UN/ECE Task Force to Phase Out Leaded Petrol in Europe

Country Assessment Report

Ministry of Environment and Energy, Denmark
Danish Environmental Protection Agency

Miljø- og Energiministeriet **Miljøstyrelsen**

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COWI Consulting Engineers and Planners

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List of Abbreviations

bbl	Barrels
BLL	Blood Lead Level
Br	Bromine
CEE	Central and Eastern Europe
CEP	Committee on Environmental Policy
Cl	Clorine
CON	Control Octane Number
CO	Carbon monoxide
DEPA	Danish Environmental Protection Agency
DTI	Danish Technological Institute
EBRD	European Bank For Reconstruction and Development
ECE	Economic Committee for Europe
EPE	Environment Programme for Europe
EU	European Union
FCC	Fluid Catalytic Cracking
g/l	gram per litre
HC	Hydrocarbons
IFI	International Financing Institutions
IQ	Intelligence Quotient
LRTAP	(Convention on) Long Range Transboundary Air Pollution.
m3	Cubic metre
MON	Motor Octane Number
MTBE	Methyl-tert-butyl-ether
NCBP	National Commitment Building Programme in Azerbaijan, Kazakhstan and Uzbekistan
NIS	Newly Independent States
NO_x	Nitrogen oxide
REC	Regional Environmental Centre
RFG	Reformulated petrol
RON	Research Octane Number
SCEP	State Committee for Environmental Protection of the Russian Federation
SILAQ	Sofia Initiatives on Local Air Quality
TEL	Tetra-Ethyl Lead

TML	Tetra-Methyl Lead
UN	United Nations
US	United States of America
USD	US Dollar
US-EPA	The US Environmental Protection Agency
v/v	volume/volume
vol/vol	volume/volume
WB	The World Bank

1 Introduction

This report presents the country assessments resulting from a major survey on the status of the phase-out of lead in petrol in European countries.

Task Force

The country assessments have been prepared in the framework of the UN/ECE Task Force to Phase Out Leaded Petrol in Europe.

The Task Force was established at the CEP (UN/ECE Committee on Environmental Policy) meeting 20-23 May 1996 to consider a strategy for the phase-out of lead in petrol in Europe. The Task Force has been led by Denmark's Ministry of Environment and Energy and the Danish Environmental Protection Agency. The Task Force held its first meeting in Geneva 7 November 1996, the second meeting in Hungary 6 May 1997, the third meeting was held 30 September 1997 in Geneva and the fourth and final meeting was held 16 January 1998 in Vienna.

Country assessment

At its first meeting, the Task Force decided to initiate a country assessment in order to obtain an improved understanding of the state of affairs in the individual countries with the aim of providing detailed country-specific information on important issues to consider in a strategy for the phase-out of lead in petrol in Europe. Issues to be considered covered: emissions of and health effects from lead; use, distribution and production of leaded and unleaded petrol; vehicle fleet features; refinery technology and number of refineries; and policies and measures applied to promote the use of unleaded petrol. The country assessments were to be based on a comprehensive questionnaire survey.

Consequently, a questionnaire (data sheets) was submitted to 50 UN/ECE member countries in the beginning of 1997. A copy of the original data sheet is found in the Appendix.

80% of the countries (40) completed the data sheets. The data sheets were subsequently compiled and analysed. In this process, consultations with individual country representatives proved highly beneficial in clarifying apparent inconsistencies and in providing more detailed background information as well as other relevant information in addition to the information included in the completed data sheet. The preliminary results were presented at the second and at the third meetings of the Task Force with the objective of obtaining comments and feed-back. Further, other sources of information have also been consulted. These efforts have assisted in enhancing the quality and the comprehensiveness of the assessments. Still, the final country assessments exhibit some variation from country to country with respect to coverage and types of information provided.

Organisation of report

This report presents the final country assessments. Each assessment is organised as follows (following the organisation of the data sheet):

- Environmental Pressure and Health Effects
- Production and Consumption of Petrol
- Refining Industry
- The Vehicle Fleet
- The Distribution System
- Policies and Measures

Acknowledgements

The data sheet survey was launched and monitored by the Task Force. Task Force members have been most active in providing the information and in assisting the Consultant with the compilation of the data sheets. These efforts are highly appreciated.

COWI, Consulting Engineers and Planners, has been responsible for conducting and co-ordinating the survey and for the compilation of the data sheets. In this, COWI has been assisted by the UN/ECE secretariat, the Danish Environmental Protection Agency and the Danish Ministry of Environment and Energy. Still, the results presented in this report remains the sole responsibility of the Consultant.

The study has been financed by the Danish Environmental Protection Agency.

2 Summary

This section summarises the main findings for each of the issues covered by the data sheet. The summary distinguishes between Western Europe, CEE excluding NIS and the NIS. In the summary, the Baltic States have been included in the group CEE excluding NIS.

2.1 Environmental Pressure and Health Effects

Reduced emissions

The environmental and health effects (measured in terms of ambient air lead concentrations and blood lead level measurements) from lead emissions have declined in the observed period 1990-1996, and a large part of the reduction in the ambient air lead concentrations can be attributed to reduced emissions from the transport sector.

Emissions from transport

Transportation in many countries still remains the single most important source of lead emissions, but the share accounted for by transportation differs significantly from one country to the other.

In Western Europe, transportation in most countries accounts for less than 40% of total lead emissions. This reflects the fact that the process of lead phase-out in petrol is well underway in Western Europe. In the CEE (excluding NIS) countries, transportation accounts for between 20% and 90% of total lead emissions, whereas almost all lead emissions in Ukraine and Uzbekistan can be attributed to transportation. It should be noted that assessments of lead emissions do involve a significant degree of uncertainty and hence, the data on lead emissions should be interpreted carefully.

Emissions per capita

Vehicular lead emissions per capita vary substantially in Europe. The lowest values (<1 and up to 3 g/capita) apply to countries that have phased out lead in petrol, or have a market share of unleaded petrol close to 100%. Among the countries covered in the survey this applies to Austria, Belarus, Denmark, Finland, Germany, Lithuania, Netherlands, Norway, Slovakia, and Sweden. At the other end of the scale are countries like Croatia, Estonia, Georgia, and Russia. In these countries more than 25 g/capita of lead was emitted in the latest year for which information was obtained. This partly reflects fairly low market shares for unleaded petrol and partly the fact that the lead content in the leaded petrol is relatively high.

Vehicular lead emissions have declined in most of the countries concerned in the period 1990-1996.

Table 2.1 *Status for Unleaded Petrol in Europe*

Country Figures apply to latest year available	Maximum lead content in leaded petrol	Emissions of lead from vehicles	Production of leaded and unleaded petrol	Refineries	Market share of unleaded petrol Year, %							petrol use	
Categorised according to 1996 market share	g/l in leaded petrol	g/capita	1000 m^3	Number	'90	'91	'92	'93	'94	'95	'96	1000 m^3	m^3 per 1000 inh.
< 25%													
Armenia	0.17-0.37	< 1	0	0					0	0	0	311	85
Bulgaria	0.15	16.2	1,653	3	<1	1	1	2	5	7	6	1,257	149
Romania	0.32		3,650	5						13	5	1,643	72
Cyprus	0.15/0.40		116	1			2	3	5	7	11	255	342
Turkey	0.15/0.40	16.9	4,109	5	<1	<1	2	5	8	8	18	4,756	78
Uzbekistan	0.17-0.37	13.3	1,733	2							1		
25%-49%													
Croatia	0.15/0.50	53.9	1,435	2	3		12	15	23	25	30	780	163
Greece	0.15/0.40		4,726	4			16	23	43	32		3,841	373
Italy	0.15		26,658	17	6	8	11	26	36	39	46	25,091	435
Poland	0.15	10.4	5,589	7					26	35	48	6,800	176
Portugal	0.15		3,424	*2*	18	15	23	37	34	35	42	2,597	262
Spain	0.15		8,950	10					22			*8,433*	*214*
Russian Fed.	0.17-0.37	27.0	36,591	26		30			38	47		33,254	224
50%-74%													
Azerbaijan	0.12-0.17	15.8	723	2							57	964	121
Belgium	0.15		*5,614*	4	27	38	47	57	65	69	74	3,658	373
Czech Rep.	0.15	22.0	1,649	4					37	48	55	2,461	238
France	0.15		22,917	15		41	47	53	58	50	56	19,863	345
Hungary	0.15		3,141	2						49	64		
Ireland	0.15		513	1		41	47	53	58	57	65	1,511	420
Latvia	0.15		0	0							60	608	243
Moldova	0.17-0.37	15.0	0	0						50	50	287	67
Monaco	0.15	15.8	0	0							67	9	300
Slovenia	0.15		105	1	3	9	20	29	36	45	54	1,249	624
UK	0.15	18.6	37,394	11		41	47	53	58	63	68		
75%-89%													
Estonia	0.15	26.7	0	0						77	81	452	301
Kazakhstan	0.17	23	3,078	*3*						80	80	2,927	180
Switzerland	0.15	13.4		2	45			78		85			
Ukraine	0.15-0.37	16.6	3,427	6					86	81	84	5,481	107
> 89%													
Albania	0.15		50							≥100	≥100	72	22
Austria	banned	<1	1,468	1					100	100	100	2,946	366
Belarus	0.17-0.37	0.9	2,376	2				57	61	79	97	1,687	162
Denmark	0.15	<1	3,309	2	58	64	70	77	100	100	100	2,539	495
Finland	0.15	<1	4,641	2	53	58	70	87	100	100	100	2,529	495
Germany	0.15	3.0	33,067	18	69	78	85	89	92	95	98	39,600	499
Georgia	0.37	25.0	0	1						75	98	445	235
Lithuania	0.15	2.7	1,159	1	76	74	69	64	41	78	98	804	217
Netherlands	0.15	3.2	*14,794*	6	49	60	71	75	80	82	92	5,535	359
Norway	0.15	<1	4,238	3			55			92	100	2,255	518
Slovakia	banned	<1	1,130	1	3	4	6	43	81	100	100	662	125
Sweden	banned	<1	5,544	5						100	100	5,180	587

Sources: Filled-in data sheets from the questionnaire survey; in the case of Spain, the source is CONCAWE , 1996

2.2 Production and Consumption of Petrol

The assessment on the use of petrol in the countries considered is based on the assumption that consumption can be calculated as production plus imports minus exports. This approach involves a certain degree of uncertainty as neither stock fluctuations nor "unofficial" cross-border trading are taken into account.

Market shares of unleaded petrol have increased in most of the countries included as shown in Table 2.1. The countries have been categorised according to the market shares of unleaded petrol in 1996. It should be noted that in all NIS (apart from the Baltic States), a major part of the petrol use is low-octane petrol (i.e. lower than RON90).

Western Europe

In Western Europe, the market share of unleaded petrol shows an increasing trend. In 1996, it is estimated at approximately 70%. Austria, Denmark, Finland, Germany, Netherlands, Norway, Sweden and Switzerland, have phased out or are close to a phase-out of lead in petrol. Other countries (mainly in Southern Europe) still have fairly low market shares (i.e. lower than or in the range of 50%). Still, the trend of increasing use of unleaded petrol applies to all countries and is strongly supported by the EU requirement for catalytic converters. This requirement also applies in other Western European countries.

CEE

In CEE excluding NIS, the market share of unleaded petrol is also increasing. Slovakia has completely phased out lead in petrol. Lithuania and Estonia are also close to a complete phase-out. However, some countries lack behind with very low market shares of unleaded petrol (e.g. Croatia 30%, Bulgaria 6%, Romania 5% and Turkey 18%).

NIS

Except from Armenia and Uzbekistan, the NIS countries covered by the survey all have fairly high market shares of unleaded petrol. However, it should still be noted that Russia and Moldova have market shares of about 50%, whereas Belarus, Kazakhstan, Ukraine and Georgia all have market shares of unleaded petrol that exceed 75%. In the NIS countries, petrol use is dominated by low-octane petrol (MON76). By comparison, the petrol market is dominated by petrol with RON numbers higher than 90 in the rest of Europe.

Petrol use per capita in CEE countries is significantly lower than in Western Europe. Thus in Western Europe, petrol use (measured as m^3/1,000 inhabitants) ranges between about 300 and 600. In CEE excluding NIS, the corresponding figures are 72 (Romania) and 624 (Slovenia). In the NIS countries, the values range between 67 (Moldova) and 224 (Russia).

2.3 **Refining Industry**

Unleaded petrol maintains an increasing share of production in the European countries covered by the survey. In countries such as Belarus, Denmark, Finland, Germany, Lithuania, Slovakia, Sweden, and Ukraine almost 100%, or 100% of the production is unleaded.

Western Europe

Many Western European countries, for example Austria, Denmark, Finland, Norway, United Kingdom and Sweden blend unleaded petrol with lubricating additives other than lead. In Germany, such an additive is sold separately at the petrol stations. All countries, except Austria, produce the unleaded RON95.

CEE

In some CEE (excluding NIS) countries there is also production of unleaded petrol with lubricating additives other than lead. Still, the use of such no-lead additives appear less widespread in CEE countries. All countries produce the unleaded RON95. Slovakia and Lithuania produce almost no leaded petrol.

Romania, Croatia and Slovakia are all major net exporters of unleaded petrol. Romania and Croatia thus have the potential of meeting increased domestic demands for unleaded petrol.

NIS

In the NIS countries considered, unleaded petrol has obtained increasing production shares throughout the period. None of the countries indicated a production of unleaded petrol with lubricating additives other than lead. Production is heavily dominated by the MON76 petrol. The latter reflects the relative poor state of the refining industry in the NIS countries. Refineries are less sophisticated and have a lower degree of complexity in their operations than the refineries in most of Western Europe as measured by the refinery industry's secondary processing capacity as a percent of the crude oil (i.e. primary) distillation capacity. This also applies to some of the refineries in the CEE. This tendency is particularly pronounced with respect to the ability to convert heavy oil components into lighter more valuable components. Furthermore, the refineries in Eastern Europe, with a few exceptions such as Slovakia, tend to be older, more energy intensive and in need of repair.

2.4 **The Vehicle Fleet**

On average, the number of cars per capita in Europe is largest in Western Europe. It is lower in CEE excluding NIS, and the lowest ratio is observed in the NIS countries (less than 0.1).

Western Europe

The number of cars per capita in Western Europe range between about 0.35 and more than 0.70. The average age of cars in Western Europe is in a range of 6-10 years. Turnover rates lie between 5% and 13%.

In countries such as Austria, Belgium, Germany and the Netherlands, the major share of the petrol driven vehicles are equipped with catalytic converters.

CEE

In the CEE countries excluding NIS, the number of cars per capita in most countries ranges between 0.2 and 0.3. Turnover rates are 8% or lower. The present share of the vehicle fleet with catalytic converters is fairly low, but several countries have implemented requirements for catalytic converters and the share is increasing.

NIS

In the NIS countries, the number of cars per capita is less than 0.10 with the exception of Belarus, Russia and Ukraine. The average age of the vehicles is estimated to be in the range of 10-15 years, but these figures should be interpreted very carefully, and turnover rates are very low - less than 2%. In general, a high fraction of the vehicle fleet is heavy duty vehicles and busses, and a fairly high fraction of those are petrol driven.

Eastern European car makes dominate the vehicle fleet in both the CEE and the NIS countries.

2.5 **The Distribution System**

Western Europe

In Western Europe, all petrol stations generally offer unleaded petrol, except in France, where about 50% of the stations offered unleaded petrol in 1995. Most stations have vapour recovery installations (stage I and stage II). Furthermore, the pump nozzles for leaded and unleaded petrol are always different thereby avoiding misfuelling. An exception is Sweden where there is only one type of pump nozzle now that a ban on leaded petrol has taken effect. Before the ban, the size was different for leaded and unleaded petrol.

CEE

In CEE, excluding NIS, the majority of petrol stations offer unleaded petrol, and pump nozzles are different. Only some petrol stations have vapour recovery installation, but the number is increasing.

NIS

In the NIS countries, information is more scarce. In general, however, labelling of leaded and unleaded petrol is insuffient. Thus, the consumers may often not be aware of whether they are fuelling leaded or unleaded petrol. Furthermore, lead may be added to the petrol at various stages in the distribution chain without proper control and without being reflected in the official statistics. Hence, market shares of unleaded petrol are uncertain and this is also the case with respect to the actual amount of lead in petrol, which as a result may exceed the already relatively high limits for the lead content in petrol (Kazakhstan, Ukraine).

There are almost no petrol stations with vapour recovery installations, and generally the pump nozzles for leaded and unleaded petrol are of the same size. Generally, there are no separate systems (dual distribution) at the retail level for distribution of unleaded and leaded petrol.

Organisational phase-out barriers

The phase-out process may also be hampered in some countries by a limited degree of formal organisation within the distribution sector which inhibits standardisation and control efforts. In Ukraine, for example, the distribution system is characterised by the emergence over the last years of a large number of independent petrol wholesalers and retailers who have replaced the formerly centrally managed distribution system. The new private distribution system is in a transition phase with a very loose structure and a low degree of integration. There are no major nation-wide distributors of branded petrol, although some regional networks are emerging.

Cost of change

It should be noted that in Slovakia, where leaded petrol is completely phased out, the shift from leaded to unleaded petrol did not require additional investments in the distribution infrastructure. The same storage terminals and transportation modes (pipeline, rail and tankers) were used after a clean-up. The switch was undertaken gradually.

2.6 **Policies and Measures**

Western Europe

In the EU and in other Western European countries, the maximum allowed lead content in petrol is 0.15 g/l, except in Greece (0.4 g/l), and the benzene limit is 5% v/v corresponding to the EU quality standards, except in Italy and Austria, where the benzene limit is 3% v/v. Furthermore, emission requirements apply necessitating the use of catalytic converters. These requirements, which were implemented in the EU in 1993, will gradually and steadily increase the market share of unleaded petrol. This development is further supported by the use of tax incentives in almost all countries considered. Awareness raising measures have been, or are, applied in many of the countries.

Sweden and Austria have imposed a ban on the sales of leaded petrol.

