclude that most of the newest vehicles were registered among the petrol fuelled light duty lorries and buses, while among passenger cars a larger amount of used vehicles were imported into Latvia.

In *Table LV.2* one can see the environmental technology distribution of the vehicle stock at the end of the years. The distribution matches to the general expectation for the other Baltic countries too.

Also this table gives the information that the renewal of vehicle stock was the strongest in case of light duty vehicles. Since a lot of old passenger cars were deregistered from the fleet, thus their fleet became younger, but there are just relatively few new cars (in coherence with the ascertainment above).

The fluctuation in age of heavy duty trucks and even more of buses must have been the lowest, since nevertheless most of the actually registered vehicles were new, yet the whole stock remained rather old.

In case of motorcycles there are not too many emission classes, but on the basis of the numbers of the table tells, that the fluctuation of motorcycles was very low in the period 2000-2005.

Table LV.1: Implementation matrix (introduction of technologies per year)

Cat.	G-PC			D-PC			G-LDV				D-LDV				BUS			HDT			PTW	
	2	3	4	2	3	4	1	2	3	4	1	2	3	4	II	III	IV	II	III	IV	I	II
2000	54	46	0	54	46	0	31	39	30	0	24	42	34	0	26	74	0	25	75	0	95	5
2001	45	55	0	47	53	0	0	39	61	0	20	34	46	0	6	94	0	29	71	0	83	17
2002	41	59	0	42	58	0	0	0	100	0	28	23	49	0	16	84	0	42	58	0	52	48
2003	36	64	0	25	75	0	9	13	79	0	20	27	54	0	17	83	0	46	54	0	53	47
2004	43	57	0	49	51	0	17	22	61	0	22	30	48	0	19	81	0	29	71	0	58	42
2005	34	25	41	35	27	38	0	3	12	85	15	38	47	0	5	14	81	38	0	62	60	40

Table LV.2: Technology mix of the stock per subsector per year

Cat.	G-PC					D-PC					G-LDV					D-LDV					BUS					HDT					PTW		
	C	1	2	3	4	C	1	2	3	4	C	1	2	3	4	C	1	2	3	4	C	I	II	III	IV	C	I	II	III	IV	C	I	II
2000	81	11	6	2	0	81	11	6	2	0	48	22	25	5	0	53	17	24	6	0	84	5	7	3	0	80	8	9	3	0	94	5	1
2001	77	14	6	3	0	75	15	7	3	0	44	20	26	10	0	47	17	25	11	0	81	5	7	6	0	76	8	9	6	0	93	6	1
2002	71	16	8	5	0	71	16	8	5	0	40	19	25	15	0	43	18	25	15	0	76	6	8	11	0	72	9	11	8	0	92	7	1
2003	63	20	9	7	0	66	18	8	7	0	35	18	25	21	0	36	18	25	21	0	74	6	9	12	0	66	10	13	11	0	91	7	2
2004	46	31	12	11	0	47	31	12	11	0	31	18	25	25	0	30	18	25	26	0	58	10	11	21	0	56	11	16	18	0	89	8	3
2005	42	27	14	13	4	42	27	14	13	4	26	17	25	26	6	27	18	27	28	0	58	10	10	19	3	52	11	17	16	4	88	8	4

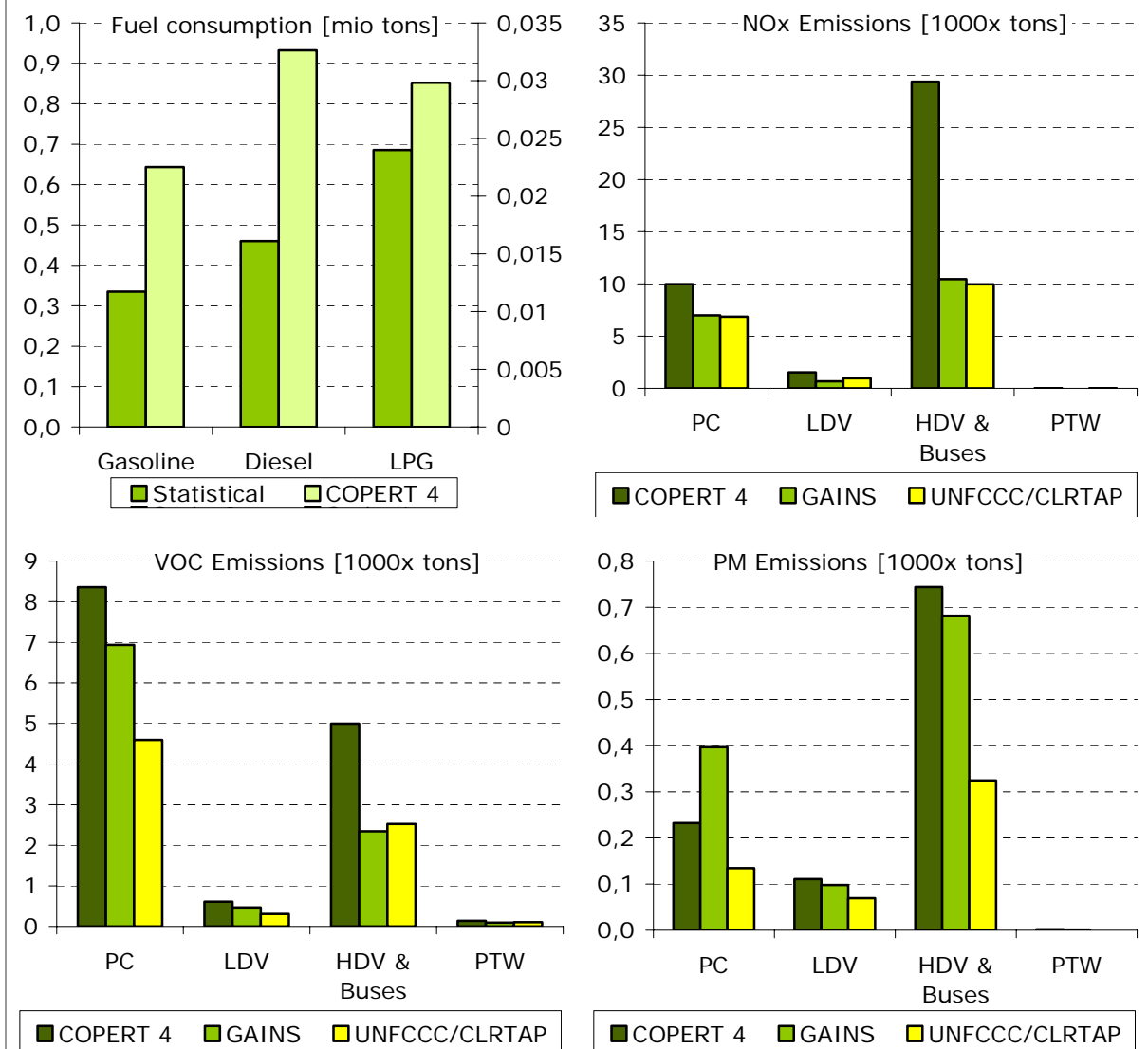
As *Fuel consumption* chart shows, there was only a relative minor LPG consumption for road transport purposes in Latvia in the year 2005 (but the scaling method of this chart is rather deceptive!).

There is a difference in petrol and diesel oil consumption between the Eurostat road transport fuel consumption data and the COPERT IV calculation. It can originate whether in the method of Eurostat (but it can likely effect only a minor error) or in the input data for recent calculation (mostly in mileage, speed and load) and also in the COPERT method gaining fuel consumption data (nominal fuel consumption factors and taking into consideration the affects of other parameters in real traffic like unsteady running, acceleration, but e.g. the truck haulage is also not taken into account).

The difference in air pollutant (NO_x, VOC, PM) emissions among several methods can be also under a similar judgment.

On the basis of available data, in Latvia during 2005 PC-s had an about thrice as big, LDVs a half as big total mileage as HDTs plus buses. Petrol fuelled PC-s took a four times as big total distance as diesel fuelled ones. Naturally there is also a significant difference among the engine power of PC, LDV and HDTs. But in order to understand the relative low role of PC-s and especially of LDVs in air pollutant emissions, you must take into consideration the age distribution for these vehicle classes, which also marks out from the *Table LV.2* in the previous page.

Figure LV.3: Results of the calculations with COPERT 4 and the updated fleets compared to other sources



The main data sources for preparing the Maltese road data tables were

- the National Statistical Yearbook on Transportation (available on the internet) and
- Eurostat data.

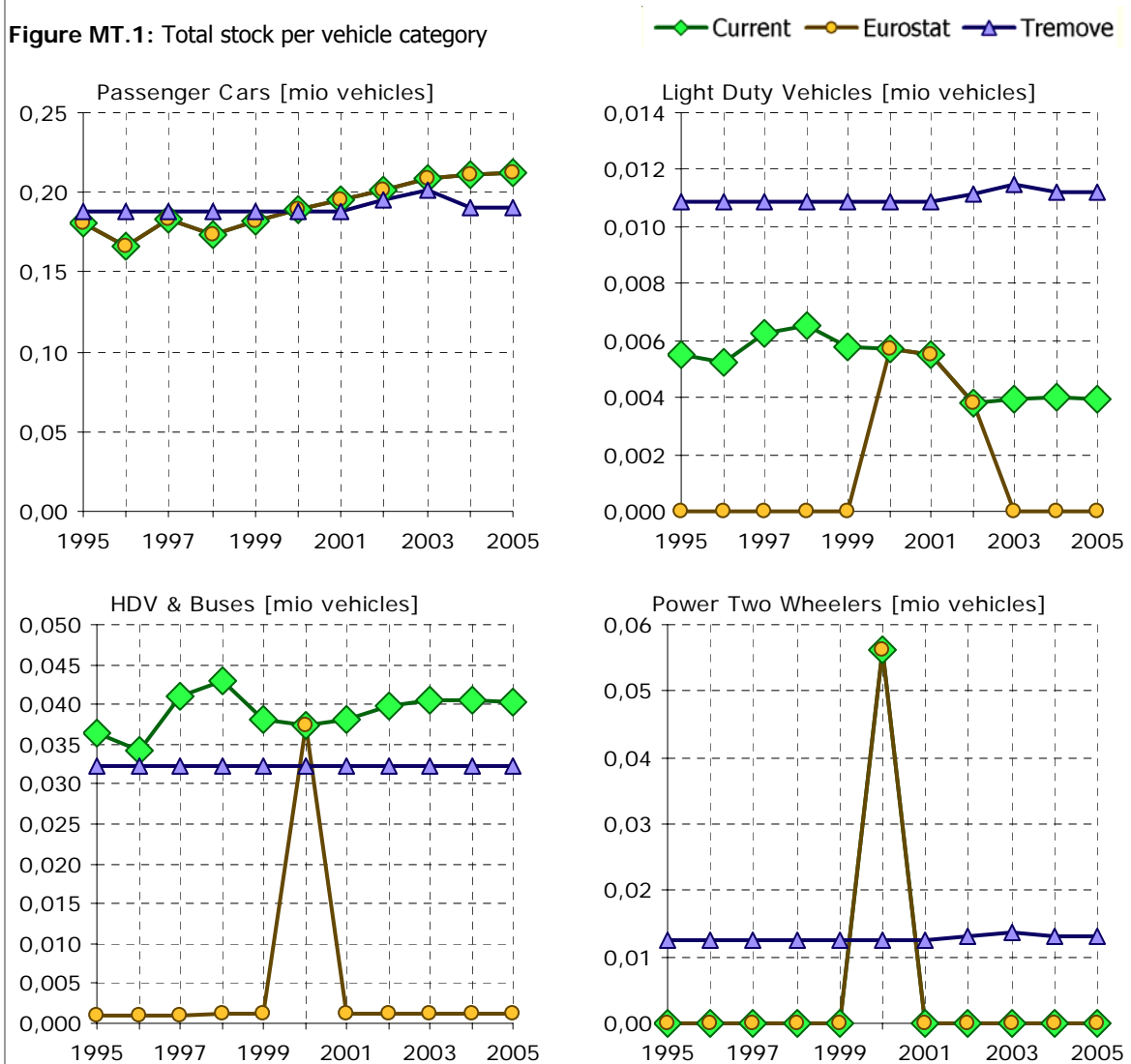
In addition, the 2004 and 2006 issues of International Road Federation yearbook contain some mileage data for the year 2000, for passenger cars and lorries – for other vehicle classes (road tractors, buses and motorcycles) and for all the subclasses the mileage data were produced by the ratios used in case of Poland.

Some further data like speeds, share of canisters and injectors within petrol vehicles, loads – the ratios applied in Hungarian, Polish etc. databases were used as basis. The share of mileage taken by vehicles of all types within inhabited areas was assumed as 50%.

The amount of data missing was 38%, which is allocated to 42% of the total stock, 26% of new registrations and 45% of deregistrations.

Since the stock data in the charts below from several sources are rather inconsistent with each other, one can not draw any exact conclusions is. There is a nearly stable or slightly rising passenger car stock; the amount of light duty vehicles can be estimated as the amount of lorries with a load capacity of maximum 1,5 tons; in case of powered two-wheelers there are data for motorcycles in Eurostat but for mopeds only in the national statistics.

Figure MT.1: Total stock per vehicle category



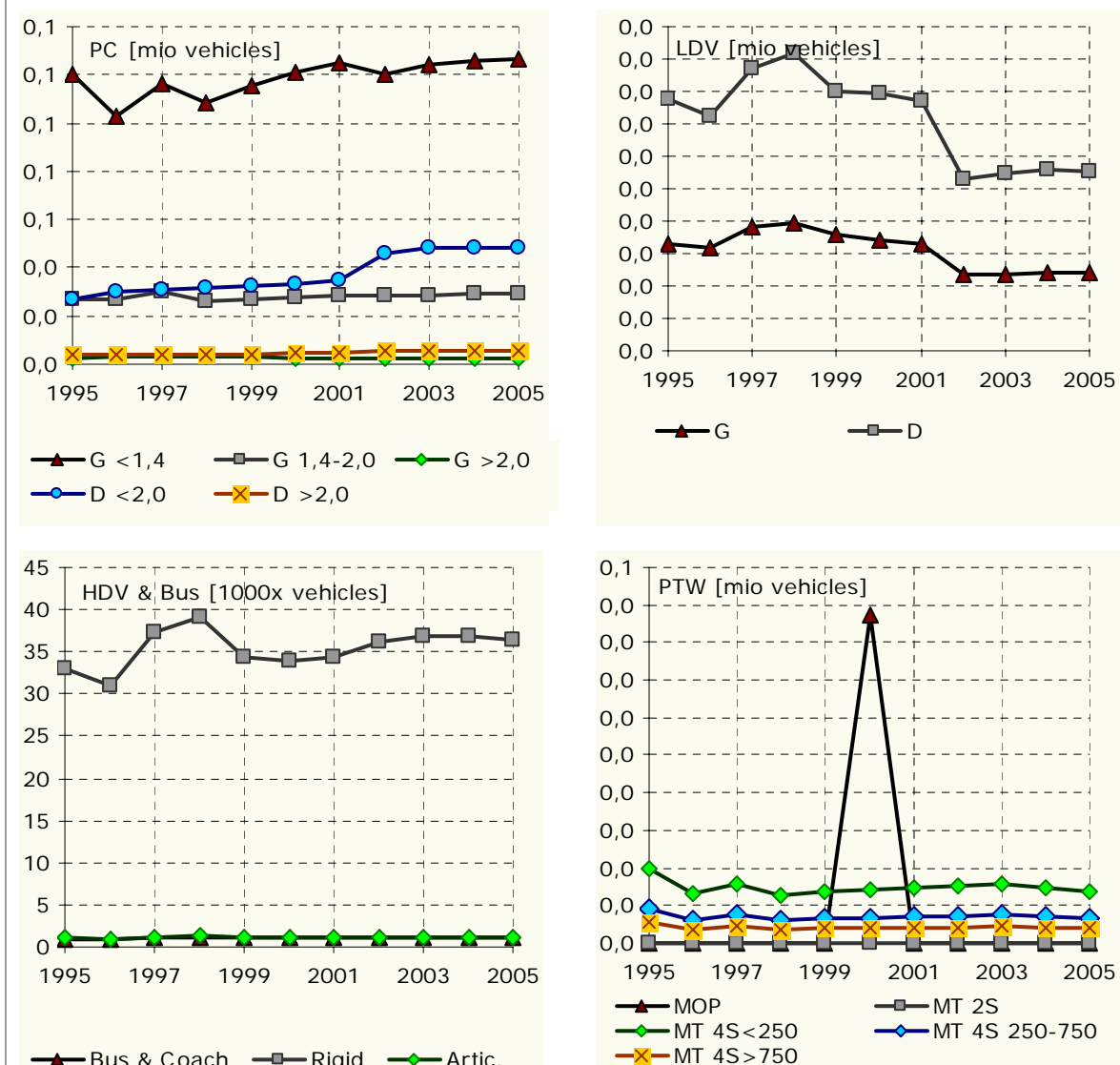
As one can see in the chart of the passenger cars, there are mainly small and medium size category petrol fuelled cars (with less than 1,4 liters piston displacement, and in a less amount with a displacement between 1,4 and 2 liters). There is also a growing number of diesel fuelled cars, with less than 2-litre engines.

There are two times more diesel fuelled light duty vehicles than petrol fuelled ones.

The determinant part of heavy duty trucks' stock is lorry, there are very few road tractors. The bus fleet is not a large one.

In the stock of powered two-wheelers the determinant share consist of mopeds, the motorcycles have a much smaller share, most of them are of the smaller category.

Figure MT.2: Evolution of vehicle type population per subsector



Country: MALTA

MT3/4

The *Table MT.1* below shows the rather simplified principle for the distribution of environmental technologies among new registered vehicles. It shows that the principle is that the new registered vehicle must be always of the newest Euro-class. It would be true when there would be only new vehicles registered in the country, but it is known that in Malta there is a number of old used imported vehicles.

The *Table MT.2* shows the actual distribution of emission classes for the year 2000 (this was our only base year). One can see that the gasoline fuelled light duty vehicles' fleet and the bus fleet were rather old (in Malta, there are buses of an age over 50 year!). The heavy duty trucks and diesel fuelled light duty vehicles were newer, and passenger cars were the most up-to-date in 2000.

It is characteristic that within the latter, diesel cars were older on the average, perhaps there is a larger demand on old, used but yet reliable diesel cars than petrol fuelled ones.

Table MT.1: Implementation matrix (introduction of technologies per year)

Cat.	G-PC			D-PC			G-LDV				D-LDV				BUS			HDT			PTW	
	2	3	4	2	3	4	1	2	3	4	1	2	3	4	II	III	IV	II	III	IV	I	II
2000	100	0	0	100	0	0	0	100	0	0	0	100	0	0	100	0	0	100	0	0	100	0
2001	0	100	0	0	100	0	0	100	0	0	0	100	0	0	100	0	0	100	0	0	100	0
2002	0	100	0	0	100	0	0	0	100	0	0	0	100	0	0	100	0	0	100	0	100	0
2003	0	100	0	0	100	0	0	0	100	0	0	0	100	0	0	100	0	0	100	0	0	100
2004	0	100	0	0	100	0	0	0	100	0	0	0	100	0	0	100	0	0	100	0	0	100
2005	0	100	0	0	100	0	0	0	100	0	0	0	100	0	0	100	0	0	100	0	0	100

Table MT.2: Technology mix of the stock per subsector per year

Cat.	G-PC					D-PC					G-LDV					D-LDV					BUS					HDT					PTW		
	C	1	2	3	4	C	1	2	3	4	C	1	2	3	4	C	1	2	3	4	C	I	II	III	IV	C	I	II	III	IV	C	I	II
2000	26	46	28	0	0	41	42	16	0	0	87	7	6	0	0	59	13	28	0	0	82	13	5	0	0	59	13	28	0	0	56	44	0
2001	23	43	27	7	0	33	39	15	12	0	85	7	8	0	0	52	13	36	0	0	81	12	7	0	0	54	12	34	0	0	74	26	0
2002	20	39	27	14	0	21	28	12	39	0	77	9	11	2	0	22	17	50	10	0	78	12	7	3	0	51	11	32	7	0	66	34	0
2003	17	36	25	21	0	17	26	11	46	0	76	9	11	5	0	16	16	47	21	0	75	12	6	7	0	47	10	30	13	0	60	32	8
2004	15	34	24	27	0	15	24	10	51	0	75	8	10	7	0	11	14	44	30	0	72	11	6	10	0	44	9	29	19	0	49	34	18
2005	13	30	22	34	0	13	22	10	55	0	74	7	10	9	0	4	13	43	40	0	69	11	6	14	0	40	8	27	25	0	37	35	28

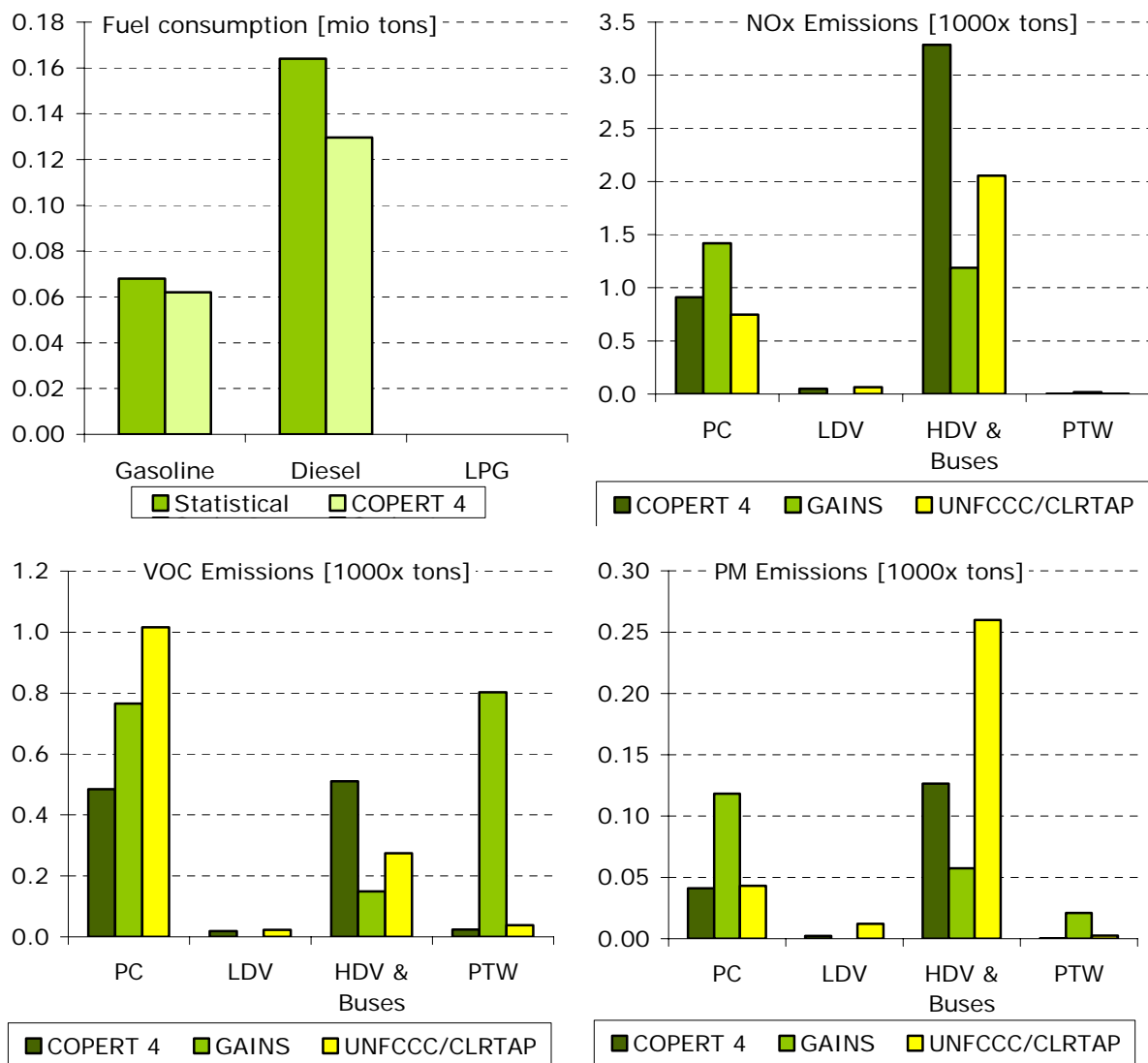
In Malta, there is no LPG consumption for transportation purposes. The ratio of diesel–petrol consumption is relative high compared to other countries in the EU. It can be anyway a consequence of the fuel supply on an island. The average mileage of Maltese vehicles values are much less than in other countries due to the small size of this island.

The total mileage values for Maltese vehicles by our own computations are for petrol PC-s 1020, for diesel PC-s 490, petrol LDV-s 11.7, diesel LDV-s 44, petrol HDT-s 19, diesel HDT-s 490, buses 18.4 and for MC-s 86 million vehicle-km. (Other data sources e. g. Eurostat don't contain any analog data.) Naturally the general differences among the nominal power and the average power demand of each vehicle class as well the age distributions must be taken into account in order to estimate the air pollutant emissions of them.

By this computation method, it is a specialty for Malta that the main pollutant sources for each exhaust components are the passenger cars, heavy duty trucks and buses, while light duty vehicles and motorcycles have almost no function in air polluting emissions.

There are yet very hard differences between several data sources: e. g. by GAINS motorcycles play a very serious part in the emission of volatile organic compounds (while by our COPERT IV they have almost no role in this).

Figure MT.3: Results of the calculations with COPERT 4 and the updated fleets compared to other sources

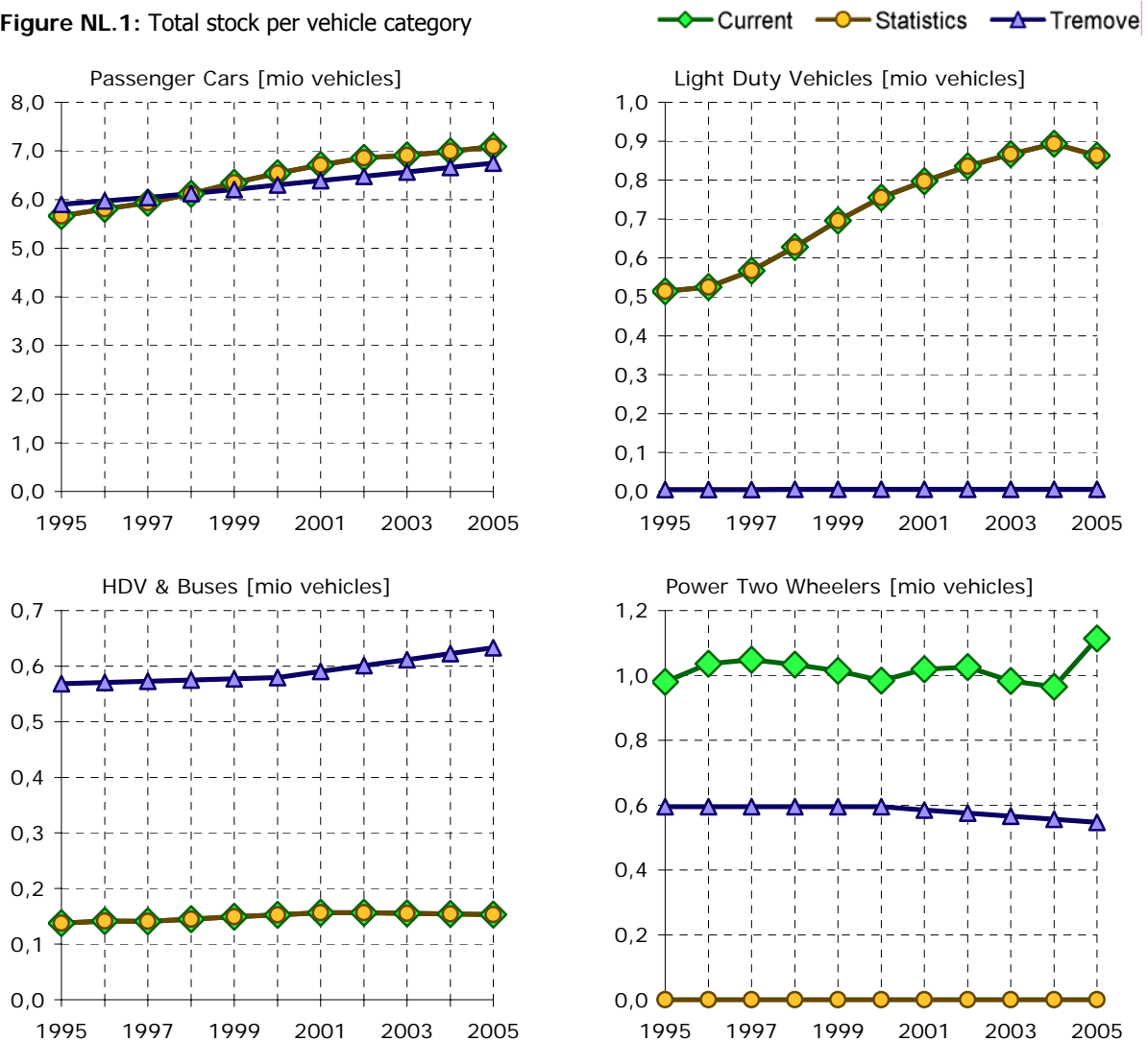


The following were the main sources of information:

- Netherlands Environmental Assessment Agency: population, pop. by age, total veh. km mileage, (2004 & 2005)
- Eurostat: fuel data (1985-1994), new registrations for motorcycles, passenger cars (mainly 79-04), population buses (mainly 1979-2004)
- Other sources included ANFAC Car Park Report, ACEA, Central database of the European Commission for new M1's

The missing information was 34%, distinguished into 25% of the total population, 30% of new registrations and 49% of deregistrations. The main information missing was distinction of engine capacity and weight classification for most vehicle categories. Only a very limited number of years was made available. Still, the total fleet and the distinction to categories and types should be considered reliable as it originates from updated official databases. The number of passenger cars increased by 25%, while the number of LDV increased by 68% augmenting their share from 7% in 1995 to 9% in 2005. HDV's & buses increased only slightly by 11% and PTW by 14%. The largest raise in the PTW fleet can be observed between 2004 and 2005 where 149.000 more vehicles are suddenly part of the fleet in 2005 in contrast to 2004. In general the number of PTW is considerably high in comparison to other central/northern European countries.