CEE

In the CEE excluding NIS, a limit for the lead content in petrol of 0.15 g/l applies, except in Croatia (0.5 g/l), Turkey (0.4 g/l) and Romania (0.32 g/l). Most countries have established a limit for the content of benzene in petrol of 5% v/v. Hungary allows only a benzene content of 3% v/v. Many countries have implemented requirements for catalytic converters. Tax incentives are applied, but the resulting differences in consumer prices are in general relatively small.

Some countries have made explicit considerations as to the possible date for a phase-out of lead in petrol e.g. Croatia (2005: 85% market share), Lithuania (1997), Poland (2000), Romania (2003), Turkey (2003). Hungary and Bulgaria aim to reduce production of leaded petrol substantially by year 2000, and Bulgaria further aims to ban production and imports of leaded petrol by year 2003.

Slovakia has imposed a ban on the sales of leaded petrol.

NIS

The limit for lead content in petrol is in general 0.37 g/l (lower however for certain grades). None of the countries have indicated any limits for the content of benzene in petrol. Some of the NIS countries covered by the analysis apply tax incentives, but generally on a very limited scale. Only Belarus has indicated the use of awareness building measures. Ukraine and Uzbekistan intend to implement requirements for catalytic converters in the near future. In Ukraine, the intention is to apply this requirement for all vehicles.

Russia has adopted an Action Plan to increase the production share of unleaded petrol by 65% by year 2000. Moldova and Belarus both aim to phase out lead in petrol by the year 1998, while the Ukrainian refining industry plans a phase-out of lead in petrol production by year 2000. It appears however that some countries do have difficulties in achieving these objectives.

3 Austria

3.1 **Environmental Pressure and Health Effect**

Total emissions of lead from all sources were 24.3 tonnes in 1994 of which vehicles accounted for less than 1 ton. The lead emission from all sources and from vehicles have declined considerably since 1992, where the emissions were 215.4 tonnes in total of which vehicles accounted for 159 tonnes.

Table 3.1 *Vehicular Lead Emissions. 1992 and 1994. Austria*

Vehicular lead emissions	1992	1994
Vehicular emissions (tonnes)	159	<1
Share of total emissions (%)	74%	<4
Emissions/km2 (kg)	1.9	
Emissions per 1,000 inhabitants (kg)	20	

3.2 **Production and Consumption of Petrol**

Total petrol consumption in Austria was 2.946 million m^3 in 1996. The market share of unleaded petrol was 100% in 1995 and 1996.

However, Austria maintains a minor production of leaded petrol, which is destined for export.

Still, Austria was also a net importer of unleaded petrol.

The maximum content of lead in unleaded petrol has been 0.013 g/l since November 1993.

Since 1993, a potassium based lubricating additive has been mandatory in unleaded RON98 (super plus). It is blended into the petrol at the production plant. There are no lubricating additives in the other unleaded petrol grades available.

During 1994 and 1995, the consumer price of leaded petrol was 18-21% higher than the consumer price of unleaded petrol.

3.3 **Refining Industry**

There is one refinery, OeMV AG-Schwechat, in Austria in which the state has a 35% stake. The utilisation of the crude oil distillation capacity was 88% in 1996.

The crude oil distillation units were constructed in 1960 and 1970, while the catalytic cracking unit is from 1963 and the reformers are from 1971 and 1983. Isomerisation and MTBE production were added in 1983. The last revamp was carried out in 1990 and involved the catalytic cracking unit.

To increase the production of unleaded petrol, reformer severity has increased and blending with MTBE is undertaken.

Forthcoming investment plans include reengineering of crude unit, reformer and catalyst.

Table 3.2 Refinery processes. 1996. Austria[1] (bbl/day)

Refinery process	Capacity 1996
Atmospheric distillation	210,000
Thermal operations	18,100
Catalytic Cracking	25,800
Catalytic Reforming	33,700
Catalytic hydrocracking	
Alkylation	
Polymerisation	
Isomerisation	14,400
Oxygenates (e.g. MTBE)	1,600

3.4 Vehicle Fleet

The number of vehicles in Austria amounted to about 5 million in 1996 corresponding to an increase of 19% since 1990. The number of passenger cars increased by 20% over the period and accounted for 73% of the vehicle fleet in 1995.

Relatively fewer passenger cars were petrol driven by the end of 1995 than in 1990. The same was the case with respect to heavy duty trucks. This structural shift in the use of fuel types has been accompanied by a substantial increase in the number of petrol driven passenger cars equipped with catalytic converters.

[1] Source: Oil and Gas Journal December 1996.

Table 3.3 *The Vehicle Fleet. 1990-1996. Austria*

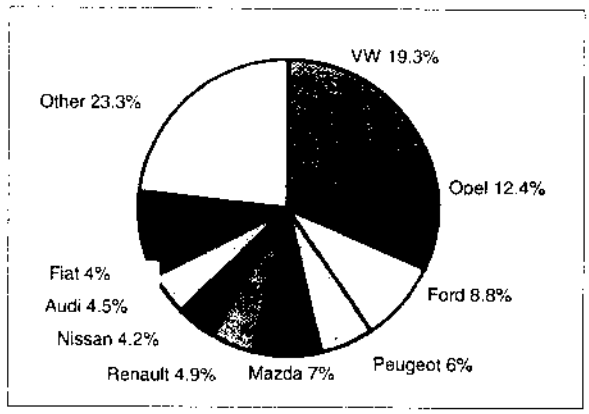
Information	1990	1991	1992	1993	1994	1995	1996
Total number of vehicles '000	4,240	4,391	4,504	4,693	4,773	4,915	5,039
Number of passenger cars '000	2,991	3,100	3,245	3,368	3,480	3,594	
Number of vehicles per 1,000 inhabitants	551	570	585	602	620	638	654
Share with catalytic converters, all vehicles, %	16	21	25	28	31	33	
Share with catalytic converters, passenger cars with petrol engine, %	26	34	42	47	53	58	

Table 3.4 *The vehicle fleet according to fuel type. 1990-1995. Austria*

Information	1990	1991	1992	1993	1994	1995
Passenger cars						
% petrol driven (%)	86	85	84	82	79	77
% diesel driven (%)	14	15	16	18	21	23
Heavy duty vehicle						
% petrol driven (%)	32	29	26	23	21	19
% diesel driven (%)	68	71	74	77	79	81

Figure 3.1 shows the most common car makes in Austria in 1996.

Figure 3.1 *The Ten Most Common Vehicles. 1996 (%)*



3.5 **Distribution System**

In 1996, there were 3,428 petrol stations in Austria down from 3,935 in 1990.

3.6 **Policies and Instruments**

The market share of unleaded petrol reached 100% in Austria in 1995 and leaded petrol is now banned. A limit for the benzene content in unleaded petrol of 3% v/v was implemented in 1990.

The phase-out of lead in petrol has been accomplished by the use of economic incentive mechanisms coupled with a mandatory requirement that a no-lead lubricating additive is added to RON98 petrol. This enables older cars to use unleaded petrol.

4 Belgium

4.1 **Environmental Pressure and Health Effect**

In Flandern, total emissions of lead from all sources were 324.1 tonnes in 1993.

In the Brussels region, total emissions of lead were 71.4 tonnes in 1995. Vehicles accounted for 48% of this amount. A decline of 7% in vehicular lead emissions can be observed over the period 1990-1995. Ambient air lead concentrations (in a canyon street with much traffic) were 0.48 µg/m^3 in 1996 down from 0.56 µg/m^3 in 1994 and 0.72 µg/m^3 in 1995.

In Antwerp and Gent, vehicular lead emissions were 8.5 tonnes and 4.4 tonnes respectively in 1994. In the period 1990-1994, emissions declined by 17% and 29% respectively. Ambient air lead concentrations in Antwerp declined from 0.87 µg/m^3 in 1990 to 0.11 µg/m^3 in 1995. In Gent, the concentrations halved in the same period reaching a level of 0.05 µg/m^3 in 1995.

In 1992, the mean average blood lead level (BLL) in Belgium was estimated at 65.8 µg/l. Table 4.1 illustrates the significant trend of decline in BLL measurements in Belgium from 1979 to the beginning of the 1990's. The Charleroi area is classified as an industrial area not polluted by lead, whereas the other three regions covered in the table are classified as urban areas.

Table 4.1 *Blood Lead Levels in Belgium 1979, 1991 and 1992. Mean values. Adults and children. µg/l.*

Year	Brussels	Gent	Charleroi	Namur
1979	176.2	155.0	181.5	172.1
1991	82.3			
1992		61.6	82.0	82.5

4.2 **Production and Consumption of Petrol**

Total petrol consumption in Belgium has remained fairly constant during the period 1990-1996, but demand has shifted markedly from leaded to unleaded petrol. As can be seen from Figure 4.1, the market share of unleaded petrol lies substantially above that for leaded petrol. In 1996, the market share of unleaded petrol was 74% compared to 27% in 1990 (Table 4.2).

Figure 4.1 *Consumption of Leaded and Unleaded Petrol. 1990-1996. Belgium (1,000 m³)*

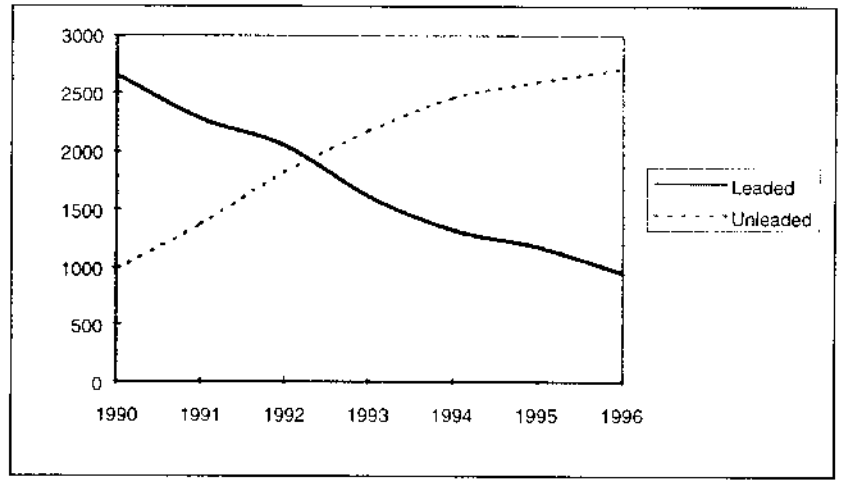


Table 4.2 does not contain information on production, import or exports, as these figures were not available. However, it can be noted that Belgium is a net-exporter of refined products primarily to other EU-countries.

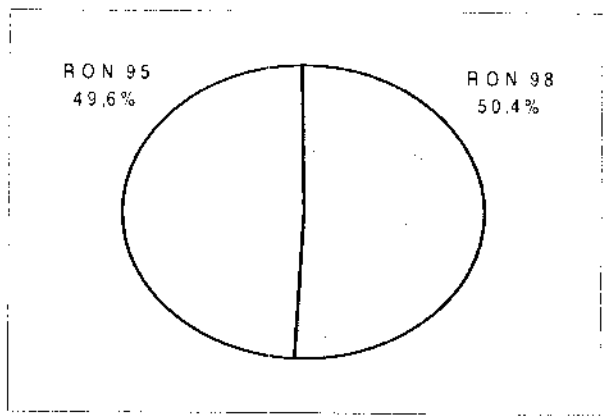
Table 4.2 *The Development in Petrol Consumption. 1990-1996 (1,000 m³)*

1,000 m3	1990	1991	1992	1993	1994	1995	1996
Leaded petrol	2,656	2,280	2,053	1,612	1,328	1,181	951
Unleaded petrol	981	1,370	1,818	2,172	2,457	2,596	2,707
Total consumption	3,637	3,650	3,871	3,784	3,785	3,777	3,658
Unleaded petrol, market share, %	27	38	47	57	65	69	74

RON98 is the only leaded grade petrol sold in Belgium. The sales of unleaded petrol is divided evenly between RON95 and RON98 petrol (Figure 4.2).

In 1996, 37% of total petrol use was RON95, while the share in 1990 was only 24%. Thus, while RON98 still is the major grade on the Belgium petrol market, the market share of RON95 is on the increase.

Figure 4.2 *Distribution of Unleaded Petrol Consumption on Different RON Qualities. 1996. Belgium (%)*



The maximum content of lead in leaded petrol is 0.15 g/l. The actual lead content in leaded petrol (RON98) is 0.14 g/l, and it is 0.001 g/l in unleaded petrol (RON98 and RON95).

4.3 **Refining Industry**

There are four refineries in Belgium, all of which are privately owned. Table 4.3 provides an overview of the processes in the Belgian refining industry. Fina Raffinaderij is the largest refinery with a crude distillation capacity of 288,000 bbl/day followed by Esso Belgium with a capacity of 246,000 bbl/day. These two refineries accounted for 85% of the primary distillation capacity in 1996.

Table 4.3 *Refinery processes. 1996. Belgium[2] (bbl/day)*

Refinery process	Capacity 1996
Atmospheric distillation	609,750
Thermal operations	61,270
Catalytic Cracking	110,900
Catalytic Reforming	98,440
Catalytic hydrocracking	
Alkylation	13,515
Polymerisation	1,600
Isomerisation	6,750
Oxygenates (e.g. MTBE)	

[2] Source: Oil and Gas Journal December 1996.

The rate of utilisation of available distillation capacity was in the range of 80-85% in the period 1991-1994, which is a substantial improvement compared to a utilisation rate of 70% in 1990. The upgrading capacity has remained constant in the 1990's. A deep conversion unit was installed in 1995 at the Fina Raffinaderij. The technical options applied for lead replacement in petrol production are: increasing reformer severity; increased production of high octane blendstocks; and the use of FCC petrol, alkylation, isomerisation and the blending of oxygenates (such as MTBE) into the petrol pool.

Other lubricating additives than lead are not applied in Belgium; neither at the refineries nor at the petrol stations. Rather, the technology of the engines of the vehicles concerned is adapted to allow for the use of unleaded petrol.

4.4 **Vehicle Fleet**

Table 4.4 provides key information on the vehicle fleet in Belgium. The number of vehicles has increased by 13% from 1990 to 1996. In the same period, however, turnover rates have declined and the average age of vehicles have increased slightly.

Table 4.4 *The Vehicle Fleet, 1990-1996, Belgium*

Information	1990	1991	1992	1993	1994	1995	1996
Total number of vehicles '000	4,198	4,307	4,418	4,495	4,581	4,659	4,741
Number of passenger cars '000	3,833	3,929	4,029	4,098	4,175	4,239	4,308
Number of vehicles per 1,000 inhabitants	432	444	455	463	472	480	484
Average age of passenger cars (years)	5.9	6.1	6.2	6.4	6.6	6.9	7.1
Estimated turnover rate (%)	10	12	8	7	7		
Share with catalytic converters, all vehicles, %			4.8	12.2	19.4	25.8	32.8
Share with catalytic converters, passenger cars with petrol engine, %			7.5	19.3	31.4	42.9	55.0

The major share, 97%, of the vehicle fleet are passenger cars and light duty vehicles, and 61% of the vehicle fleet use petrol.

It is noteworthy that a fairly high share, 33%, of the passenger cars have diesel engines. This share has increased steadily from 27% in 1990. A similar trend can be observed for heavy duty vehicles where 73% had diesel engines in 1990, and 81% in 1996.

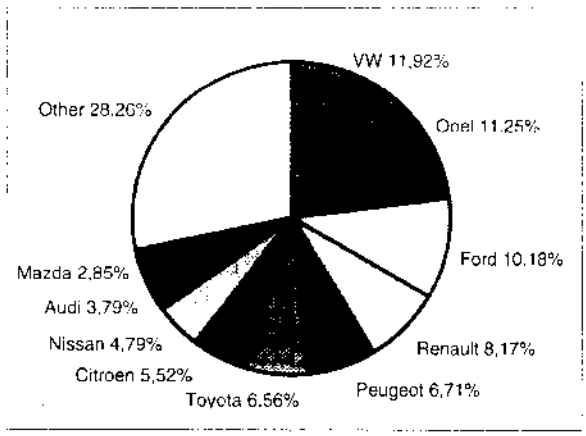
The number of cars with catalytic converters has increased steadily from 1992 to 1996. In 1992, 5% of all vehicles had catalytic converters. In 1996, this figure had increased to 33%, corresponding to 55% of the passenger cars with petrol engines.

Table 4.5 *The vehicle fleet according to fuel type, 1990-1996, Belgium*

Information	1990	1991	1992	1993	1994	1995	1996
Passenger cars							
% petrol driven (%)	72	71	71	70	68	67	66
% diesel driven (%)	27	28	28	29	31	32	33
% other (%)	1	1	1	1	1	1	1
Heavy duty vehicles & busses							
% petrol driven (%)	23	22	21	20	19	17	16
% diesel driven (%)	73	75	76	78	78	79	81
% other (%)	3	3	3	2	3	4	3
All vehicles							
% petrol driven (%)	67	66	66	65	64	62	61
% diesel driven (%)	31	32	33	34	35	37	38
% other (%)	1	1	1	1	1	1	1

Figure 4.3 shows the most common car makes in Belgium in 1995.

Figure 4.3 *The Ten Most Common Vehicles. 1995 (%)*



4.5 **Distribution System**

In 1994, there were 5,350 petrol stations in Belgium down from 6,273 in 1990.

From 1990 to 1994 retail sales of motor fuels increased by about 15% (from 4.4 million tonnes to 5.05 million tonnes), solely because of increased sales of automotive diesel oil. While sales of petrol has remained fairly constant, sales of automotive diesel oil has increased by 30% (from 1.8 million tonnes to 2.35 million tonnes).

4.6 **Policies and Instruments**

Belgium applies the EU-limits of 0.15 g/l for leaded petrol and 0.013 g/l for unleaded petrol. The actual lead content is estimated at 0.14 g/l for the leaded petrol and at only 0.001 g/l for the unleaded petrol. Furthermore, the limit for the benzene content in petrol is 5% v/v. In accordance with EU regulations, the 1989 limit for sulphur content in automotive diesel oil of 0.2% has been reduced to 0.05% by the 1 January 1996.

The EU emission requirements which necessitate the use of catalytic converters has applied in Belgium since 1993. In 1996, it is estimated that 55% of the petrol driven passenger cars had catalytic converters, whereas the share was only 7.5% in 1992.

In support of the use of unleaded petrol, Belgium has, since 1989, applied a tax incentive scheme favouring unleaded petrol. The excise duty advantage was initially 1 BEF/l and reached a peak of 2.95 BEF/l in 1992. Since then, it has gradually been reduced and in 1996, the advantage amounted to 2.35 BEF/l. The resulting consumer price difference has ranged between 7% and 9% over the period 1993-1995.

There is a significant, duty-related pump price advantage in favour of auto diesel. The diesel powered cars therefore represent a

relatively large proportion of the total vehicles fleet in Belgium. The advantage in favour of diesel has increased since mid 1992. The result being that diesel accounted for a total share of retail sales of motor fuels of 44% in 1994 compared to 39% in 1992 and 38% in 1990.

5 Denmark

5.1 Environmental Pressure and Health Effect

Since 1995, there has not been observed any vehicular lead emissions in Denmark. Lead was completely phased out of petrol in 1994. However, in 1994, a trace of lead of an estimated 5 tonnes was estimated.

In 1990 and 1991, a substantial share of total atmospheric lead emissions could be attributed to petrol (in the magnitude of 90%). Thus, petrol consumption was the single most important source of lead emissions, and elimination of lead in petrol could substantially reduce total emissions of lead. Since 1991, the share of total lead emission originating from petrol consumption has declined significantly.

Table 5.1 *Vehicular Lead Emissions. 1990-1995. Denmark*

Vehicular lead emissions	1990	1991	1992	1993	1994	1995
Vehicular emissions (tonnes)	102	93	65	20	5	0
Share of total emissions (%)	90	90	87	67	11	0
Emissions/km2 (kg)	2.37	2.16	1.51	0.46	0.12	0
Emissions per 1,000 inhabitants (kg)	20	18.2	12.7	3.9	0.98	0

The values for ambient air lead concentrations in three major Danish cities (Copenhagen, Aalborg and Odense) show that the ambient air lead concentrations declined in the period from 1990 to 1995, cf. Table 5.2. In Copenhagen, ambient air lead concentrations at a street with dense traffic were 0.030 $\mu g/m^3$ in 1995 down from 0.25 $\mu g/m^3$ in 1990.

Table 5.2 *Ambient air lead concentrations in Danish cities. Streets with very dense traffic. Max. short term measurements. µg/m³*

Year	Copenhagen	Odense	Aalborg
1990	0.250	0.148	0.294
1991	0.220	0.168	0.130
1992	0.190	0.130	0.212
1993	0.130	0.097	0.140
1994	0.040	0.032	0.045
1995	0.030	0.022	0.031

The mean blood lead level concentrations in children have been measured to 5 µg/dl with a maximum of 14 µg/dl.

5.2 **Production and Consumption of petrol**

Petrol consumption has increased steadily in Denmark since 1990. In the period 1990-1996, the use of petrol increased by 21% as can be seen from Table 5.4 below. Over the same period, the use of gas and diesel oil remained fairly stable.

Since 1990, petrol consumption in Denmark has shifted markedly from leaded to unleaded petrol. Thus, in 1990, unleaded petrol accounted for 58% of total petrol consumption. The market share has been steadily increasing and reached 100% in 1995. Thus, leaded petrol has been phased out in Denmark. Figure 5.1 illustrates these developments. Since the beginning of 1994, a potassium based additive has been applied to provide the lubricating effect for the valves. This petrol is marketed as Super RON98 and can be used by vehicles in need of the lubricating effect. This petrol type is shown as the unleaded petrol containing other lubricating additives than lead in Figure 5.1.

Figure 5.1 *Consumption of Leaded and Unleaded Petrol. 1990-1996. Denmark (1,000 m³)*

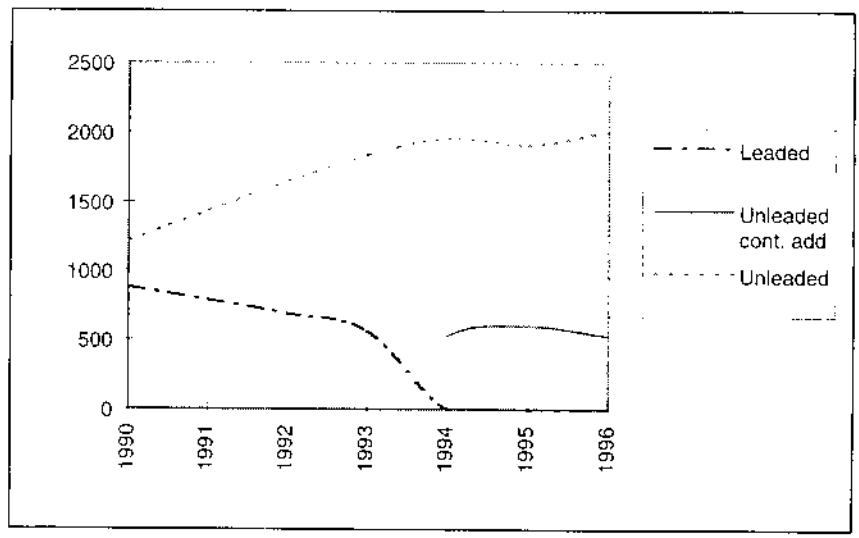
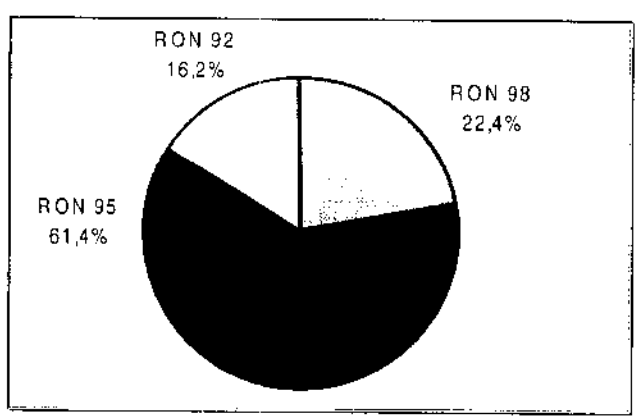


Figure 5.2 shows that RON95 petrol dominates the unleaded petrol market in Denmark. In Figure 5.2, RON98 includes the unleaded petrol with the potassium based additive (55% of all RON98 petrol use).

Figure 5.2 *Distribution of Unleaded Petrol Consumption on Different RON Qualities. 1996. Denmark (%)*



In Table 5.3 the petrol supply balance for Denmark in 1996 is shown. Denmark has net-exports of unleaded petrol. Unleaded petrol with other lubricating additives than lead had a market share of 21% in 1996.

Table 5.3 *Supply Balance for Leaded and Unleaded Petrol. 1996. Denmark (1,000 m^3)*

1,000 m3	Production	Import	Export	Consumption
Unleaded petrol with lubricating additives	528	0	0	528
Unleaded petrol	2,781	785	1,555	2,011

Table 5.4 *The Development in Petrol Consumption. 1990-1996.*

1,000 m3	1990	1991	1992	1993	1994	1995	1996
Leaded petrol	880	792	690	564	0	0	0
Unleaded petrol	1,213	1,434	1,648	1,842	2,490	2,518	2,539
Total consumption	2,093	2,226	2,338	2,406	2,490	2,518	2,539
Unleaded petrol, market share, %	58	64	70	77	100	100	100

The maximum lead content allowed in leaded petrol is 0.15 g/l and 0.013 g/l for unleaded petrol. The actual content of lead in petrol is estimated at 0.003 g/l (trace amount of lead).

Further, it should be noted that the actual lead content has been continuously on the decline since 1990. In 1990 and 1991, it was only the leaded RON98 which had a lead content of 0.15 g/l. The other leaded quality, RON96, only had a lead content of 0.075 g/l. In 1992 and 1993, RON98 was the only leaded quality at the Danish market. In 1992, this petrol had a lead content of 0.11 g/l and in 1993, the lead content was further reduced to 0.05 g/l.

5.3 **Refining Industry**

Until April 1997, there were 3 refineries in Denmark. One of these ceased its operations in April 1997. The remaining two, as well as the closed refinery, are privately owned.

Recent revamps in 1996 at the two remaining refineries comprise: Reformer and isomerisation (Statoil); and Hydro-desulphurzation (Shell). The latter further plans to install a new precut-splitter to reduce the content of benzene in final products. The revamps at Statoil also implied a substantial extension of production capacity.

There is a marginal shortage of octane, which is compensated for by means of MTBE purchases. Further, increasing reformer severity is done to produce a 100 octane reformate. The use of isomerisation allows this to be done without increasing the content of benzene.

In terms of crude oil distillation capacity, the Statoil refinery is the largest of the two Danish refineries. However, the capacity for upgrading is of about the same magnitude at the two refineries. There is a full utilisation of the production capacity at the two refineries.

Table 5.5 *Refinery Processes 1996, Denmark*[3] *(bbl/day)*

Refinery process	Capacity 1996
Atmospheric distillation	189,100
Thermal operations	74,200
Catalytic Cracking	
Catalytic Reforming	32,300
Catalytic hydrocracking	16,00
Alkylation	
Polymerisation	
Isomerisation	6,000
Oxygenates (e.g. MTBE)	

5.4 **Vehicle Fleet**

Table 5.6 provides key information on the vehicle fleet in Denmark. In 1996 there were 2.09 million vehicles in Denmark, which corresponds to 410 vehicle per 1,000 inhabitants. 95% of the total vehicle fleet were passenger cars and light duty trucks in 1994. 84% of the vehicle fleet was petrol driven in 1995.

[3] Source: Oil and Gas Journal December 1996.

Table 5.6 *The Vehicle Fleet, 1990-1996, Denmark*

Information	1990	1991	1992	1993	1994	1995	1996
Total number of vehicles, ('000)	1,887	1,888	1,912	1,932	1,928	2,027	2,093
Number of passenger cars ('000)	1,784	1,797	1,810	1,829	1,829	-	-
Number of vehicles/1000 inhabitants	362	363	368	379	378	397	410
Share with catalytic converters, all vehicles, %	9.5	14.0	18.3	22.5	-	25.3	31.2
Share with catalytic converters, passenger cars with petrol engine, %	11.3	16.5	21.6	26.6	25.3		
Estimated turnover rate (%)	4.6	4.8	4.8	4.6	8.0		

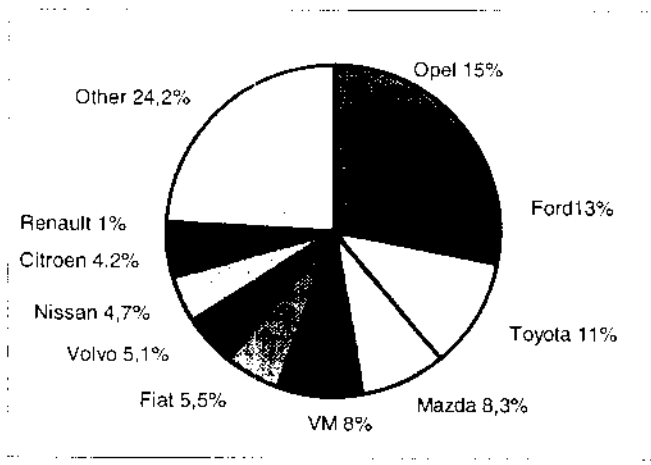
Since October 1990 catalytic converters have been required for all new cars. The share of cars equipped with catalytic converters has shown substantial annual increases. In 1996, the share of the vehicle fleet with catalytic converters was 31%.

Table 5.7 *The vehicle fleet according to fuel type, 1990-1995, Denmark*

Information	1990	1991	1992	1993	1994	1995
Passenger cars						
% petrol driven	89	89	89	89	89	-
% diesel driven	11	11	11	11	11	-
Heavy duty vehicles & busses						
% petrol driven	5	5	5	5	5	-
% diesel driven	95	95	95	95	95	-
All vehicles						
% petrol driven	85	85	85	85	84	84
% diesel driven	15	15	15	15	16	16

Figure 5.3 shows the ten most common car makes in Denmark in 1994.

Figure 5.3 *The ten most common vehicles (%). 1994. Denmark.*



5.5 Distribution System

In 1995 there were 2,647 petrol stations in Denmark, all privately owned. They all offer unleaded petrol, and there are between 4 and 7 fuel pumps per station. Also, there is differentiation between pump nozzles for leaded and unleaded petrol.

All the stations have vapour recovery installations for tank filling ("Stage I"), and half of them also have for car filling ("Stage II"). There are 90 tank distribution lorries (only from the companies Statoil, Shell and Kuwait Petrol).

5.6 Policies and Instruments

Leaded petrol was phased out in Denmark in 1994, following a period with gradual and significant annual increases in the market share of unleaded petrol.

The Danish lead phase-out has been achieved through a mix of different instruments:

- Awareness building measures in the form of information campaigns have been undertaken by the authorities and the petrol companies;
- Economic measures: Tax differentiation have been applied. In 1990 and 1991, unleaded petrol was 7% cheaper than leaded petrol. In 1992, the difference was 6% (comparing RON98);
- Regulatory measures: Emission requirements which imply a need for catalytic converters on all new cars have been in force since October 1990 (3 years before the EU regulation took effect). Quality standards similar to the EU quality standards apply for both leaded and unleaded petrol i.e. maximum lead content in leaded petrol 0.15 g/l and for unleaded petrol 0.013 g/l, while a common limit for benzene of 5% v/v is in force.

A lubrication additive is added to the RON98 petrol. This enabled a shift to unleaded petrol also for older cars in need of the lubricating effect which was previously provided by lead.

Major constraints in the process of phasing out lead in petrol were 1) consumers reluctance and 2) the need for older cars to obtain the lubricating effects from lead. The latter was overcome by means of adding a potassium based additive instead of lead and the former by means of applying tax incentives and information campaigns. Further, the requirement for catalytic converters also supported the process. Information campaigns are believed to have had substantial effects. Further, the competitive environment for the refineries implied that the tax incentives were quickly reflected in a change of production towards more unleaded petrol. The oil companies also contributed to the information campaigns.

6 Finland

6.1 **Environmental Pressure and Health Effect**

The emission of lead by vehicles was 189 tonnes in 1990, but declined gradually thereafter and reached nil in 1994[4]. The lead emission from all sources declined by 79% from 1990 to 1995, when the total emission was 49 tonnes.

Over the period 1980-1990, the annual average ambient air lead concentrations were 0.05-1.0 µg/m^3. The ambient air lead concentrations declined to 0.01-0.1 µg/m^3 in 1993.

The national average blood lead level concentrations for males were 11 µg/dl in 1975 and 2.8 µg/dl for males and females in 1992. In Helsinki, the blood lead level concentrations for children were 4.6 µg/dl in 1983, which declined to 3.0 µg/dl in 1988. The maximum level observed was 8.3 µg/dl.

Measurements and studies of the discharges of lead into soil, groundwater etc. have also been undertaken in Finland:

Water

The discharge of lead into the aquatic environment was estimated to 2.9 tonnes per year in 1990, which was a decrease of 42% compared to the discharges in 1980.

Measurements of 8,500 samples from drinking water supply sources in the beginning of the 1990s revealed lead concentrations below 1 µg/l in 8,490 of the samples. In the remaining ten samples, the values were about 50 µg/l. Groundwater measurements at 56 stations were studied over the period 1975-1988. The maximum lead concentration was 80 µg/l with a mean value of 2.8 µg/l.

Snowpack

In southern Finland, the atmospheric lead deposition in the snowpack during winter was 4.8 µg/l (mean value) and 2.2 µg/l in northern Finland. In the 1970s, the lead deposition in Finland was estimated to 28.4 mg/m^2 per year , but studies from the beginning of the 1990s using a climatological model indicated that the lead deposition in southern Finland varies between 4-7 mg/m^2 per year and in northern Finland between 1.5-2.5 mg/m^2 per year.

Soil

Lead discharged through waste and other lead containing materials in soil was estimated to 5,890 tonnes in 1990, which was an increase of 15% compared to the discharges in the beginning of the 1980s. The lead concentration in soil generally varied between 15-20 µg/g in the beginning of the 1990s, but was higher in industrial and urban areas.

[4] Although there may be minor emissions due to traces of lead in unleaded petrol.

Dietary intake of lead was 40-60 µg per day in the beginning of the 1990s compared to the respiratory air that could increase the lead exposure by about 5 µg per day in urban areas. However, absorption through the lungs are greater than through the gastro-intestinal tract.

Table 6.1 *Vehicular Lead Emissions. 1990-93. Finland*

Vehicular lead emissions	1990	1991	1992	1993
Total lead emissions (tonnes)	189	168	118	49
Share of total emissions (%)	60	65	79	52
Emissions/km2 (kg)	0.56	0.50	0.35	0.14
Emissions per 1,000 inhabitants (kg)	37.8	33.6	23.6	9.8

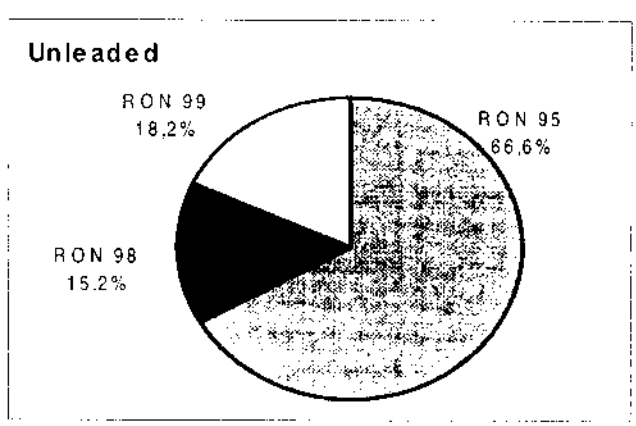
6.2 Production and Consumption of Petrol

The market share of unleaded petrol was 100% in 1995 up from 70% in 1993. The consumption of unleaded petrol was 2.529 million m^3 in 1995.

Table 6.2 *Supply Balance for Leaded and Unleaded Petrol. 1995. Finland. (1,000 m^3)*

1,000 m^3	Production	Import	Export	Consumption
Leaded petrol	0	-	-	0
Unleaded petrol	4,641	174	2,286	2,529

Figure 6.1 *Distribution of Petrol Consumption on Different RON Qualities. 1995. Finland (%)*



The consumption of unleaded petrol is divided between RON95 (67%) and RON98/99 (33%).