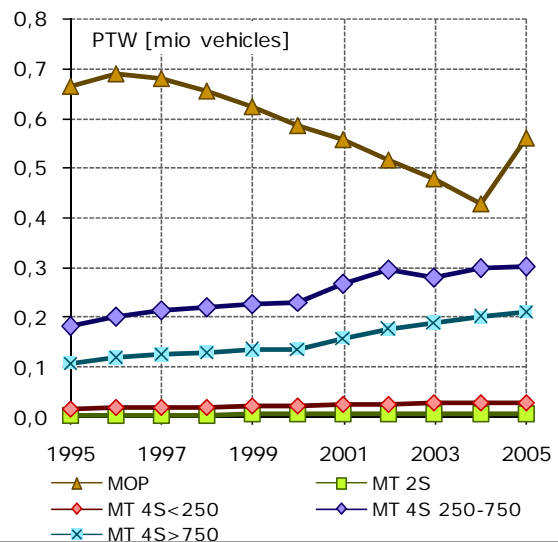
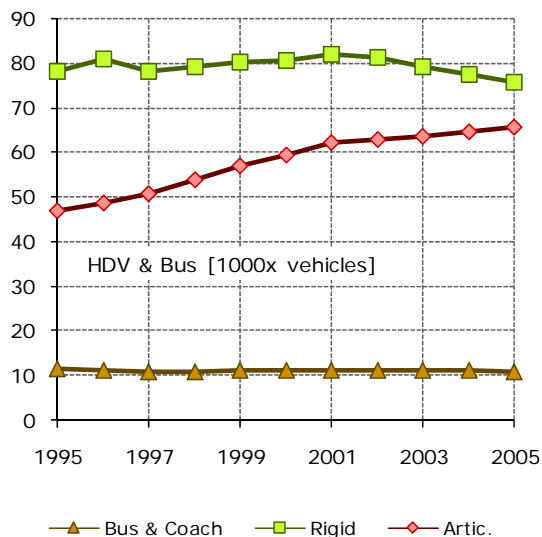
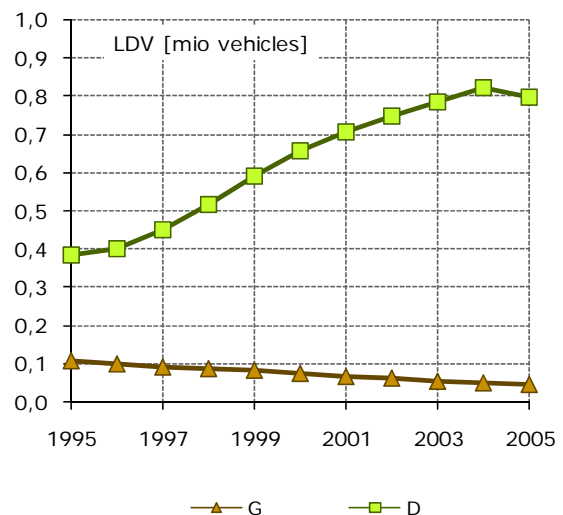
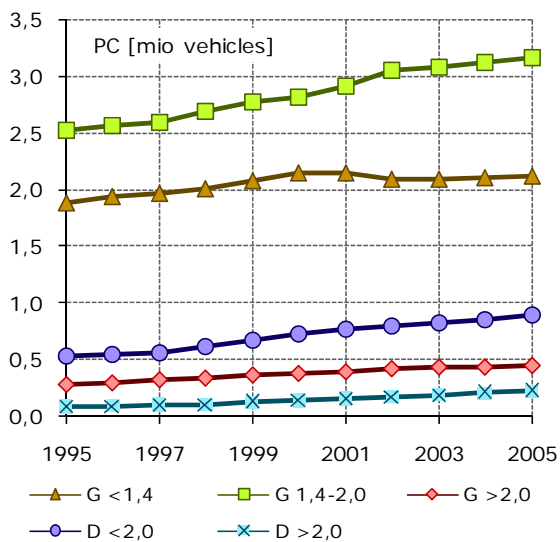
Figure NL.1: Total stock per vehicle category



Among the passenger cars no drastic trends are identifiable. G-PC dominates the fleet due to their share. The highest growth rate is identifiable for D-PC > 2,0l. Their overall impact remains little due to the low share (3% in 2005). More relevant is the increase in D-PC < 2,0l as this category gained 4% over the period, resulting in a share of 13% in 2005. The dieselisation of the Dutch LDV fleet seems to be completed as the share of D-LDV accounts for 93% and the stock shows a decrease in 2005 which could be an indicator of market saturation.

The bus and coach stock remains quite constant. The number rigid vehicles decreases slightly while the growth rate of articulated vehicles shows a relatively steep upward trend. Mopeds showed a constant and significant decrease from 1997 to 2004. From 2004 to 2005 the number of mopeds jumped by ~133.000 vehicles leaving them with a share of 50% among the PTW. For the motorcycles a remarkable trend lays with the motorcycle above 250cm³, they account for 46% of the PTW share.

Figure NL.2: Evolution of vehicle type population per subsector



Early introduction schemes for G-PC and G-LDV fulfilling Euro 4 can be identified. Still, due to higher growth rates for D-PC/LDV the technology mix in Table NL.2 shows larger shares of the Euro 2/3 standard than among the gasoline fuelled PC's/LDV's.

Table NL.1: Implementation matrix (introduction of technologies per year)

Cat.	G-PC			D-PC			G-LDV				D-LDV				BUS			HDT			PTW		
	Euro	2	3	4	2	3	4	1	2	3	4	1	2	3	4	II	III	IV	II	III	IV	I	II
2000	100	0	0	100	0	0	0	100	0	0	0	0	100	0	0	100	0	0	100	0	0	100	0
2001	26	74	0	36	64	0	0	56	44	0	0	0	100	0	64	36	0	66	34	0	100	0	0
2002	15	85	0	7	93	0	0	0	100	0	0	0	100	0	28	72	0	18	82	0	100	0	0
2003	17	63	20	0	100	0	0	0	75	25	0	0	100	0	10	90	0	0	100	0	0	100	0
2004	20	33	47	0	100	0	0	0	44	56	0	0	100	0	5	95	0	0	100	0	0	100	0
2005	19	17	64	0	51	49	0	0	23	77	0	0	51	49	7	81	12	0	86	14	0	100	0

Table NL.2: Technology mix of the stock per subsector per year

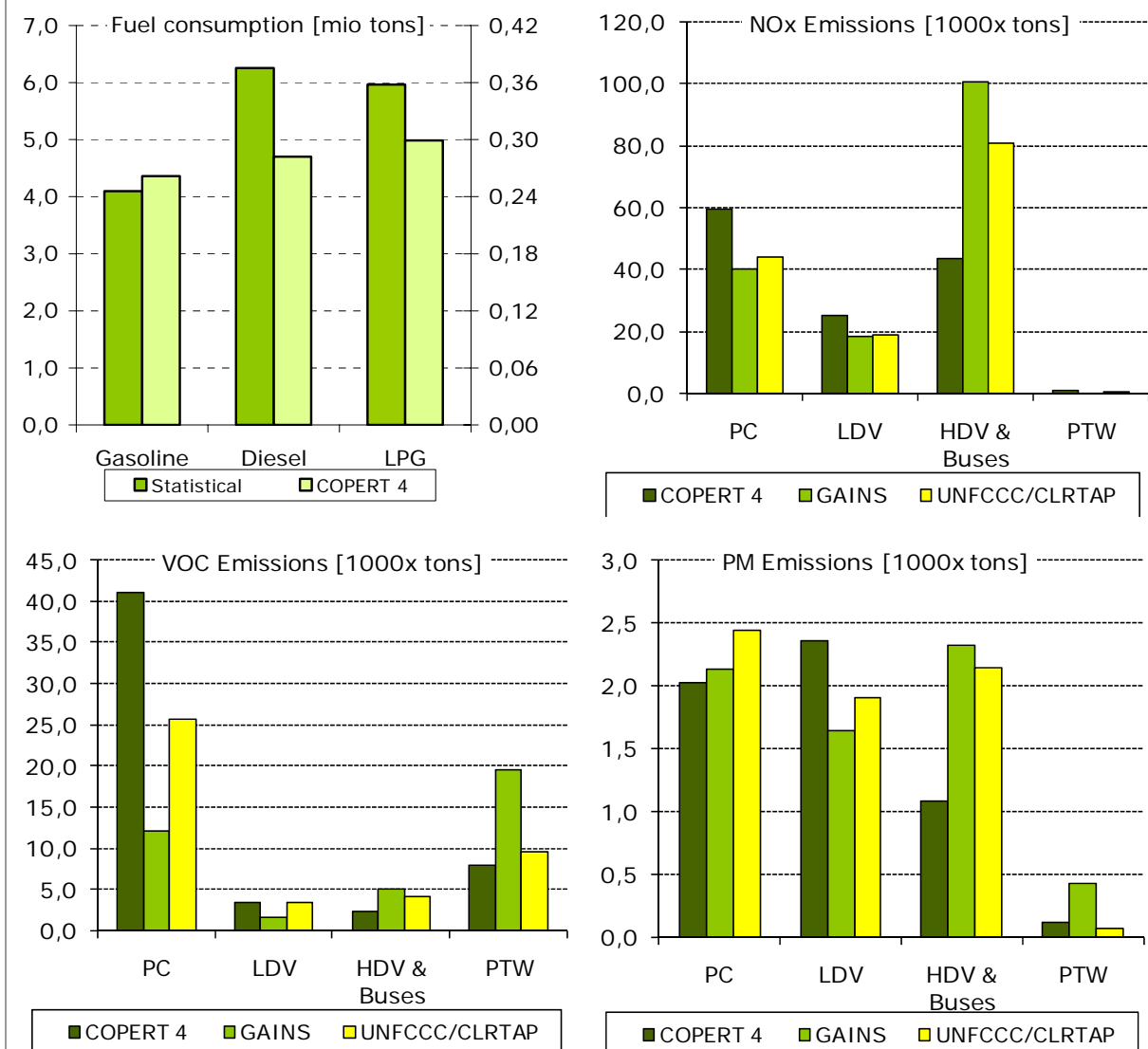
Cat.	G-PC					D-PC					G-LDV					D-LDV					BUS					HDT					PTW		
	Euro	C	1	2	3	4	C	1	2	3	4	C	1	2	3	4	C	1	2	3	4	C	I	II	III	IV	C	I	II	III	IV	C	I
2000	44	30	26	0	0	39	22	39	0	0	65	25	10	0	0	18	23	59	0	0	59	17	24	0	0	35	20	45	0	0	71	29	0
2001	39	27	27	6	0	25	20	43	12	0	59	26	13	2	0	15	20	52	12	0	51	17	29	3	0	27	17	51	5	0	61	39	0
2002	34	27	27	12	0	19	18	40	22	0	56	27	13	3	0	12	18	48	23	0	45	16	31	8	0	22	15	51	13	0	54	46	0
2003	29	26	27	17	1	15	16	38	31	0	53	27	14	5	0	10	15	44	31	0	39	15	30	16	0	19	12	48	21	0	51	46	3
2004	24	25	27	19	5	11	13	36	40	0	50	27	15	6	1	7	13	40	40	0	33	14	29	24	0	16	10	44	30	0	45	44	10
2005	20	24	27	19	10	9	11	32	43	5	48	27	15	7	3	6	11	36	43	4	25	13	29	32	1	15	8	38	37	1	32	36	32

The fuel consumption of gasoline differs by 7%, the diesel values by 25% and the LPG values by 17%. The difference for diesel (and also LPG) may be explained by the fact that the mileage values that have been used for the Netherlands are first order estimates and not official data. Therefore, the mileage value has to be increased, since the total fleet of HDVs is a robust value based on the detailed Dutch statistics.

The difference between the calculated and the statistical fuel consumption is directly reflected to the emissions from HDVs where our results seem to fall largely below the national submissions by 50%. This means that the total HDV mileage needs to be almost doubled to reach the national submissions.

With regard to the other vehicle categories, national submissions and our results are quite close with individual differences less than 20%. The only large difference is for VOC passenger cars where, again, our calculations include VOCs due to fuel evaporation.

Figure NL.3: Results of the calculations with COPERT 4 and the updated fleets compared to other sources



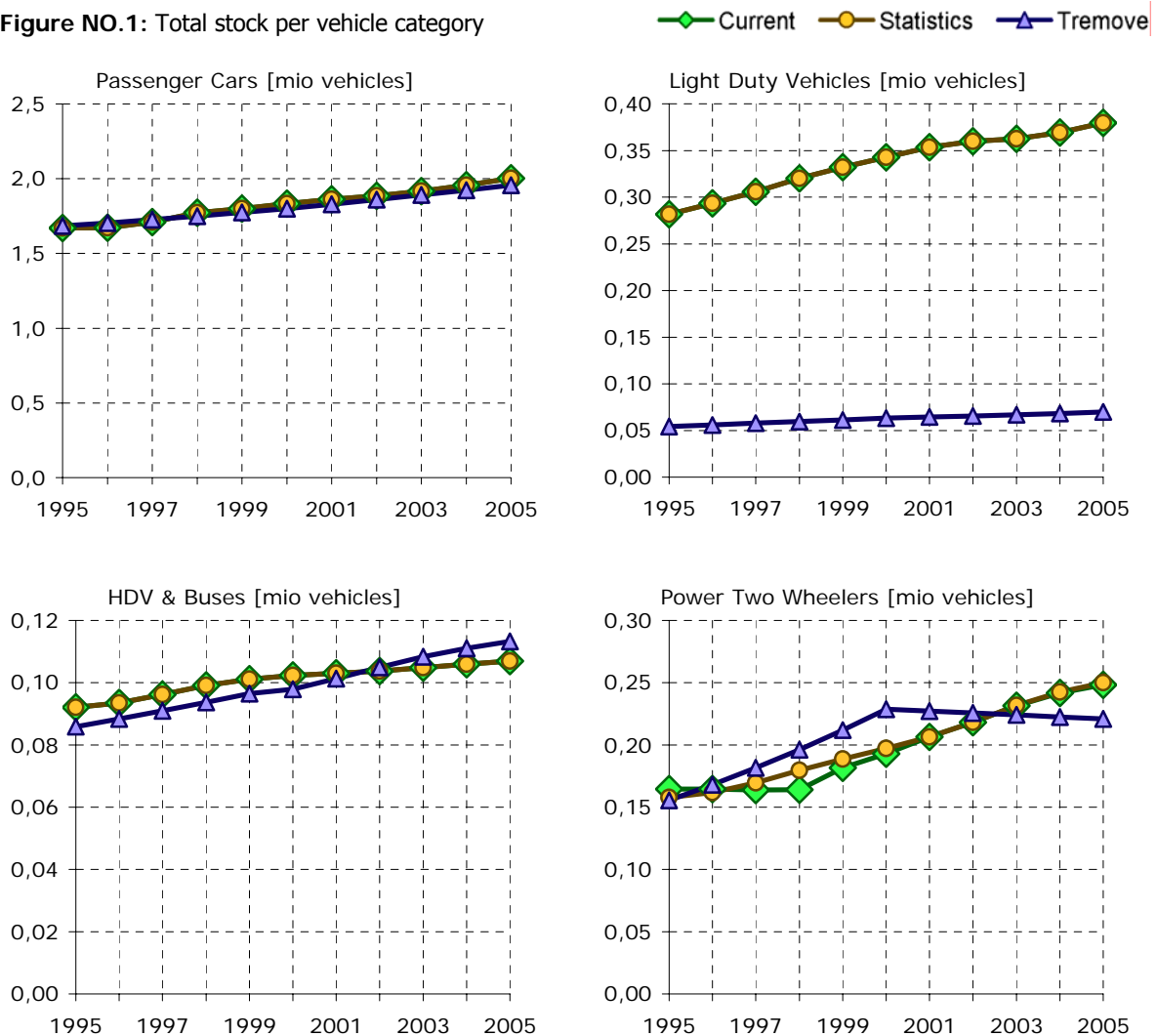
The following were the main sources of information:

- Norwegian Pollution Control Authority: Population, Speed, Share, mileage, % of fuel injection & evaporation control, annual fuel consumption. All for 1973, 1980, 1986-2005
- Eurostat: bus population 89-00, New registrations bikes 89-00,
- ACEA: passenger cars 2001-2006, commercial vehicles 2001-2006, Buses 1989-2000

The missing information was only 21, split into less than 1% of total fleet, 23% of new registrations and 39% of deregistrations. The main data missing were the weight classes for HDV & Buses and differentiated data for all PTW's and data for large PTW's. The total fleet and the distinction to categories and types should be considered reliable as it originates from updated official databases.

The number of passenger cars increases by about 20% from 1995 to 2005 resulting in 2 mio passenger cars in 2005. The number of LDV's increases even more over the same period by ~ 35%. The largest increase though can be observed for PTW with an augmentation by 50 %.

Figure NO.1: Total stock per vehicle category



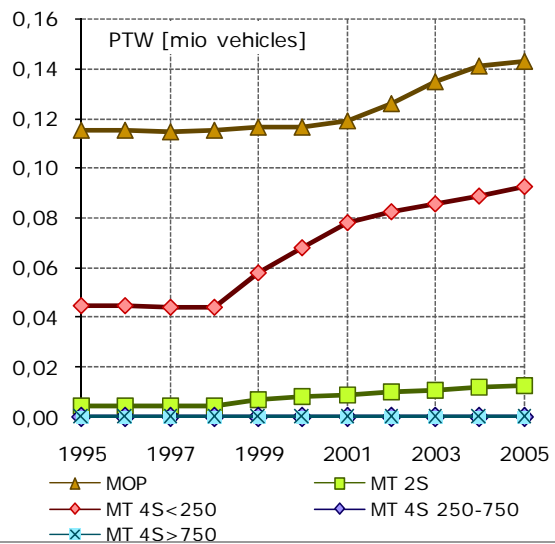
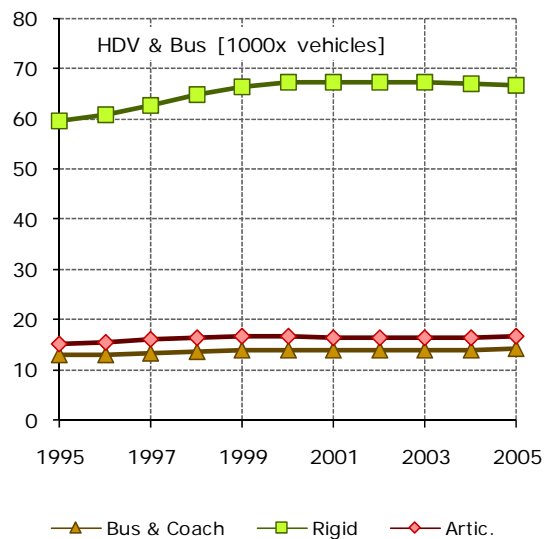
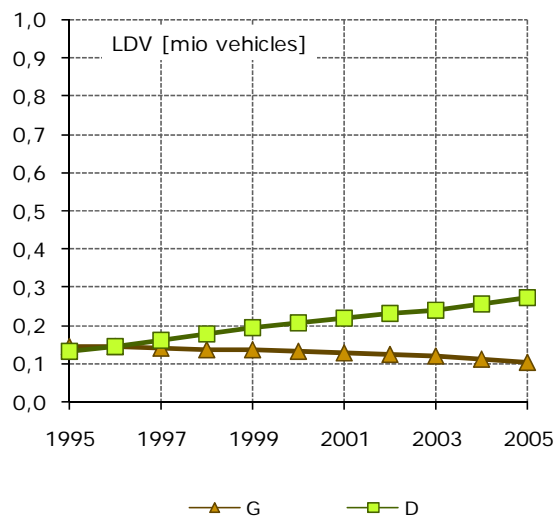
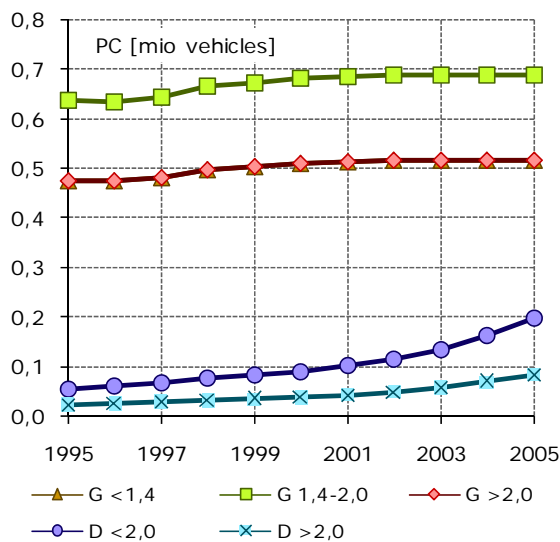
The development over time for G-PC is the same for all engine capacities with the difference that the number of PC with an engine capacity between 1,4-2,0 has the highest share among the gasoline fuelled passenger cars. Since 2000 the share of those vehicles remains constant. The share of vehicles with an engine capacity of < 1,4 and > 2,0 is almost equal. The number of D-PC has risen constantly since 1995 and its growth rate accelerated since 2001 (in particular for D-PC < 2,0). Nevertheless its share remains low in comparison with the total.

The share of diesel fuelled LDV's is higher than for G-LDV and also constantly rising while the share of G-LDV is decreasing by the same rate.

The bus and HDV stock increase is mainly due to the increase of rigid vehicles until 2000, since then the values remain constant showing a slight decline in 2005.

Data for motorcycles above 250 cm³ was not available. The highest share of PTW are mopeds which are increasing constantly since 2001. The other large share is made up by motorcycles below 250cm³. Their number doubled 1995 showing a very steep development in growth since 1998. Although the number of 2 stroke motorcycles has almost tripled since 1995 their share remains quite low.

Figure NO.2: Evolution of vehicle type population per subsector



Country: **NORWAY**

NO3/4

The implementation matrix reveals that no passenger car with an Euro 4 technology entered the Norwegian market in 2005.

The technology mix in Norway (Table NO.2) shows that there is a large fraction of old (even non-catalyst) cars, in particular for G-PC and G-LDV. The same holds true for Buses, HDT and PTW.

A high number of D-LDV and D-PC is equipped with Euro 3 in 2005

Table NO.1: Implementation matrix (introduction of technologies per year)

Cat.	G-PC			D-PC			G-LDV				D-LDV				BUS			HDT			PTW		
	Euro	2	3	4	2	3	4	1	2	3	4	1	2	3	4	II	III	IV	II	III	IV	I	II
2000	100	0	0	100	0	0	0	100	0	0	0	0	100	0	0	100	0	0	100	0	0	100	0
2001	56	44	0	58	42	0	0	43	57	0	0	54	46	0	49	51	0	58	42	0	100	0	0
2002	6	94	0	29	71	0	0	0	100	0	0	0	100	0	0	100	0	0	100	0	42	58	0
2003	2	98	0	27	73	0	0	0	100	0	0	0	100	0	0	100	0	0	100	0	0	100	0
2004	13	87	0	18	82	0	0	0	100	0	0	0	100	0	1	99	0	0	100	0	0	100	0
2005	0	100	0	7	93	0	0	0	100	0	0	0	100	0	0	100	0	0	100	0	0	100	0

Table NO.2: Technology mix of the stock per subsector per year

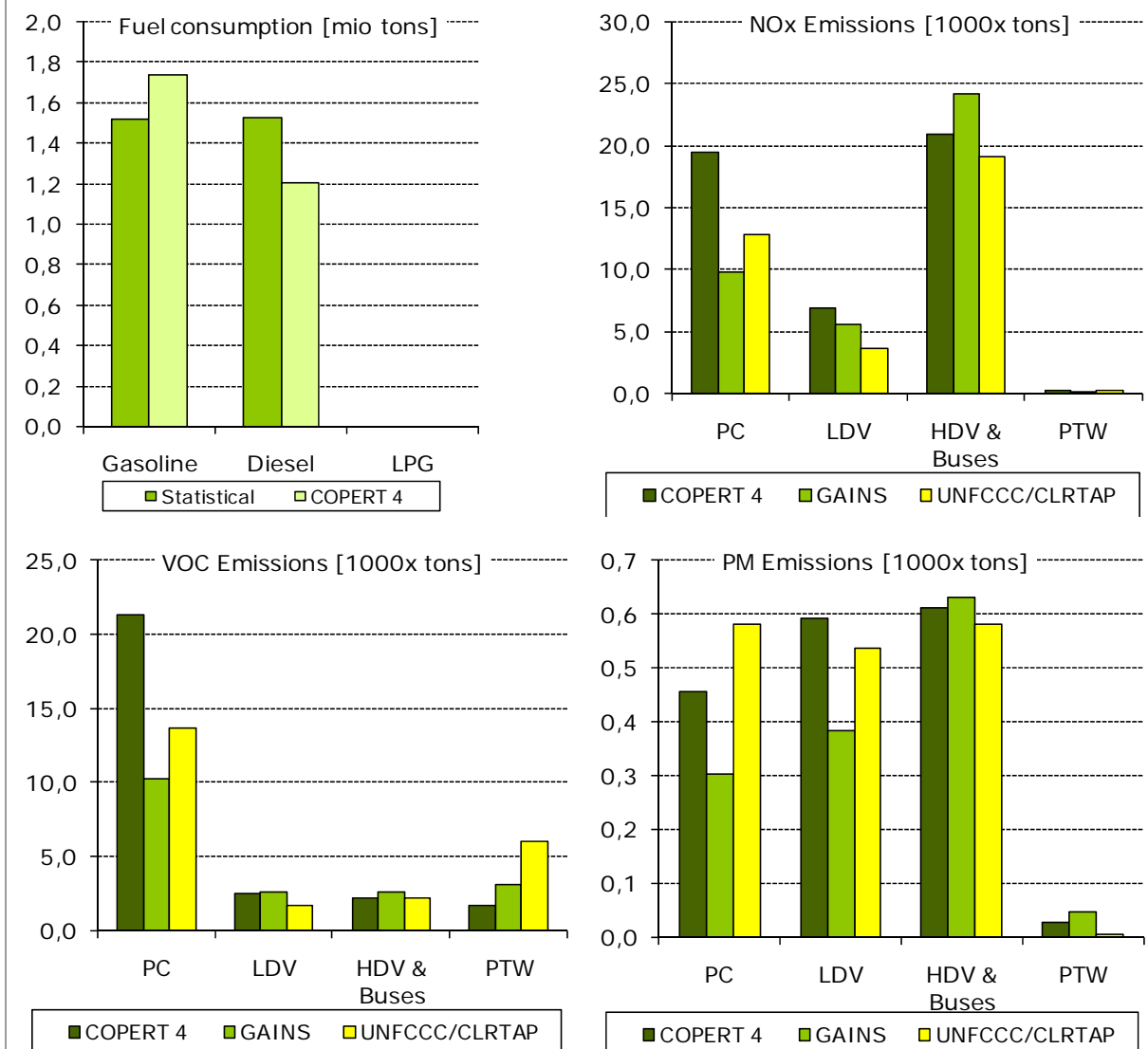
Cat.	G-PC					D-PC					G-LDV					D-LDV					BUS					HDT					PTW		
	Euro	C	1	2	3	4	C	1	2	3	4	C	1	2	3	4	C	1	2	3	4	C	I	II	III	IV	C	I	II	III	IV	C	I
2000	42	36	22	0	0	34	41	25	0	0	55	32	14	0	0	26	49	25	0	0	61	16	24	0	0	55	14	30	0	0	70	30	0
2001	38	35	25	2	0	29	39	28	4	0	48	31	17	4	0	22	45	28	5	0	56	16	26	2	0	51	14	33	3	0	61	39	0
2002	33	35	25	7	0	24	35	28	13	0	43	31	17	10	0	19	42	26	12	0	51	15	25	8	0	47	13	32	8	0	55	40	6
2003	29	35	25	11	0	20	31	27	22	0	38	30	17	15	0	16	39	25	19	0	47	15	25	13	0	44	12	31	13	0	49	36	16
2004	24	35	25	15	0	15	27	26	32	0	34	29	17	19	0	14	36	23	27	0	42	14	25	19	0	41	12	29	19	0	44	32	24
2005	20	35	25	20	0	11	23	22	44	0	31	29	18	23	0	11	31	21	36	0	37	13	24	26	0	38	10	28	24	0	40	29	31

The fuel consumption differs by 200.000t for gasoline and diesel. For the latter COPERT indicates a lower fuel consumption and for gasoline a higher consumption was indicated. No fuel consumption for LPG was specified.

The highest contributor to NOx emissions are HDV and buses having larges differences between the values of the different sources. Depending on the source passenger cars follow the heavy vehicles closely or with a greater gap. Again the sources show large differences, even greater than for the heavy vehicles. The largest contributor for VOC emissions are passenger cars according to all sources. The differences are again quite considerable e.g. Gains indicating less than half of the emissions indicated by COPERT. The emission for LDV, HDV & Buses match better for all sources. The only other remarkable difference can be observed for PTW where UNFCCC/CLRTAP indicated three times higher emissions than COPERT.

Regarding PM emissions the highest contributor are HDV & buses, all sources indicating the same range of emissions. Depending on the source either passenger cars or LDV follow the heavy vehicles more or less closely. The Gains value for both vehicle categories is significantly lower than for COPERT and UNFCCC/CLRTAP.

Figure NO.3: Results of the calculations with COPERT 4 and the updated fleets compared to other sources



The main data sources were as follows:

- the simplified COPERT database got from the Polish national expert which contains all vehicle stock and mileage data for the year 2000 excepted distribution into engine/weight size classes (in case of passenger cars and motorcycles by piston displacement and in case of trucks and buses by maximal gross weight);
- and the Eurostat database (for distribution into the missing size classes mentioned above).

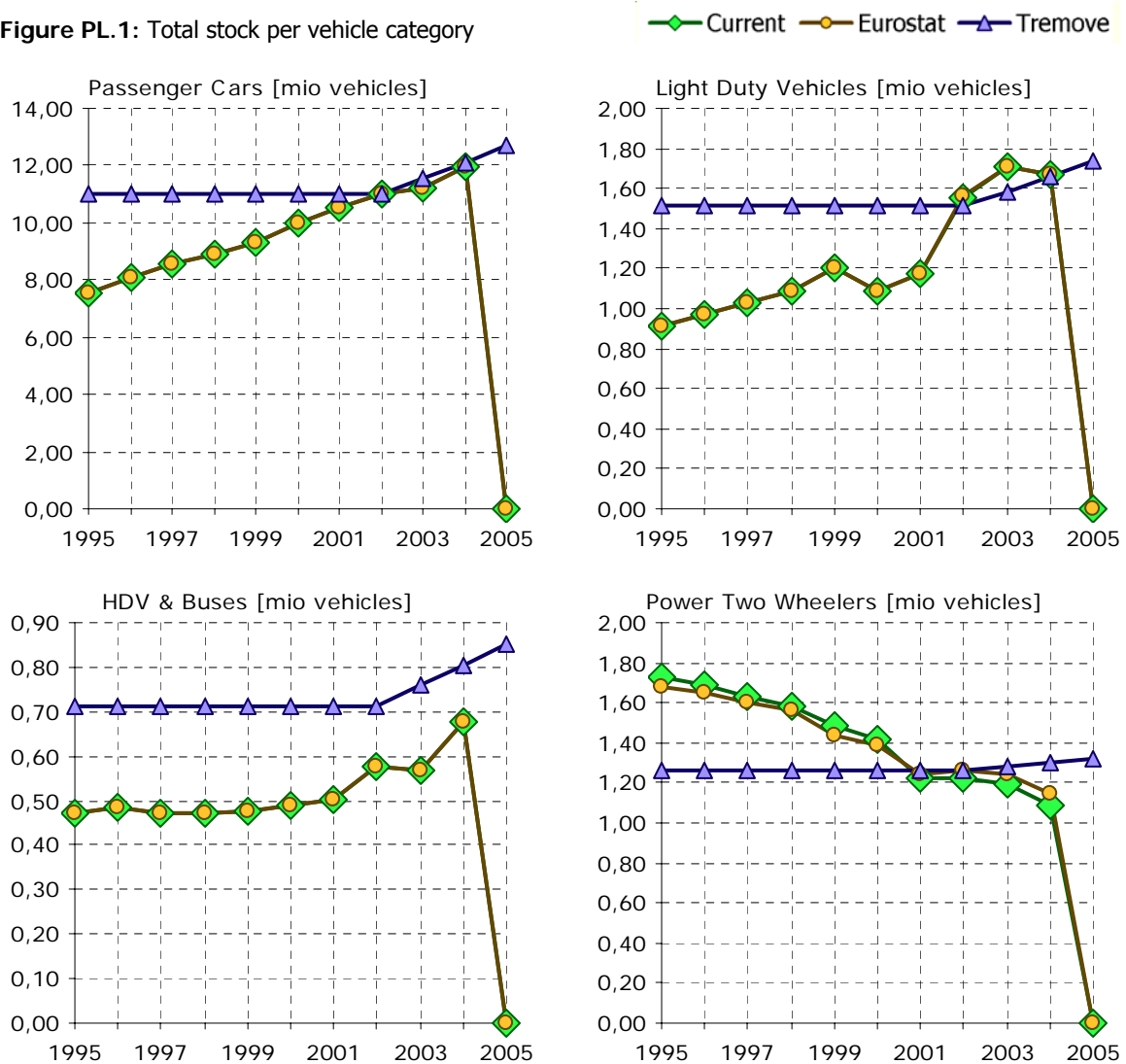
The missing information was 44%, split into 44% of the total population, 37% of new registrations and 52% of deregistrations. In Eurostat these distributions are available only from 2002 or 2003, but they are suitable to extrapolate them and to estimate the amounts of vehicles in the appropriate subclasses in 2000.

In order to do this, for lorries and road tractors the same method was applied as in case of e. g. Estonia and Slovakia, and for our method was the same as in case of e. g. Lithuania. For the produced subclasses the same Euro-classification was applied as for the primary vehicle classes from the COPERT table by the Polish expert.

On the basis of the charts below one can draw the following conclusions:

- a considerable persistent increase in case of passenger cars;
- a similar, near persistent increase in case of light duty vehicles (excepted the 2000 and 2001 years when their stock was unexpected less than in the neighbouring years);
- the HDV and bus stock didn't change up to the end of the last millennium, but from then there is also a considerable increase;
- the stock of powered two-wheelers fell off continuously in the period 1995–2005.

Figure PL.1: Total stock per vehicle category



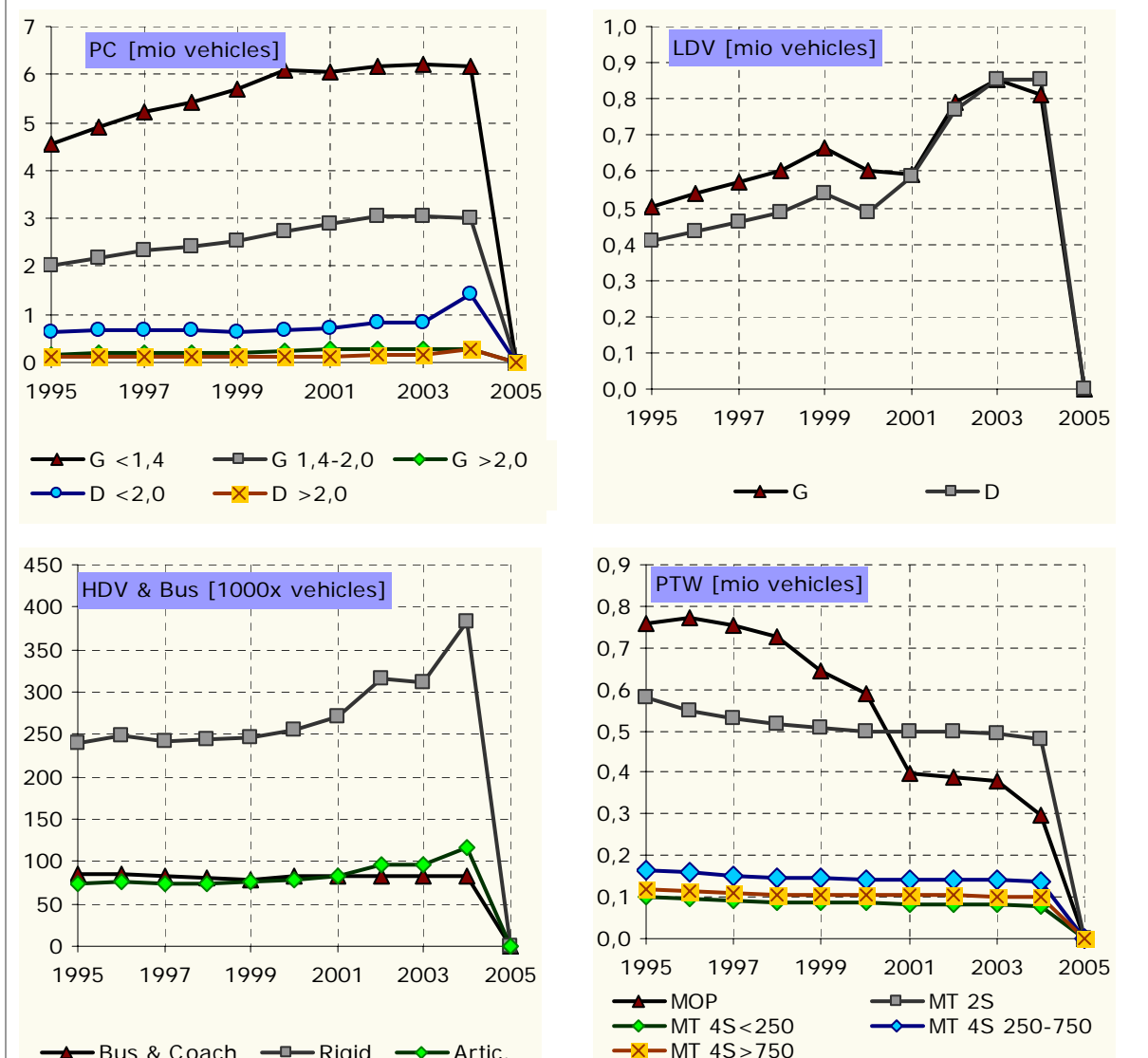
The PC chart below shows that the biggest share of passenger cars is petrol fuelled, have a piston displacement of less than 1,4 litres, but also the 1,4...2,0 litres petrol fuelled cars and in a smaller compass the less than 2 litres diesel cars are frequent in Poland. (For the development of petrol, diesel and LPG share there are exact Eurostat data, but the development of piston displacement distribution is only estimation, excepted the last few years.)

The share of diesel fuelled vehicles among the LDV-s grows only rather lowly, there is only a obvious growth in share in the year 2001.

While the lorries and road tractors have a slowly then rapidly growing amount, the buses have a nearly constant sized fleet in the studied period.

The powered two-wheelers are mainly mopeds and two-stroke engined motorcycles in Poland, their amount (mostly of the mopeds) is decreasing.

Figure PL.2: Evolution of vehicle type population per subsector



Country: **POLAND**

PL3/4

From *Table PL.1* it marks out that the registered vehicles met the newest environmental technology requirements in most cases from 2000 to 2004.

But on the basis of *Table PL.2*, in 2000 the stock of the light duty vehicles is the oldest, while the passenger cars, mainly the diesel ones are the newest.

Opposite to this, in 2004 the stock of buses and heavy duty trucks remained rather old, opposite to the light duty vehicles and passenger cars, which exchanged in a serious measure. It is worth to mention that the diesel fuelled passenger cars' stock become very new during these years.

Since there are only few data available for the development of the vehicle age and environmental technology classification for vehicle (sub-)classes, these results must be treated carefully.

These data inform about the ratio between the fluctuation (registrations and deregistrations) and the stock size within each studied vehicle category. This must have been the lowest in case of the heavy duty trucks and buses, and the highest in case of the diesel fuelled passenger cars and light duty vehicles.

There is an open question: since the statistical data aren't available for the year 2005, could be the fuel consumption and pollutant emission data for 2005 (*Figure PL.3*) produced from the 2004 data?

Table PL.1: Implementation matrix (introduction of technologies per year)

Cat.	G-PC			D-PC			G-LDV				D-LDV				BUS			HDT			PTW	
	2	3	4	2	3	4	1	2	3	4	1	2	3	4	II	III	IV	II	III	IV	I	II
2000	100	0	0	100	0	0	36	64	0	0	51	49	0	0	100	0	0	100	0	0	79	21
2001	100	0	0	100	0	0	8	92	0	0	17	83	0	0	100	0	0	100	0	0	11	89
2002	24	76	0	0	100	0	2	77	21	0	15	61	24	0	10	90	0	49	51	0	82	18
2003	0	100	0	36	64	0	4	48	48	0	31	0	69	0	0	100	0	46	54	0	68	32
2004	1	99	0	4	96	0	0	33	67	0	38	0	62	0	0	100	0	0	100	0	67	33
2005				##	##	##	##	##	##	##	##	##	##	##	##	##	##	##	##	##	##	##

Table PL.2: Technology mix of the stock per subsector per year

Cat.	G-PC					D-PC					G-LDV					D-LDV					BUS					HDT					PTW		
	C	1	2	3	4	C	1	2	3	4	C	1	2	3	4	C	1	2	3	4	C	I	II	III	IV	C	I	II	III	IV	C	I	II
2000	64	20	16	0	0	42	45	13	0	0	83	9	8	0	0	82	12	6	0	0	74	12	14	0	0	69	13	19	0	0	72	22	6
2001	57	21	21	0	0	27	53	20	0	0	71	10	19	0	0	63	13	24	0	0	70	12	18	0	0	66	13	21	0	0	67	25	8
2002	51	22	22	5	0	16	53	17	15	0	55	8	32	5	0	49	14	32	6	0	65	14	18	3	0	64	11	21	3	0	60	30	10
2003	48	21	22	9	0	10	55	18	17	0	50	7	34	9	0	43	16	26	15	0	62	14	18	7	0	59	11	24	7	0	55	34	11
2004	46	21	21	11	0	4	35	12	49	0	43	6	36	14	0	33	20	25	22	0	59	13	17	10	0	65	8	19	8	0	48	38	13
2005	#	#	#	#	#	#	#	#	#	#	#	#	#	#	#	#	#	#	#	#	#	#	#	#	#	#	#	#	#	#	#	#	#

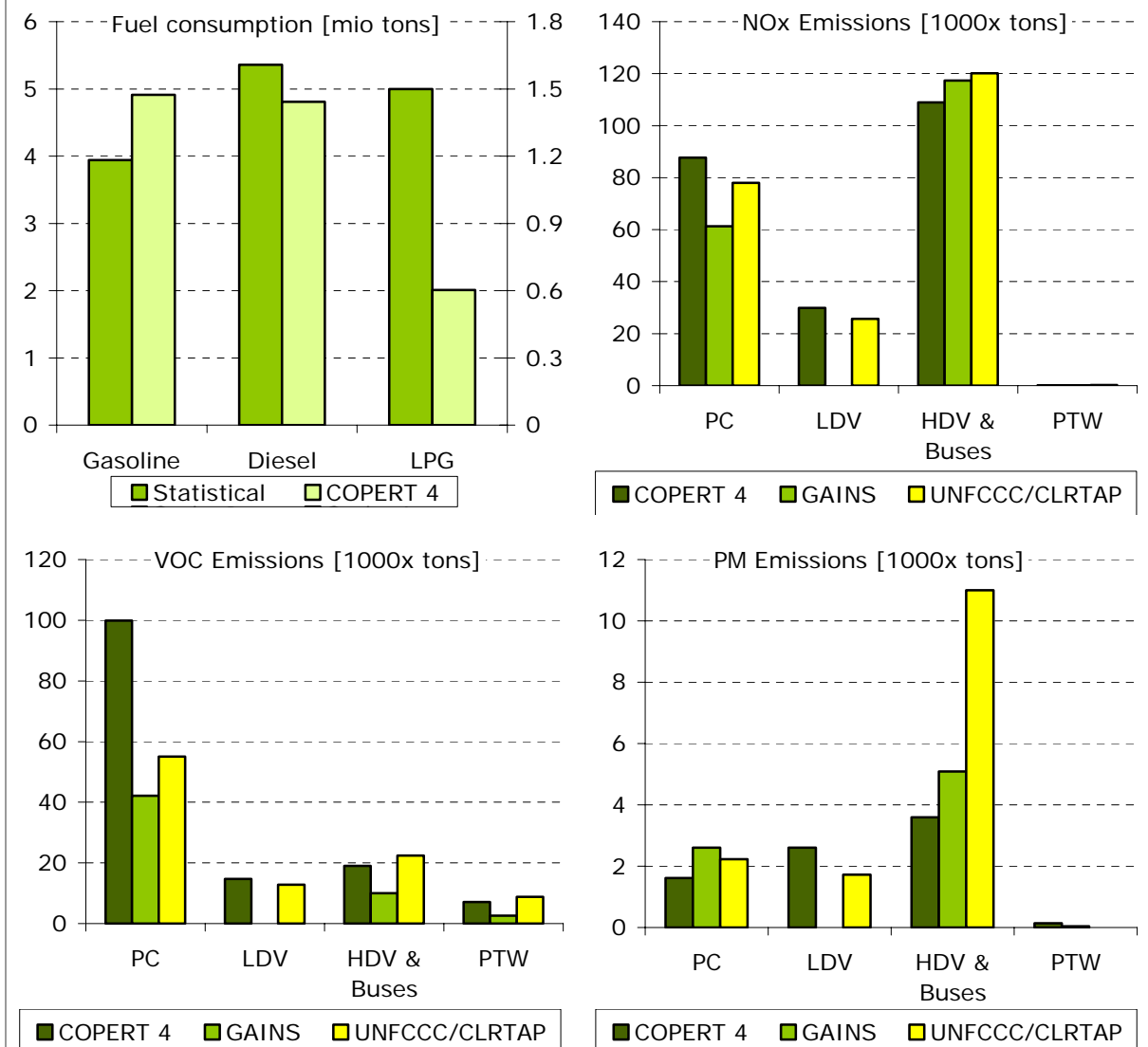
As *Fuel consumption* chart shows, there was a considerable LPG consumption for road transport purposes in Poland in 2005. The big difference between LPG consumption reported by Eurostat and the one computed by COPERT IV can originate in that in this region lots of old petrol fuelled cars were retrofitted for LPG fuelling, and because not all of these cars were officially registered as retrofitted, the tanked LPG at filling stations throughout the country still show the notable demand.

The much less differences between the two data methods in case of petrol and diesel fuel consumption can be explained by the measuring and calculating errors detailed in case of e. g. Hungary or Latvia. Another problem source can be that there is no data available for the year 2005 (neither from national data sources nor from international purpose statistics e. g. Eurostat or Annual Bulletin of Transport Statistics for Europe and North America).

As the figures on pollutant emissions show, there are considerable uncertainties in calculation methods. Since these differences are not too big in case of e. g. NO_x emissions but much more serious in case of e.g. PM emissions, there can be also considerable differences among the applied emission factors in the shown data processing methods.

The charts below show just the expected characteristics for each pollutant components and vehicle classes, but since the sketched problems they aren't yet suitable for drawing the very special conclusions for Poland.

Figure PL.3: Results of the calculations with COPERT 4 and the updated fleets compared to other sources



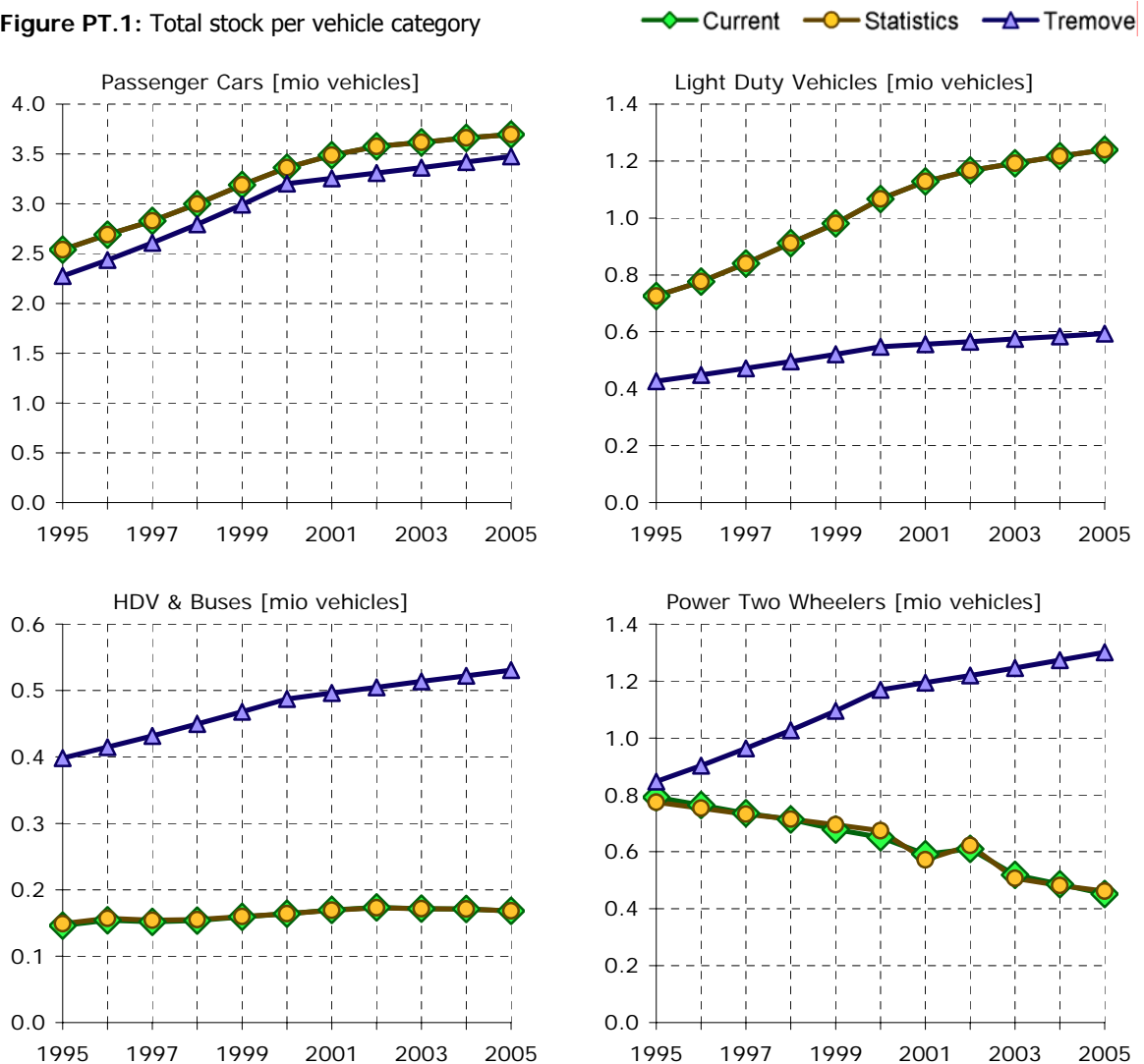
The following were the main sources of information:

- Total fleets per category: Portuguese national expert (1990-2005)
- Split in types: Portuguese national expert (1990-2005)
- New registrations: ACEA (2001-2006)
- Age/technology distribution of vehicles: Portuguese national expert (1990-2005)
- Other sources included UITP

The missing information was 25%, with 0% of total population, 30% of new registrations and 43,5% of deregistrations. The total fleet and the distinction to categories and types should be considered reliable as it originates from updated official databases.

The evolution of the main vehicle categories in Portugal recorded different behavior over the period 1995-2005. Passenger cars increased by almost 50% from 2.5 mio vehicles in 1995 to 3.7 mio in 2005. LDVs increased considerably by about 70% while HDVs increased slightly over the same period. On the other hand, PTWs decreased almost by half, mainly because of the considerable drop in the number of mopeds, although the number of motorcycles increased.

Figure PT.1: Total stock per vehicle category



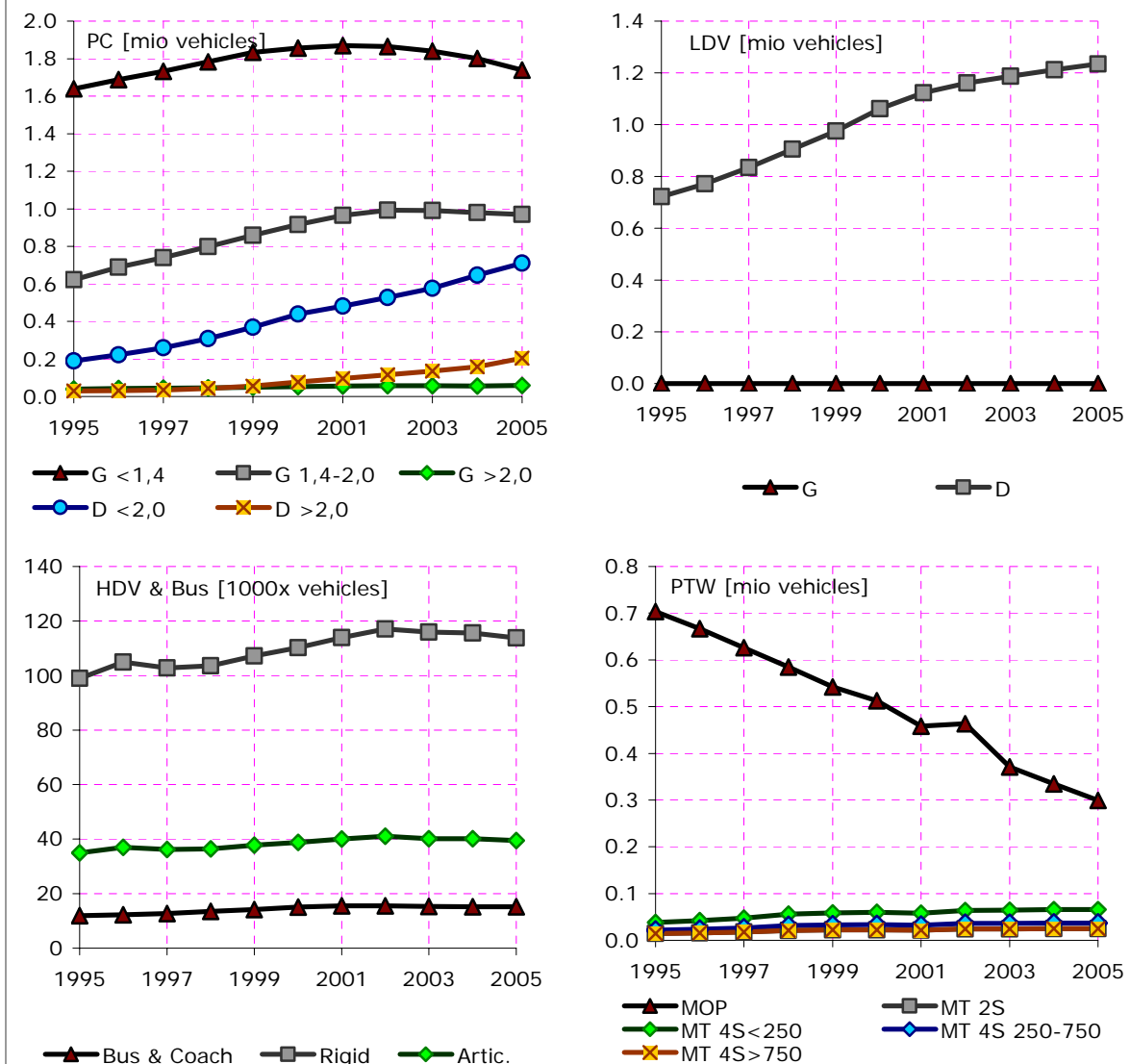
G-PC falling in the small and medium class (<1,4 & 1,4-2,0 l) dominate the passenger car fleet, accounting for about 75% of the fleet. The G-PC fleet increased by 20% over the period 1995-2005. Large (>2.0 l) G-PC have a low share of about 2% of the total G-PC fleet. The D-PC fleet has more than quadrupled over the same period, accounting for 25% of the PC fleet in 2005, compared to only 9% in 1995.

The LDV fleet in Portugal consists of D-LDVs only and has increased consistently over the years reaching 1,2 mio vehicles in 2005.

The population of HDVs in 2005 has increased by 15% since 1995, with rigid trucks accounting for about 75% of the HDV fleet. The fleet of buses & coaches recorded a higher increase of about 30% over the same period.

The fleet of mopeds, accounting for about 65% of the PTW stock, decreased by almost 60% over the period 1995-2005, while the population of motorcycles increased significantly by more than 70%.

Figure PT.2: Evolution of vehicle type population per subsector



The implementation matrix (Table PT.1) is based on a complete and consistent dataset and therefore it can be considered as reliable. A large fraction of Euro 4 PCs are already introduced in 2005, one year ahead of the official implementation date. For HDTs the data suggest that second-hand vehicles are introduced in the market (e.g. Euro I HDTs are registered for the first time even in 2005). Therefore, the technology replacement is slower than for PCs and LDVs.

The large expansion in the D-PC and D-LDV fleet has resulted in a fast technology replacement (Table PT.2). On the contrary, there is still an important fraction of older (including pre-Euro) G-PC cars. The fleet renewal is slower for the bus and HDT fleet. For the PTWs there is a significant decrease in their population, which means that very few new vehicles are introduced in the market, as mentioned above.

Table PT.1: Implementation matrix (introduction of technologies per year)

Cat.	G-PC			D-PC			G-LDV				D-LDV				BUS			HDT			PTW		
	Euro	2	3	4	2	3	4	1	2	3	4	1	2	3	4	II	III	IV	II	III	IV	I	II
2000	100	0	0	100	0	0						0	100	0	0	100	0	0	100	0	0	100	0
2001	0	100	0	0	100	0						0	100	0	0	100	0	0	42	58	0	100	0
2002	0	100	0	0	100	0						0	0	100	0	38	62	0	23	77	0	100	0
2003	0	100	0	0	100	0						0	0	100	0	0	100	0	17	83	0	100	0
2004	0	100	0	0	100	0						0	0	100	0	0	100	0	17	83	0	100	0
2005	0	7	93	0	2	98						0	0	100	0	0	100	0	11	89	0	100	0

Table PT.2: Technology mix of the stock per subsector per year

Cat.	G-PC					D-PC					G-LDV					D-LDV					BUS					HDT					PTW		
	Euro	C	1	2	3	4	C	1	2	3	4	C	1	2	3	4	C	1	2	3	4	C	I	II	III	IV	C	I	II				
2000	44	27	28	0	0	13	29	58	0	0						28	41	31	0	0	57	18	25	0	0	57	21	22	0	0	96	4	0
2001	40	26	28	6	0	10	26	51	13	0						24	38	38	0	0	54	17	29	0	0	51	21	23	4	0	91	9	0
2002	36	25	27	11	0	8	22	45	24	0						21	36	37	7	0	51	16	30	3	0	46	21	24	8	0	84	16	0
2003	33	25	27	15	0	7	19	40	34	0						18	34	35	13	0	50	15	29	6	0	41	22	25	13	0	79	21	0
2004	31	24	27	18	0	5	16	35	43	0						16	32	34	18	0	48	15	28	9	0	35	22	25	17	0	76	24	0
2005	28	23	27	19	3	4	14	30	38	14						14	30	33	23	0	45	14	26	14	0	29	23	26	22	0	72	28	0

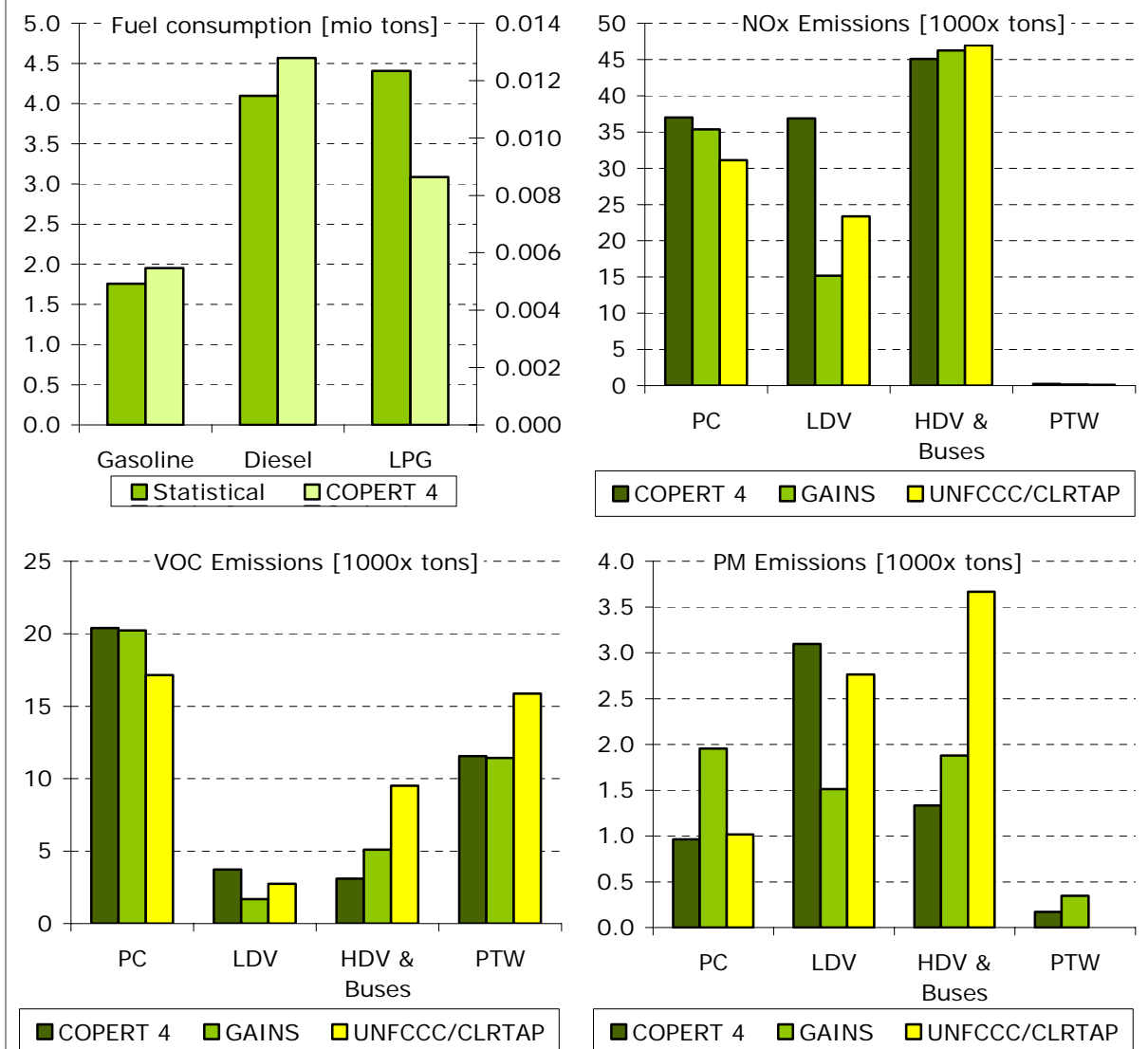
Small differences on the order of 10% may be observed when comparing gasoline and diesel consumption calculated with COPERT 4 with the respective statistical values reported by Eurostat (for LPG the difference is about 40%). These deviations may be explained by the difference in the use of gasoline, diesel and LPG vehicles (mainly annual mileage) considered for the calculations and the real-world vehicle use.

Despite the considerable increase in D-PC over the last years, HDV & Buses remain the main source of NOx emissions. There is a fair agreement between NOx emissions calculated with COPERT 4 and those reported by GAINS and UNFCCC/CLRTAP for the main vehicle categories except for LDV.

PC and in particular G-PC dominate VOC emissions. PTW, though their fleet has decreased over the last years, account for an important 30% of the total VOC emissions.

Some large differences between PM emissions calculated with COPERT 4 and those reported by GAINS and UNFCCC/CLRTAP may be observed for all vehicle categories; however, total PM emissions from COPERT 4 and GAINS are almost identical; UNFCCC/CLRTAP emissions are somewhat higher.