Finland produces more petrol than can be consumed domestically. Consequently, more than 50% of the production in 1995 was exported. The export increased from about 600,000 m^3 in 1990 to more than 3 million m^3 in 1994.

The maximum lead content in leaded and unleaded petrol in Finland is similar to the EU limits, i.e. 0.15 g/l and 0.013 g/l respectively. The average actual lead content in unleaded petrol is 0.003 g/l.

Tax differentiation of leaded and unleaded petrol was introduced in 1986 and is actively used to favour the consumption of unleaded petrol, cf. section 6.6 on policies and instruments.

Tax differentiation has also been used to promote the use of low sulphur diesel oil.

6.3 **Refining Industry**

There are two refineries in Finland, both owned by Neste Oy Oil Refining. The refinery Neste Oy Parvoo accounts for 75% of the total crude oil processing capacity. The Parvoo refinery is relatively well-equipped in terms of up-grading capacity as reflected in Table 6.3 below.

The technical options for lead replacement given the present refinery technology are MTBE or TXME. Imported petrol contains MTBE. The Oil Marketing Companies add sodium/potassium as a lubricating additive to RON98 and 99. Approximately 15-20% of the total petrol pool contain lubricating additives.

Table 6.3 *Refinery processes. 1996. Finland[5] (bbl/day)*

Refinery process	Capacity 1996
Atmospheric distillation	200,000
Thermal operations	35,100
Catalytic Cracking	45,200
Catalytic Reforming	42,800
Catalytic hydrocracking	16,00
Alkylation	4,200
Polymerisation	280
Isomerisation	3,600
Oxygenates (e.g. MTBE)	4,100

[5] Source: Oil and Gas Journal December 1996.

6.4 Vehicle Fleet

In 1995 there were 2.181 million vehicles in Finland, which corresponds to 0.436 vehicles per inhabitant. The vehicle fleet declined by 2.4% from 1990 to 1995. The passenger vehicle fleet declined by 2% over the same period and accounted for 96% of the vehicle fleet in 1995.

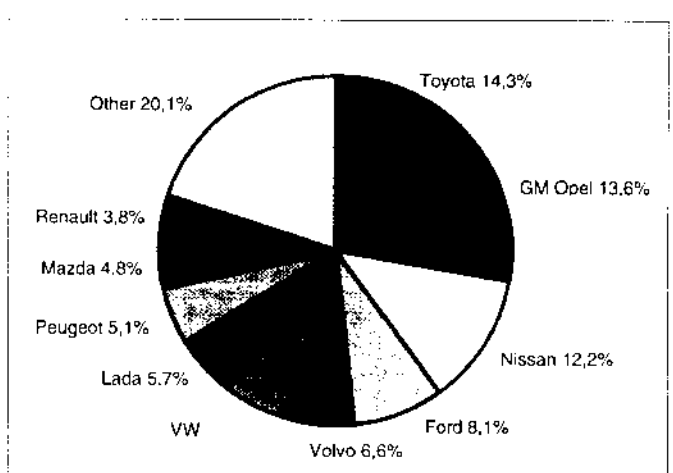
Since 1992, Finland has had emission standards for new cars, which requires the use of catalytic converters. In 1995, 24% of the petrol driven vehicle fleet was equipped with catalytic converters.

Table 6.4 *The Vehicle Fleet. 1990-1995. Finland*

Information	1990	1991	1992	1993	1994	1995
Total number of vehicles ('000)	2,233	2,218	2,213	22,156	2,151	2,181
Total number of passenger cars ('000)	1,939	1,923	1,936	1,873	1,873	1,901
Number of cars/1,000 inhabitants	447	444	446	431	430	436
Share with catalytic converters, petrol driven vehicles, %	-	-	-	-	-	24%

The composition of the total fleet on major car makes is shown in Figure 6.2.

Figure 6.2 *The Ten Most Common Vehicles (%)*



6.5 Distribution System

In 1996, there were 1,785 petrol stations in Finland. About 500 of the stations had vapour recovery installation for tank filling (stage 1) and 20 gas stations had installations for car filling (stage 2).

All stations offer unleaded petrol with a requirement for differentiation of pump nozzles between unleaded and leaded petrol if the latter is offered for sale.

6.6 **Policies and Instruments**

Since 1994 the market share of unleaded petrol has been 100%. However, marketing of leaded petrol is not forbidden per se.

The phase out of leaded petrol has been achieved primarily through the use of tax differentiation and emission standards requiring catalytic converters. Further, the use of lubricating additives other than lead has facilitated the phase-out.

A tax differentiation scheme for leaded and unleaded petrol was introduced in 1986. As a result, the difference in consumer prices between unleaded petrol (RON98) and leaded petrol (RON99) was 8-12% in favour of the unleaded RON98 over the period 1991-1993.

From 1993 and onwards, petrol and diesel oil have been classified into standard and reformulated qualities. The latter complies with the following requirements:

Quality measure	Limit value
Benzene content	max 3% v/v
Oxygen content	2-2.7% v/v
RVP	max 70 kPa (summer) max 90 kPa (winter)

Unleaded reformulated petrol is taxed at the lowest rate. The excise duty on this type of petrol is 3.58 FIM/l. Normal unleaded petrol is taxed 1.6% higher, reformulated leaded petrol 14% higher and normal leaded 16% higher.

Reformulated petrol can be used in cars that normally require leaded petrol.

For diesel oil, sulphur free oil (i.e. reformulated) is taxed 3% lower than normal diesel oil and consequently has a high market share.

Emission requirements which imply a need for catalytic converters on all new cars have been in force since 1992.

A limit value or value for concern with respect to air lead concentration was introduced in 1996 and amounts to 0.5 $\mu g/m^3$.

7 France

7.1 Environmental Pressure and Health Effect

No data has been provided for the lead emissions from vehicles. Total emissions from all sources amounted to 2,940 tonnes in 1995 corresponding to a small decrease from lead emissions of 2,987 tonnes in 1990.

The ambient air lead concentrations (maximum short term measurement) have been measured in Paris, Lille, Marseille and Grenoble over the period 1993-1995. The values declined or remained fairly constant over the period. The values ranged between 0.21 and 0.4 µg/m^3 in 1995. The highest values have been observed in Grenoble.

Studies of the human exposure to lead from different sources have identified the following relation between ambient air lead concentration and total human lead absorption per day:

Mean Air lead concentration (µg/m^3)	Source of lead				Total absorbed (µg/m^3)
Adults	Air	Dust	Food	Water	
0.3	2.4	-	10	2	14.4
0.5	4.0	-	10	2	16.0
1.0	8.0	-	10	2	20.0
2.0	16.0	-	10	2	28.0
Children (1-5 years old)					
1.0	2.0	-	25	5	32.0
2.0	4.0	-	25	5	34.0

The health effects for adults have been described for different levels of blood lead level concentrations. For BLL concentrations above 300 µg/l peripheral nerve dysfunction was observed. For BLL above 500 µg/l neurologic symptoms were observed.

7.2 Production and Consumption of Petrol

The market share of unleaded petrol was 56% in 1996, up from 50% in 1995.

The consumption of petrol decreased from 1995 to 1996, while the domestic production increased. More unleaded petrol was produced, while the production of leaded grades decreased.

Table 7.1 *Production and Consumption of Leaded and Unleaded Petrol. 1995-1996. France. (1,000 m^3)*

	1995	1996
Total petrol production	21,535	22,917
-Leaded	9,070	8,475
-Unleaded	12,465	14,442
Total petrol consumption	20,728	19,863
-Leaded	10,319	8,752
-Unleaded	10,409	11,111
Market share unleaded petrol	50%	56%

France had net-exports of unleaded petrol and to a lesser extent net-imports of leaded petrol in 1995 and 1996.

RON98 petrol accounted for 74% of the unleaded petrol consumed in 1996. RON95 accounted for the remaining 26% of consumption.

The maximum lead content in leaded petrol has been gradually reduced. From 1989 to 1991 the maximum allowed lead content in leaded petrol was 0.25-0.4 g/l. The limit was reduced to 0.15-0.25 g/l by mid-1991.

7.3 Refining Industry

There are 15 refineries in France. All refineries are privately owned and the majority of the refineries are owned by the major oil companies. ELF has 3 refineries, while Exxon, Shell and BP each own 2 refineries.

Table 7.2. *Refinery Processes. 1978-1996. France. (1,000 tonnes)*

Refinery process	Capacity 1978	Capacity 1994	Capacity 1995	Capacity 1996
Atmospheric distillation	171,200	84,000	90,400	91,900
Desulphurisation	19,100	24,200	24,000	24,700
Catalytic Cracking	9,400	18,200	18,200	18,600
Reforming	18,200	10,750	11,000	11,100
Alkylation	-	800	800	900
Isomerisation	-	2,200	2,100	2,100
Oxygenates (e.g. MTBE)			130	

As indicated by Table 7.2 above, total crude oil distillation capacity has been reduced significantly since 1978 as have the catalytic reforming capacity. On the other hand, conversion capacity has been added in order to produce more light products i.e. petrol and diesel fuel. Furthermore, alkylation and isomerisation capacity has been added to produce high octane petrol blend stocks.

Expected investments in order to produce more unleaded petrol and reduce the sulphur content in unleaded petrol amount to FFR 10 billion over the period 1991-1999.

The refinery industry in France has invested in two main fields:

- Investments required to produce unleaded petrol (FFR 5 billion)
- An increase in the capacity of sulphur treatment of petrol (an estimated increase of 0.7 million tonnes per year) in order to comply with the new regulation concerning the sulphur content in unleaded petrol. From October 1996, the maximum sulphur content allowed is 0.05%. The increase in the sulphur treatment capacity is divided on the Gonfreville refinery unit (ELF) with 99,000 tonnes per year, the Port Jerome refinery unit (Exxon) with 168,000 tonnes per year and the Fos Sur Mer refinery (ESSO) by 500,000 tonnes per year.

7.4 **Vehicle Fleet**

In 1996, there were 25.1 million passenger cars and light duty vehicles in France corresponding to 0.430 per capita. From 1990 to 1996, the total number of passenger cars and light vehicles increased by approximately 9%. Over the period 1990-1996, the number of petrol driven passenger cars and light duty vehicles declined by 8%, while diesel driven passenger cars and light duty vehicles more than doubled to 6.9 million corresponding to 28% of the total number of passenger cars and light duty vehicles in 1996.

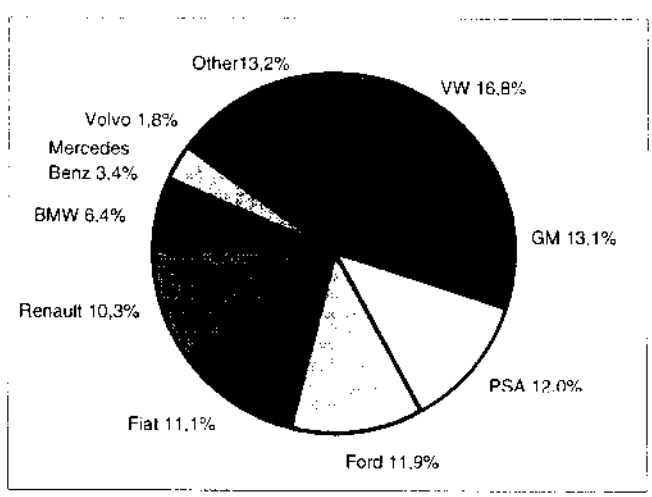
The registrations of new cars have declined between 1990 and 1995 for both passenger cars and trucks. In 1996, about 2.3 million new registrations were undertaken.

Table 7.3. *The Vehicle fleet. 1990-1996. France*

	1990	1991	1992	1993	1994	1995	1996
Number of passenger cars and light duty vehicles ('000)	23,010	23,550	23,610	24,020	24,385	24,900	25,074
Number of passenger cars and light duty vehicles per 1,000 inhabitants	397	407	408	415	421	430	433
Petrol driven passenger cars as % of all passenger cars (%)	86%	84%	82%	80%	77%	75%	72%
Diesel driven passenger cars as % of all passenger cars (%)	14%	16%	18%	20%	23%	25%	28%

The most common vehicles in France in 1995 are shown in Figure 7.1 below.

Figure 7.1 *The ten most common vehicles (%). 1995. France.*



7.5 The Distribution System

In 1995, there were 16,900 petrol stations in France, which is an increase of 43% compared to number of stations in 1990. All stations are privately owned. The major oil companies dominate with ownership of almost 60% of the petrol stations.

In 1995, 50.2% of the petrol stations offered unleaded petrol.

7.6 **Policies and Instruments**

France expects a complete phase-out of leaded petrol by 2003.

This is expected to be accomplished by continued tax differentiation between leaded and unleaded petrol, by adopting the EU fuel directive, and by continuing the replacement of the old vehicle fleet with new vehicles.

The main obstacle in France to accelerate phase-out of lead in petrol is the high number of old vehicles, even though a high rate of replacement of old vehicles (around seven years old) by new cars take place already.

8 Germany

8.1 Environmental Pressure and Health Effect

In 1995, 240 tonnes of lead were emitted from vehicles, which corresponded to 38% of total lead emissions. The total lead emissions as well as the lead emissions from vehicles have declined significantly since the beginning of the 1990s.

The lead emission from vehicles declined by 82% from 1990 to 1995.

Table 8.1 *Vehicular Lead Emissions, 1990 and 1995, Germany*

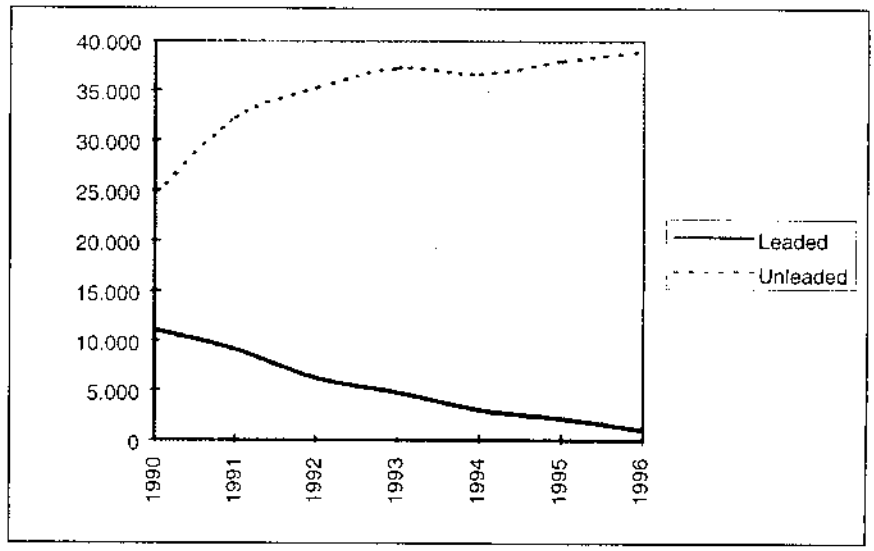
Vehicular lead emissions	1990	1995
Total lead emissions (tonnes)	1,300	240
Share of total emissions (%)	56	38
Emissions/km2 (kg)	3.6	0.7
Emissions per 1,000 inhabitants (kg)	-	3.0

The annual reporting of Germany on lead in suspended matter is done in accordance with the EEC regulation 82/884/EWG. The lead concentration was in 1995 generally below 5 per cent of the limit of the mentioned regulation (2 $\mu g/m^3$ as annual mean value). The highest recorded value in Germany was 0.69 $\mu g/m^3$ measured in terms of annual mean concentration.

8.2 Production and Consumption of Petrol

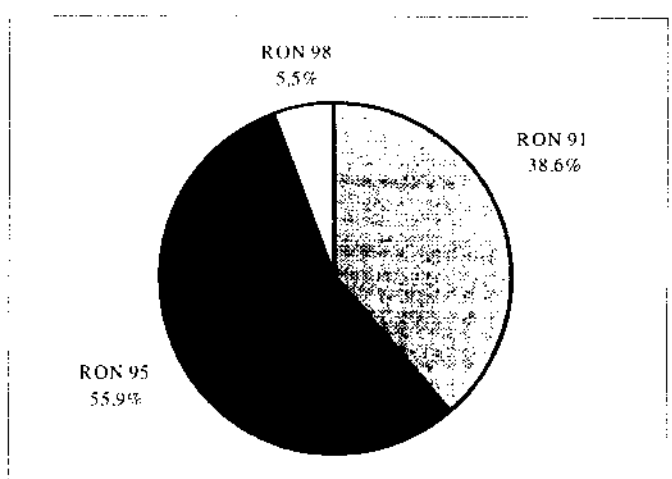
Figure 8.1 below shows the development in the consumption of leaded and unleaded petrol. The figure clearly shows that Germany already by the beginning of the decade was well underway in the process of lead phase-out in petrol. The market share of unleaded petrol was 97.4% in 1996. A complete phase-out of lead in petrol is expected very soon.

Figure 8.1 *Consumption of Leaded and Unleaded Petrol. 1990-1996. Germany (1,000 m³)*



In the period from 1990 to 1996, the total consumption of petrol increased by approximately 12%, but consumption has remained fairly constant since 1994. The market share of unleaded petrol increased from 69% in 1990 to 97.4% in 1996.

Figure 8.2 *Distribution of Unleaded Petrol Consumption by Different RON Qualities. 1996. Germany*



The consumption of unleaded petrol is mainly RON95 (and RON91), cf. Figure 8.2, while the leaded petrol is RON98.

25% of the total consumption of unleaded petrol is imported.

Table 8.2 *Supply Balance for Leaded and Unleaded Petrol. 1996. Germany (1,000 m^3)*

1,000 m^3	Production	Import	Export	Consumption
Unleaded petrol	32,267	9,733	3,200	38,800
Leaded petrol	800	133	133	800

The maximum lead content in leaded petrol is 0.15 g/l (in force since mid-1970's) and 0.013 g/l in unleaded petrol. The actual average lead concentration in leaded petrol was 0.14 g/l in 1994, which is the latest available figure, and less than 0.005 g/l for unleaded petrol in 1995.

The use of scavengers to minimise combustion chamber deposits from the use of leaded petrol was phased out in the beginning of the 1990's, thereby eliminating toxic emissions of chlorine and bromine.

Production of petrol containing lubricating additives is prohibited in Germany. However, the additives are sold separately at the petrol stations. The car owner must buy the additive and add it while fuelling.