Figure PT.3: Results of the calculations with COPERT 4 and the updated fleets compared to other sources



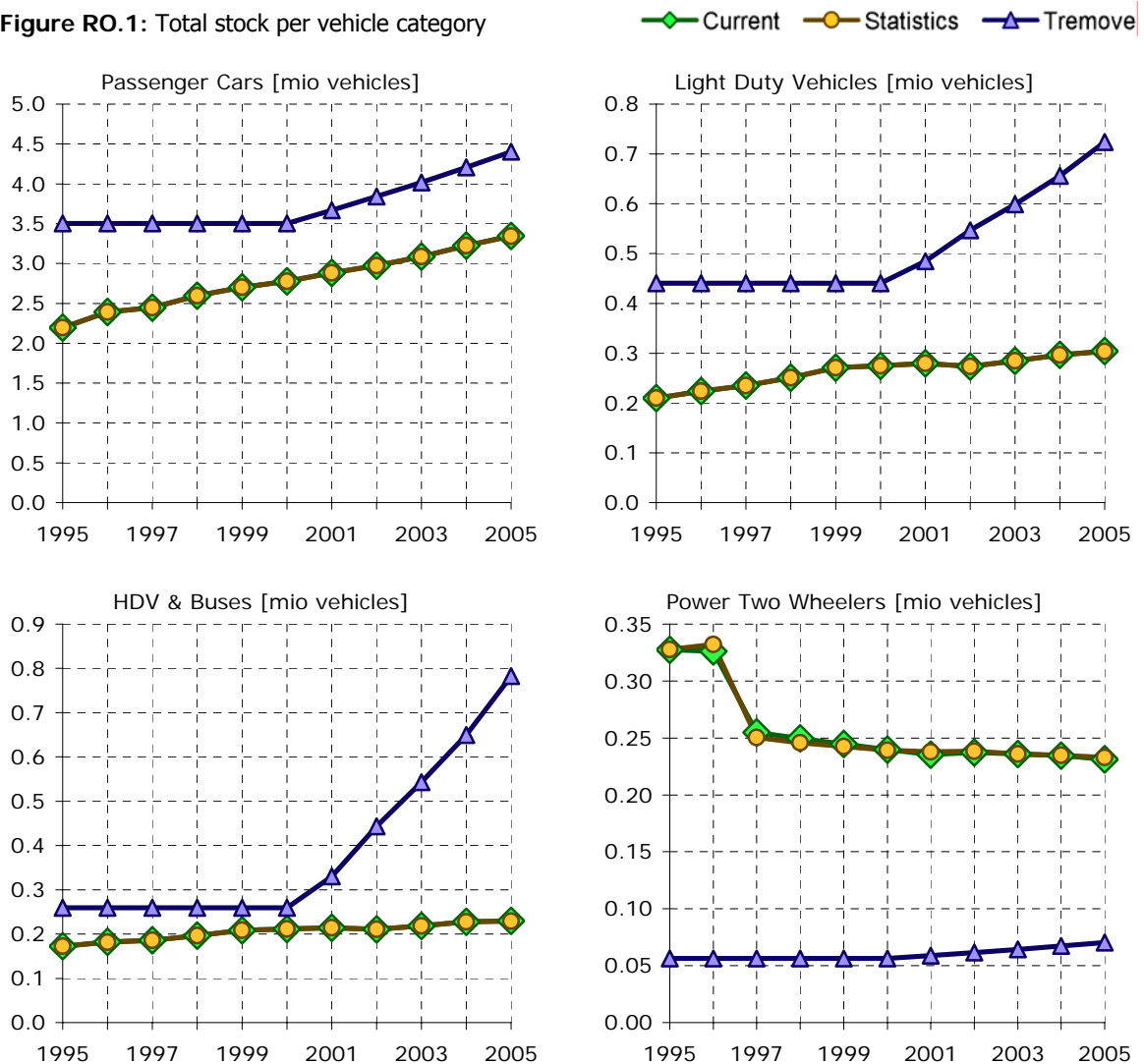
The following were the main sources of information:

- Total fleets per category: UNECE (1990-2004), Romanian Environmental Protection Agency (2005-2006)
- Split in types: Romanian Environmental Protection Agency (2005-2006)
- New registrations: UNECE (1997-2004), ACEA (2006)
- Age/technology distribution of vehicles: Romanian Environmental Protection Agency (2005-2006)
- Other sources included UITP

The information missing was 38%, with an equal amount of the total stock missing, 35% of new registrations and 41% of deregistrations. The main information missing was technology distinction for more years. The total fleet and the distinction to categories and types should be considered reliable as it originates from updated official databases.

The vehicle stock of Romania develops significantly over the period 1995-2005, with passenger cars reaching 3,5 mio vehs in 2005 compared to about 2 mio vehs in 1995. A similar increase was also recorded for LDVS and HDVs, while PTWs were decreased by about 30% over the same period.

Figure RO.1: Total stock per vehicle category



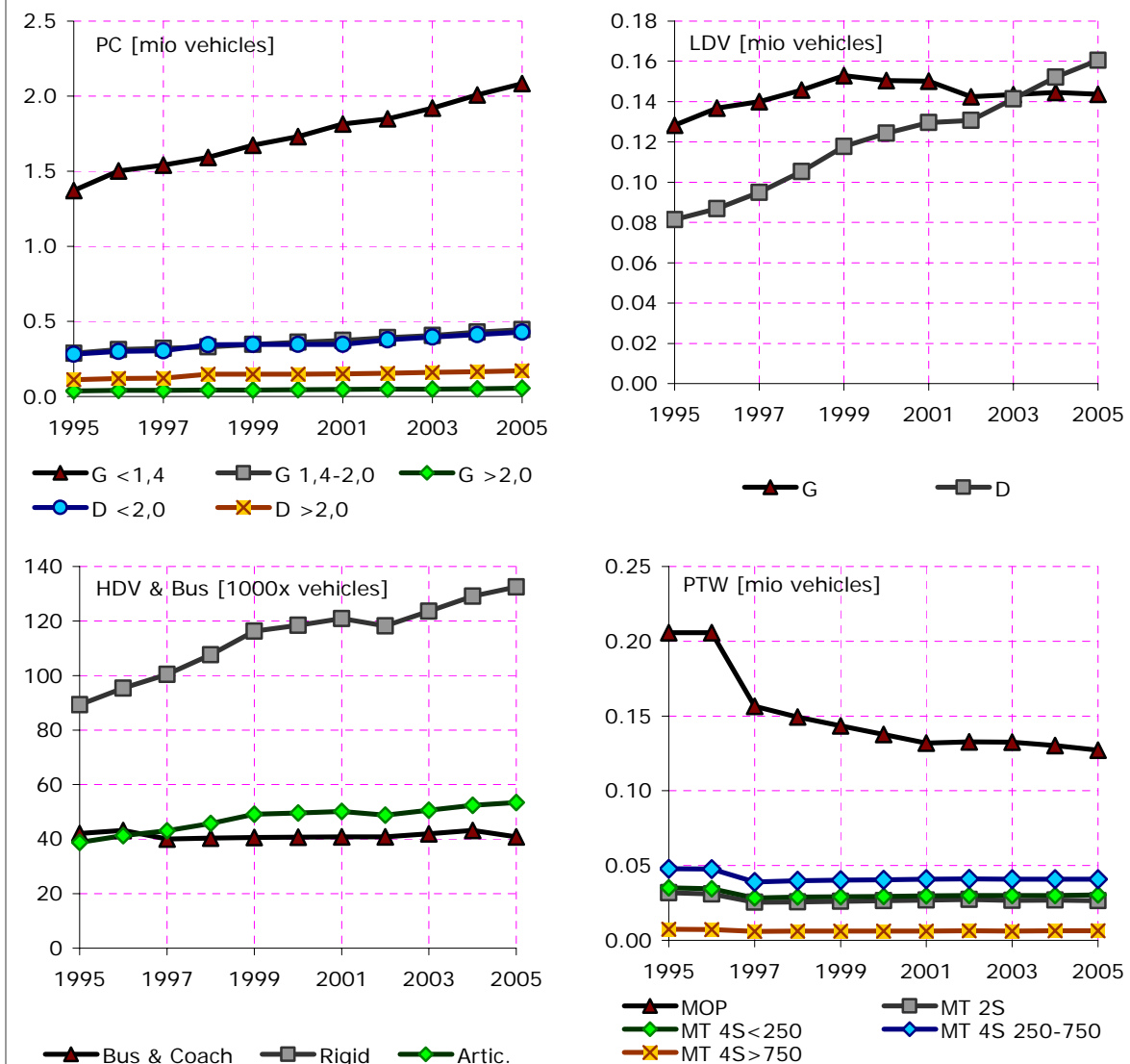
The passenger car fleet is dominated by G-PC falling in the <1.4 l class. Their fleet increased by more than 50% over the period 1995-2005. Large (>2.0 l) G-PC are less than 2% of the total G-PC fleet. This is probably due to the combined effect of higher purchase price of >2.0 l G-PC and the lower, compared to other EU MS, GDP in Romania. D-PC account for almost 20% of the PC fleet.

On the contrary, the penetration of D-LDVs is significant, resulting to a higher share compared to G-LDVs. The population of D-LDVs almost doubled, while that of G-LDVs recorded a small increase of about 10% over the period 1995-2005. This has been the effect of lower diesel cost compared to gasoline fuel.

The bus and HDV stock increase is mainly due to the increase of rigid trucks, followed by articulated, while the urban bus and coach fleet remains rather constant over the years.

The fleet of mopeds, accounting for more than half of the PTW stock, decreased considerably (by almost 40%) period 1995-2005. The population of motorcycles (all size classes) also decreased, however to a lesser extent.

Figure RO.2: Evolution of vehicle type population per subsector



Country: **ROMANIA**

RO3/4

Information on the technology of vehicles for Romania was only available for two years (2004 and 2005). Based on these data, the population of almost all technologies increases over these two years. This is an indication that the second-hand market is important in Romania. Unfortunately, there is no consistent information on the technology level or the age of second-hand imports. Therefore, there is a high uncertainty over the implementation matrix of Table RO.1.

The technology mix in Romania (Table RO.2) shows that there is a significant fraction of pre-Euro cars in all vehicle categories. This is more obvious in the case of the HDT and Bus stock, which is dominated by conventional vehicles. The adoption of EU emission regulations after joining the EU may result in significant acceleration of the fleet renewal.

Table RO.1: Implementation matrix (introduction of technologies per year)

Cat.	G-PC			D-PC			G-LDV				D-LDV				BUS			HDT			PTW	
	2	3	4	2	3	4	1	2	3	4	1	2	3	4	II	III	IV	II	III	IV	I	II
2000	100	0	0	100	0	0									100	0	0	100	0	0	100	0
2001	100	0	0	100	0	0	0	100	0	0	0	100	0	0	17	83	0	21	79	0	100	0
2002	49	51	0	0	100	0	0	99	1	0	0	36	64	0	18	82	0	21	79	0	10	90
2003	50	50	0	0	100	0	0	99	1	0	0	36	64	0	15	85	0	20	80	0	9	91
2004	51	49	0	0	100	0	0	99	1	0	0	36	64	0	14	86	0	17	83	0	11	89
2005	28	26	46	0	81	19	0	96	1	3	0	37	63	0	20	80	0	16	83	1	13	87

Table RO.2: Technology mix of the stock per subsector per year

Cat.	G-PC					D-PC					G-LDV					D-LDV					BUS					HDT					PTW		
	C	1	2	3	4	C	1	2	3	4	C	1	2	3	4	C	1	2	3	4	C	I	II	III	IV	C	I	II	III	IV	C	I	II
2000	95	0	5	0	0	91	0	9	0	0	100	0	0	0	0	100	0	0	0	0	99	0	1	0	0	95	0	5	0	0	96	4	0
2001	93	0	7	0	0	86	0	14	0	0	95	0	5	0	0	94	0	6	0	0	96	0	2	2	0	90	0	6	4	0	94	6	0
2002	89	0	9	2	0	73	0	13	14	0	89	0	11	0	0	78	0	12	11	0	95	0	2	3	0	85	0	7	8	0	84	7	10
2003	85	0	10	4	0	62	0	12	26	0	84	0	16	0	0	64	0	16	20	0	93	0	2	5	0	81	0	8	11	0	73	7	20
2004	82	0	12	6	0	51	0	11	38	0	79	0	21	0	0	53	0	20	27	0	91	0	3	7	0	77	0	8	15	0	62	8	29
2005	75	0	13	8	4	39	0	10	48	3	73	0	26	0	0	42	0	24	34	0	89	0	3	8	0	74	0	9	18	0	52	10	38

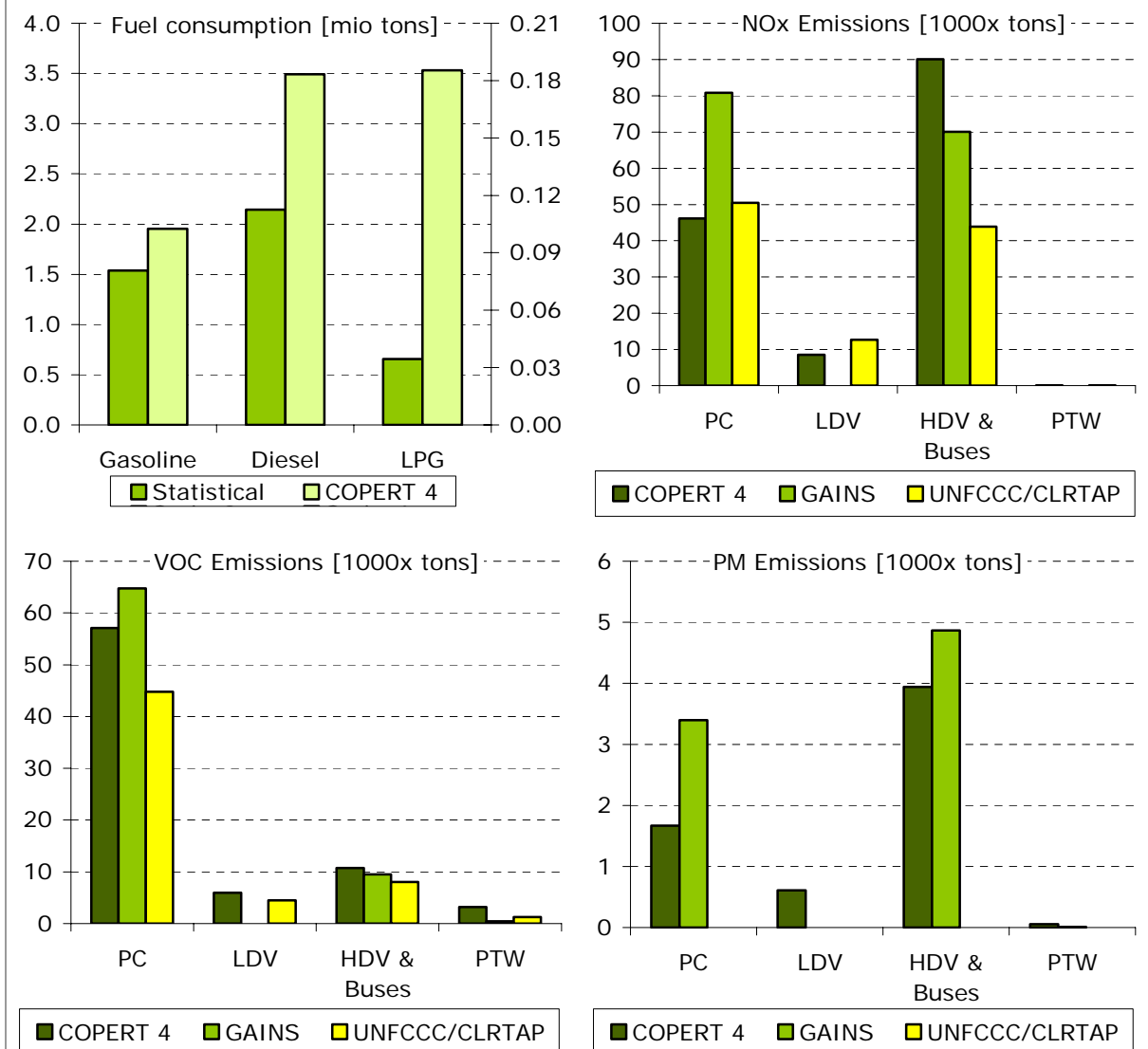
Gasoline and diesel consumption calculated with COPERT 4 are overestimated by 25% and 60% respectively. LPG consumption is also overestimated, being more than 4 times higher than the statistical consumption. These deviations may be explained by the difference in the use of gasoline, diesel and LPG vehicles (mainly annual mileage) considered for the calculations and the real-world vehicle use.

HDV & Buses are the main source of NO_x and PM emissions, followed by PC. Emissions from LDV are generally low, due to the relatively low (compared to other countries) share of D-LDV.

PC and in particular G-PC dominate VOC emissions. Emissions from PC reported under UNFCCC/CLRTAP are about 25% lower than calculated with COPERT 4 due to the fact that evaporative emissions from gasoline vehicles were not included.

In general, all emissions calculated with COPERT 4 are higher compared to the emissions reported under UNFCCC/CLRTAP. Differences with GAINS are much smaller.

Figure RO.3: Results of the calculations with COPERT 4 and the updated fleets compared to other sources



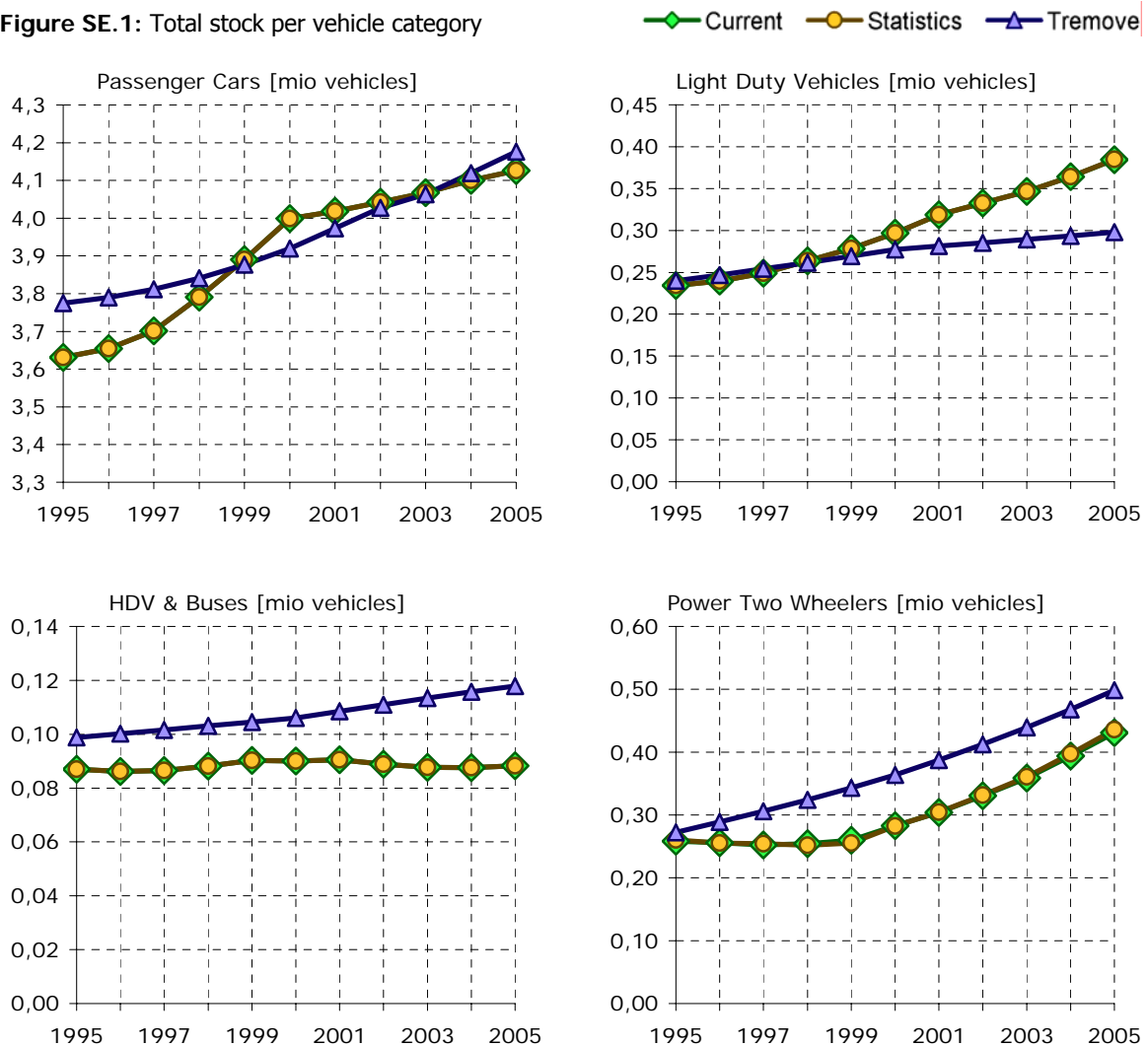
The following were the main sources of information:

- Swedish Road Administration: population, average speed, share (1980-2006)
- Eurostat: fuel consumption data (85-04), new registrations of passenger cars & motorbikes (1989-2004)
- Other sources included UITP, ANFAC Car Park Report, ACEA, Central database of the European Commission for new M1's

The total fleet and the distinction to categories and types should be considered reliable as it originates from updated official databases. The information missing was 25%, with no missing information for the population; 29% of new registrations and 47% of deregistrations missing.

The vehicle stock of Swedish passenger cars increased by 14% between 1995-2005 leading to a stock of ~4,1 mio. vehicles. During the same period the number of LDV's increased by 71% augmenting its share from 6% to 8% of the total fleet. The fleet of HDV and Buses remains relatively constant. The number of PTW's increases significantly by 84% augmenting their share from 6% to 9% if compared to the total vehicle fleet.

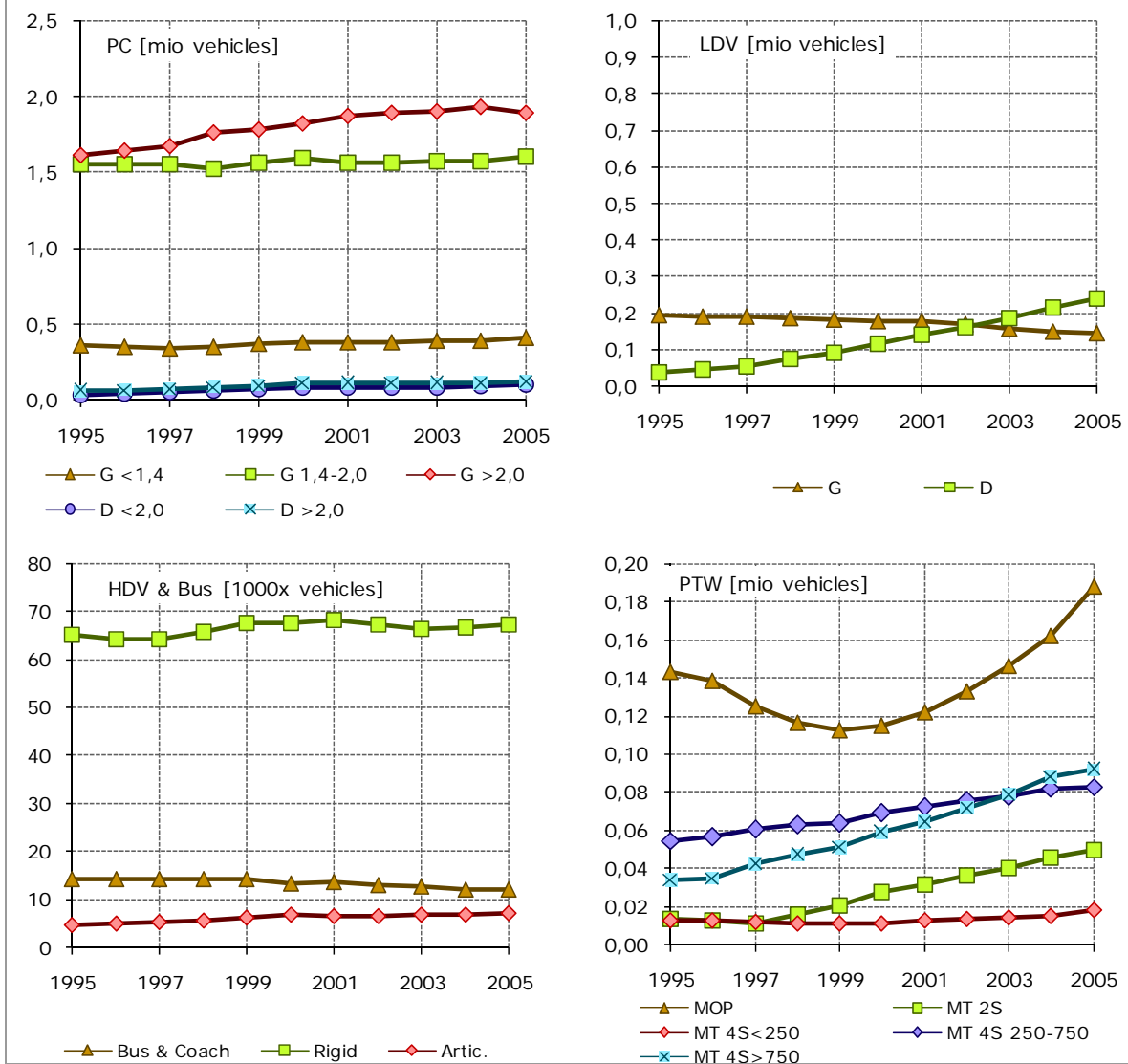
Figure SE.1: Total stock per vehicle category



The passenger car fleet is dominated by a large amount of G-PC with an engine capacity 1,4-2,0 and > 2, while the latter has a higher share (44% vs. 40%) in 2005. Both sectors increased moderately between 1995-2005. The >2,0 sector nevertheless shows a slight decline in 2005. The G-PC <1,4 is slightly increasing at a low share (10%) in comparison with the total passenger cars. The same holds true for D-PC vehicles having a share of 6%.

The share of diesel fuelled LDV's has sextupled between 1995 to 2005 increasing its share from 17% in 1995 to 66% in 2005. During the same period the number of Gasoline LDV as decreased by 31% reducing its share from 83% in 1995 to 35% in 2005. In 2003 the number of D-LDV's is higher for the first time. The number of Buses & Coaches has decreased by 15% between 1995-2005. Both rigid and articulated vehicles increased over the years. Articulated vehicles augmented by 50% although at a very low share. Mopeds represent the largest single PTW fraction with a 47% share of the total. Nevertheless their growth rate has only been 14% between 1995-2005 due to a significant decline between 1996 and 1999. This decline has been shared to a lesser extent by motorcycles <250 cm³. The number of 2 stroke motorcycles has quadrupled since 1995 and the number of motorcycles with an engine capacity >750 has tripled during the same period. Although the number of motorcycles with an engine capacity < 250 and 250-750cm³ raised significantly their share remained at a constant 5% resp. 21% due to the large growth rates of other PTW's.

Figure SE.2: Evolution of vehicle type population per subsector



Country: SWEDEN	SE3/4
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Early introduction schemes for G/D-PC and G-LDV fulfilling Euro 4 can be identified, leading to high shares in 2005 at least for G/D-PC in 2005.

An astounding developed show the G-LDVs as only Euro 1 vehicles are indicate to be newly registered in 2005. Apparently this technology is being reintroduced. The rate of reintroduction is nevertheless questionable. According to Table SE.2 the technology mix of those vehicles shows also a very old technology mix having a share of more than 50% of the total fleet in 2005. In addition a comparison to 2004 reveal an increase of older technologies and a decrease of Euro3 and 4 in 2005.

The other passenger cars and light duty vehicles show an even distribution mix. The only remarkable points are a relative high share of non-catalyst cars and Euro4 cars within the G-PC sector and a comparably low amount of non catalyst cars in the D-PC and D-LDV sector.

Table SE.1: Implementation matrix (introduction of technologies per year)

Cat.	G-PC			D-PC			G-LDV				D-LDV				BUS			HDT			PTW	
	2	3	4	2	3	4	1	2	3	4	1	2	3	4	II	III	IV	II	III	IV	I	II
2000	65	7	28	85	13	1	40	58	1	1	29	70	1	0	100	0	0	100	0	0	100	0
2001	49	26	25	10	90	0	27	58	9	6	91	0	9	0	100	0	0	41	59	0	100	0
2002	0	30	70	22	77	1	0	0	70	30	0	56	44	0	9	91	0	2	98	0	100	0
2003	0	25	75	26	71	3	0	0	52	48	21	31	47	0	0	100	0	2	98	0	17	83
2004	0	20	80	0	86	14	0	0	37	63	20	25	55	0	0	100	0	2	98	0	23	77
2005	0	13	87	0	14	86	100	0	0	0	0	28	70	3	0	100	0	0	100	0	13	87

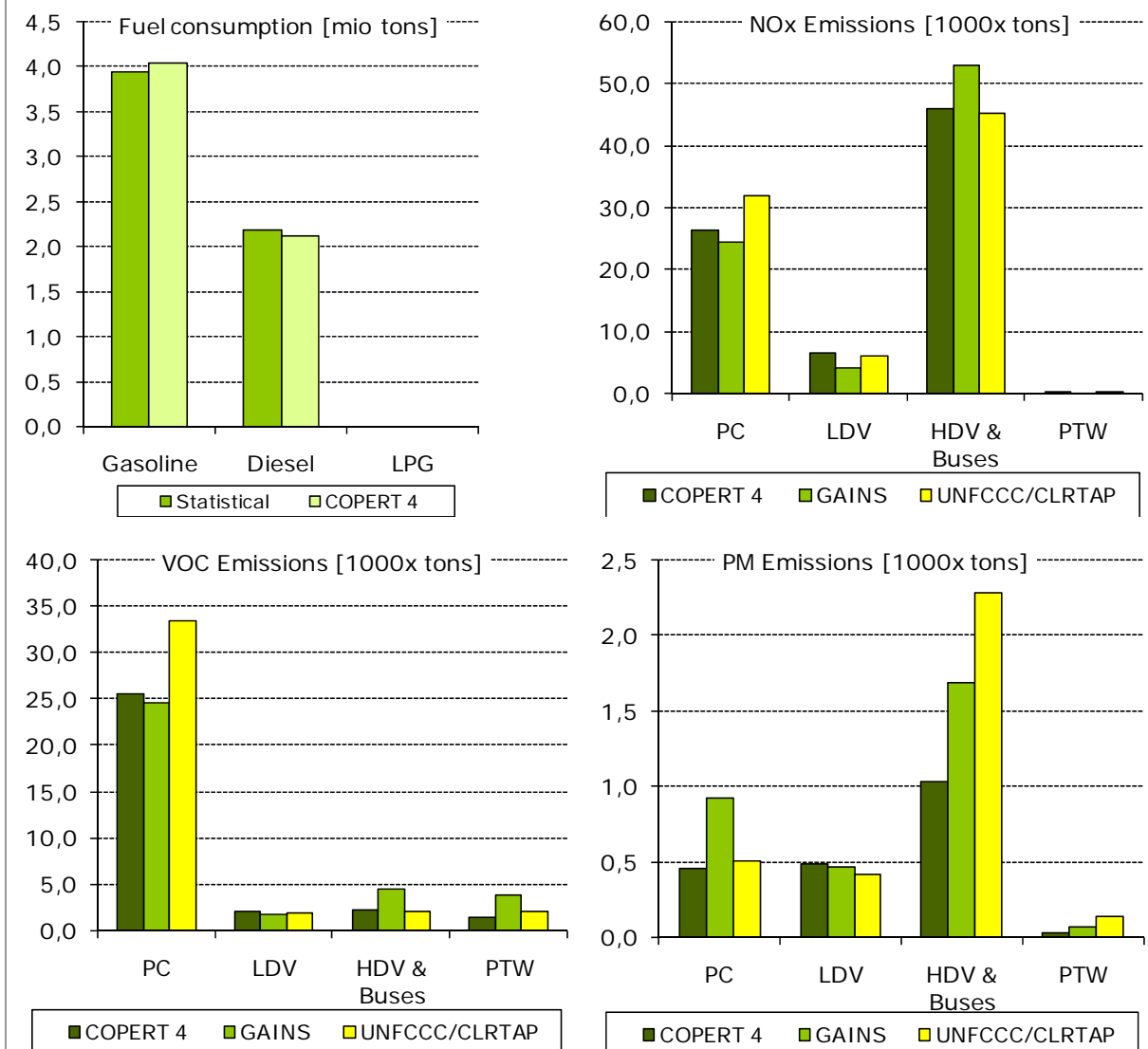
Table SE.2: Technology mix of the stock per subsector per year

Cat.	G-PC					D-PC					G-LDV					D-LDV					BUS					HDT					PTW		
	C	1	2	3	4	C	1	2	3	4	C	1	2	3	4	C	1	2	3	4	C	I	II	III	IV	C	I	II	III	IV	C	I	II
2000	40	25	32	1	2	25	26	47	2	0	53	25	23	0	0	40	23	37	0	0	45	18	38	0	0	56	12	32	0	0	78	22	0
2001	31	25	37	3	5	8	34	47	12	0	42	27	29	1	1	41	30	27	1	0	29	25	46	0	0	45	18	33	3	0	76	24	0
2002	28	22	35	5	10	7	23	48	21	0	38	25	29	5	3	42	24	28	6	0	22	22	48	8	0	41	16	34	10	0	69	31	0
2003	24	21	33	7	15	7	13	50	30	1	34	22	29	9	6	38	22	28	12	0	17	19	48	17	0	38	13	33	16	0	63	29	8
2004	19	21	31	8	20	6	8	45	39	2	32	22	25	11	10	31	21	27	20	0	14	14	45	26	0	35	9	32	23	0	56	29	15
2005	16	21	30	9	24	4	15	36	35	10	35	26	22	8	9	9	17	33	40	1	10	13	43	34	0	31	7	31	31	0	50	27	22

The fuel consumption values of the different sources match quite well. No fuel consumption values for LPG are available.

The main contributor of NOx emissions are HDV & Buses. The COPERT and UNFCCC/CLRTAP value showing good match at ~ 45.000tons while the Gains value indicated a value being 7.000tons higher. For the other vehicle types Gains shows always the lowest value. Depending on the source the passenger cars emit between 25.000 and 32.000 tons NOx. Again for the LDV the COPERT and UNFCCC/CLRTAP values match closely around 6.000tons while the value stemming from Gains estimates lower emissions. Passenger cars are the main contributor for VOC emissions with about 25.000tons according to COPERT & Gains and 33.000tons according to UNFCCC/CLRTAP. The emissions for the other vehicle types are significantly lower than 5.000 tons. The different sources show very good matches for LDV's. For HDV, Buses and PTW the COPERT and UNFCCC/CLRTAP correspond with each other, while the Gains value is significantly higher in both cases. The largest contributor for PM are HDV & Buses with emissions between 1.000tons (COPERT) to 2.300tons (UNFCCC/CLRTAP). PC and LDV follow far behind with 500tons ignoring the peak value for passenger cars stemming from Gains. The reasons for the deviation between national submissions and COPERT for PM needs to be further examined.

Figure SE.3: Results of the calculations with COPERT 4 and the updated fleets compared to other sources



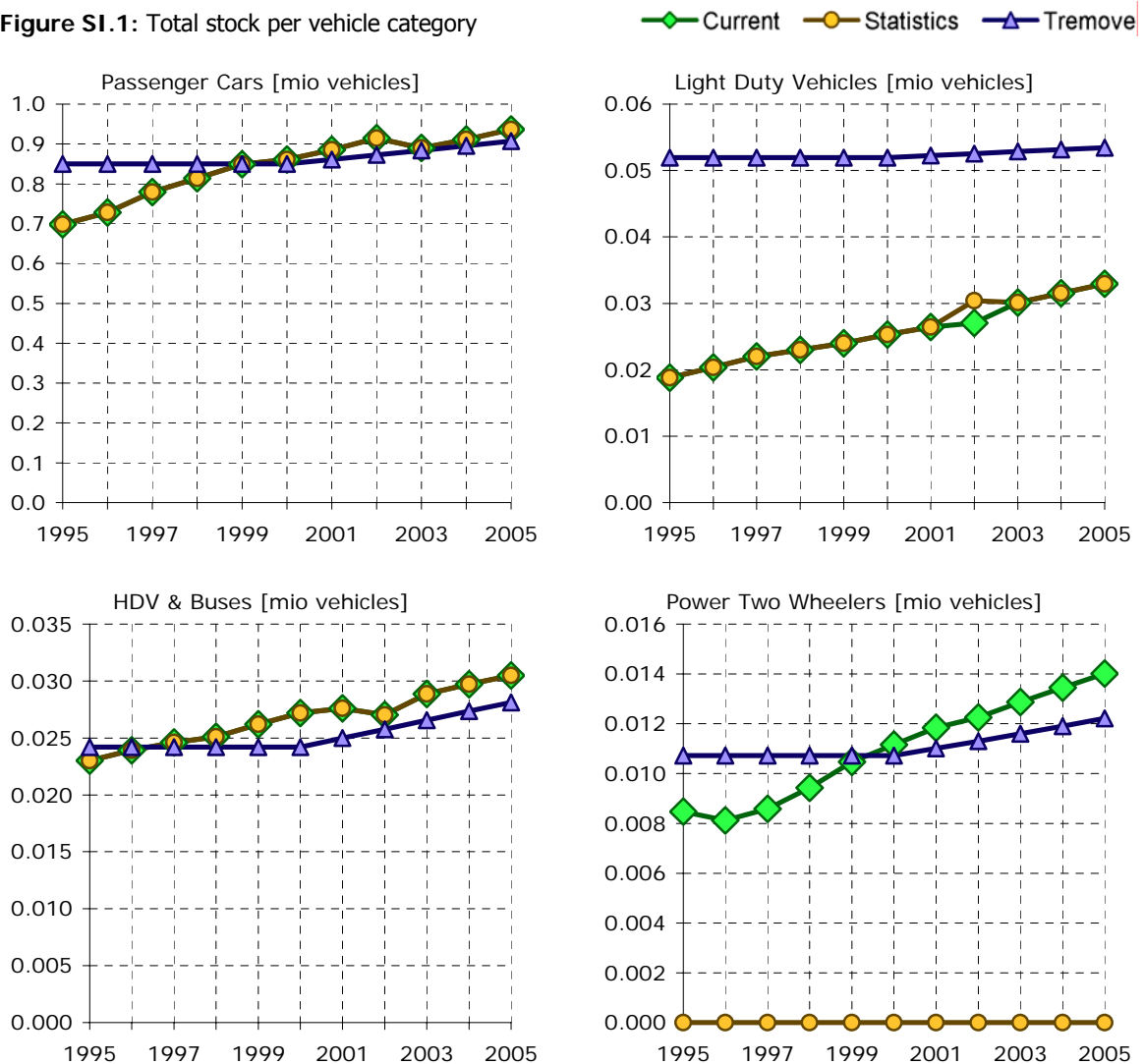
The following were the main sources of information:

- Total fleets per category: Eurostat (1990-2005), Ministry of the Environment and Spatial Planning (1995-2005)
- Split in types: Eurostat (1990-2005)
- New registrations: Eurostat (1990-2002), ACEA (2003-2006)
- Age/technology distribution of vehicles: Ministry of the Environment and Spatial Planning (2000, 2005)
- Other sources included UITP

40% of the total information was missing, split into 43% of total stock, 23% of new registrations and 52% of deregistrations. The main information missing was technology distinction for more years. The total fleet and the distinction to categories and types should be considered reliable as it originates from updated official databases.

The number of passenger cars in Slovenia has increased from 0.7 to almost 1 mio vehicles over the period 1995-2005. A similar increase was also recorded for HDVs, buses & coaches, while LDVs and PTWs were increased by about 70% over the same period.

Figure SI.1: Total stock per vehicle category

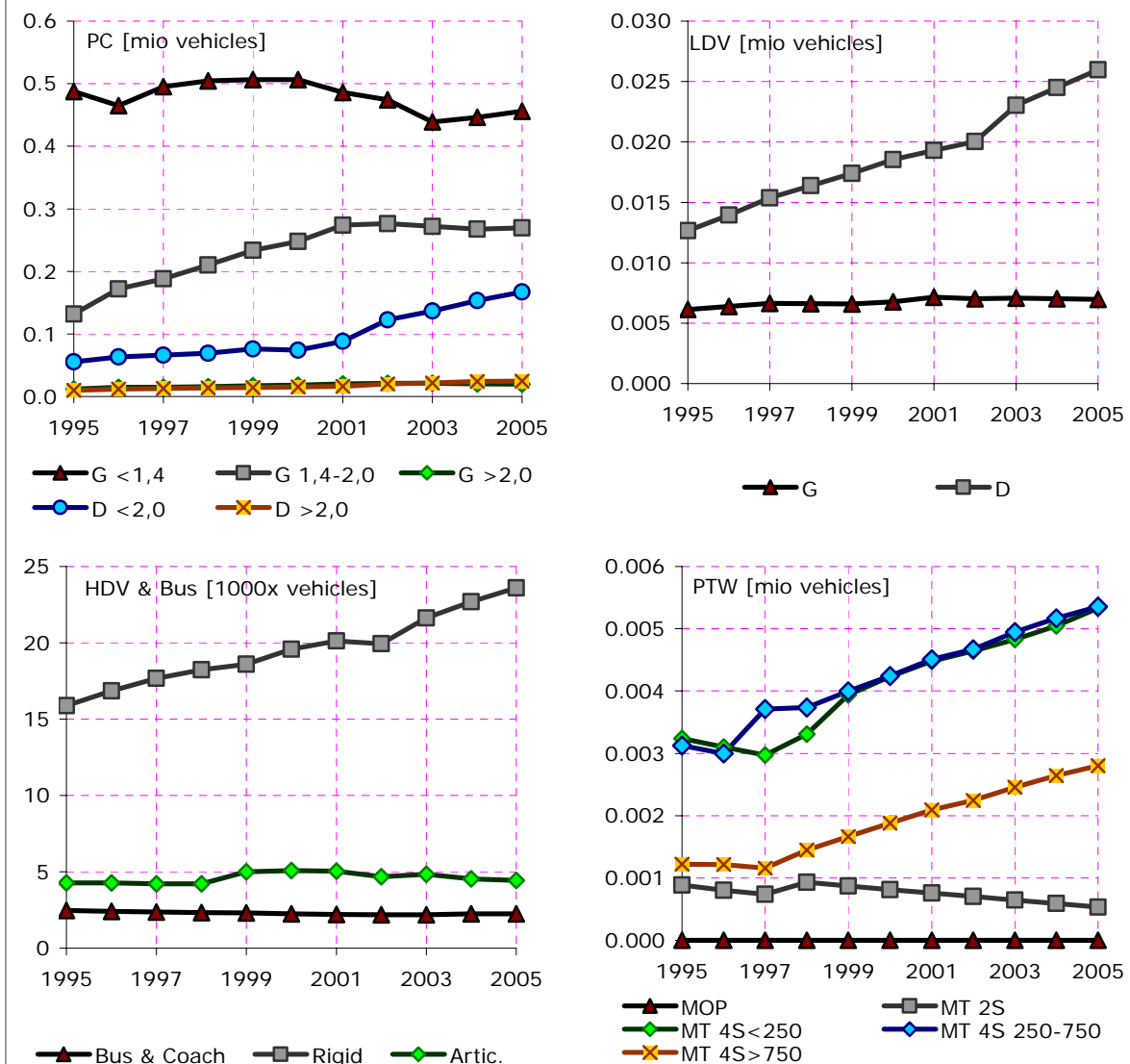


Although small G-PC (<1,4 l) have decreased over the period 1995-2005, they account for almost 50% of the total PC fleet. G-PC falling in the small and medium class (<1,4 & 1,4-2,0 l) dominate the passenger car fleet, accounting for more than 75% of the fleet. The respective share of large (>2.0 l) G-PC is as low as 2.5%. The population of D-PC fleet has increased considerably, exceeding 20% of the total PC fleet in 2005.

The LDV fleet has also expanded, mainly due to D-LDVs, which have doubled their population over the period 1995-2005. G-LDVs have recorded a small increase of about 15%.

The bus and HDV stock increase is mainly due to the increase of rigid trucks, while the articulated truck fleet remains rather constant over the years. The fleet of buses & coaches decreased by about 10% over

Figure SI.2: Evolution of vehicle type population per subsector



Information on the technology of vehicles for Slovenia was only available for two years (2000 and 2005). Therefore, the implementation matrix largely follows the implementation dates considered by the regulations. According to statistical data, Euro 4 PCs are already introduced in 2005, one year earlier than the official implementation date. Since there is no information on the registration of second-hand vehicles, the technology replacement might be slower than suggested by the implementation matrix of table SI.1.

The Slovenian vehicle fleet is one of the youngest in the EU. Most pre-Euro vehicles are phased-out in 2005, with Euro 2 and 3 PCs and LDVs and Euro II and III buses and HDVs dominating the fleet, resulting in a fast technology replacement.

Table SI.1: Implementation matrix (introduction of technologies per year)

Cat.	G-PC			D-PC			G-LDV				D-LDV				BUS			HDT			PTW	
	2	3	4	2	3	4	1	2	3	4	1	2	3	4	II	III	IV	II	III	IV	I	II
2000	100	0	0	100	0	0	0	100	0	0	0	100	0	0	100	0	0	100	0	0	100	0
2001	84	16	0	100	0	0	0	63	37	0	0	0	100	0	70	30	0	81	19	0	100	0
2002	0	100	0	0	100	0	0	0	100	0	0	0	100	0	0	100	0	0	100	0	100	0
2003	0	100	0	0	100	0	0	0	100	0	0	0	100	0	0	100	0	0	100	0	100	0
2004	0	100	0	0	100	0	0	0	100	0	0	0	100	0	0	100	0	0	100	0	100	0
2005	0	43	57	0	0	100	0	0	100	0	0	0	100	0	0	100	0	0	100	0	100	0

Table SI.2: Technology mix of the stock per subsector per year

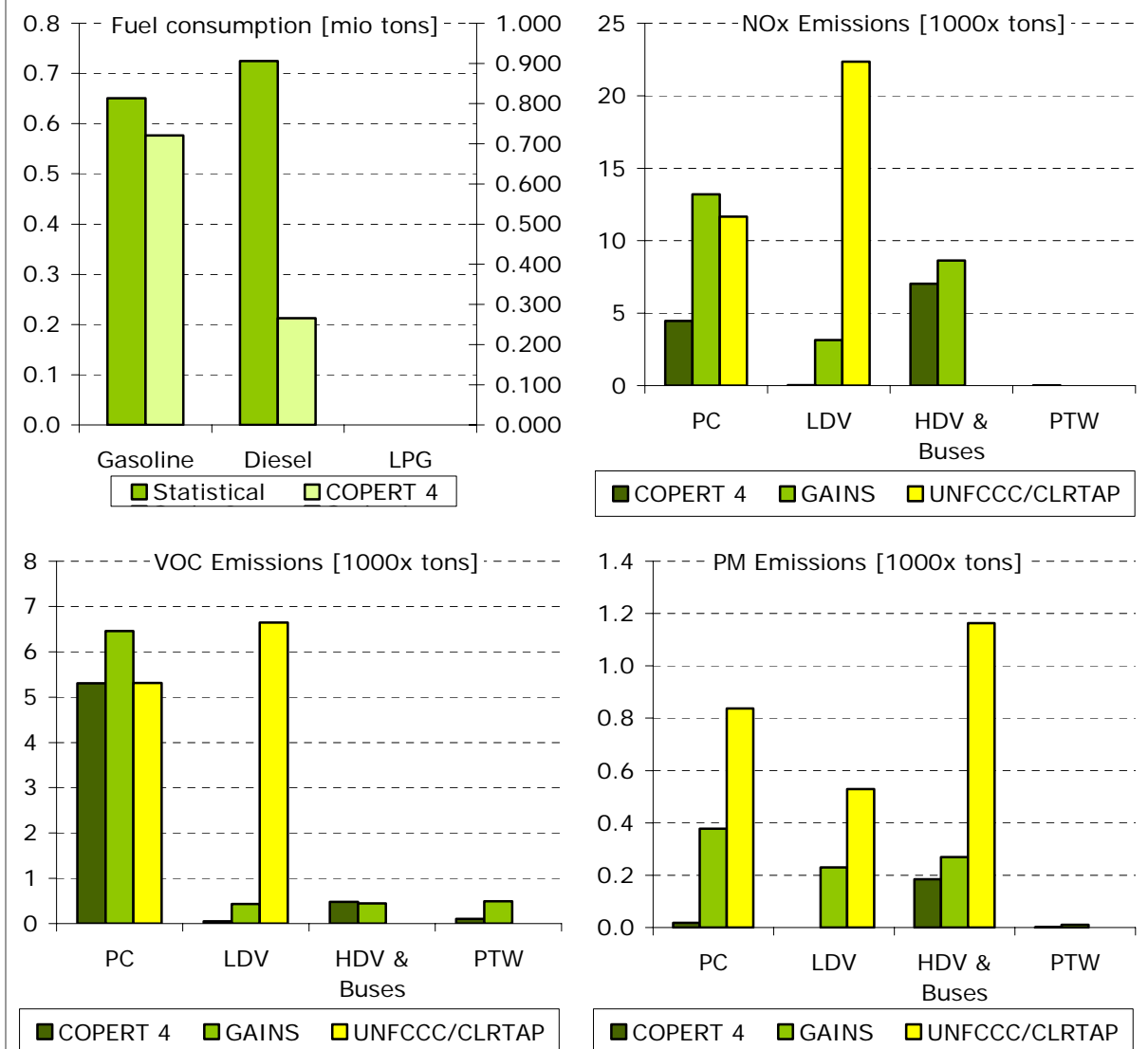
Cat.	G-PC					D-PC					G-LDV					D-LDV					BUS					HDT					PTW		
	C	1	2	3	4	C	1	2	3	4	C	1	2	3	4	C	1	2	3	4	C	I	II	III	IV	C	I	II	III	IV	C	I	II
2000	38	31	31	0	0	57	16	26	0	0	25	31	44	0	0	38	33	29	0	0	56	15	29	0	0	44	17	39	0	0	76	24	0
2001	29	30	39	2	0	44	13	43	0	0	16	28	50	6	0	26	29	28	17	0	39	14	41	5	0	31	14	51	3	0	68	32	0
2002	25	29	39	7	0	29	10	31	31	0	13	26	50	11	0	20	26	26	28	0	34	14	40	12	0	27	13	49	11	0	62	38	0
2003	21	30	39	10	0	24	8	27	41	0	9	24	47	19	0	13	19	22	46	0	29	14	38	19	0	25	11	45	20	0	56	44	0
2004	17	29	37	16	0	20	7	23	51	0	8	22	45	25	0	11	16	21	52	0	27	13	36	24	0	22	9	39	30	0	51	49	0
2005	15	28	34	19	4	17	6	20	46	11	6	21	43	30	0	9	14	19	58	0	25	13	34	28	0	20	8	33	39	0	45	55	0

Gasoline and diesel consumption calculated with COPERT 4 are underestimated by 10% and 70% respectively compared to statistical consumption. For gasoline this may be explained by the difference in the use of gasoline vehicles (mainly annual mileage) considered for the calculations and the real-world vehicle use. The larger deviation in diesel consumption may be explained by the fuel tourism, i.e. diesel vehicles traveling to neighboring former Yugoslav countries for fuelling, due to lower diesel fuel prices.

HDV & Buses dominate NOx emissions, followed by PC. Although the D-PC share is relatively low, their NOx emissions are comparable those of HDV & Buses. This is due to the very low population of the latter, which is about one tenth of the respective population in Greece.

For the same reason, PC are the main source of PM emissions, followed by HDV & Buses and LDV. PC and in particular G-PC dominate VOC emissions.

Figure SI.3: Results of the calculations with COPERT 4 and the updated fleets compared to other sources



The required data were produced by using the COPERT III tables for years 1990 and 2004 submitted by the national expert of Slovakia. From this, we deduced the distribution of vehicles required at COPERT 4. The information missing was 36%, with 32% of the total stock, 31% of enw registrations and 45% of deregistrations missing.

Since COPERT III contains a much simpler distribution for HDTs than what is currently required, the following method was applied on the basis of available data:

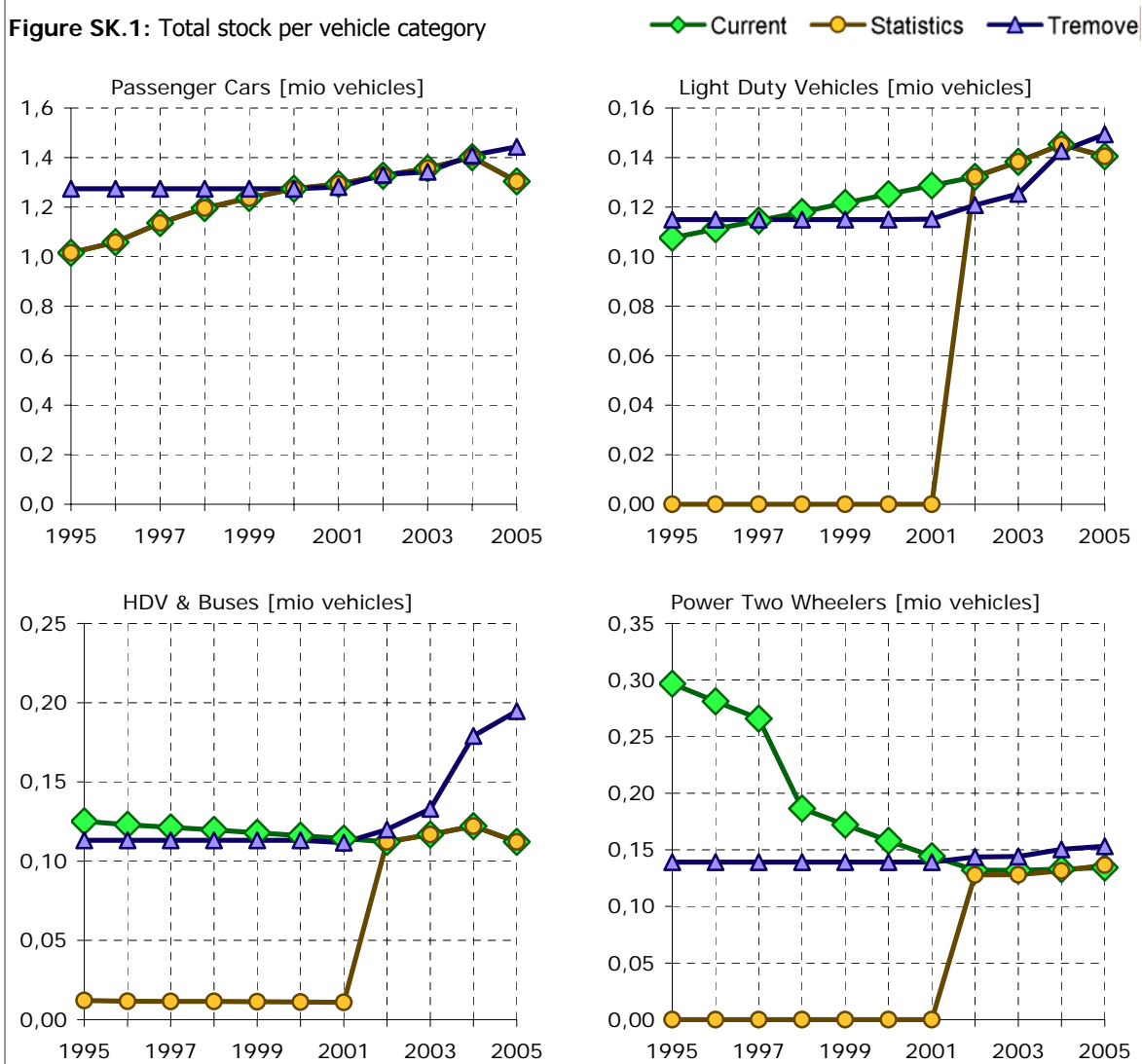
- A distribution curve (by maximum gross weight) was fitted to the available data;
- The number of HDT-s within any of the new weight classes was estimated;
- A further distribution into rigid lorries and articulated road tractors was produced on the basis of other countries' data – but with regard to emissions this latter is not of great importance.

For buses the solo-articulated ratio was estimated on the basis of the Hungarian and Czech stock.

It is worth considering, that stock data offered by the national expert are rather different from the ones in Eurostat. There are 20% less PCs, several times less LDVs, about 30% more HDTs and more than 10% less buses in Eurostat. The following figures rather represent the data submitted from the national expert and not the Eurostat ones.

On the basis of data by the expert between 1990 and 2006, there is a notable, near steady increase in passenger car and light duty lorry stock. The decrease of them in 2005 could be caused by an economic impact. There is a distinct stock of powered two-wheelers in Slovakia, proportionally much more than in Northern countries, but not as considerable as in the Mediterranean region. Motorcycle stock decreased significantly in this period.

Figure SK.1: Total stock per vehicle category



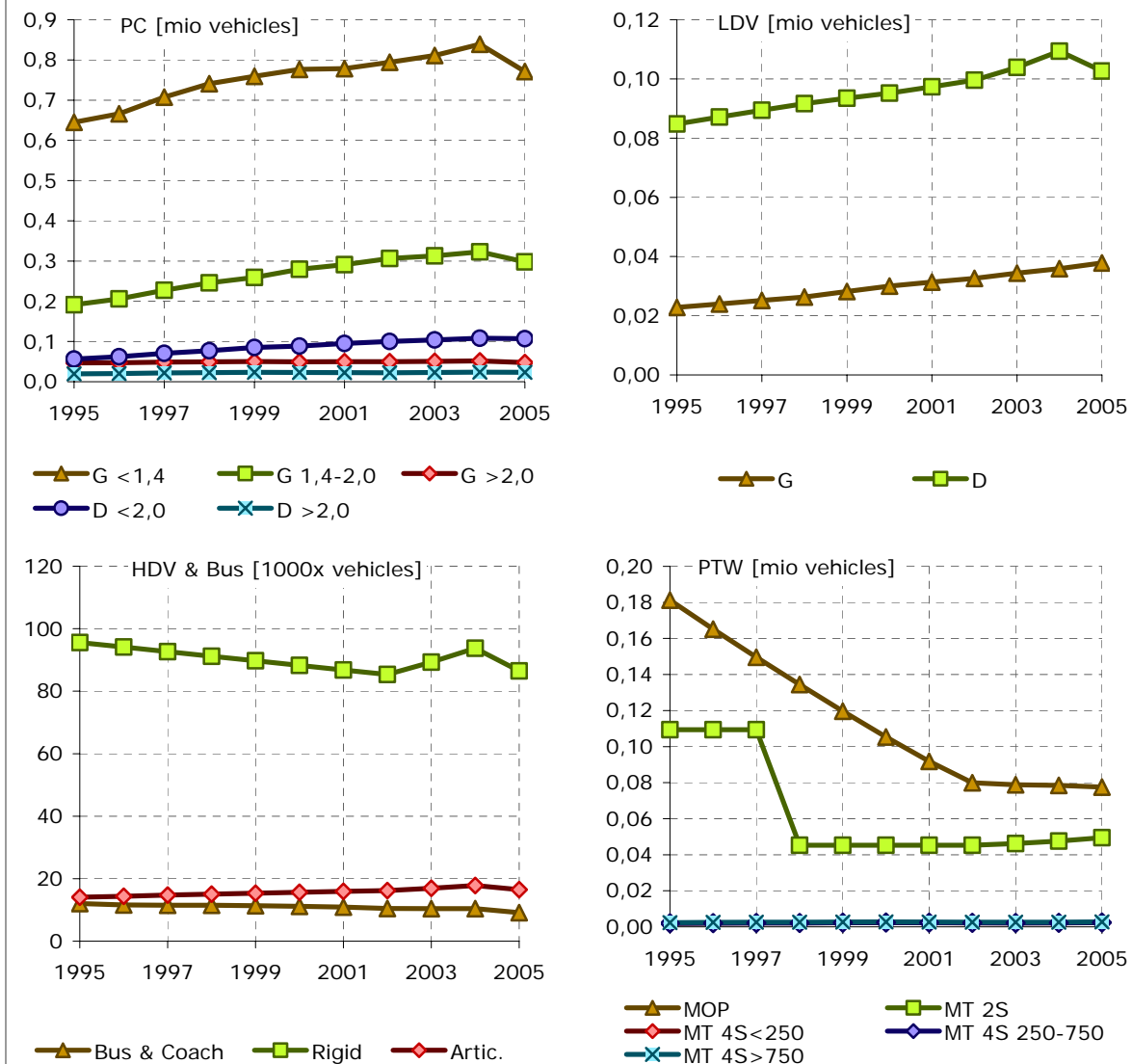
In relation to the chart below on passenger cars, there are only very few data on distribution by fuel type and engine displacement –it had to be determined the fleet data for 2002, 2003 and 2005 from them. But it can be seen from the tendency that a rising share of cars is diesel fuelled, and in the whole fleet far the less powered category cars are preferred. There are only very few cars of above two litre displacement.

In case of light duty lorries there are even less data available to estimate the distribution between fuel types. There is a little rising of diesel share, too.

Articulated trucks had an increasing importance in the Slovak goods vehicle fleet, this is shown by the third chart. This is no wonder, in the Middle European region the short-distance transport of goods was on a rising tendency in the latest decade. The amount of buses decreased: it can be in relation to the decreasing demand on public passenger transport.

Also for motorcycles, that there were no available data for us to estimate the development of shares of subclasses. So the tendency for mopeds seeming to become no-decreasing any more in the last years of the chart is questionable. In Slovakia there were a lot of small mopeds and two-stroke engine motorcycles in this period.

Figure SK.2: Evolution of vehicle type population per category



Country: **SLOVAKIA**

SK3/4

The emission technology distribution of vehicles was delivered for every vehicle subclass in 2004 by the Slovak expert. Table SK.1 shows the distribution of new registrations to different technology level. The table shows that several of the vehicles introduced in the fleet are considered second-hand ones. Therefore, there is a distribution of emission standards in one or more technologies per year, to reflect the registration of second-hand and new cars.

The generally increasing trend for the Slovak fleet of PCs and LDVs means that there is general an introduction of new technologies over the last years. However, based on the available data of new registrations from ACEA and the increase in the total fleet size mean that the deregistration rate is rather small. This means that although new vehicles are introduced, there is still a large fraction of older technologies which are very slowly removed from the fleet.

As it can be seen from *Table SK.2*, petrol fuelled light duty lorries and perhaps petrol fuelled passenger cars have a relative new stock, opposite to other vehicle categories – especially the heavy duty truck and bus stock is rather old. (It is valid exactly just for 2004, but based on the previous analysis, this conclusion can be generalized to 2005 and later as well).