In 1995, the consumer price of unleaded RON95 was 8% lower than that of leaded RON98 petrol.

8.3 **Refining Industry**

As per January 1, 1997, Germany had 18 refineries. The refineries are privately owned. The standard of the refineries is good, and the upgrading capacity is relatively high as indicated in Table 8.3 below.

Table 8.3 *Refinery Processes. 1996, Germany[6] (bbl/day)*

Refinery process	Capacity 1996
Atmospheric distillation	2,108,300
Thermal operations	288,600
Catalytic Cracking	275,750
Catalytic Reforming	398,503
Catalytic hydrocracking	177,000
Alkylation	16,300
Polymerisation	2,450
Isomerisation	56,300
Oxygenates (e.g. MTBE)	14,930

[6] Source: Oil and Gas Journal December 1996

For lead replacement the refineries add MTBE.[7]

8.4 Vehicle Fleet

The number of vehicles in Germany numbered 45.9 million in 1996 corresponding to 0.56 vehicle per capita. The total vehicle fleet increased by 3% from 1994 to 1996.

Passenger cars accounted for 89% of the total vehicle fleet in 1996. 35.5 million passenger cars corresponding to 86% of the total number of passenger cars and light duty vehicles were petrol driven.

In 1996, there were more than 4.8 million heavy duty trucks and busses in Germany.

62% of the petrol driven vehicle fleet was equipped with catalytic converter by the end of 1996.

The latest available data for the registration of new cars indicates an estimated turnover rate of 7-10% in 1993 based on the number of new registrations.

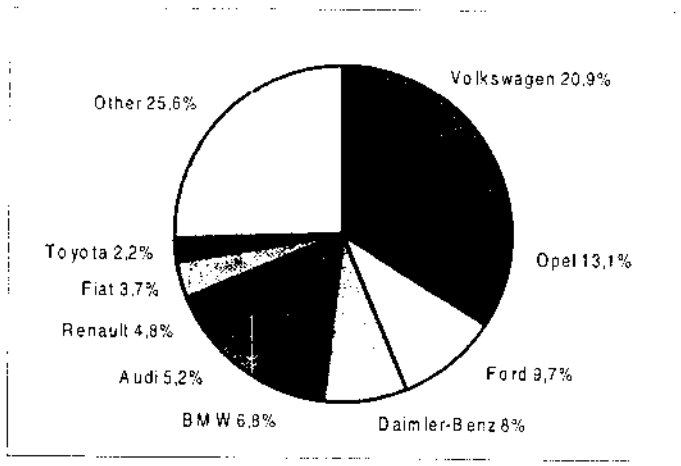
Table 8.4 *The Vehicle Fleet, 1994-96, Germany*

Information	1994	1995	1996
Number of vehicles ('000)	44,462	45,218	45,871
Number of passenger cars and light duty vehicles ('000)	39.765	40,404	40,988
Number of vehicles/1,000 inhabitants	546	556	564
Petrol driven passenger cars in % of all passenger cars (%)			86%
Share of petrol driven vehicles with catalytic converters (%)	49.8%	56.3%	62%

Figure 8.3 shows the composition of the vehicle fleet.

[7] The refineries in Germany are on average smaller than in for example France and have less conversion capacity, but their up-grading capacity (reforming, isomerisation and MTBE production) is higher, but still Germany is a major net importer of petrol.

Figure 8.3 *The Ten Most Common Vehicles, 1994, Germany (%)*



8.5 **Distribution System**

The number of petrol stations increased from 10,041 in 1990 to 11,118 in 1995. Furthermore, there were 17,957 tank distribution lorries by the end of 1995.

More than 95% of the petrol stations offered unleaded petrol, and more than 90% of the stations had a vapour recovery installation for tank filling (Stage I), and 40% for car filling (Stage II). The average number of fuel pumps per station was 6.8 in 1995.

A potassium based lubricating additive is sold by the petrol stations separately and added to the petrol by the car user during tank filling.

8.6 **Policies and Instruments**

Germany expects to attain a complete phase-out of leaded petrol within a short period without any major constraints.

The strategy for the phase out of leaded petrol in Germany has been a gradual approach with stepwise reduction of the lead content and the introduction of one or more unleaded petrol grades including the availability of additives against valve seat recession in older cars. The quality standards applied to petrol with respect to lead and benzene content have been similar to the present EU standards throughout the 1990s.

The gradual shift in the composition of the petrol driven part of the vehicle fleet towards cars with catalytic converters, which has been going on since 1985, has over a ten year period fundamentally altered the demand for petrol. An estimated 70% of the petrol driven part of the vehicle fleet will have catalytic converters by 1997.

Phase-out of lead in petrol is stated to have been achieved on a voluntary basis by the major oil companies, as they have been able to gradually adjust their technical capacity.
Information campaigns focusing on car owners have been carried out since the mid-1980's.

9 Greece

9.1 Environmental Pressure and Health Effect

No information was provided.

9.2 Production and Consumption of Petrol

Over the period 1991-1995, the market share of unleaded petrol increased from 10% to 32%. Over the same period the total petrol consumption increased by 17%. The consumption of leaded petrol decreased by 12%, while the consumption of unleaded petrol increased by more than 300%.

Figure 9.1 *Consumption of Leaded and Unleaded Petrol. 1991-95.Greece (1,000 m^3)*

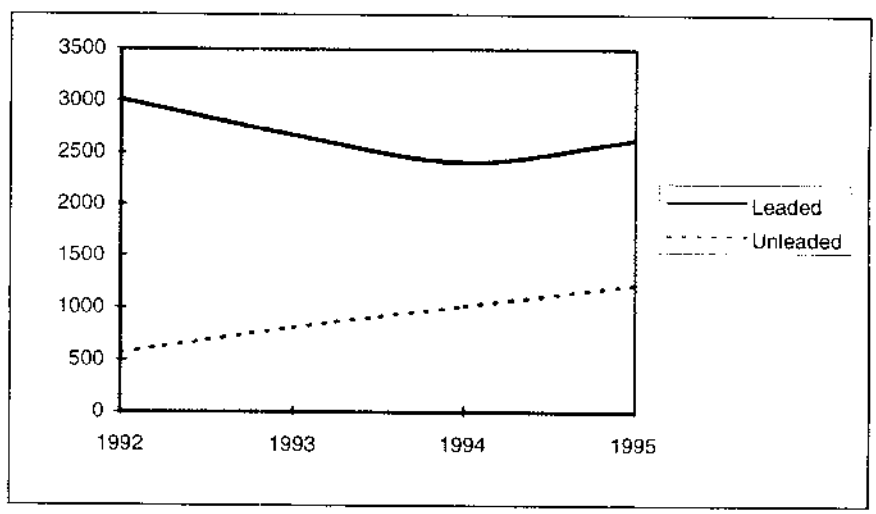


Table 9.1 below shows that Greece was a net exporter of petrol in 1995 of both leaded and unleaded petrol. However, the export quantity was lower in 1995 than realised in the earlier years, where a larger share (above 50%) of the domestic production of unleaded petrol was exported.

Table 9.1 *Supply Balance for Leaded and Unleaded Petrol. 1995. Greece (1,000 m^3)*

1,000 m^3	Production	Import	Export	Consumption
Leaded petrol	3,057	208	645	2,620
Unleaded petrol	1,669	81	529	1,221

The maximum lead content in leaded RON96 premium petrol is 0.15 g/l, and 0.4 g/l for leaded RON90 regular petrol.

9.3 **Refining Industry**

There are four refineries in Greece with a primary crude oil distillation capacity in the range of 3-6 million tonnes per year. Two of the refineries are state owned and two are privately owned. In 1995, the total crude oil distillation capacity was 19.7 million tonnes per year and 14.9 million tonnes were processed. Capacity utilisation has remained stable at about 60-70% since 1991. Two of the refineries are conversion refineries with advanced upgrading facilities i.e. isomerisation and oxygenate production.

Table 9.2 *Refinery Processes.1996, Greece*[8] *(bbl/day)*

Refinery process	Capacity 1996
Atmospheric distillation	395,500
Thermal operations	45,600
Catalytic Cracking	66,400
Catalytic Reforming	51,600
Catalytic hydrocracking	28,000
Alkylation	2,400
Polymerisation	8,850
Isomerisation	12,200
Oxygenates (e.g. MTBE)	1,750

9.4 **Vehicle Fleet**

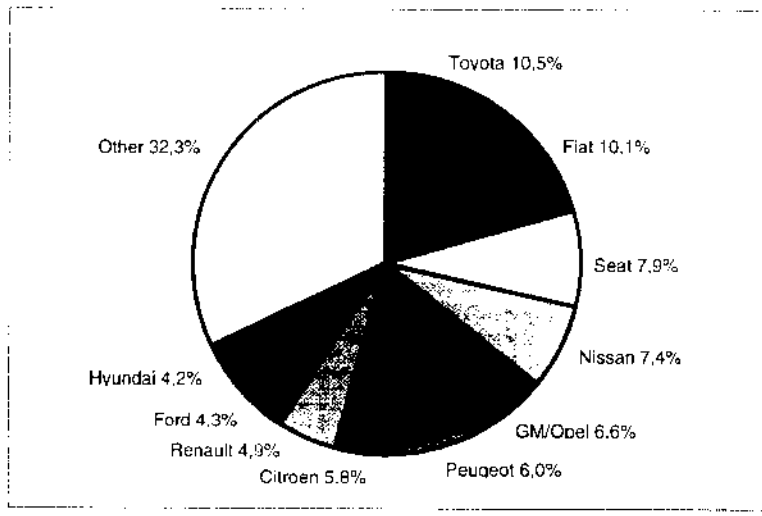
No information on the size of the total vehicle fleet has been obtained.

The latest available data on registration of new passenger cars are from 1993, where the registration of new cars amounted to 192,000.

The ten most common vehicles are shown in Figure 9.2 below.

[8] Source: Oil and Gas Journal December 1996

Figure 9.2 *The Ten Most Common Vehicles, 1993, Greece (%)*



9.5 **Distribution System**

No information was provided.

9.6 **Policies and Instruments**

The market share of unleaded petrol increased from 10% in 1991 to 32% in 1995. However, the limit for the lead content in leaded petrol has been 0.4 g/l throughout the 1990s, but the consumption of the petrol with high lead content is limited and the maximum lead content in petrol is planned to be reduced to 0.15 g/l by the year 2000.

Furthermore, it is expected that 80% of production will be unleaded by the year 2002.

Greece has a energy taxation scheme, which distinguishes between leaded and unleaded petrol. The excise duty on leaded petrol was 15% (16 Drs/l) higher than the excise duty on unleaded petrol in 1996.

10 Ireland

10.1 Environmental Pressure and Health Effect

No figures have been available concerning the total lead emissions and the lead emissions from vehicles. However, Ireland has informed that the use of leaded petrol is the primary source of lead emissions.

The ambient air lead levels have decreased significantly since the mid-1980's. Annual ambient mean lead concentrations at eight sites in Dublin in 1993 were in most cases well below the WHO guideline of 0.5 $\mu g/m^3$.

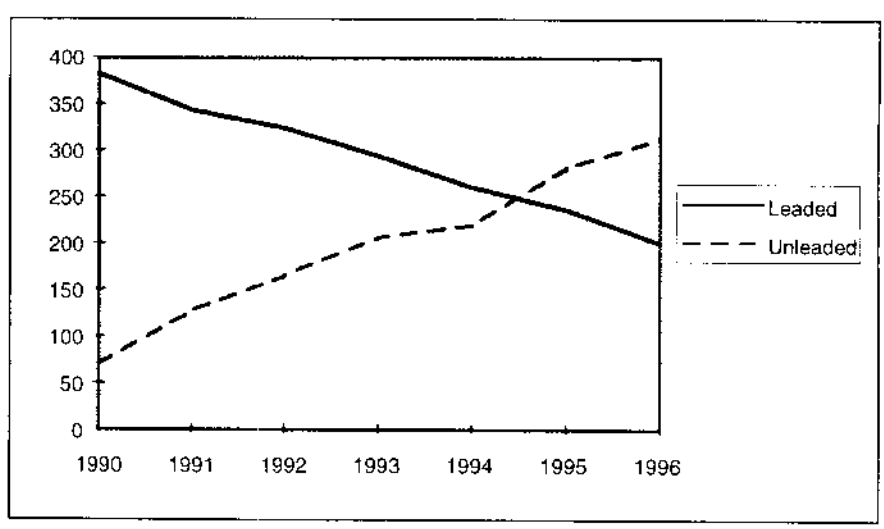
10.2 Production and Consumption of Petrol

Figure 10.1 provides information on the production of leaded and unleaded petrol[9]. Overall petrol production has increased by 13% since 1990, while the production of unleaded petrol has increased by more than 400%.

Hence, the production share of unleaded petrol has increased steadily since 1990, where it was 20%, to 61% in 1996

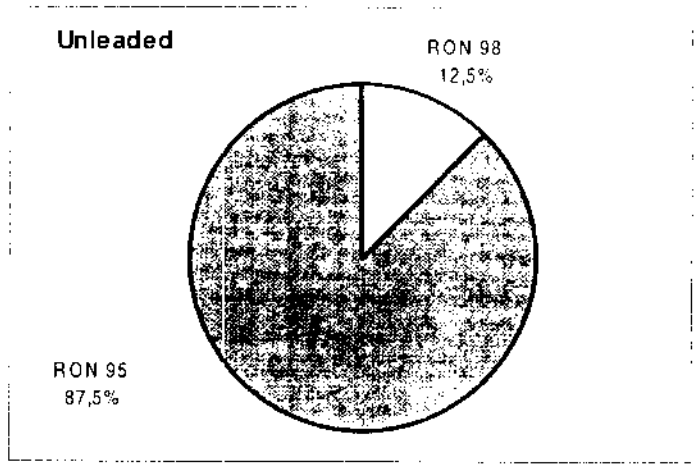
The leaded petrol production is RON97, while the unleaded petrol is mainly RON95. A minor fraction of the unleaded petrol is RON98.

Figure 10.1 *Production of Leaded and Unleaded Petrol. 1990-96. Ireland (1,000 m^3)*



[9] Information on consumption was only provided for 1995 and 1996.

Figure 10.2 *Distribution of Petrol Production by Different RON Qualities. 1996. Ireland (%)*



In terms of consumption, the market share of unleaded petrol was 65% in 1996, up from 57% in 1995.

Table 10.1 *Supply Balance for Leaded and Unleaded Petrol. 1996. Ireland (1,000 m³)*

1.000 m^3	Production	Import	Export	Consumption
Leaded petrol:	200	325	0	525
Unleaded petrol:	313	680	7	986

The total consumption of petrol increased by 9% from 1995 to 1996. The increase was due to increased consumption of unleaded petrol (+24%), while the consumption of leaded petrol declined by 11%.

Ireland imports leaded as well as unleaded petrol. In 1996, net-import of unleaded petrol accounted for 69% of the consumption of unleaded petrol and the net-import of leaded petrol for 62% of the consumption of leaded petrol.

The maximum lead content in leaded and unleaded petrol is in accordance with EU regulations.

The average actual lead content in leaded petrol has been 0.15 g/l throughout the period 1990-1996.

10.3 **Refining Industry**

There is one refinery in Ireland. It is state owned and was constructed in 1957-59. It is a relatively small and simple refinery about half the size of the average European refinery in terms of primary distillation capacity.

However, in 1996 a new crude oil distillation unit was installed. In the future new investments will be driven not least by environmental concerns.

The main technical option for lead replacement is to add purchased MTBE.

Table 10.2 *Refinery Processes. 1996. Ireland[10] (bbl/day)*

Refinery process	Capacity 1996
Atmospheric distillation	65,000
Thermal operations	
Catalytic Cracking	-
Catalytic Reforming	12,000
Catalytic hydrocracking	
Alkylation	-
Isomerisation	-
Oxygenates (e.g. MTBE)	-

10.4 **Vehicle Fleet**

In 1995, there were 1.3 million vehicles in Ireland corresponding to 0.37 vehicle per capita. The vehicle fleet increased by 20% over the period 1990-1995.

Passenger cars accounted for 87% of the vehicle fleet in 1995 compared to 84% in 1990. A development that reflects the 25% increase in the number of passenger cars since 1990. 86% of the passenger cars were petrol driven in 1995 compared to 90% in 1990.

The number of light duty vehicles, heavy duty trucks and busses increased slightly over the period and amounted to 149,000 in 1995. However, the composition of this part of the vehicle fleet over the period 1990-1995 reflect a further shift towards using diesel. Hence, in 1995, 93% of the light duty vehicles, heavy trucks and busses were diesel driven compared to 77% in 1990.

In 1995, the average age of a passenger car was 7.3 years and 6.4 years for trucks with an estimated turnover rate for the total vehicle fleet of 8%. The average age of the vehicle fleet has increased slightly over the period 1990-1995. The distribution of the vehicle fleet with respect to age shows a relatively wide dispersion in the age distribution. Hence, cars older than 10 years still accounts for 20-25% of the private cars.

Ireland introduced emission standards requiring catalytic converters on new cars in 1993. However, no information was available concerning the number of cars equipped with catalytic converters.