Table SK.1: Implementation matrix (introduction of technologies per year)

Cat.	G-PC			D-PC			G-LDV				D-LDV				BUS			HDT			PTW	
	2	3	4	2	3	4	1	2	3	4	1	2	3	4	II	III	IV	II	III	IV	I	II
2000	25	75	0	53	47	0	0	66	34	0	15	53	32	0	100	0	0	100	0	0	100	0
2001	26	74	0	54	46	0	0	0	100	0	20	48	33	0	76	24	0	23	77	0	100	0
2002	28	72	0	57	43	0	0	0	100	0	27	44	30	0	72	28	0	22	78	0	100	0
2003	3	97	0	0	100	0	0	0	100	0	38	10	52	0	26	74	0	25	75	0	40	60
2004	0	100	0	0	100	0	0	0	100	0	0	0	100	0	2	98	0	20	80	0	39	61
2005	0	100	0	0	100	0	0	0	100	0	0	0	100	0	0	100	0	0	100	0	51	49

Table SK.2: Technology mix of the stock per subsector per year

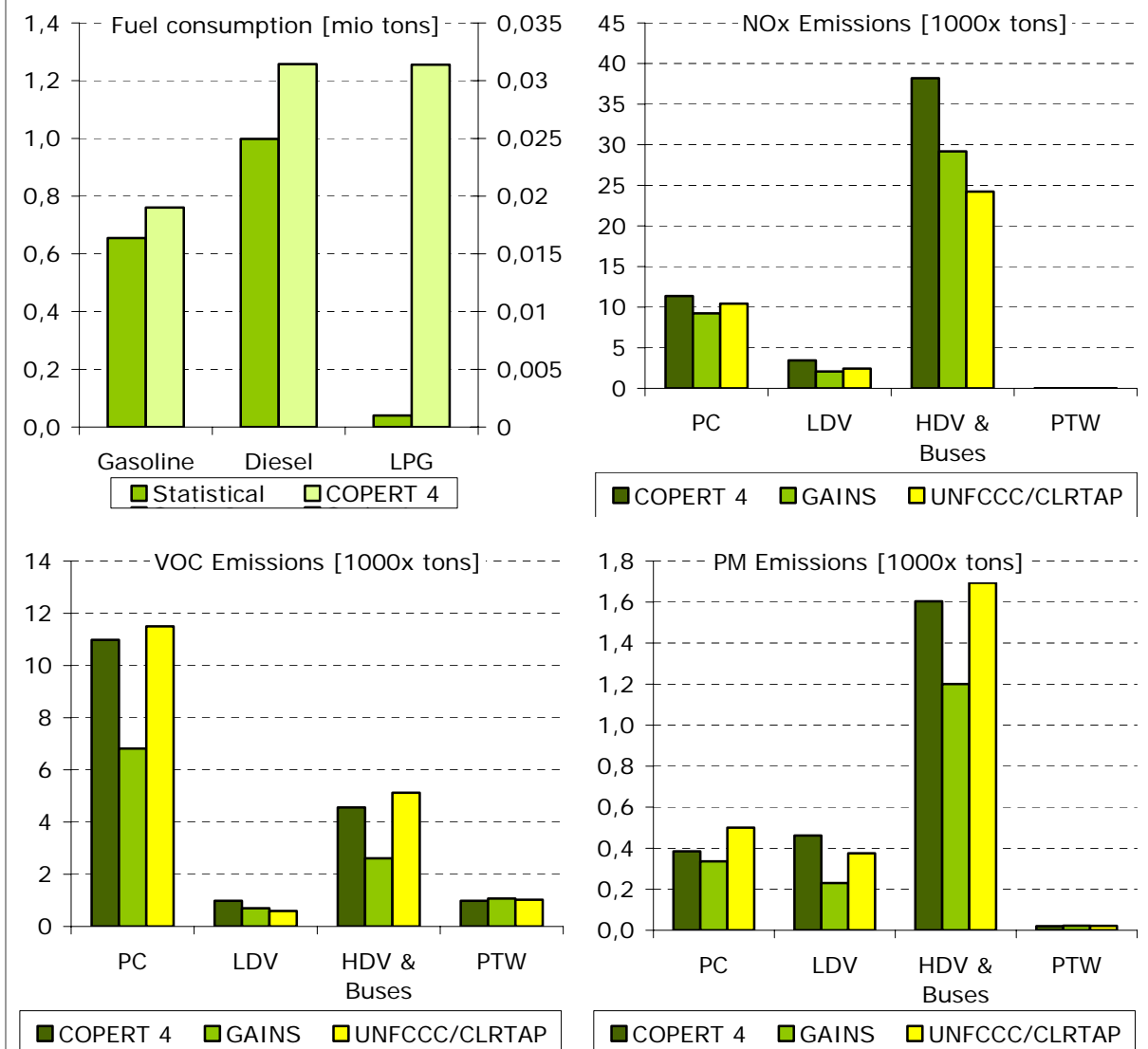
Cat.	G-PC					D-PC					G-LDV					D-LDV					BUS					HDT					PTW		
	C	1	2	3	4	C	1	2	3	4	C	1	2	3	4	C	1	2	3	4	C	I	II	III	IV	C	I	II	III	IV	C	I	II
2000	61	32	3	4	0	78	15	5	2	0	62	11	21	5	0	94	3	3	1	0	88	10	3	0	0	94	2	3	0	0	98	2	0
2001	57	31	4	8	0	75	13	7	4	0	59	10	20	11	0	92	3	4	2	0	87	10	3	0	0	91	3	4	2	0	98	2	0
2002	54	29	5	11	0	72	13	9	6	0	56	9	19	16	0	89	3	5	2	0	87	10	3	0	0	89	3	5	4	0	97	3	0
2003	50	28	5	17	0	68	12	9	11	0	48	9	18	26	0	89	4	5	3	0	83	10	4	3	0	86	3	5	6	0	94	4	2
2004	46	27	5	21	0	64	11	9	16	0	40	8	17	35	0	79	3	5	13	0	80	10	4	6	0	82	3	6	9	0	91	5	3
2005	37	29	5	28	0	60	11	8	21	0	36	8	16	41	0	69	3	5	23	0	75	12	4	9	0	77	4	6	13	0	88	7	5

In connection with the *Fuel consumption* chart, apart from the relative low deviation between statistical (Eurostat) data and computation results from recent COPERT method (for which there is the explanation stated in case of several other countries), the main problem is the notable difference in the road transportation LPG consumption by the two methods. The Slovakian expert attached a table containing data for fuel consumptions per not only fuel type but also vehicle class, and the data generated from COPERT method agree with the mentioned national fuel consumption data and not with Eurostat data (and also in case of petrol and diesel oil consumption there is a better accord with former than with the latter).

The annual total mileage by COPERT 4 method is for petrol PC-s 12 000, diesel PC-s 2 400, petrol LDV-s 600, diesel LDV-s 1 800, HDT-s and buses 5 000 and for PTW-s 170 million vkm in 2004. On the basis of fuel consumption data (as it is in close relation with mileage), these mileage data increased by about 25% for trucks, buses and motorcycles, and just by hardly 10% for passenger cars.

Also from these data and the charts below one can confirm that heavy duty truck and motorcycle stock is really old. In order to improve the national road transport emission level, mainly the old diesel engine vehicles, especially heavy duty trucks and buses should be replaced as soon as possible for a fleet modernization, but there are a lot of very old petrol fuelled cars, too.

Figure SK.3: Results of the calculations with COPERT 4 and the updated fleets compared to other sources



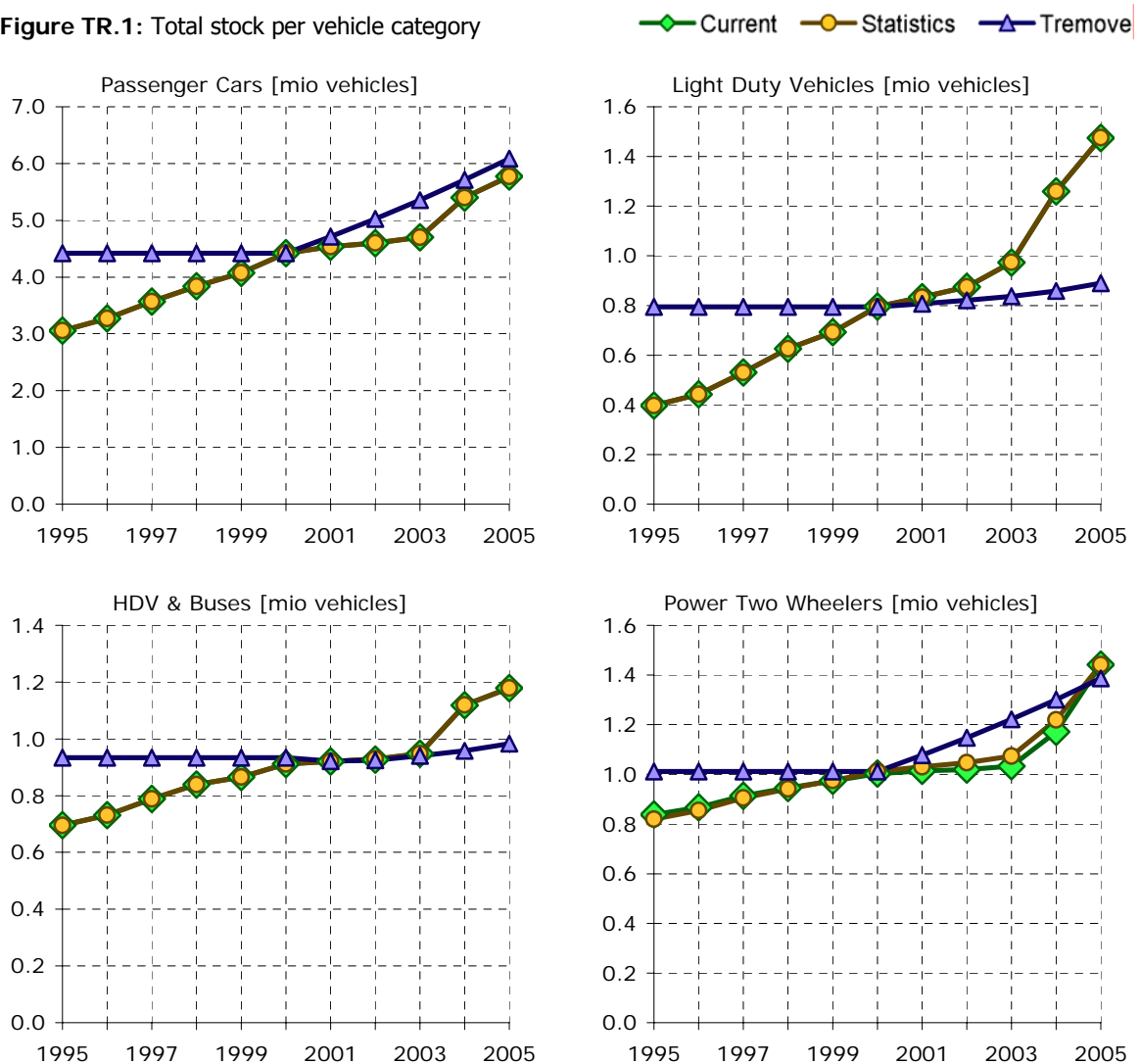
The following were the main sources of information:

- Total fleets per category: UNECE (1993-1994), Turkish Statistical Institute (1995-2006)
- Split in types: no relevant information was available
- New registrations: Eurostat and ACEA (1994-2006)
- Age/technology distribution of vehicles: Relevant Journal paper (2004, only for gasoline passenger cars)

The information missing was 40%, split as 46% of the total fleet, 26% of new registrations and 44% of deregistrations. Apart from total numbers for the main vehicle categories, no other information was available. In the absence of any other data, information from the Greek fleet was used for the distribution into fuel and weight classes. The total fleet should be considered reliable as it originates from updated official databases. However, the distinction to categories and types should be treated with caution as it is based on assumptions, as explained above.

There is a significant increase of all vehicle categories over the period 1995-2005 in Turkey, especially for LDVs which almost quadrupled from 0,4 mio in 1995 to 1,5 mio in 2005 and PC which doubled their population from 3 mio in 1995 to 6 mio vehicles in 2005.

Figure TR.1: Total stock per vehicle category



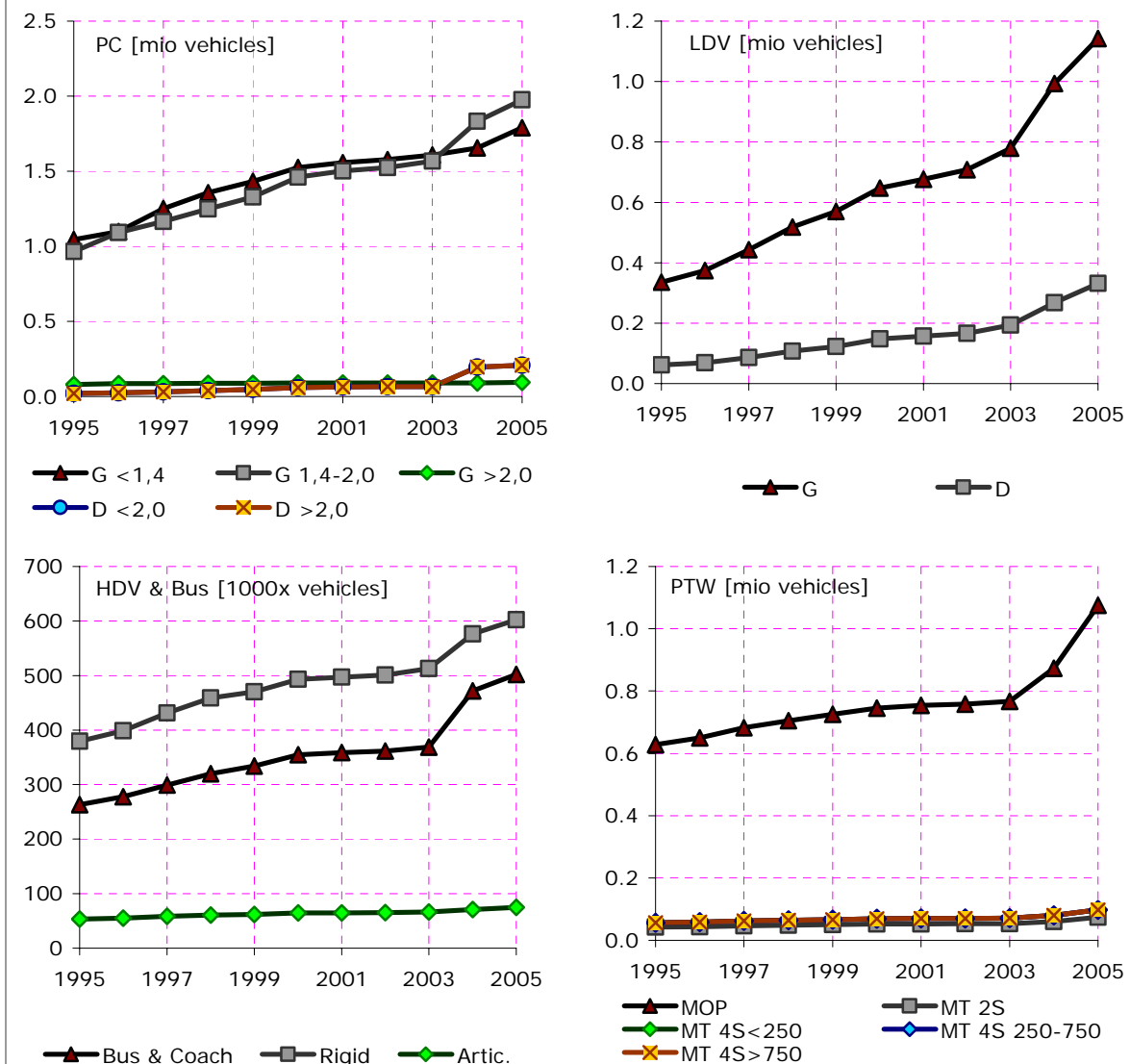
The passenger car fleet is dominated by G-PC falling in the small and medium (<1.4 & 1.4-2.0 l) class. Their fleet increased by more than 40% over the period 1995-2005. Large (>2.0 l) G-PC are less than 2% of the total G-PC fleet. This is probably due to the combined effect of higher purchase price of >2.0 l G-PC and the low GDP in Turkey. The penetration of D-PC is still low, accounting for about 10% of the PC fleet.

Contrarily to most European countries, the penetration of D-LDVs is very low despite the significant increase. The population of G-LDVs more than tripled over the period 1995-2005, accounting for 75% of the LDV fleet in 2005.

The bus and HDV stock has also increased, with the population of urban bus and coach doubling over the years.

The fleet of mopeds, accounting for 75% of the PTW stock increased considerably (by more than 70%). The population of motorcycles (all size classes) recorded similar increases.

Figure TR.2: Evolution of vehicle type population per subsector



Information on the technology of vehicles for Turkey was available only for G-PC and for one year (2004). Therefore, the implementation matrix largely follows the implementation dates considered by the regulations. The effect of this would be that the fleet developed in this project leads to a faster technology replacement than what occurs in reality. Because of this, there is a high uncertainty over the implementation matrix of Table TR.1.

As mentioned above, information on the vehicle allocation into technology classes for Turkey was very scarce and therefore the technology mix shown in Table TR.2 is only indicative.

Table TR.1: Implementation matrix (introduction of technologies per year)

Cat.	G-PC			D-PC			G-LDV				D-LDV				BUS			HDT			PTW	
	2	3	4	2	3	4	1	2	3	4	1	2	3	4	II	III	IV	II	III	IV	I	II
2000							100	0	0	0	100	0	0	0	100	0	0	100	0	0	100	0
2001							0	100	0	0	0	100	0	0	0	100	0	0	100	0	100	0
2002	0	100	0	0	100	0	0	0	100	0	0	0	100	0	0	100	0	0	100	0	27	73
2003	0	100	0	0	100	0	0	0	100	0	0	0	100	0	0	100	0	0	100	0	0	100
2004	0	100	0	0	100	0	0	0	100	0	0	0	100	0	0	100	0	0	100	0	0	100
2005	0	100	0	0	100	0	0	0	100	0	0	0	100	0	0	100	0	0	100	0	0	100

Table TR.2: Technology mix of the stock per subsector per year

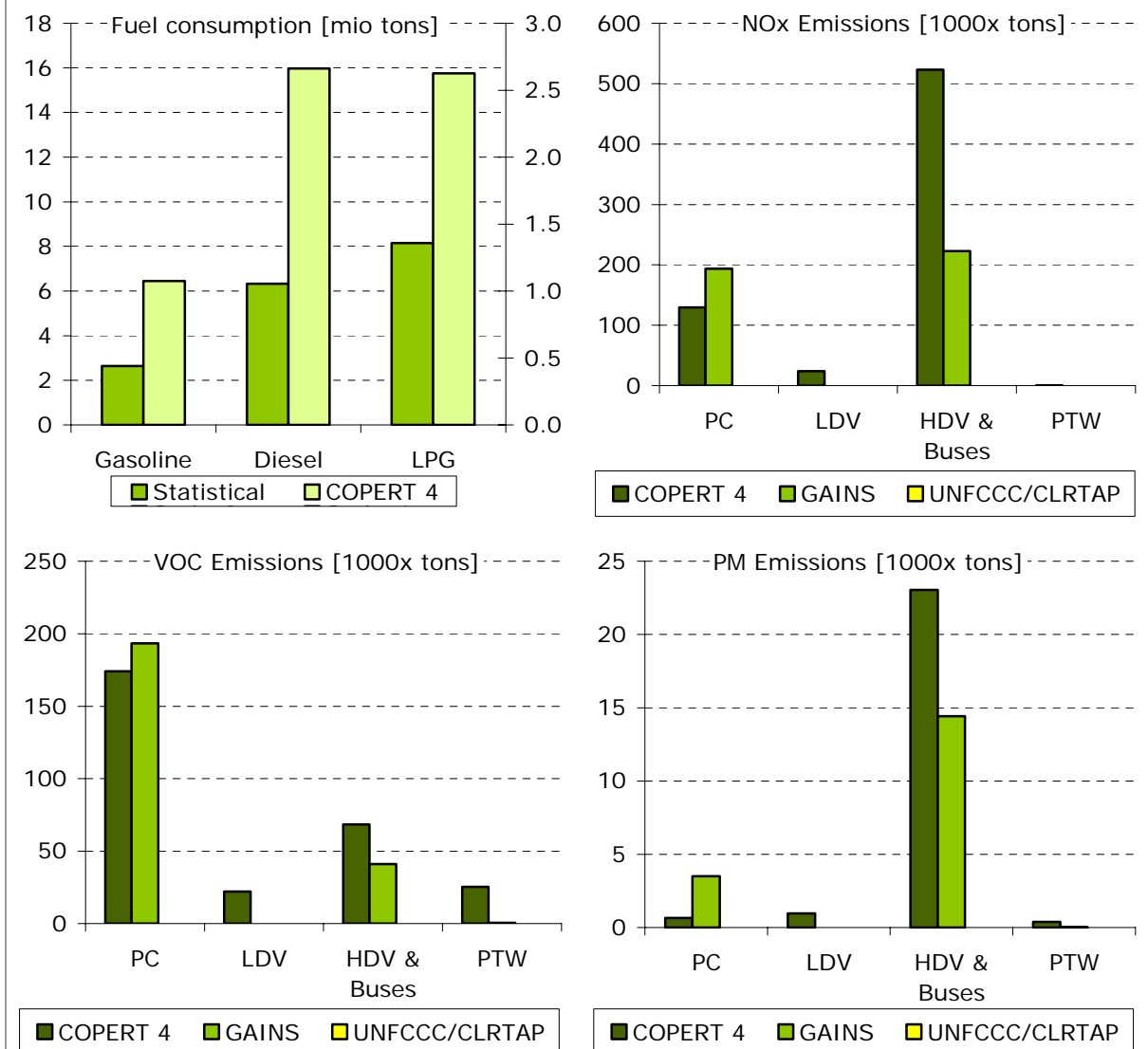
Cat.	G-PC					D-PC					G-LDV					D-LDV					BUS					HDT					PTW		
	C	1	2	3	4	C	1	2	3	4	C	1	2	3	4	C	1	2	3	4	C	I	II	III	IV	C	I	II	III	IV	C	I	II
2000	72	28	0	0	0	22	78	0	0	0	55	45	0	0	0	42	58	0	0	0	71	4	25	0	0	77	4	19	0	0	86	14	0
2001	70	30	0	0	0	19	81	0	0	0	52	43	5	0	0	39	54	7	0	0	70	4	24	2	0	76	4	19	1	0	84	16	0
2002	69	29	0	2	0	17	79	0	4	0	50	40	5	5	0	36	50	6	7	0	68	4	24	4	0	76	4	19	2	0	83	16	1
2003	67	28	0	5	0	11	74	0	16	0	45	36	4	15	0	30	42	5	22	0	66	4	23	7	0	74	3	18	5	0	81	15	4
2004	61	19	0	20	0	2	23	0	74	0	34	27	3	35	0	21	29	4	46	0	51	3	17	29	0	66	3	16	16	0	70	13	17
2005	56	17	0	27	0	1	21	0	78	0	29	23	3	46	0	16	22	3	59	0	47	2	15	36	0	62	2	15	21	0	54	9	37

Gasoline and diesel consumption calculated with COPERT 4 are significantly overestimated while LPG consumption is underestimated compared to the respective statistical values reported by Eurostat. These deviations may be explained by the difference in the use of gasoline, diesel and LPG vehicles (mainly annual mileage) considered for the calculations and the real-world vehicle use as well as possible fuel use that is not reported (e.g. due to fuel smuggling).

Only total emissions are reported for Turkey under UNFCCC/CLRTAP and therefore emissions from vehicle categories are not shown in Figure TR.3 below. Emissions information from GAINS was available only for PC, HTV and PTW.

PC and in particular G-PC dominate VOC emissions. HDV & Buses are the dominant source of NOx and PM emissions, while emissions from PC and LDV are considerably lower due to their low share.

Figure TR.3: Results of the calculations with COPERT 4 and the updated fleets compared to other sources



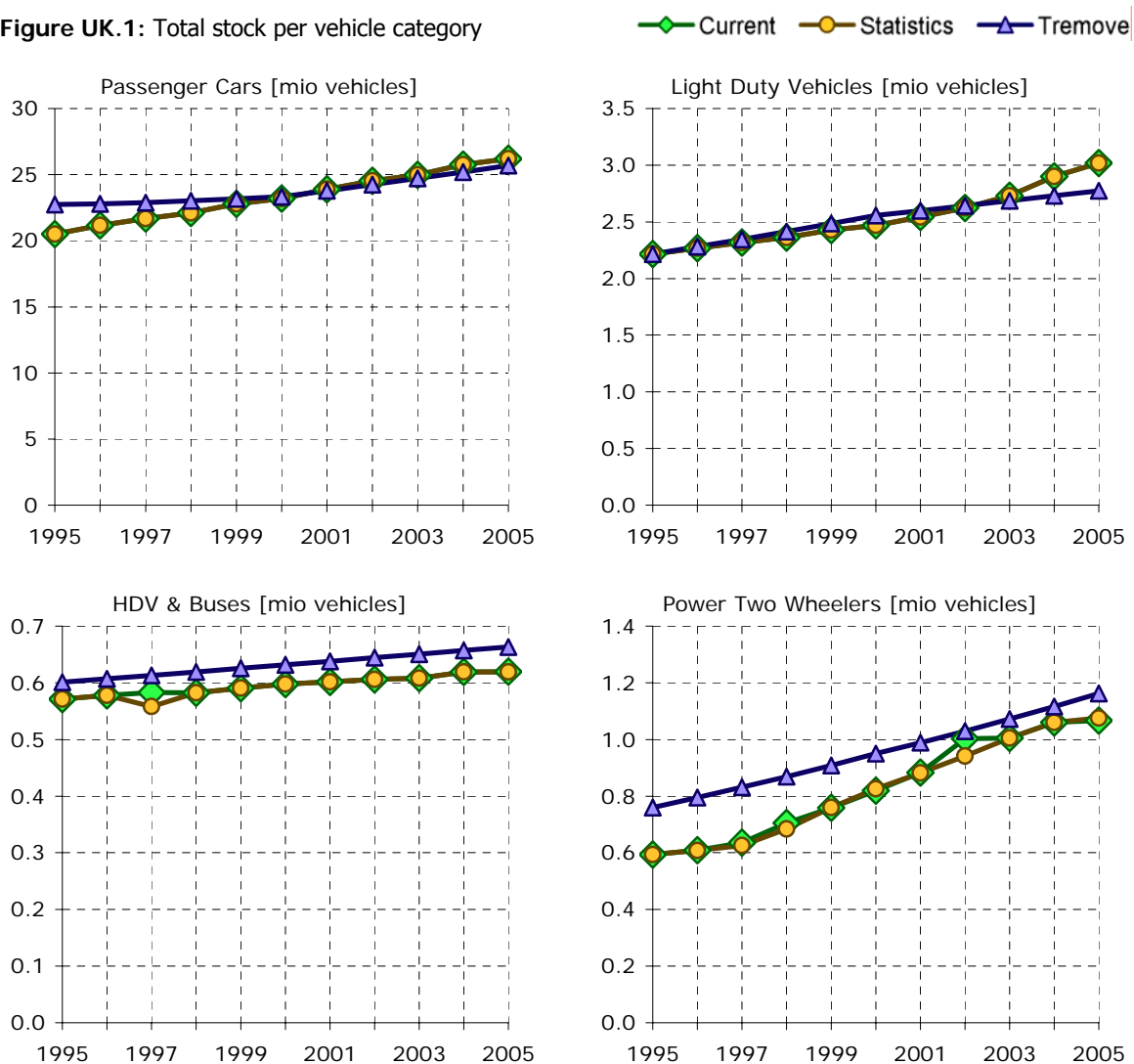
The following were the main sources of information:

- Total fleets per category: Department for Transport (1995-2005)
- Split in types: Department for Transport (1995-2005)
- New registrations: Eurostat (1970-2004), ACEA (2001-2006)
- Age/technology distribution of vehicles: Department for Transport (2000, 2005)
- Other sources included UITP

In total, 36% of the total information was missing, split into 34% of total stock, 23% of new registrations and 50% of deregistrations. The main information missing was technology distinction for more years. The total fleet and the distinction to categories and types should be considered reliable as it originates from updated official databases.

A moderate increase in the number of passenger cars and LDVs is observed for the period 1995-2005 in the UK (28% and 36% respectively). HDVs, buses and coaches have recorded a smaller increase (8%) over the same period, while mopeds and motorcycles have increased considerably (80%).

Figure UK.1: Total stock per vehicle category



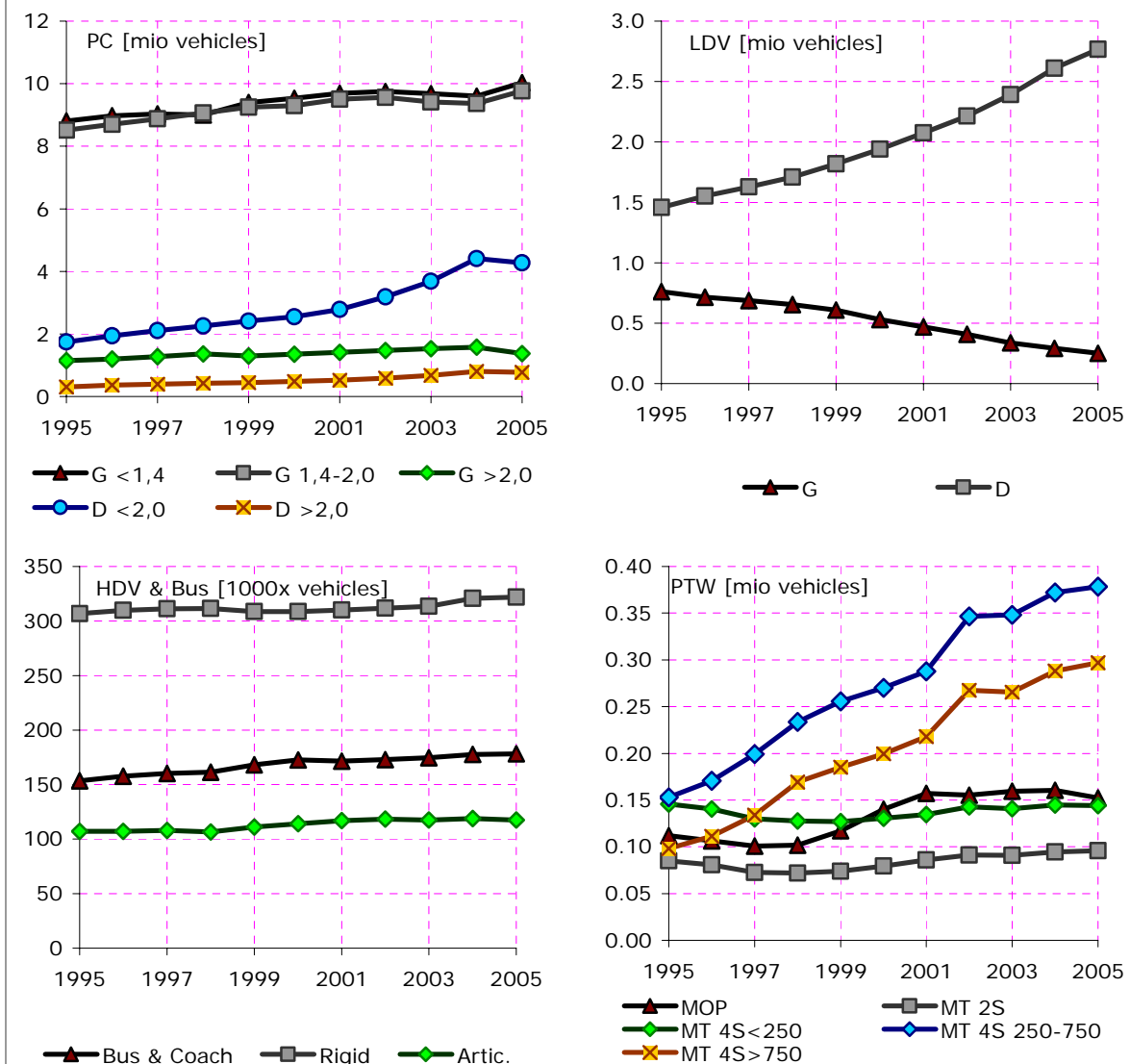
G-PC falling in the small and medium class (<1,4 & 1,4-2,0 l) dominate the passenger car fleet, accounting for 75% of the fleet. The G-PC fleet increased by more about 20% over the period 1995-2005. Large (>2.0 l) G-PC have a low share of about 6% of the total G-PC fleet. The D-PC fleet has increased by more than 2.5 times over the same period, accounting for about 20% of the PC fleet in 2005.

The share of D-LDVs has increased considerably over the years reaching 92% in 2005 compared to 65% in 1995. The number of G-LDV in 2005 is reduced consistently to less than half compared to 1995.

The HDV stock in 2005 has increased slightly since 1995, with rigid trucks accounting for about 75% of the HDV fleet. The fleet of buses & coaches increased by about 15% over the above period.

Large motorcycles (MT 4S 250-750 & >740) dominate the PTW fleet. Their fleet more than doubled over the period 1995-2005. This is mostly occurring due to change in both driving (congestion) and social conditions. Mopeds also increased, by about 35%, however, their share in the PTW fleet remains relatively low (less than 15%).

Figure UK.2: Evolution of vehicle type population per subsector



Country: **UNITED KINGDOM**

UK3/4

Information on the technology of vehicles for the United Kingdom was only available for two years (2000 and 2005). Therefore, the implementation matrix largely follows the implementation dates considered by the regulations. The error is not expected large, as the ratio of new over second-hand imports is very low for all vehicle categories. According to statistical data, a number of Euro 3 PCs were introduced in 2000 and Euro 4 PCs are already introduced in 2005, one year earlier than the official implementation date.

The UK vehicle fleet is one of the youngest in the EU (the mean age of the PC fleet in 2005 was about 6.5 years). Most pre-Euro vehicles are phased-out in 2005, with Euro 2 and 3 PCs and LDVs and Euro II and III buses and HDTs dominating the fleet, resulting in a fast technology replacement.

Table UK.1: Implementation matrix (introduction of technologies per year)

Cat.	G-PC			D-PC			G-LDV				D-LDV				BUS			HDT			PTW	
	2	3	4	2	3	4	1	2	3	4	1	2	3	4	II	III	IV	II	III	IV	I	II
2000	83	17	0	83	17	0	0	100	0	0	0	100	0	0	100	0	0	100	0	0	100	0
2001	0	100	0	0	100	0	0	100	0	0	0	100	0	0	100	0	0	100	0	0	100	0
2002	0	100	0	0	100	0	0	0	100	0	0	0	100	0	0	100	0	1	99	0	97	3
2003	0	100	0	0	100	0	0	0	100	0	0	0	100	0	0	100	0	0	100	0	0	100
2004	0	100	0	0	100	0	0	0	100	0	0	0	100	0	0	100	0	0	100	0	0	100
2005	0	0	100				0	0	100	0	0	0	100	0	0	97	3	1	99	0	0	100

Table UK.2: Technology mix of the stock per subsector per year

Cat.	G-PC					D-PC					G-LDV					D-LDV					BUS					HDT					PTW		
	C	1	2	3	4	C	1	2	3	4	C	1	2	3	4	C	1	2	3	4	C	I	II	III	IV	C	I	II	III	IV	C	I	II
2000	35	28	36	2	0	16	43	39	2	0	74	10	16	0	0	31	26	44	0	0	44	14	42	0	0	29	20	50	0	0	78	22	0
2001	28	26	35	12	0	12	37	35	16	0	68	10	21	0	0	25	23	52	0	0	37	14	50	0	0	21	18	61	0	0	62	38	0
2002	21	24	34	21	0	8	30	30	32	0	60	10	23	6	0	20	20	48	12	0	30	12	47	10	0	16	16	57	11	0	46	53	1
2003	14	23	34	29	0	5	24	26	45	0	49	10	26	15	0	16	17	43	24	0	25	11	44	20	0	11	13	52	24	0	43	52	5
2004	9	21	33	37	0	3	19	21	58	0	38	10	27	25	0	13	14	38	35	0	20	10	41	29	0	7	11	47	35	0	38	48	14
2005	6	19	31	22	21	2	18	21	59	0	20	11	30	38	0	6	14	36	45	0	16	9	37	37	0	4	9	42	45	0	35	46	19

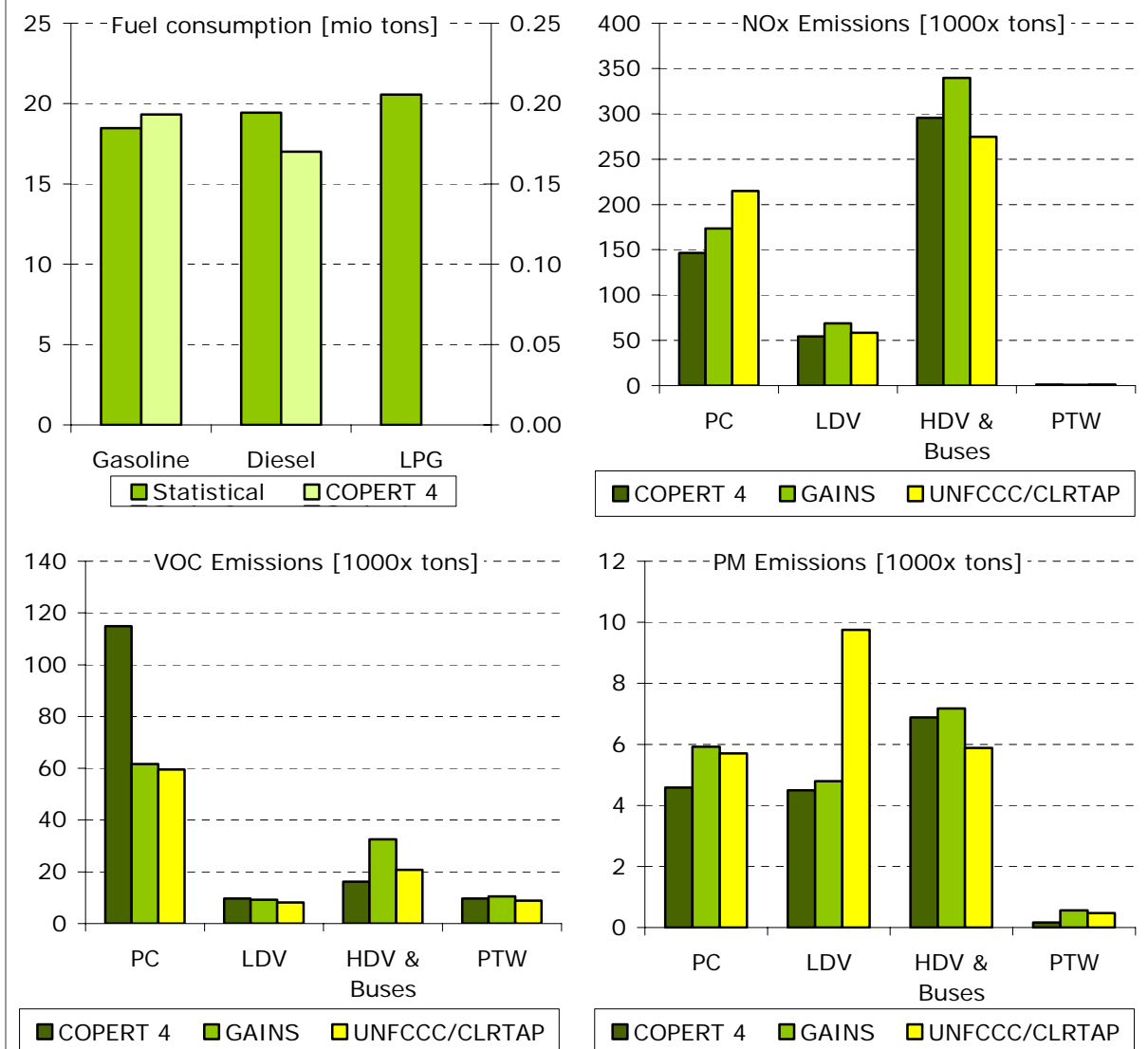
Small differences on the order of 5% for gasoline and 10% for diesel may be observed when comparing fuel consumption calculated with COPERT 4 with the respective statistical values reported by Eurostat. These deviations may be explained by the difference in the use of gasoline and diesel vehicles (mainly annual mileage) considered for the calculations and the real-world vehicle use. LPG consumption could not be calculated with COPERT 4, because no LPG vehicles were reported.

HDV & Buses dominate NOx emissions, followed by PC. All results are rather close to each other with only passenger cars showing some differences between COPERT and the national submissions.

PC and in particular G-PC dominate VOC emissions. Emissions from PC reported under UNFCCC/CLRTAP are about 45% lower than calculated with COPERT 4 due to the fact that evaporative emissions from gasoline vehicles are reported as a whole and not allocated into vehicle categories. When comparing total VOC emissions of the entire fleet, differences are considerably lower. Apart from PC, VOC emissions calculated with COPERT 4 for the other vehicle categories compare reasonably well with emissions reported by GAINS and UNFCCC/CLRTAP.

HDV & Buses are the main source of PM emissions, followed by PC and LDV.

Figure UK.3: Results of the calculations with COPERT 4 and the updated fleets compared to other sources



6 Summary and Conclusions

6.1 Comparison of calculated with statistic values

Table 6-1 provides a summary of the fuel consumption values calculated within the project, using the stock and activity data calculated for the year 2005. It should be stated that no mileage tuning has been performed to adjust the calculated fuel consumption in any country. National data have been used or the average of EU15 in countries which submitted no mileage ranges. The results are shown per country and summations have been added for EU15, EU27 (excluding Malta and Cyprus for CO₂ where no national information has been made available) and non EU countries (Croatia, Norway, Switzerland, Turkey). Based on the results of the table, a number of conclusions can be drawn which also reflect the representativeness of the data collected in the framework of the project.

Table 6-1: Comparison of calculated with statistical values (Year 2005). All values (except Deviations) in million tones.

Country	Statistical			Calculated			CO ₂		Deviations (%)			
	G	D	LPG	G	D	LPG	Stat	Calc	G	D	LPG	CO ₂
Austria	1.49	3.32	0.00	1.50	2.99	0.00	23.0	21.7	0.9	-10.1		-5.8
Belgium	1.93	6.31		2.46	8.01		24.9	33.4	27.2	27.0		34.1
Bulgaria	0.54	1.38	0.31	1.50	2.75	0.14	7.2	13.9	176.0	99.4	-55	93.3
Croatia	0.69	0.96	0.02	0.89	0.93	0.01	5.3	5.8	28.7	-3.1	-45	9.6
Cyprus	0.30	0.52	0.00	0.35	0.37	0.00		2.3	16.8	-29.2		
Czech Rep.	2.06	3.72	0.24	1.69	2.17	0.00	16.0	12.2	-17.6	-41.6	-99	-23.7
Denmark	1.75	2.07	0.00	1.82	2.11	0.00	12.2	12.4	3.9	1.7	-5	2.4
Estonia	0.29	0.40	0.00	0.31	0.40	0.00	1.9	2.3	6.9	0.4		16.5
Finland	1.75	2.01	0.00	2.21	1.86	0.00	11.8	12.9	26.4	-7.5		9.3
France	10.70	29.87	0.14	10.26	30.74	0.14	131.5	130.3	-4.1	2.9	0	-0.9
Germany	23.16	26.89	0.00	25.05	25.17	0.00	152.2	159.0	8.2	-6.4		4.5
Greece	3.89	2.06	0.01	5.77	3.03	0.00	18.9	27.8	48.3	47.4	-78	47.4
Hungary	1.46	1.91	0.04	1.62	1.98	0.23	11.6	12.1	11.1	3.7	556	4.0
Ireland	1.71	2.24	0.00	1.69	2.16	0.00	12.5	12.2	-1.3	-3.5	-100	-2.1
Italy	13.45	22.53	1.03	12.49	23.03	1.02	117.0	115.5	-7.2	2.2	-1	-1.3
Latvia	0.34	0.46	0.00	0.64	0.93	0.03	2.6	5.1	92.1	101		96.4
Lithuania	0.34	0.76	0.21	0.42	0.52	0.21	3.9	3.6	24.9	-32.3	2	-7.4
Luxembourg	0.55	1.61	0.00	0.16	0.39	0.00	7.2	1.8	-70.3	-75.8	-87	-75.5
Malta	0.07	0.16	0.00	0.06	0.13	0.00		0.6	-8.8	-21.0		
Netherlands	4.16	6.16	0.38	4.36	4.70	0.30	33.9	29.6	4.9	-23.6	-21	-12.7
Norway	1.52	1.53	0.00	1.74	1.20	0.00	9.6	9.3	14.3	-21.2		-3.2
Poland	3.94	5.36	1.50	4.91	4.81	0.60	34.2	32.6	24.5	-10.3	-60	-4.9
Portugal	1.76	4.10	0.01	1.95	4.57	0.01	18.5	20.7	11.0	11.5	-30	11.4
Romania	1.54	2.14	0.03	1.95	3.49	0.19	11.5	17.8	26.9	62.9	439	54.9
Slovakia	0.70	1.19	0.03	0.76	1.26	0.03	6.1	6.5	8.6	5.3	5	6.4
Slovenia	0.65	0.73	0.00	0.58	0.21	0.00	4.3	2.5	-11.4	-70.6		-42.3
Spain	7.26	22.12	0.05	8.10	20.14	0.00	92.7	89.4	11.6	-9.0	-100	-3.5
Sweden	3.94	2.18	0.00	4.03	2.13	0.00	18.5	19.5	2.5	-2.3		5.4
Switzerland	3.60	1.71	0.00	3.10	1.10	0.00	15.1	13.3	-13.8	-35.9		-11.8
Turkey	2.64	6.33	1.36	6.44	15.97	2.62	34.5	78.9	143.6	153	93	128.6
UK	18.47	19.43	0.21	19.33	17.01	0.00	120.1	115.0	4.7	-12.4	-100	-4.2
EU15	96.0	152.9	1.8	101.2	148.0	1.5	794.9	801.3	5.5	-3.2	-19.7	0.8
EU27*	108.2	171.6	4.2	116.0	167.0	2.9	894.3	909.8	7.2	-2.7	-30.7	1.7
nonEU	8.5	10.5	1.4	12.2	19.2	2.6	64.5	107.3	44.0	82.5	90.8	66.4

* Excluding Malta and Cyprus for CO₂ emissions (no national data on UNFCCC)

1. The fuel consumption of diesel and gasoline calculated per EU15 country in generally does not differ by more than 15% from the statistically reported fuel consumption.

Based on the detailed information which is available for the stock of vehicles in these countries, the difference in statistical and calculated fuel consumption has to do with either differences in the estimated mileage per vehicle category or due to tank tourism between the different countries. The most well-known case is Luxembourg where the statistical fuel consumption appears 70-76% higher than the calculated one.

2. EU15 countries for where rather large differences are observed is Belgium (+27%), gasoline in Finland (+26%) and Greece (+48%). The substantial difference in Belgium is obviously due to an overestimation of the mileage, as the data used only originate from Wallonia who reported total traffic (including International – e.g. a truck driven for 120000 km per year) and may not be representative of the whole region. The same also should apply in Finland. The decision taken in this project was not to tune the mileage values but use the ones stated in section 5.1.6. Therefore, for actual use of these activity data, it is first recommended to tune the mileage values in collaboration with the national experts in Belgium and Finland, in order to bring fuel consumption in line with national statistics. The case of Greece with regard to Gasoline is rather similar; obviously the mileage of passenger cars has been overestimated, as this originated from earlier statistics (pre-2000) when one car per family was the usual case. However, the diesel consumption also reflects the outgoing international traffic of trucks (mainly to Italy) which are fuelled in Greece to take benefit of the large difference in diesel price. This also reflects the usual practice up to 2007 to blend heating oil and maritime fuel with diesel fuel, again due to large tax differences. Hence, the diesel vehicle mileage tuning in Greece should take these two practices into account.
3. The differences in statistical and calculated fuel consumption in new Member States are in general larger than in EU15, with some very large differences in the case of BG, LV and RO. In all cases, the calculated fuel consumption is much larger than the statistical one. For these countries, no mileage was provided but the average EU15 mileage has been used instead. It may therefore be the case that these are much larger values than the actual usage of the vehicles in these countries, as the relatively lower per capita GDP may lead to much less average use of the existing stock than in EU15. On the other hand, the reliability of statistics in some countries may also be questionable, while fuel smuggling is also a common practice. Therefore, it is recommended that any mileage tuning is performed with care, in order to reflect these uncertainties.
4. For the non-EU countries there are very large differences in the case of Turkey, where the calculated fuel consumption is some 2.5 times higher than the statistical one. Just for comparison, Turkey reports 1.1 million HD trucks and the same diesel fuel consumption to the Netherlands who reported 150 thousand ones. In order to match the statistical with the calculated fuel consumption, and average truck in Turkey needs to be driven for ~20000 km which is a rather low value. The other important difference occurs for Switzerland (-36%) for diesel but this is rather due to tank

tourism and transit traffic, as the activity data in Switzerland occur from a reliable source.

5. When looking at average differences in EU25 and EU27, these appear rather small for diesel and gasoline and CO₂ emissions. In particular, the CO₂ emissions calculated with COPERT 4 differ by only 0.8% to what is in total reported in EU15 and 1.7% of what is in total reported in EU27. The difference for non-EU countries is larger, mostly due to the issue with Turkey that was previously reported. The difference in LPG also significant, as COPERT 4 calculates some -20% and -30% of total statistical fuel consumption in EU15 and EU27, respectively. This is most probably due to the conversion of some gasoline cars to LPG, which are not accurately reported in national statistics. However, the total LPG consumption is only 0.7% in EU15 and 1.5% in EU27 of total fuel consumption, hence deviations have a small effect on total CO₂ and regulated pollutant emissions

6.2 Stock Evolution

The comparison in section 6.1 showed that for the Year 2005, the total stock and the activity data estimated in 2005 are in good match to the statistical values reported by member states. Our data show that the same good match holds for all other years as well. On the basis of this finding, Figure 6-1 shows the evolution of the stock of different vehicle categories, distinguished in three different regions (EU15, new member states – i.e. EU27-EU15 and non-EU). Based on this picture, the following conclusions may be drawn for the evolution of the fleet:

1. The total number of gasoline passenger cars seems rather saturated in EU15 at 140 mio vehs after 2000. On the contrary, the number in new MSs and non-EU constantly increases quite importantly since 1995. Saturation seems to occur in 2004-2005 in new MSs as well.
2. The total number of diesel passenger cars is constantly increasing in all regions. In EU15, their total fleet has more than doubled in a period of 10 years, reaching 50 mio cars in 2005, or more than 25% of the total passenger car fleet. The trend is similar in new MSs and non-EU countries, with important increases occurring in 2004, together with the introduction of the new member states in EU.
3. The total number of gasoline LDVs is constantly decreasing in EU15, as their number are replaced by diesel ones due to the superior fuel economy. In non EU15 markets, gasoline LDVs have been increasing but there is a downward trend started to appearing in new MSs after 2003. In non-EU the number of gasoline LDVs has not shown signs of saturation and continues to larger than the diesel stock. These trends represent a typical example in the vehicle usage, where any new trends in EU5 are first followed by new MSs and then, later, by non EU countries.

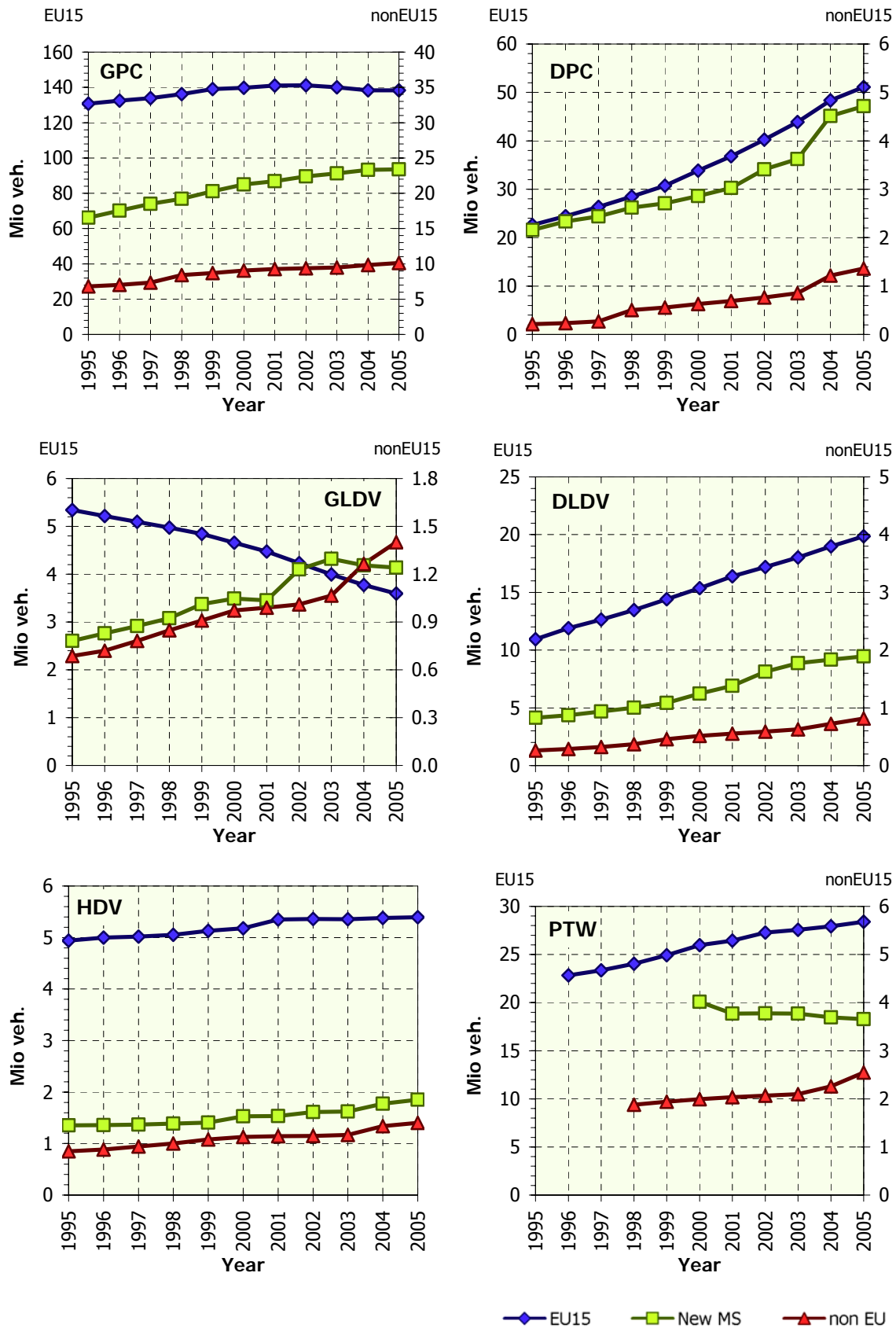


Figure 6-1: Stock evolution per vehicle category and region

4. The HDV fleet is the least variable, in what concerns its total stock, in Europe. The total truck and bus number is between 5-5.5 million vehicles in EU15. In non EU15 regions, the truck stock increases as a result of the increasing commerce needs with the rest of the European continent.
5. The power two wheeler stock also shows some interesting trends. Despite earlier pessimistic view on the development of the total stock in EU15, there are important increases observed, mainly fuelled by the increase in fuel prices and congestion conditions. This increase is not followed in new MSs, where the total stock declines over the years. This is most probably a reflection of the increase in GDP per capita, which has forced an important increase in the number of cars than PTWs. For non-EU, all four countries report in an increase in the number of PTWs. This is more important in Turkey and only marginal in Switzerland.

6.3 Emissions Comparison

Based on the stock for 2005, Table 6-2 presents a comparison of emissions calculated with different models and estimates. The range of countries not included in the comparison due to lack of national data submission is also given on the Table. The comparison leads to the following conclusions:

Table 6-2: Comparison of calculated with statistical emissions (Year 2005).
All values (except Deviations) in million tones.

EU15	Current	Tremove v2.52	National Data	Gains	Excluded Countries
NOx	4155	4063	3646	3988	LU
PM	136	120	146	140	GR, IT, LU
CO	10087	11361	9980		LU
VOC	1468	1814	1456	1095	LU
EU27					
NOx	4854	4577	4337	4636	BG, CY, LU
PM	153	132	179	157	BG, CY, GR, IT, LU, RO
CO	12594	12906	11856		BG, CY, LU, MT
VOC	1659	2740	1592	1184	BG, CY, LU
nonEU					
NOx	789	396	513	540	
PM	2.9	2.4	3.5	2.8	HR, TR
CO	2404	719	1985		
VOC	361	1306	321	311	

1. Emissions of NOx calculated with the current fleet appear larger than the national estimates in all regions. There are different reasons for this, according to the region. For EU27, this mainly is the effect of the higher HDV emission factors in COPERT 4, than the emission factors in COPERT 3 used by several member states to calculate emissions in 2005. The COPERT 4 emission factors implement the findings of the ARTEMIS project and are considered more reliable estimates than COPERT III ones. A second reason is that the mileage needs to be adjusted in some countries (see

discussion in section 6.1) in order to bring fuel consumption closer to the statistical consumption. This second reason is more important in the case of non-EU countries.

2. PM_{2.5} emissions do not differ much between the current estimates, the national data and GAINS. The national estimates look rather high, given that the current calculation includes emissions from all vehicle categories, including gasoline cars and power two wheelers. The reasons for these higher emissions need to be discussed with the national experts
3. CO emissions are not calculated by GAINS. With regard to the other sources of information, the deviation is less than 6% between the current estimate and the national data at EU27 level (even less at EU15 level) and some 20% at non-EU. The current Tremove deviations are larger.
4. VOC emissions include evaporation emissions in all sources, which lacked from the national data presented in section 5.5. There are minor differences in VOC emissions when including the effect of fuel evaporation between the current estimates and national data in all regions considered. The GAINS results and in particular the Tremove v2.52 estimate are rather more distant.

6.4 Outlook

The current stock and activity data compare already fairly well with the national statistics on fuel consumption at EU15 level and the national emission estimates. However, it would be highly recommended that these data are sent back to the national experts listed in Annex II to provide feedback, as several countries may provide objections even to slight deviations from national estimates. Therefore, it would be worthwhile to initiate a round of discussions and clarify deviations with the national experts. Unfortunately, this was not made possible given the limited time frame of the project.

With regard to new member states and non EU countries some larger deviations occur. In several cases the results of the current project may be more reliable than national estimates, which may even use empirical emission factors or calculation models. In these cases, it is again recommended to invite the national experts and present them both with the results but also the method used to derive them. It is expected that this will be a very educative process which may result in improvement of the national inventories in these cases.

Finally, the consortium believes that the data collection and refinement is an iterative process which can be largely benefit by establishing a more permanent mechanism for information exchange, gap filling and data reconciliation. This is put forward to the European Commission that should consider establishing such a mechanism.

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(This is a non-exhaustive list of main data sources for the project. More individual sources are given in each country's report.)

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Annex I – Data Definitions and Structure Required

The report uses a large number of vehicle categories which may not be straightforward to not experts in the area. Hence, some definitions of vehicle categories are given in this annex. These definitions have been taken from the Eurostat Reference manual for the implementation of Council Regulation No 1172/98/EC on statistics on the carriage of goods by road (Version 1, May 2003).

Based on these definitions, the detailed structure of data collected and estimated in this project are also given

Road motor vehicle

Alternative terminology.

Road transport vehicle.

First reference in Regulation.

Article 2.

Definition.

A road vehicle fitted with an engine whence it derives its sole means of propulsion, which is normally used for carrying persons or goods by road, or for drawing, on the road, vehicles used for the carriage of persons or goods.

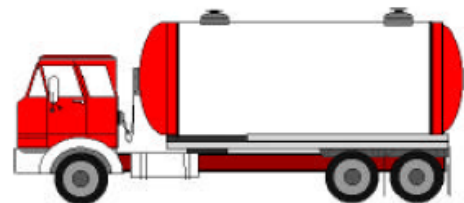
Source of definition.

The Glossary for Transport Statistics, Part B, Section II.05

Article 2 of Council Regulation 1172/98 uses the alternative terminology of "road transport vehicle" with the same definition. Although the definitions are identical, the word "transport" has a different meaning to "motor" in the English language.

The definition excludes motor vehicles running on rails embedded in roads.

Explanation and examples.



Goods road motor vehicle

Related terminology.

Goods road transport vehicle.

First reference in Regulation.

Article 1.

Definition.

Any single road transport vehicle (lorry), or combination of road vehicles, namely road train (lorry with trailer) or articulated vehicle (road tractor with semi-trailer), designed to carry goods.

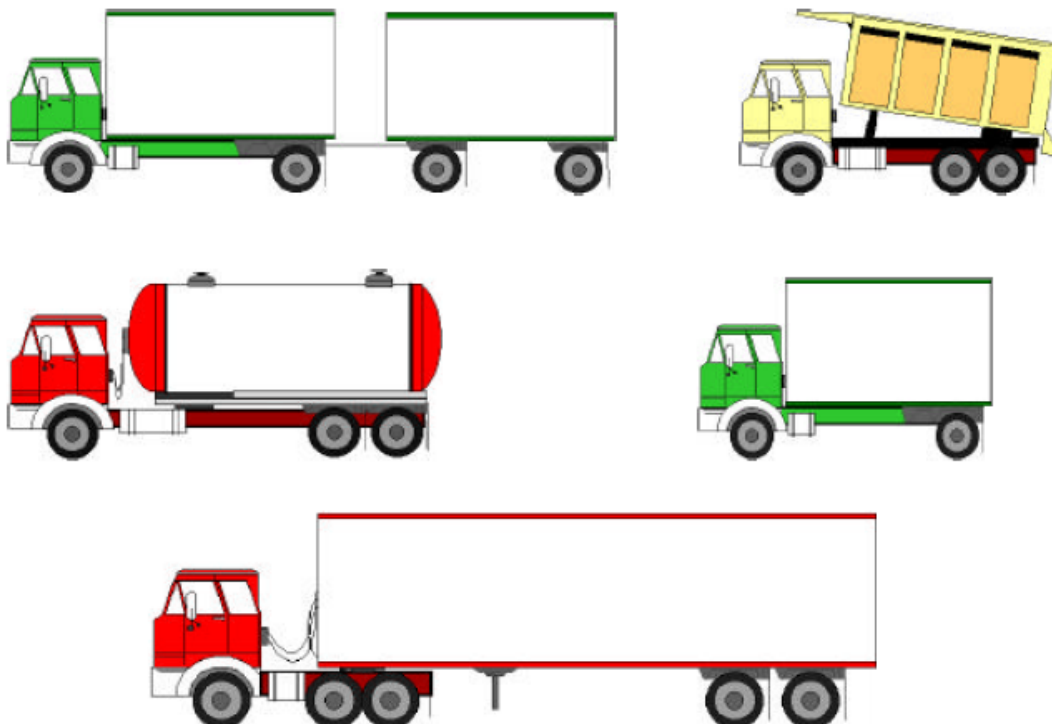
Source of definition.

The Glossary for Transport Statistics, Part B, Section II.20

Article 2 of Council Regulation 1172/98 uses the terminology of "goods road transport vehicle" with the same definition.

Explanation and examples.

Vehicles designed for the transport of both passengers and goods should be classified either among the passenger road vehicles or among the goods road vehicles, depending on their primary purpose, as determined either by their technical characteristics or by their category for tax purposes.



Lorry

First reference in Regulation.

Article 2.

Definition.

A rigid road motor vehicle designed exclusively or primarily to carry goods.

Source of definition.

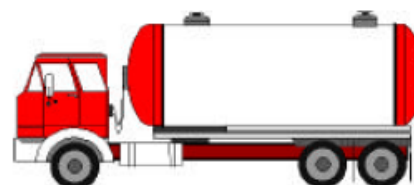
The Glossary for Transport Statistics, Part B, Section II.21.

Article 2 of Council Regulation 1172/98 gives the same definition with the exclusion of the word "motor" after "road".

Explanation and examples.

This category includes vans which are rigid road motor vehicles designed exclusively or primarily to carry goods with a gross vehicle weight of not more than 3 500 Kg. This category may also include "pick-ups".