[10] Source: Oil and Gas Journal December 1996

Table 10.3 *The Vehicle Fleet. 1990-1995. Ireland*

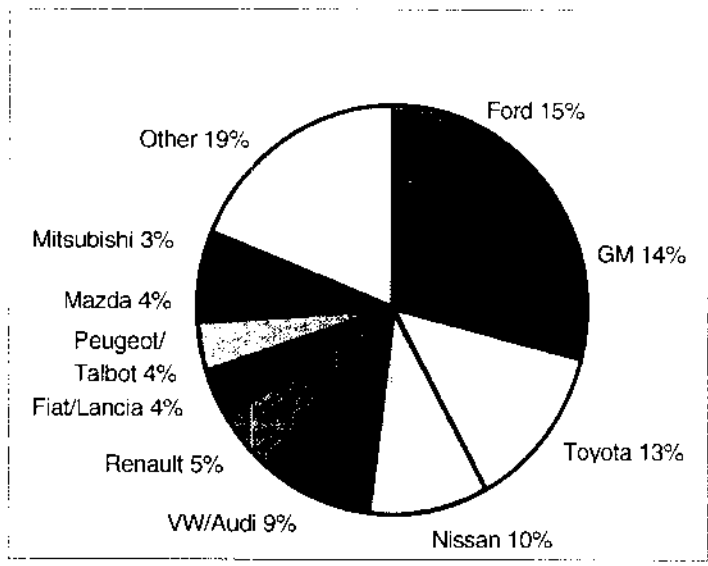
Information	1990	1991	1992	1993	1994	1995
Number of vehicles ('000)	1,054	1,105	1,126	1,151	1,202	1,262
Number of passenger cars ('000)	799	840	862	895	944	997
Number of vehicles per 1,000 inhabitants	293	307	313	320	334	351
Average age passenger cars (years)	7.0	7.0	7.0	7.2	7.3	7.3
Average age light duty vehicles, heavy trucks and busses cars (years)	5.7	5.7	5.9	5.9	6.2	6.4
Turnover rate (%)	11%	8%	8%	7%	8%	8%

Table 10.4 *The vehicle fleet according to fuel type. 1990-1995. Ireland*

Information	1990	1991	1992	1993	1994	1995
Passenger cars						
% petrol driven (%)	90	89	88	87	86	86
% diesel driven (%)	10	11	12	13	14	14
Light and heavy duty vehicles & busses						
% petrol driven (%)	23	18	15	11	9	7
% diesel driven (%)	77	82	85	89	91	93
All vehicles						
% petrol driven (%)	80	78	77	77	76	76
% diesel driven (%)	20	22	23	23	24	24

The ten most common vehicles is given below in Figure 10.3.

Figure 10.3 *The Ten Most Common Vehicles (%)*



10.5 **Distribution System**

In 1996, there were 2,630 petrol stations in Ireland. The petrol stations are privately owned. There are 3-4 fuel pumps per station and all stations differentiate between pump nozzles for leaded and unleaded petrol. Less than 1% of the stations have vapour recovery installations.

98% of the petrol stations offered unleaded petrol in 1996 compared to 30% in 1990.

In 1996, there were 180 tank distribution lorries of which 50% distributed petrol.

10.6 **Policies and Instruments**

The market share of unleaded petrol was 65% in 1996 and Ireland apply standards for the lead content and the benzene content in petrol similar to the present EU standards.

To increase the market share of unleaded petrol, Ireland has applied tax differentiation between leaded and unleaded petrol throughout the period 1990-1996.

Furthermore, the introduction in 1993 of emission standards requiring catalytic converters on new cars has promoted the consumption of unleaded petrol. However, there are still many old cars in Ireland. To increase the renewal of the vehicle fleet, Ireland has implemented a "scrapping scheme", whereby car owners with cars older than 10 years will get a scrap premium, when buying a new car and scrapping the old one.

In 1990 and in the years before, information campaigns were also used

11 Italy

11.1 Environmental Pressure and Health Effect

The latest available data from 1992 show that 2,233 tonnes of lead were emitted from vehicles in that year. This corresponded to 62 % of the total lead emissions. The total lead emissions from all sources in Italy declined by 33% from 1990 to 1992, while the lead emissions from vehicles declined by 44%.

Measurements of ambient air lead concentrations in Parma over the period 1990-1995 show a decrease in the lead concentrations from 0.84 µg/m^3 in 1990 to 0.53 µg/m^3 in 1995. However a modest increase in the concentrations is observed from 1993 and onwards. In Firenze, the ambient air lead concentration in a heavy traffic zone was 1.35 µg/m^3 in 1994 compared to 1.9 µg/m^3 in 1990. Ambient air lead concentrations in a residential zone in Firenze were 4-5 times lower than in the heavy traffic zone.

Table 11.1 *Vehicular Lead Emissions. 1990-92. Italy*

Vehicular lead emissions	1990	1991	1992
Total lead emissions (tonnes)	3,983	2,974	2,233
Share of total emissions (%)	74	68	62
Emissions/km^2 (kg)	13.2	9.9	7.4
Emissions per 1,000 inhabitants (kg)	69.0	51.5	38.7

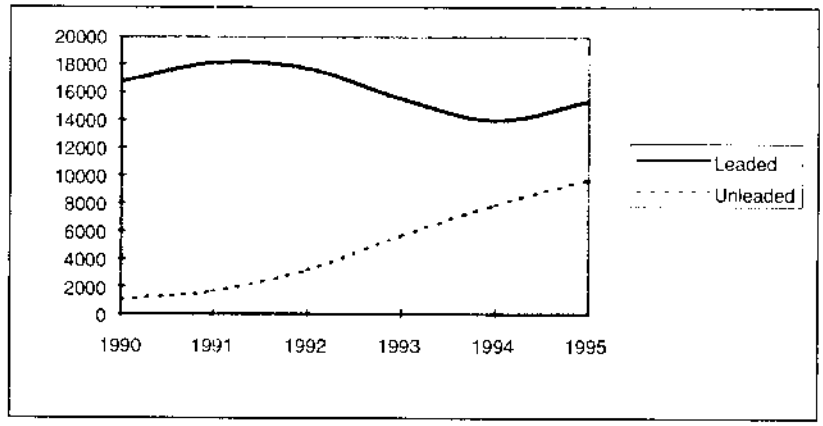
A study of adults in the city of Rome showed a decrease in the blood lead concentration in males from 11.1 µg/dl in 1990 to 6.5 µg/dl in 1992. For females, the BLL fell from 7.9 µg/dl to 4.0 µg/dl over the same period. In the region of Lazio, blood lead levels for children were 3.4-3.6 µg/dl in 1992 and in the city of Naples blood lead levels in children were 13.7-13.8 µg/dl in 1993.

The main conclusions from the assessments of health effects linked to vehicle lead emissions in Italy are that the blood lead levels have declined gradually during recent years. The decrease, however, can only partly be attributed to the reduced content of lead in petrol. The major determinant of blood lead levels was the level of alcohol consumption e.g. wine.

11.2 Production and Consumption of Petrol

Total petrol consumption increased by 41% from 1990 to 1995. The consumption of leaded petrol declined by 8%, while the consumption of unleaded petrol increased substantially. However, the consumption of leaded petrol still accounted for 61% of total petrol consumption in 1995 declining to 54% in 1996.

Figure 11.1 *Consumption of Leaded and Unleaded Petrol, 1990-95, Italy (1,000 m³)*



The consumption of leaded petrol is RON 97, while the unleaded petrol is RON95.

Italy is a net exporter of leaded as well as unleaded petrol. However, the total exports of petrol declined by 41% from 1990 to 1995. The export of leaded petrol declined substantially from 5.9 million m^3 in 1990 to 2.2 million m^3 in 1995, while the export of unleaded petrol increased from 92,000 m^3 in 1990 to 1.4 million m^3 in 1995. The import of petrol almost tripled over the same period mainly due to a major increase in the import of unleaded petrol.

Table 11.2 *Supply balance for Leaded and Unleaded Petrol, 1995, Italy (1,000 m³)*

1,000 m^3	Production	Import	Export	Consumption
Leaded petrol:	16,581	946	2,162	15,365
Unleaded petrol:	10,077	1,081	1,432	9,726

A substantial reduction in the production of leaded petrol is expected for 1996, where production is expected to amount to 11.9 million m^3 compared to 16.6 million m^3 in 1995.

The maximum lead content in leaded petrol has been 0.15 g/l since 1991. The lead content in unleaded petrol has also remained unchanged at 0.013 g/l since 1990. The average actual lead content in leaded petrol was 0.3 g/l in 1990, but was reduced thereafter to 0.15 g/l.

Domestically produced and imported unleaded petrol do not contain lubricating additives.

11.3 **Refining Industry**

Italy has 17 refineries. Approximately 50% of the refineries are owned by ENI SpA. The refining industry in Italy will invest

large amounts of funds in order to reduce the content of benzene, aromatics and sulphur in both leaded and unleaded petrol and to reduce the sulphur content in gas oils and fuel oils. The refining industry has advanced technology available, but a number of refineries are small and use simple technologies e.g. 10 of the refineries had no catalytic cracking units as per 1995.

The technical options for replacement of lead in petrol are to increase reformer severity and upgrading, catalytic cracking and blending with MTBE.

Table 11.3 *Refinery Processes, 1996, Italy*[11] *(bbl/day)*

Refinery process	Capacity 1996
Atmospheric distillation	2,261,818
Thermal operations	416,289
Catalytic Cracking	298,400
Catalytic Reforming	286,795
Catalytic hydrocracking	197,000
Alkylation	36,900
Polymerisation	3,100
Isomerisation	90,115
Oxygenates (e.g. MTBE)	5,670

11.4 **Vehicle Fleet**

In 1996, there were 32.8 million vehicles in Italy, which corresponds to 0.57 per capita. Over the period 1991-1996, the vehicle fleet decreased by less than 1%.

Passenger cars accounted for 98% of the vehicle fleet in 1996. 83% of the passenger cars were petrol driven. The number of passenger cars decreased by 1% from 1991 to 1996, as the number of petrol driven passenger cars decreased.

The number of heavy duty trucks and busses amounted to 73,000, all diesel driven vehicles.

The estimated turnover rate has remained constant at 7% over the period 1990-1996. The average age is 6 years for passenger cars and 8 years for trucks.

Italy introduced emissions standards requiring catalytic converters on new cars in 1993 and the number of passenger cars with catalytic converter has more than tripled from 1993 to 1996.

The share of the total vehicle fleet equipped with catalytic converter increased from 5% in 1991 to 29% in 1996. 36% of the petrol driven passenger cars were equipped with catalytic converter in 1996.

[11] Source: Oil and Gas Journal December 1996

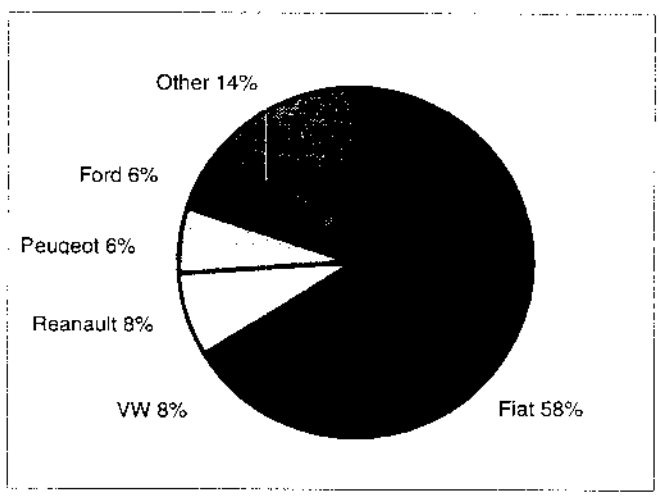
Table 11.4 *The Vehicle Fleet, 1990-96, Italy*

Information	1990	1991	1992	1993	1994	1995	1996
Number of vehicles (million)	29.86	32.94	32.01	32.28	32.50	32.76	32.81
Number of passenger cars (million)	29.20	32.30	31.35	31.60	31.81	32.05	32.08
Number of vehicles/1,000 inhabitants		545	555	559	563	568	569
Average age of passenger cars (years)		7	7	7	7	6	6
Average age trucks (years)				8.5			8.1
Estimated turnover rate (%)	7	7	7	7	7	7	7
Share with catalytic converters, all vehicles, %	3	5	9	13	18	24	29
Share with catalytic converters, passenger cars with petrol engine, %	4	7	11	16	23	30	36

Table 11.5 *The vehicle fleet according to fuel type. 1990-1996. Italy*

Information	1990	1991	1992	1993	1994	1995	1996
Passenger cars							
% petrol driven (%)	82	83	83	83	83	83	83
% diesel driven (%)	18	17	17	17	17	17	17
Heavy duty vehicles & busses							
% petrol driven (%)	0	0	0	0	0	0	0
% diesel driven (%)	100	100	100	100	100	100	100
All vehicles							
% petrol driven (%)	80	82	81	81	81	81	81
% diesel driven (%)	20	18	19	19	19	19	19

Figure 11.2 *The Ten Most Common Vehicles. 1993. Italy (%)*



11.5 **Distribution System**

There were 28,200 petrol stations in 1995, a decrease of 10% since 1990. State owned gas stations constitute 40% of all petrol stations. The number of state owned petrol stations declined by 6% over the period 1990-95, while the number of privately owned gas stations declined by 11%.

An increasing number of petrol stations offer unleaded petrol corresponding to 92% of the stations in 1995 compared to 80% in 1990. On average, there are 3 fuel pumps per station. There are differentiation of pump nozzles between leaded and unleaded petrol.

100 petrol stations or less than 1% have vapour recovery installations.

11.6 **Policies and Instruments**

The consumption of unleaded petrol has increased substantially in Italy since 1990 and the market share of unleaded petrol increased from 6% in 1990 to 39% in 1995 and 46% in 1996. However, the consumption of leaded petrol has only declined moderately and leaded petrol still had a market share of 61% in 1995 declining to 54% in 1996.

Applied policy measures include a reduction in the maximum lead content in leaded petrol to the EU limit of 0.15 g/l.

Furthermore, the introduction in 1993 of emissions standards requiring catalytic converters on new cars has resulted in a rapid increase in the number of petrol driven vehicles with catalytic converter. Furthermore, the introduction of economic incentives for car owners to replace old cars with new ones has been applied with success. The primary aim of this policy measure was to reduce emissions of benzene. Italy is highly concerned with the issue of benzene emissions and consequently applies a limit of 3% v/v for the content of benzene, whereas the EU limit is 5% v/v.

Economic instruments in the form of tax differentiation schemes have also been applied. Taxes levied on unleaded petrol (RON95) was 1,280 Lire/litre in 1995 compared to 1,407 Lire/litre on leaded petrol (RON97) corresponding to a difference of 9% in favour of unleaded petrol. The consumer price was 1,833 Lire/litre for leaded RON97 and 1,718 Lire/litre for unleaded RON95 in 1995.

No information campaigns have been carried out.

Major constraints for accelerating the phase-out of lead in petrol are 1) the risk of damaging the catalytic converter due to pollution of unleaded petrol with lead and 2) the risk that a too rapid phase-out may result in an increased content of aromatics including benzene in petrol.

12 Monaco

12.1 Environmental Pressure and Health Effect

In 1996, the lead emission from vehicles in Monaco was 475 kg, corresponding to 15.85 kg per 1,000 inhabitants and 250 kg per km^2.

The ambient air lead concentrations varied between 0.20 and 0.43 $\mu g/m^3$ over the period 1992-1996.

No information has been available on blood lead level concentrations or health benefits from reducing lead in petrol.

12.2 Production and Consumption of Petrol

The market share of unleaded petrol was 67% in 1996. Monaco consumed 3,000 m^3 of leaded petrol and 6,000 m^3 of unleaded petrol in 1996 corresponding to 300 m^3 per 1,000 inhabitants. All petrol is imported.

The maximum allowed lead content in leaded petrol is 0.15 g/l.

12.3 Refining Industry

There are no refineries in Monaco.

12.4 Vehicle Fleet

In 1996, there were 23,100 vehicles in Monaco corresponding to 0.74 vehicle per inhabitant. 76% of the vehicle fleet were petrol driven passenger cars and light duty vehicles, 15% diesel driven passenger cars, and 9% diesel driven heavy duty vehicles and busses.

Table 12.1 *The Vehicle Fleet, 1996, Monaco*

Information	1996
Number of vehicles('000)	23.1
Number of passenger cars ('000)	21.0
Number of vehicles/1,000 inhabitants	740
Petrol driven passenger cars as % of all passenger cars (%)	83
Diesel driven vehicles as % of total vehicle fleet (%)	27

Standards for emissions and petrol quality follow the principles in France.

12.5 **Distribution System**

In 1996, there were 7 petrol stations in Monaco. All the stations offer unleaded petrol and have different pump nozzles for leaded and unleaded petrol. All the gas stations in Monaco are privately owned.

12.6 **Policies and Instruments**

Monaco has introduced emissions standards requiring catalytic converters on new cars in line with France and apply a similar tax regime as France.

No information campaigns or awareness building activities have been undertaken in Monaco.

The limit value for air lead concentrations is 2 $\mu g/m^3$.

There are no major obstacles for phasing out lead in petrol.

13 The Netherlands

13.1 Environmental pressure and Health Effect

Since 1986, the lead emissions from vehicles have declined significantly as a consequence of a reduction of the lead content in petrol and increased market share of unleaded petrol. Also, the share of vehicular emission of total emissions has declined substantially.

Table 13.1 *Vehicular Lead Emissions. 1985,1990,1995, and 1995, the Netherlands*

Vehicular lead emissions	1985	1990	1995	1996
Vehicular emissions (tonnes)	910	269	79	49
Share of total emissions (%)	88	69	52	40
Emissions/km^2 (kg)	26.8	7.9	2.3	1.4
Emissions per 1,000 inhabitants (kg)	62.8	18.1	5.1	3.2

Other lead emission sources are the refineries sector (below 1% of total lead emissions), the industry accounting for a larger share of total lead emissions (8% in 1985; 58% in 1996), and the energy sector (below 1%).

Average ambient air lead concentrations measured in 1995 were between 0.02-0.04 µg/m^3 in non-urban areas and 0.05-0.1 µg/m^3 in urban areas.

Between 1979 and 1993 several studies were carried out measuring the blood lead level concentrations in children (each study has included about 10 locations in the Netherlands). The studies show a decline in the BLL concentrations of approximately 9 µg/dl between 1979 and 1992 as a consequence of lower lead content in petrol, introduction of unleaded petrol, and the replacement of drinking water pipes containing lead.