Council Regulation 1172/98 permits a country to exclude the collection of data for vehicles with a load capacity 3 500 kilograms or less or a maximum vehicle weight not exceeding 6 tonnes.



Classification and Codes to be used.

No separate coding is provided for lorries but the coding for axle configuration provides, in the first digit of the code, a method of identification of lorries and road tractors. A first digit of 1 or 2 in the axle configuration code indicates that the powered vehicle is a lorry.

Note: The term "Rigid truck" has been widely used in this report as a synonym of the word "Lorry"

Road tractor

First reference in Regulation.

Article 2.

Definition.

A road motor vehicle designed exclusively or primarily to haul other road vehicles which are not power-driven (mainly semi-trailers).

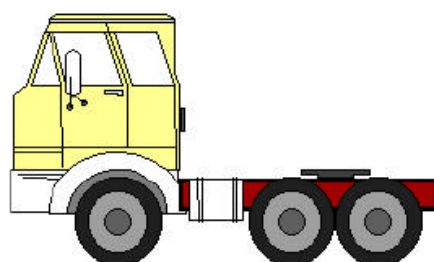
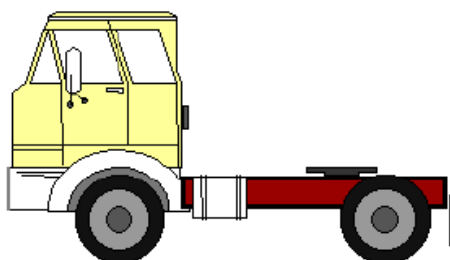
Source of definition.

The Glossary for Transport Statistics, Part B, Section II.22.

Article 2 of Council Regulation 1172/98 gives the same definition with the replacement of the word "transport" for "motor".

Explanation and examples.

Agricultural tractors are excluded.



Classification and Codes to be used.

No separate coding is provided for road tractors but the coding for axle configuration provides, in the first digit of the code, a method of identification of lorries and road tractors. A first digit of 3 or 4 in the axle configuration code indicates that the powered vehicle is a road tractor.

Trailer

First reference in Regulation.

Article 2.

Definition.

Goods road vehicle designed to be hauled by a road motor vehicle.

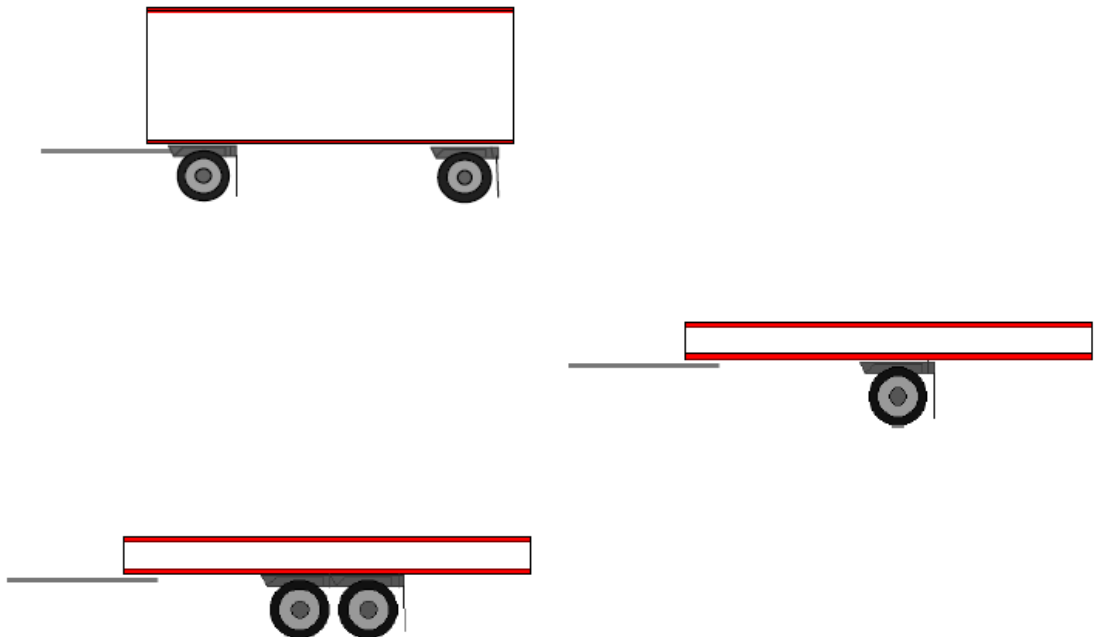
Source of definition.

The Glossary for Transport Statistics, Part B, Section II.24.

Article 2 of Council Regulation 1172/98 gives the same definition but using slightly different wording, namely "A road vehicle for transporting goods designed to be hauled by a road transport vehicle".

Explanation and examples.

This category excludes agricultural trailers and caravans.



Classification and Codes to be used.

No separate coding is provided for trailers but the coding for axle configuration provides, in the first digit of the code, a method of identification of a combination of a lorry and trailer(s). A first digit of the axle configuration code of '2' indicates that the lorry has at least one trailer attached.

Semi-trailer

First reference in Regulation.

Article 2.

Definition.

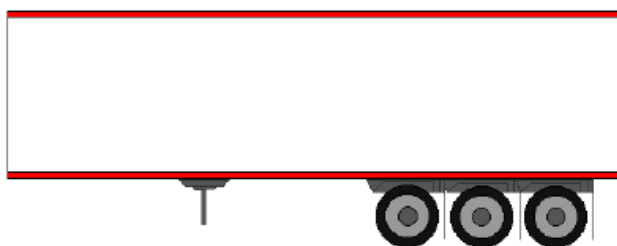
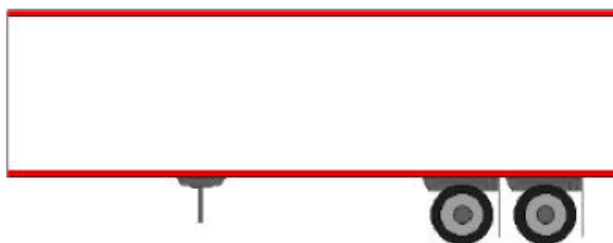
A road vehicle for transporting goods with no front axle so designed that part of the vehicle and a substantial part of its loaded weight rest on the road tractor.

Source of definition.

Article 2 of Council Regulation 1172/98.

The Glossary for Transport Statistics, Part B, Section II.26 gives an identical definition.

Explanation and examples.



Classification and Codes to be used.

No separate coding is provided for semi-trailers but the coding for axle configuration provides, in the first digit of the code, a method of identification of a combination of a road tractor and semi-trailer. A first digit of the axle configuration code of '3' indicates that the road tractor has a semi-trailer attached.

Articulated vehicle

First reference in Regulation.

Article 2.

Definition.

A road tractor coupled to a semi-trailer.

Source of definition.

Article 2 of Council Regulation 1172/98.

The Glossary for Transport Statistics, Part B, Section II. 27 gives an identical definition.

Explanation and examples.



Classification and Codes to be used.

No separate coding is provided for articulated vehicles but the coding for axle configuration provides, in the first digit of the code, a method of identification of an articulated vehicle. A first digit of the axle configuration code of '3' indicates that the road tractor has a semi-trailer attached (an articulated vehicle).

Table A. 1: Passenger car categories in COPERT

Vehicle Type	Class	Legislation	Implementation Years ⁽³⁾
Passenger Cars	Gasoline <1.4l 1.4 - 2.0l >2.0l	PRE ECE	<1971
		ECE 15/00-01	1972-1977
		ECE 15/02	1978-1980
		ECE 15/03	1981-1985
		ECE 15/04	1985-1992
		Improved Conventional ⁽¹⁾	D:1986, DK:1988, NL: 1986
		Open Loop ⁽²⁾	D:1986, DK: 1989, GR:1990, NL:1987
		Euro 1 - 91/441/EEC	1992-1995
		Euro 2 - 94/12/EC	1996-1999
		Euro 3 - 98/69/EC Stage 2000	2000-2004
Euro 4 - 98/69/EC Stage 2005	2005-2009		
Euro 5 – EC 715/2007	2010-2014		
Euro 6 – EC 715/2007	>2015		
Passenger Cars	Diesel <2.0l >2.0l	Conventional	<1992
		Euro 1 - 91/441/EEC	1992-1995
		Euro 2 - 94/12/EC	1966-1999
		Euro 3 - 98/69/EC Stage 2000	2000-2004
		Euro 4 - 98/69/EC Stage 2005	2005-2009
		Euro 5 – EC 715/2007	2010-2014
Euro 6 – EC 715/2007	>2015		
Passenger Cars	LPG	Conventional	<1992
		Euro 1 - 91/441/EEC	1992-1995
		Euro 2 - 94/12/EC	1996-1999
		Euro 3 - 98/69/EC Stage 2000	2000-2004
Euro 4 - 98/69/EC Stage 2005	2005-2009		
Passenger Cars	2 Stroke	Conventional	
	Hybrids <1.6l	Euro 4 - 98/69/EC Stage 2005	

⁽¹⁾ Improved conventional takes into account national incentives, runs in parallel with other technologies and does not replace any other technology step. This step includes no kind of aftertreatment and is only applicable to cars <2.0 l. The exact implementation date is country and vehicle size specific. National data detail the introduction of this step.

⁽²⁾ Open loop takes into account national incentives, runs in parallel with other technologies and does not replace any other technology step. This technology includes a three way catalyst as aftertreatment but without lambda control. It is applicable only to vehicles <2.0 l while, similar to improved conventional.

⁽³⁾ Usually, emission regulations come into force in two steps. Each new regulatory requirement is first applied for new model types and the requirement for all model types comes six months to more than one year later. In addition, some regulations are not applicable since Jan. 1 of each year but since September or October of the previous year. The implementation years in these tables correspond to complete calendar years that each regulation was effective for new vehicle types, for at least eight months during the year.

Table A. 2: Light-duty vehicle categories in COPERT 4

Vehicle Type	Class	Legislation	Implementation Years
Light Duty Vehicles	Gasoline <3.5t	Conventional	<1993
		Euro 1 - 93/59/EEC	1995-1997
		Euro 2 - 96/69/EC	1998-2000
		Euro 3 - 98/69/EC Stage 2000	2001-2005
		Euro 4 - 98/69/EC Stage 2005	2006-2010
		Euro 5 – EC 715/2007	2011-2015
	Euro 6 – EC 715/2007	>2016	
	Diesel <3.5t	Conventional	<1993
		Euro 1 - 93/59/EEC	1995-1997
		Euro 2 - 96/69/EC	1998-2000
		Euro 3 - 98/69/EC Stage 2000	2001-2005
		Euro 4 - 98/69/EC Stage 2005	2006-2010
Euro 5 – EC 715/2007		2011-2015	
Euro 6 – EC 715/2007	>2016		

Table A. 3: Power Two Wheelers in COPERT 4

Vehicle Type	Class	Legislation	Implementation Years
Mopeds	<50cm ³	Conventional	<2000
		97/24/EC Stage I – Euro 1	2000-2002
		97/24/EC Stage II – Euro 2	2003-2008
		Euro 3 proposal	>2009
Motorcycles	2 Stroke >50cm ³	Conventional	<2000
	4 stroke 50 - 250cm ³	97/24/EC – Euro 1	2000-2002
	4 stroke 250 - 750cm ³	2002/51/EC Stage I – Euro 2	2003-2005
	4 stroke >750cm ³	2002/51/EC Stage II – Euro 3	>2006

Table A. 4: Heavy duty vehicles and busses in COPERT 4

Vehicle Type	Class	Legislation	Implementation Years
Heavy Duty Vehicles	Gasoline >3.5t	Conventional	All Years
	Rigid <=7.5t	Conventional Euro I - 91/542/EEC Stage I Euro II - 91/542/EEC Stage II Euro III - 1999/96/EC Stage I Euro IV – 1999/96/EC Stage II Euro V – 1999/96/EC Stage III Euro VI – No proposal yet	<1992 1992-1996 1997-2000 2001-2005 2006-2008 2009-2014 >2015
	Rigid 7.5-12t		
	Rigid 12-14t		
	Rigid 14-20t		
	Rigid 20-26t		
	Rigid 26-28t		
	Rigid 28-32t		
	Rigid >32t		
	Articulated 14-20t		
	Articulated 20-28t		
	Articulated 28-34t		
	Articulated 34-40t		
	Articulated 40-50t		
Articulated 50-60t			
Buses	Urban <=15t	Conventional Euro I - 91/542/EEC Stage I Euro II - 91/542/EEC Stage II Euro III - 1999/96/EC Stage I Euro IV – 1999/96/EC Stage II Euro V – 1999/96/EC Stage III Euro VI – No proposal yet	<1992 1992-1996 1997-2000 2001-2005 2006-2008 2009-2014 >2015
	Urban 15-18t		
	Urban >18t		
	Coaches standard <=18t		
	Coaches articulated >18t		
	CNG		
		Euro II – 91/542/EEC Stage II	1997-2000
		Euro III – 1999/96/EC Stage I	2001-2005
		EEV – 1999/96/EC	>2000

Table A. 5: Inland shipping vessel categories in Tremove

Vessel type	Class
Dry cargo	Dry Cargo <250 ton
	Dry Cargo 250-400 ton
	Dry Cargo 400-650 ton
	Dry Cargo 650-1000 ton
	Dry Cargo 1000-1500 ton
	Dry Cargo 1500-3000 ton
	Dry Cargo > 3000 ton
Push barge	Push barge <250 ton
	Push barge 250-400 ton
	Push barge 400-650 ton
	Push barge 650-1000 ton
	Push barge 1000-1500 ton
	Push barge 1500-3000 ton
Tanker	Push barge > 3000 ton
	Tanker <250 ton
	Tanker 250-400 ton
	Tanker 400-650 ton
	Tanker 650-1000 ton
	Tanker 1000-1500 ton
	Tanker 1500-3000 ton
	Tanker > 3000 ton

Table A. 6: Maritime vessel categories in Tremove

	Vessel type
Liquefied Gas	Ro-Ro Cargo
Chemical	Passenger/Ro-Ro Cargo
Oil	Passenger
Other Liquids	Other Dry Cargo
Bulk Dry	Fish Catching
Bulk Dry / Oil	Other Fishing
Self-Discharging Bulk Dry	Offshore Supply
Other Bulk Dry	Other Offshore
General Cargo	Research
Passenger/General Cargo	Towing / Pushing
Container	Dredging
Refrigerated Cargo	Other Activities

Table A. 7: Rail categories in Tremove

Train type	Class
Passenger	freight locomotive diesel
	freight locomotive electric
	passenger railcar diesel
Freight	passenger railcar electric
	passenger high speed train electric
	passenger locomotive diesel
	passenger locomotive electric

Annex II – Country Invitations

Invitation letter from the European Commission



EUROPEAN COMMISSION
DIRECTORATE-GENERAL
ENVIRONMENT
Directorate C - Climate Change & Air
ENV.C.5 - Energy & Environment
The Head of Unit

Brussels, 16 March 2007
ENV/C5/PT/sdp

D(2007) 4949

NOTE TO WHOM IT MAY CONCERN

A consortium lead by Laboratory of Applied Thermodynamics/Aristotle University of Thessaloniki, including EnviCon, ICCS, Ökopol, KTI, and Renault is currently contracted by the European Commission, Environment Directorate-General, for the building of a European database of vehicle stock for the calculation and forecast of pollutant and greenhouse gases emissions with TREMOVE and COPERT.

An essential task is to collect information on current operating vehicle parks in all EU27 Member States, as well as Croatia, Turkey, Switzerland, and Norway. The information should cover all available sources, such as official national databases, type-approval databases and databases obtained by official inspection schemes established in each country.

I would greatly appreciate your collaboration with the above mentioned entities towards a successful completion of this project, which we believe will enable a more reliable assessment of environmental policies in the transport sector.



Piotr Tulej

Invitation letter to the national experts (example shown for Greece)



TO: Ms. Demetra Koutentakis
dkouten@meteo.noa.gr

FROM: Leonidas Ntziachristos
Tel: (+30) 2310 996031
Fax: (+30) 2310 996019
Email: leon@auth.gr

Thessaloniki, 2007-05-24

Αγαπητή Κα. Κουτεντάκη,

Our consortium, consisting of the Laboratory of Applied Thermodynamics in Greece (co-ordinator), EnviCon, ICCS, Oekopol, KTI and Renault, is conducting a survey to collect vehicle stock and activity data in the EU27 countries, plus Croatia, Norway, Switzerland and Turkey. These data will be used as input to the COPERT and TREMOVE models to estimate emissions and make emission projections to support future environmental policies of the European Commission (DG Environment). Our aim is to produce reliable emission figures, based on a solid vehicle stock dataset, validated against national data. The project runs from January to December 2007.

The attached letter from the European Commission invites you to assist us in this data collection process.

We would therefore like to ask you to make available to our consortium the official dataset of Greece, compiled for reporting to the European Commission and international bodies (CLRTAP, UNFCCC). Our consortium is looking for detailed fleet and activity information which will be introduced in the models to make precise emission estimations. In order to guide you with the detail of information required, we have attached two spreadsheets with corresponding names for road and non-road transport emissions. The resolution is the maximum possible required by the models to run.

However, we very well understand that the level of information required is in some cases overwhelming. In this respect, we need to clarify the following issues:

1. We mainly seek for data corresponding to year 2000 and, if possible, 2005. The spreadsheets go back to 1970 for those users that have this information available. If no more information can be made available, delivery of the 2000 fleet data would be sufficient for us.
2. The level of technological detail required may be overwhelming for some countries. We understand that maybe only more aggregated information is available. For example, the number of passenger cars may be known with good confidence, but not their classification to technology classes. In this case, we would still need the total number of passenger cars as input.

3. Again, those spreadsheets are only guides for possible data classification. For example, different criteria might be used in some countries to classify flights when estimating aviation emissions. The data, even if classified differently, are still useful.
4. You do not need to follow the exact format of the attached spreadsheets when submitting information. Maybe your data is stored in other formats (e.g. "mdb" files such as the output of Copert) or in Excel spreadsheets with different structure. In this case, you may as well submit your own files and we will extract all relevant information.

In addition, we would be highly interested in obtaining any national reports you may have available, or other sources containing relevant information for transport details in Greece. For example, reports with information on the level of maintenance of vehicles, the split of light duty vehicles in passenger vs, freight transport, the function of vehicle age and annual mileage, estimates of the lifetime function of different vehicle classes, etc. are all important elements in our calculations.

Finally, we would like to let you know that your prompt response would be highly appreciated. Given that our project ends in December this year and that we need to make all processing of the data, we would be grateful if we could receive your contributions by **June 29**.

Please do not hesitate to contact us for any clarifications and questions concerning data details and structure. Also, if you are not the designated expert for data submission in the area of transport, could you please inform us of who should we come in contact with in Greece to ask for information.

Thank you for your collaboration.

Your contact,



Dr. Leonidas Ntziachristos

The coordinator,



Prof. Zissis Samaras

Attachments

1. Invitation letter from the European Commission (EC Letter.PDF)
2. Spreadsheet with on-road fleet data details (Data Road.xls)
3. Spreadsheet with non-road fleet data details (Data NonRoad.xls)

List of national experts contacted by letter invitation

Country	Contact Person	Email
EU27		
Austria	Barbara SCHODL	Barbara.schodl@umweltbundesamt.at
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Belgium	Ina DE VLIENER (Flanders)	ina.devlieger@vito.be
	Tzvetina TZENOVA	ttzenova@mt.government.bg
Bulgaria	Tzvetina TZENOVA	ttzenova@mt.government.bg
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Other Countries		
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Norway	Alice GAUSTAD	alice.gaustad@sft.no
Switzerland	Felix REUTIMANN	felix.reutimann@bafu.admin.ch
Turkey	Fatma Betül BAYGÜVEN	betul.bayguven@die.gov.tr , ali.can@tuik.gov.tr

Excerpt of road-transport data collection file

The screenshot shows a Microsoft Excel spreadsheet titled "Data Road.xls". The spreadsheet contains logos for several organizations: LAT/AUTH, KTI (Alpiava - Since 1938), Renault, ICCS, and Okopol. Below the logos is a yellow box titled "GENERAL INFORMATION" containing the following text:

GENERAL INFORMATION

The spreadsheets include fields for submission of data in 203 vehicle categories, distinguished in vehicle type, fuel, subsector (capacity or weight class) and technology level (Euro level or ECE classification).

THESE SHOULD BE ONLY CONSIDERED AS EXEMPLARY TEMPLATES, BECAUSE IT IS EXPECTED THAT THIS DETAIL OF INFORMATION IS NOT AVAILABLE IN EACH COUNTRY.

If the detail of information requested cannot be found, then more aggregated information should be used, at the detail which is available to each country.

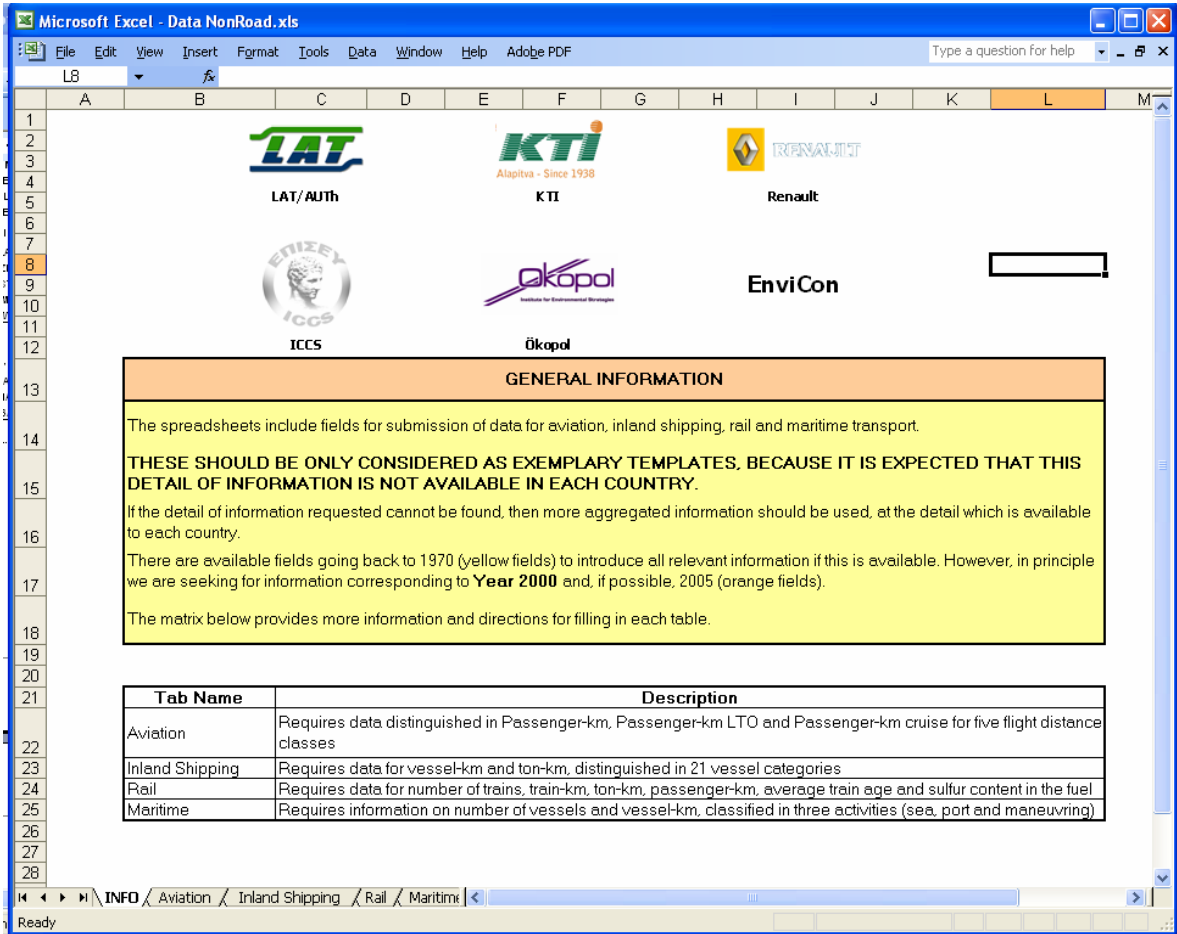
There are available fields going back to 1970 (yellow fields) to introduce all relevant information if this is available. However, in principle we are seeking for information corresponding to **Year 2000** and, if possible, 2005 (orange fields).

The matrix below provides more information and directions for filling in each table.

Tab Name	Description
Fuel Data	This tab requires information on the statistical fuel consumption figures for gasoline, diesel and lpg in two fuel grades are foreseen per fuel type (e.g. summer and winter gasoline) but one could in principle in case more fuels are available, please add corresponding rows. Also, the Reid vapour pressure of the fuel is an input, again distinguished in summer and winter grade.
Population	The number of registered vehicles per category in each year
Annual Mileage	The total distance [km] travelled by the average vehicle in one year
Urban Speed	The mean speed corresponding to the operation of vehicles in urban roads (km/h)
Rural Speed	The mean speed corresponding to the operation of vehicles in rural roads (km/h)
Highway Speed	The mean speed corresponding to the operation of vehicles in highways (km/h)
Urban Share	The percentage fraction of total mileage (%) driven in urban roads
Rural Share	The percentage fraction of total mileage (%) driven in rural roads
Highway Share	The percentage fraction of total mileage (%) driven in highways
Fuel Injection	The percentage fraction of gasoline vehicles equipped with fuel injection. This is required to estimate gasoline evaporation losses.
Evap Canister	The percentage fraction of gasoline vehicles equipped with fuel evaporation canister. This is required to estimate gasoline evaporation losses.
Urban Load	The load factor in percentage units (0.. 100%) for the average operation of heavy duty trucks in urban
Rural Load	The load factor in percentage units (0.. 100%) for the average operation of heavy duty trucks in rural
Highway Load	The load factor in percentage units (0.. 100%) for the average operation of heavy duty trucks in

The spreadsheet interface shows the "INFO" tab selected, with "Fuel Data" and "Population (Veh.)" tabs also visible. The status bar at the bottom indicates "Ready".

Excerpt of the data collection file for non-road transport modes



Annex III – Data Summary Excerpt

Excerpt of the Excel file used for data summary and input to the data reconciliation module.

	A	B	C	D	E	F	G	H	I	J	K
1	Sector	Subsector	Technology	1970	1971	1972	1973	1974	1975	1976	1977
3	Passenger Cars	Gasoline <1,4l	PRE ECE								
4	Passenger Cars	Gasoline <1,4l	ECE 15/00-01								
5	Passenger Cars	Gasoline <1,4l	ECE 15/02								
6	Passenger Cars	Gasoline <1,4l	ECE 15/03								
7	Passenger Cars	Gasoline <1,4l	ECE 15/04								
8	Passenger Cars	Gasoline <1,4l	Improved Conventional								
9	Passenger Cars	Gasoline <1,4l	Open Loop								
10	Passenger Cars	Gasoline <1,4l	PC Euro I - 91/441/EEC								
11	Passenger Cars	Gasoline <1,4l	PC Euro II - 94/12/EEC								
12	Passenger Cars	Gasoline <1,4l	PC Euro III - 98/69/EC Stage2000								
13	Passenger Cars	Gasoline <1,4l	PC Euro IV - 98/69/EC Stage2005								
14	Passenger Cars	Gasoline <1,4l	PC Euro V (post 2005)								
15	Passenger Cars	Gasoline <1,4l	All								
16	Passenger Cars	Gasoline 1,4 - 2,0l	PRE ECE								
17	Passenger Cars	Gasoline 1,4 - 2,0l	ECE 15/00-01								
18	Passenger Cars	Gasoline 1,4 - 2,0l	ECE 15/02								
19	Passenger Cars	Gasoline 1,4 - 2,0l	ECE 15/03								
20	Passenger Cars	Gasoline 1,4 - 2,0l	ECE 15/04								
21	Passenger Cars	Gasoline 1,4 - 2,0l	Improved Conventional								
22	Passenger Cars	Gasoline 1,4 - 2,0l	Open Loop								
23	Passenger Cars	Gasoline 1,4 - 2,0l	PC Euro I - 91/441/EEC								
24	Passenger Cars	Gasoline 1,4 - 2,0l	PC Euro II - 94/12/EEC								
25	Passenger Cars	Gasoline 1,4 - 2,0l	PC Euro III - 98/69/EC Stage2000								
26	Passenger Cars	Gasoline 1,4 - 2,0l	PC Euro IV - 98/69/EC Stage2005								
27	Passenger Cars	Gasoline 1,4 - 2,0l	PC Euro V (post 2005)								
28	Passenger Cars	Gasoline 1,4 - 2,0l	All								
29	Passenger Cars	Gasoline >2,0l	PRE ECE								
30	Passenger Cars	Gasoline >2,0l	ECE 15/00-01								
31	Passenger Cars	Gasoline >2,0l	ECE 15/02								
32	Passenger Cars	Gasoline >2,0l	ECE 15/03								
33	Passenger Cars	Gasoline >2,0l	ECE 15/04								
34	Passenger Cars	Gasoline >2,0l	PC Euro I - 91/441/EEC								
35	Passenger Cars	Gasoline >2,0l	PC Euro II - 94/12/EEC								
36	Passenger Cars	Gasoline >2,0l	PC Euro III - 98/69/EC Stage2000								
37	Passenger Cars	Gasoline >2,0l	PC Euro IV - 98/69/EC Stage2005								
38	Passenger Cars	Gasoline >2,0l	PC Euro V (post 2005)								
39	Passenger Cars	Gasoline >2,0l	All								
40	Passenger Cars	Gasoline									
41	Passenger Cars	Diesel <2,0l	Conventional								
42	Passenger Cars	Diesel <2,0l	PC Euro I - 91/441/EEC								
43	Passenger Cars	Diesel <2,0l	PC Euro II - 94/12/EEC								
44	Passenger Cars	Diesel <2,0l	PC Euro III - 98/69/EC Stage2000								
45	Passenger Cars	Diesel <2,0l	PC Euro IV - 98/69/EC Stage2005								

Annex IV – DVD Contents

The DVD accompanying this report contains both free and confidential market information. Therefore, the DVD is for European Commission use only. All publicly available information may be found at <http://lat.eng.auth.gr/copert>.

Folder	Files	Description
1 Input Stock	[CR] Data Road.xls	The input data on road stock, mileage and other activity summarized per country from all available sources.
2 Model Output	[CR] results road.xls	The final results of the reconciliation model for the vehicle stock per country.
3 Emission and Consumption	[CR]_results_2005.xls	Aggregated results calculated with COPERT 4 and compared with other sources for the Year 2005 per country.
4 New Cronos database	Fuel Consumption.zip New Registrations.zip Population.zip Vehicle km.zip	EUROSTAT data (New Cronos database) on activity, stock and new registrations per country
5 AAA	AAAagregatedEU27_1990_2007.xls AAA2000.zip	New PC registrations per country in the period 1990-2007 and detailed registrations per model and country in 2000
6 N1	Base IDVU.zip Europe DES 27.zip ObservatoireVehiculeEntreprise2005.pdf	Registrations of N1 vehicles per model and per country in 2005, the Renault LCV worldwide statistics book per year and panorama of the enterprise cars in Europe in 2005.
7 Non Road	[CR] Non Road.xls, [CR] Non Road Source or Non Road Overview.xls	National non-road input data on stock and other activity. Non road data from Eurostat, World Bank, UN Statistics and UNCTAD.
8 Various	UITP Data.zip UIC Data.zip ARTEMIS Data.zip CDB_2006.mdb LPG_CNG.zip	Data from the UITP database on urban busses fleets Data and report from the UIC study on emissions fro, rail transport Data and report relevant to this study from the ARTEMI project Database on CO2 monitoring of new passenger cars registrations Data on LPG and CNG vehicle use in Europe from ENGVA and AEGPL