Table 13.2 *Blood Lead Level concentrations in children, a summery of the results from different studies since 1990*

Area	Number of children	Average BLL (µg/dl)
Rural	12	5.4
	343	4.5
	141	4.3
Urban	149[1]	6.4
	55[2]	5.2
Local source	21	5.4
	40	4.1
	67	4.8

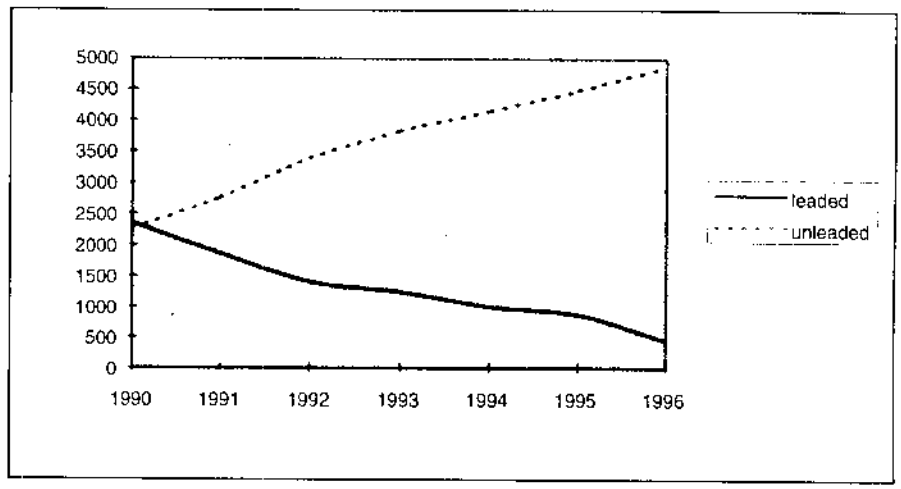
1) Living in the old centre of big cities (Amsterdam, Rotterdam)
2) Living in the suburban parts.

From smaller studies, it turned out that BLL in children living in the neighbourhood of local (industrial) emission sources was about the same as in children living in rural areas. Based on a study in 1992, it is estimated that in the Netherlands about 3% of all children (up to 12 years old) have BLL between 10 and 15 µg/dl and about 0 5% of all children (up to 12 years old) have BLL between 15 and 25 µg/dl. This last group of about 11,000 children live in the centre of big cities.

13.2 **Production and consumption of petrol**

Unleaded petrol was introduced in 1986 but only on a limited scale. Therefore the market penetration was low initially. However, since 1990, petrol consumption in the Netherlands has changed significantly from leaded to unleaded petrol, and the market share of unleaded petrol has increased steadily reaching 92% in 1996. In 1997, no leaded petrol was sold in the Netherlands.

Figure 13.1 *Consumption of Leaded and Unleaded Petrol, 1990-1996. The Netherlands (1.000 m³)*



In 1986 (the same year as unleaded petrol was introduced), the Decree on the Lead Content in petrol was revised. According to the revised Decree, the maximum lead content in leaded petrol was reduced to 0.15 g/l. The maximum limit for lead content in unleaded petrol is 0.013 g/l.

The consumption of leaded petrol in the period 1990-1996 was entirely RON98. For unleaded petrol, RON95 petrol dominates the market.

Figure 13.2 *Distribution of Unleaded Petrol consumption on Different RON qualities. 1996. The Netherlands*

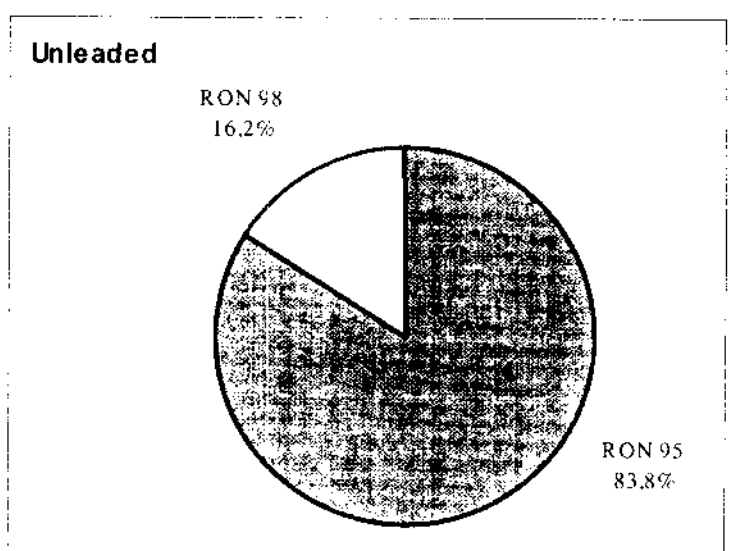


Table 13.3 *The Development in Petrol Consumption, 1990-1996 (1,000 m^3), The Netherlands*

1,000 m^3	1990	1991	1992	1993	1994	1995	1996
Leaded (RON98)	2,349	1,861	1,407	1,244	1,004	876	448
Unleaded (RON95 & 98)	2,253	2,756	3,391	3,825	4,143	4,483	4,854
Total consumption[12]	4,618	4,632	4,810	5,082	5,160	5,346	5,535
Unleaded petrol, market share (%)	49	60	71	75	80	82	92

Over the period 1990-1996, the consumption of diesel oil increased from 4.435 million m^3 to 5.639 million m^3.

13.3 **Refining Industry**

There are six refineries in the Netherlands of which five are producing petrol. All the refineries are privately owned. Two refineries, Netherlands Refining Co. and Shell Nederland Raffinaderij BV account for more than 2/3 of primary distillation capacity and almost all catalytic cracking and reforming capacity.

Table 13.4 *Refinery Processes, 1996, The Netherlands*[13] *(bbl/day)*

Refinery process	Capacity 1996
Atmospheric distillation	1,186,500
Thermal operations	121,300
Catalytic Cracking	137,400
Catalytic Reforming	168,780
Catalytic hydrocracking	94,850
Alkylation	12,650
Polymerisation	
Isomerisation	13,700
Oxygenates (e.g. MTBE)	3,900

The Dutch refineries export approximately 50% of their total production primarily to Germany, Belgium, other Northern European countries and the United States.

13.4 **Vehicle Fleet**

The number of motor vehicles in the Netherlands has increased steadily. Between 1980 and 1990 the number of passenger cars increased by 22%, and between 1990 and 1996 it increased by 10%. In 1996, there were 6,420,000 vehicles in the Netherlands corresponding to 0.415 vehicles per capita.

[12] Include all grades i.e. there is minor non-explained difference to the sum of leaded and unleaded in the rows above.

[13] Source: Oil and Gas Journal December 1996

Table13.5 *The Vehicle Fleet, 1990-1996, The Netherlands*

Information	1990	1991	1992	1993	1994	1995	1996
Total number of vehicles, ('000)	5,756	5,801	5,914	6,063	6,211	6,290	6,420
Number of passenger cars ('000)	5,196	5,224	5,297	5,411	5,558	5,633	5,740
Number of vehicles/1000 inhabitants	372	375	383	392	402	407	415
Share with catalytic converters, petrol driven passenger cars (%)		22	31	39	46	50	61
Average age (years)	11						12

In 1992, emission standards requiring catalytic converters were introduced in the Netherlands. As shown in Table13.5 the number of passenger cars equipped with catalytic converters increased steadily from 22% of the total number of petrol driven passenger cars in 1991 to 61% in 1996.

The most common car makes in the Netherlands are Renault and Audi. The vehicle fleet consists mainly of Western European and East Asian car makes.

Table 13.6 *The vehicle fleet according to fuel type. 1990-1996. The Netherlands*

Information	1990	1991	1992	1993	1994	1995	1996
Passenger cars and light duty vehicles							
% petrol driven	-	75	75	76	77	79	79
% diesel driven	-	15	14	15	15	15	15
% LPG		10	11	9	8	6	6
Heavy duty vehicles & busses							
% petrol driven	0	0	0	0	0	0	0
% diesel driven	100	100	100	100	100	100	100
All vehicles							
% petrol driven	-	73	73	74	75	77	77
% diesel driven	-	17	17	17	17	17	17
% LPG		10	10	9	8	6	6

13.5 **Distribution System**

No information has been provided.

13.6 **Policies and Instruments**

Leaded petrol was phased out in the Netherlands in 1997.
The Dutch lead phase-out has been achieved through a mix of different measures:

- Tax differentiation has been the most important measure to phase out lead in petrol in the Netherlands. The tax differentiation is about 10-15% in favour of unleaded petrol.
- Information campaigns on TV have been initiated by the government

Regulatory measures as emissions standards, which require the use catalytic converters was adopted in 1988. Limits for the lead content in petrol has been similar to the present EU standard since 1992.

14 Norway

14.1 Environmental Pressure and Health Effect

The lead emission from vehicles declined rapidly from 1990 to 1996. In 1996, the vehicular lead emission was estimated to 3 tonnes. In the 1970's, lead emissions were 600-700 tonnes per year, but declined to 300-500 tonnes per year in the 1980's as the maximum lead content in petrol gradually was reduced.

Table 14.1 *Vehicular Lead Emissions. 1990-1996. Norway*

Vehicular lead emissions	1990	1991	1992	1993	1994	1995	1996
Total lead emissions from vehicles (tonnes)	208	168	138	96	16	10	3
Share of total emissions (%)	90	91	92	90	73	67	38
Emissions/km^2 (kg)	0.64	0.52	0.43	0.30	0.05	0.03	0.01
Emissions per 1,000 inhabitants (kg)	49.5	39.1	32.1	22.3	3.7	2.3	0.68

In 1991 and 1992, the ambient air lead concentrations were measured in Oslo, Drammen, Skien and Trondheim. In 1991, Oslo had the lowest level of 0.22 µg/m^3, while Drammen had the highest level of 0.49 µg/m^3. In 1992, the ambient air lead concentrations increased in Oslo and Drammen to 0.32 µg/m^3 and 0.73µg/m^3 respectively, but declined in Skien and Trondheim.

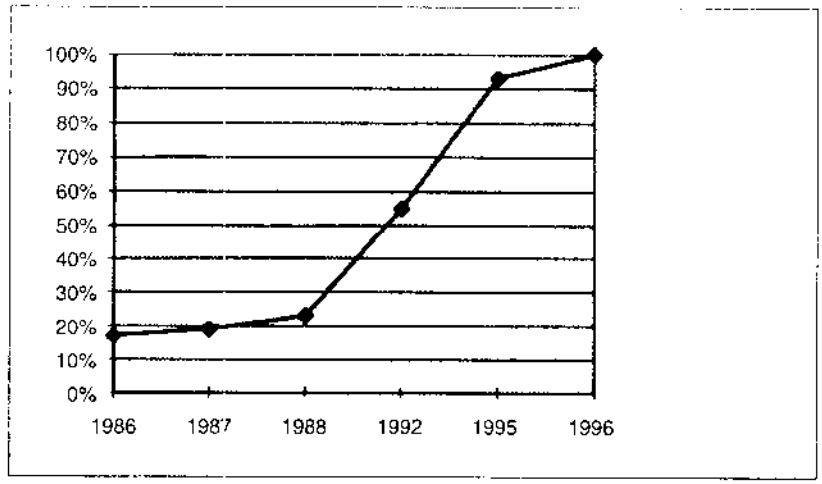
Measurements of ambient air lead concentrations in 9 major cities were stopped in 1992 due to the low values recorded.

No figures are available on blood lead level concentrations.

14.2 Production and Consumption of Petrol

The market share of unleaded petrol has increased substantially since 1985, when unleaded petrol was initially introduced. In 1992, the market share of unleaded petrol was 55%, increasing to 93% in 1995 and reaching 100% in 1996.

Figure 14.1 *Market share unleaded petrol 1985-1996, Norway*



Unleaded petrol consumption was mainly RON95 (62%) in 1996, while RON98 accounted for the remaining 38% of consumption.

The production share of leaded petrol (RON98) was 16% in 1996 compared to 19% in 1995. The production of leaded petrol was entirely destined for export to Great Britain in 1996.

Table 14.2 *Supply Balance for Leaded and Unleaded Petrol. 1996. Norway (1,000 m^3)*

1,000 m^3	Production	Import	Export	Consumption
Unleaded petrol	3,565	625	1,935	2,255
Leaded petrol	673	0	673	0

The maximum lead content in leaded petrol has been gradually reduced since the beginning of the 1970's.

Table 14.3 *History of lead content reduction in petrol 1970-1996. Norway*

Year	Maximum allowed lead content in leaded petrol (g/l)
Until 1970	0.7
1971-1974	0.6
1974-1980/1983	0.4
1980/1983-1996	0.15
1987	0.013 (unlead)

The average actual lead content in leaded petrol was 0.14 g/l until 1993, but decreased to 0.09 g/l in 1995. The unleaded grades RON95 and RON98 have a lead content below 0.001 g/l.

From 1993 and onwards a potassium based lubricating agent has been added to RON98 petrol. 24% of the total petrol marketed in 1996 contained the additive.

14.3 Refining Industry

The three refineries in Norway are owned by Esso, Shell and Statoil. The latter is the most modern refinery constructed in the 1980's and accounts for approximately 50% of crude oil distillation capacity and is the only refinery with catalytic cracking (conversion) facilities. The refinery produces petrol with a low sulphur content. However, in general the Norwegian refineries produce petrol with a high benzene content. Statoil is currently constructing facilities to lower the benzene content.

Table 14.4 *Refining Industry in Norway[14]. (bbl/day)*

Refinery process	Capacity 1996
Atmospheric distillation	307,000
Thermal operations	48,200
Catalytic Cracking	48,000
Catalytic Reforming	48,700
Catalytic hydrocracking	
Alkylation	
Polymerisation	11,500
Isomerisation	8,000
Oxygenates (e.g. MTBE)	

14.4 Vehicle Fleet

In 1996, there were 2.06 million vehicles in Norway of which 95% were passenger cars and light duty vehicles. 88% of all passenger cars and light duty vehicles were petrol driven, while 96% of heavy duty trucks and busses were diesel driven.

Passenger cars equipped with catalytic converters amounted to 512,000 corresponding to 30% of all petrol driven passenger cars compared to 11% in 1990. Emission standards requiring catalytic converters on new cars has been in force throughout the 1990's.

The registration of new cars varied between 61,000 and 96,000 per year for passenger cars and between 3,000 and 6,000 per year for heavy vehicles over the period 1990-1996. In 1994 and 1995, the highest number of new registrations were recorded. The estimated turnover rate was 4% in 1996.

[14] Source: Oil and Gas Journal December 1996

Table 14.5 *The Vehicle Fleet. 1996. Norway*

Information	1996
Number of vehicles('000)	2.060
Number of passenger cars ('000)	1.967
Number of vehicles/1.000 inhabitants	490
Average age of passenger cars (years)	-
Average age trucks (years)	-
Estimated turnover rate (%)	4
Share with catalytic converters, all vehicles (%)	25
Share with catalytic converter, all petrol driven vehicles (%)	30

Table 14.6 *The vehicle fleet according to fuel type. 1996. Norway*

Information	1996
Passenger cars	
% petrol driven (%)	88
% diesel driven (%)	12
Heavy duty vehicles & busses	
% petrol driven (%)	4
% diesel driven (%)	96
All vehicles	
% petrol driven (%)	84
% diesel driven (%)	16

The most common vehicles in Norway in 1993 were Golf (7%), Opel Astra (6.6%) and Toyota Corolla (5.9%).

14.5 Distribution System

In 1995, there were 2,147 petrol stations in Norway with an average of 3.7 fuel pumps per station.

Throughout the 1990's, there has been differentiation between pump nozzles for leaded and unleaded petrol and all petrol stations offered unleaded petrol.

Approximately 1,000 petrol stations have a vapour recovery installation for tank filling (Stage I) and about 10 gas stations have such installations for car filling (Stage II).

40% of the gas stations are state owned.

14.6 Policies and Instruments

Leaded petrol has been phased out in Norway, but is not banned per se. This has been achieved over a ten year period starting in 1985/1986 with the introduction of unleaded petrol. However, a gradual lowering of the lead content in petrol was carried out in the years before. To ensure compliance with the petrol quality standards on-the-spot checks were undertaken at petrol stations over a five year period. No violations were observed.

Emission standards requiring the use of catalytic converters were introduced in the second half of the 1980's. To increase the number of cars fulfilling the emission standards, car buyers received a rebate of NOK 6,000 (USD 850), if buying this type of car. The scheme was originally intended to be in force from June 1987 to January 1989, but was extended to 1995. From January 1989, catalytic converters became compulsory in new passenger cars.

Furthermore, tax differentiation has been applied since 1986. The consumer price of unleaded RON95 during 1985 was NOK 0.05 above the consumer price of leaded RON98 and NOK 0.16 above RON93/94. After the introduction of the tax differentiation scheme, the consumer price of unleaded RON95 was NOK 0.19 below the consumer price of leaded RON98. For 1994 and 1995, the tax differentiation scheme resulted in a consumer price difference of 4% in favour of unleaded RON98 petrol and 8% for unleaded RON95 petrol compared to leaded RON98 petrol. The excise tax on leaded petrol (lead content higher than 0.05 g/l) is NOK 0.74 higher than the excise tax on unleaded petrol in 1997.

Information campaigns in the form of unleaded petrol promotion and campaigns to affect the petrol filling behaviour of owners of old cars with potential soft valve seats have been used e.g. promoting "one tank filling with lead, three without", which was considered to provide sufficient valve seat protection. A potassium based lubricating additive was introduced in 1993.

Separate pumps, visibly marked "unleaded" and having small nozzle diameter for unleaded petrol was made obligatory by mid-1986. Larger nozzle diameter for leaded petrol pumps was also made mandatory. However, to maximise the sale of unleaded petrol, unleaded petrol was allowed to be available at pumps with large nozzle diameter in an interim period of 1½ year. Problems encountered in this process were petrol stations with thin nozzles, which only slowly changed to thick nozzles and customers filling catalyst cars with thick nozzles. To ensure compliance with the regulations, on-the-spot inspections were carried out. The cost of this activity is financed by the oil companies according to their market shares.

Other obstacles encountered during phase-out was that the initial types of lubricating agents created sludge in the petrol station tanks.

The marketing of unleaded petrol by the petrol stations was made compulsory by mid-1987 and by January 1992 also for stations with only one grade available. The introduction of unleaded petrol in the distribution chain was managed by using the existing distribution system (depot tanks and tanks/pumps at the petrol stations) used for the regular grade 93/94 and converting it to be used for unleaded RON95.

Table 14.7 *Summary of Norwegian lead phase out process*

February 1985	Commercial introduction of unleaded petrol
January 1986	Tax incentive unleaded
June 1987	Tax rebate for cars fulfilling emissions standards
July 1987	Unleaded compulsory in outlets
January 1989	Catalytic converters compulsory in passenger cars
1993	Potassium gradually replaces lead

15 Portugal

15.1 **Environmental Pressure and Health Effect**

In 1990, emissions of lead from vehicles were 265 tonnes. The emissions remained at this level over the period 1990-1994.

Ambient air lead concentrations in the city of Porto were 1.12-1.28 $\mu g/m^3$ in 1994, but declined to 0.26-0.47 $\mu g/m^3$ in 1996.

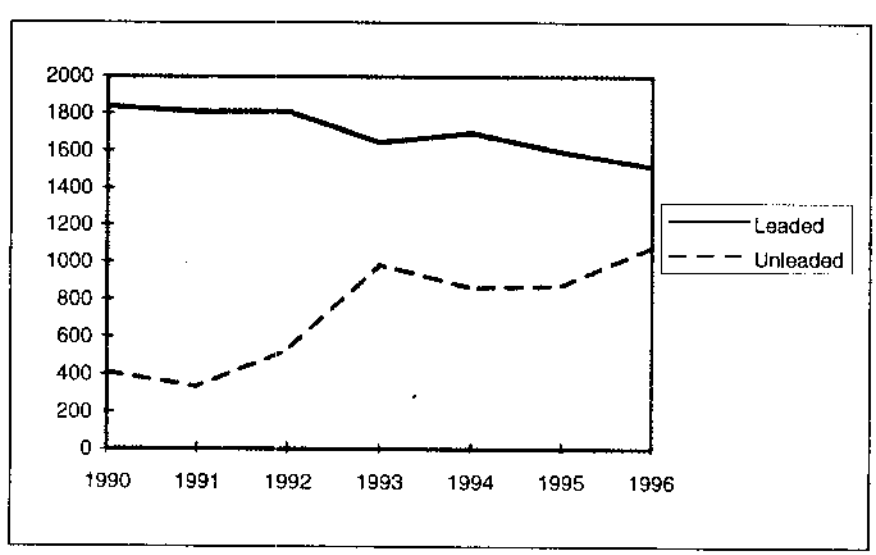
Table 15.1 *Vehicular Lead Emissions, 1990-1994, Portugal*

Vehicular lead emissions	1990	1991	1992	1993	1994
Total lead emissions (tonnes)	265	273	290	288	265
Share of total emissions (%)	..	..	..	..	..
Emissions/km^2 (kg)	2.9	3.0	3.1	3.1	2.9
Emissions per 1,000 inhabitants (kg)	25.2	26.0	27.6	27.4	25.2

15.2 **Production and Consumption of Petrol**

Total petrol consumption in 1996 amounted to about 2.5 million m^3 corresponding to an increase in petrol consumption of 15% since 1990. The market share of unleaded petrol increased from 18% in 1990 to 42% in 1996 as the consumption of unleaded petrol more than doubled, while consumption of leaded petrol declined by 18%.

Figure 15.1 *Consumption of leaded and unleaded petrol 1990-1996, Portugal, (1,000 m3).*



In terms of production, unleaded petrol has accounted for the larger share of domestic production since 1995, but 40-50% of the unleaded petrol has been destined for export.

Table 15.2 *Supply Balance for Leaded and Unleaded Petrol. 1996. Portugal (1,000 m^3)*

1,000 m^3	Production	Import	Export	Consumption
Leaded petrol	1,539	20	43	1,516
Unleaded petrol	1,885	8	812	1,081

In the period 1990-1993, the petrol grade structure consisted of leaded RON90 and RON98, and unleaded RON95. In 1993, unleaded petrol of RON98 was introduced and a year later, in 1994, the leaded RON90 was phased out. Hence, the grade structure has consisted of unleaded RON95 and RON98 and leaded RON98 since 1994. In 1995 and 1996, the consumer price of leaded RON98 was 0.5% lower than the consumer price of unleaded RON98.

The maximum lead content of unleaded petrol has been 0.013 g/l throughout the period 1990-1996. For leaded petrol, the maximum lead content has been 0.15 g/l starting in 1995. In the beginning of the 1990s, the limit was 0.4 g/l.

15.3 **Refining Industry**

There are two refineries in Portugal both owned by Petrogal. The latter is 55% state-owned. The refinery Sines accounts for more than two-thirds of overall primary distillation capacity and all catalytic cracking capacity, while the refinery in Porto is a simpler refinery relying on reforming. The refinery in Porto was constructed in the late 1960s, while the Sines refinery was constructed in 1978. Both refineries have been revamped in 1996/1997 and gas oil hydrotreaters been installed.

Table 15.3 *Refinery Processes. 1996. Portugal[15] (bbl/day)*

Refinery process	Capacity 1996
Atmospheric distillation	304,172
Thermal operations	23,400
Catalytic Cracking	31,500
Catalytic Reforming	50,182
Catalytic hydrocraking	9,180
Alkylation	5,400
Polymerisation	
Isomerisation	
Oxygenates (e.g. MTBE)	

[15] Source: Oil and Gas Journal December 1996

15.4 Vehicle Fleet

No actual figures concerning the vehicle fleet have been provided. Portugal introduced emissions standards requiring catalytic converters on new cars in 1992.

15.5 Distribution System

No information has been provided.

15.6 Policies and Instruments

The market share of unleaded petrol increased from 18% in 1990 to 42% in 1996. Furthermore, the maximum lead content in leaded petrol was reduced from 0.4 g/l to 0.15 g/l in 1995. Portugal intends to phase-out leaded petrol in the year 2000.

Beside the introduction of emission standards requiring catalytic converters on new cars in 1992 and reducing the maximum lead content in leaded petrol, Portugal has not indicated the use of other policy instruments for phasing out lead in petrol e.g. tax differentiation between leaded and unleaded petrol.

Portugal produces more unleaded petrol than consumed domestically and a constraint for phasing out lead in petrol may be that the Portuguese vehicle fleet to a certain extent consist of old vehicles. However, Portugal does not consider this a major constraint for phasing out lead in petrol.

16 Sweden

16.1 Environmental Pressure and Health Effect

In 1990, emissions of lead from vehicles were 363 tonnes, but in 1995 less than 3 tonnes of lead were emitted. The lead emissions from vehicles declined rapidly from 1993 to 1994 as a result of unleaded petrol being the only petrol type available from mid-1994.

Table 16.1 *Vehicular Lead Emissions, 1990-1995, Sweden*

Vehicular lead emissions	1990	1991	1992	1993	1994	1995
Total lead emissions (tonnes)	363	346	330	125	6	< 3
Share of total emissions (%)	..	..	..	..	..	..
Emissions/km^2 (kg)	0.8	0.8	0.7	0.3	0.01	< 0.01
Emissions per 1,000 inhabitants (kg)	42.2	40.2	38.4	14.5	0.7	< 0.35

Blood lead levels were 23-27 µg/l in children in 1994 compared to 53-57µg/l in 1978.

16.2 Production and Consumption of Petrol

All petrol produced and sold in Sweden has been unleaded since mid-1994. One of the largest oil companies changed to 100% production of unleaded petrol in 1993 and other oil companies reduced the lead level to one third by the end of 1993 i.e. 0,05 g/l.

From 1980 and onwards, the maximum lead level permitted was 0,15 g/l. The previous restrictions on lead content in petrol were 0.70 g/l from 1970 to 1973 and 0.40 g/l from 1973 to 1980.

There used to be two leaded petrol qualities RON96 and RON98 on the Swedish market. The unleaded RON95 was introduced in 1985.

Lubricants are added to the petrol, but only in unleaded RON96 and RON98 and should not be used in RON95 for catalyst cars. There is a risk of damage to the catalyst by unburned lubricants i.e. ash.

The cost is about 0.003 USD/l for the additive package and the cost of compensating for loss of octane level (3 points) is 0.009-0.026 USD per litre. The total cost of the additive and the increase from RON95 to RON98 is 0.01-0.03 USD per litre of petrol in comparison with the cost of lead added to petrol of 0.0015 USD per litre.

The lubricants (potassium and sodium combined with detergents and solvents) give sufficient protection against valve seat recession under normal working conditions. Four times higher concentration is needed under extreme conditions e.g. high load.

Field experience from Sweden shows the importance of preventing contamination of the fuel by water and of adding the additive as close to the petrol station as possible. The additives are added at the same time as the petrol is distributed from the depot.

Table 16.2 *Supply Balance for Leaded and Unleaded Petrol. 1995. Sweden (1,000 m^3)*

1,000 m^3	Production	Import	Export	Consumption
Leaded petrol:	< 3	0	0	0
Unleaded petrol:	5,544	2,011	2,375	5,180

16.3 **Refining Industry**

There are five refineries in Sweden. Two of the refineries are very small with a crude oil distillation capacity below 30,000 BBL/day. The largest refinery "Skandinaviska Raffinaderi AB" owned by Norsk Hydro and Preem Petroleum AB accounted for almost 50% of the primary distillation capacity in 1996 and was also the only refinery having catalytic cracking (conversion) facilities. Three of the refineries have reforming and isomerisation facilities.

Table 16.3 *Refinery Processes. 1996. Sweden[16] (bbl/day)*

Refinery process	Capacity 1996
Atmospheric distillation	427,000
Thermal operations	62,800
Catalytic Cracking	29,700
Catalytic Reforming	69,900
Catalytic hydrocraking	
Alkylation	
Polymerisation	3,420
Isomerisation	28,400
Oxygenates (e.g. MTBE)	

16.4 **Vehicle Fleet**

The number of vehicles in Sweden increased moderately over the period 1992-1995 and amounted to 3.9 million in 1995, which corresponds to 0.46 per capita. 98% of the vehicle fleet were passenger cars and light duty trucks, of which 96% used petrol.

[16] Source: Oil and Gas Journal December 1996

Furthermore, there were 88,000 heavy-duty trucks and buses in 1995, all diesel driven vehicles.

Since 1989, only catalyst equipped new cars have been for sale in Sweden and the number of passenger cars with catalytic converter have more than doubled since 1990 reaching almost 40% of the total vehicle fleet in 1995.

Table 16.4 *The Vehicle Fleet, 1992-1995. Sweden*

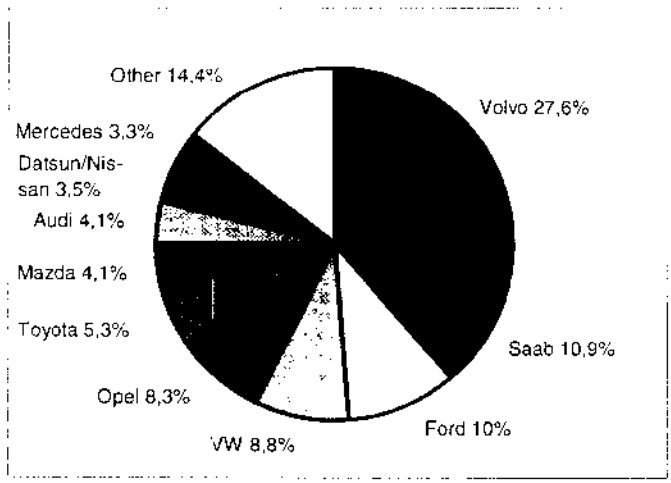
Information	1992	1993	1994	1995
Number of vehicles('000)	3,893	3,870	3,892	3,923
Number of passenger cars ('000)	3,803	3,783	3,706	3,835
Number of vehicles/1,000 inhabitants	453	450	453	456
Average vehicle age (years)				10
Estimated turnover rate passenger cars (%)	4.3	3.5	4.4	4.7
Share with catalytic converters, all vehicles (%)	29	33	36	39
Share with catalytic converter, all petrol driven vehicles (%)	31	35	38	41

Table 16.5 *The vehicle fleet according to fuel type. 1992-1995 Sweden*

Information	1992	1993	1994	1995
Passenger cars				
% petrol driven (%)	97	96	97	96
% diesel driven (%)	3	4	3	4
Heavy duty vehicles & busses				
% petrol driven (%)	0	0	0	0
% diesel driven (%)	100	100	100	100
All vehicles				
% petrol driven (%)	94	94	94	94
% diesel driven (%)	6	6	6	6

In 1996, less than 0.5 million petrol driven vehicles in Sweden needed lubricants to prevent valve seat recession. It is expected that in the year 2010 no cars will need lubricants.

Figure 16.1 *The Ten Most Common Vehicles (%)*



16.5 **Distribution System**

The number of petrol stations in 1995 was 3,600, all of them privately owned.

All petrol stations offer (only) unleaded petrol. Prior to the ban of leaded petrol there used to be differentiation of pump nozzles for leaded and unleaded petrol.

During the phase-out period, some instances of lead contamination of unleaded petrol were observed.

The lubricating additives are added at the same time as the petrol is distributed from the depot. The most likely scenario within a couple of years is that the sales of additives will be "in bottles". The car owner will thus be able to add the lubricant by himself.

16.6 **Policies and Instruments**

Leaded petrol was phased out in 1994 and sale and production of leaded petrol for the Swedish market was banned in March 1995.

The maximum lead content has been gradually reduced from 0.4 g/l in the 1970's to 0.15 in the 1980's and finally 0.013 g/l in 1995.

Unleaded petrol was introduced in 1985 and was promoted by the use of tax differentiation. The tax incentive on unleaded petrol (0.54 SKR/l since 1993) was the main reason, why all oil companies became interested in substituting lead with other lubricants in 1993/94.

To cope with the fact that lead phase-out might create other environmental problems, e.g. increased aromatics and benzene content, a system of voluntary regulation of petrol with tax incentives based on the environmental classification of petrol (the maximum

benzene content is in general 5% v/v, but the maximum allowed in better classified petrol is 3% v/v) was introduced in 1994. The best environmental class of petrol had a market share of 100% in 1996.

Since 1989, catalytic converters have been required for new cars.

17 Switzerland

17.1 Environmental Pressure and Health Effect

In 1995, 90 tonnes of lead were emitted from vehicles, which corresponds to 40 % of total lead emissions. Over the period 1990-1995, the total emissions of lead have declined by 57%. Over the same period, the emissions from vehicles declined by 69%.

Total lead emissions peaked in 1970 with 2,160 tonnes and vehicles accounting for 71% of the emissions.

While lead emission from vehicles was the major source of lead emissions over the period 1955-1990 followed by industry emissions, the trend was reversed in 1995. Hence, lead emission from the industry was the major source of lead emissions in 1995 accounting for 54% of emissions, vehicles accounted for 40%, while households and agriculture accounted for less than 4% each. The lead emission from vehicles is expected to decrease to 13 tonnes in the year 2000 and remain stable thereafter. This level of emissions is comparable to the level at the beginning of the century.

Table 17.1 *Vehicular Lead Emissions. 1985-95. Switzerland*

Vehicular lead emissions	1985	1990	1995
Total lead emissions (tonnes)	502	292	90
Share of total emissions (%)	65	56	40
Emissions/km^2 (kg)	12.2	7.1	2.2
Emissions per 1,000 inhabitants (kg)	74.9	43.6	13.4

17.2 Production and Consumption of Petrol

In order to prepare for catalyst cars Switzerland replaced leaded RON91 by unleaded RON95 in 1985. In the first months of 1985, the market share of unleaded petrol was 2%. The market share increased to 45% in 1990 and 85% in 1995.

Before introducing unleaded petrol, the limit for the content of lead in petrol was gradually reduced. For the regular RON91, the maximum lead content was reduced from 0.54 g/l in 1972 to 0.15 g/l in 1978. For the premium RON98, the maximum lead content was reduced from 0.57 g/l in 1970 to 0.15 g/l in 1982.

A benzene limit of 5% v/v was also introduced in the process to back-up the gradual reduction in the lead content of petrol.

17.3 **Refining Industry**

Switzerland has two refineries, both privately owned and almost with the same crude oil distillation capacity.

In the lead reduction phase from 1972-1982, the refineries increased reformer severity and constructed isomerisation units.

Furthermore, MTBE (5-15%) with a RON above 120 were added to the petrol pool to boost the octane level.

The use of alcohol as octane booster was stopped due to inferior engine performance compared to MTBE.

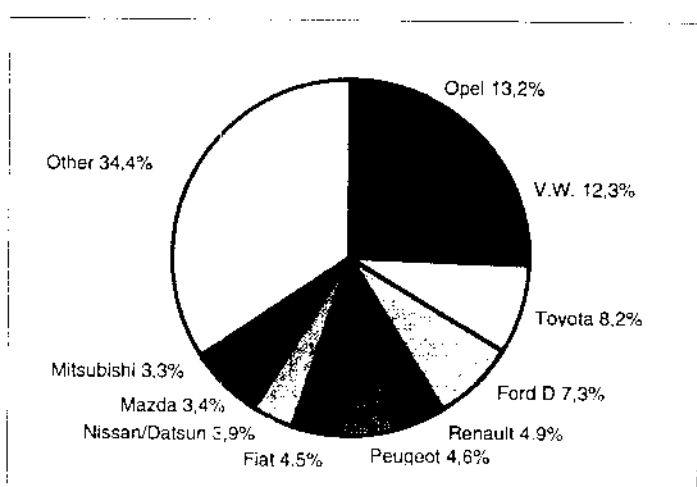
Table 17.2 *Refinery processes. 1996. Switzerland*[17] *(bbl/day)*

Refinery process	Capacity 1996
Atmospheric distillation	132,000
Thermal operations	20,000
Catalytic Cracking	
Catalytic Reforming	26,000
Catalytic hydrocracking	6,300
Alkylation	
Polymerisation	
Isomerisation	10,000
Oxygenates (e.g. MTBE)	

17.4 **Vehicle Fleet**

In 1990, there were 2.98 million passenger cars in Switzerland which corresponds to 0.4 per capita. In 1991, 310,000 new cars was recorded corresponding to 10% of the vehicle fleet.

Figure 17.1 *Ten most Common vehicles (%), 1993.*



[17] Source: Oil and Gas Journal December 1996

17.5 Distribution System

The introduction of unleaded petrol in 1985 was carried out by replacing the regular leaded grade with the unleaded grade. The petrol stations differentiate between pump nozzles for leaded and unleaded petrol.

The change from leaded to unleaded petrol with a lead content of 0.013 g/l did not entail any cleaning related to the distribution system. A complete draining of tanks, pumps and pipes was found sufficient.

A list of car models which can use unleaded petrol is accessible at each gas stations.

17.6 Policies and Instruments

The phase out of lead has been implemented in two phases.

Phase 1 running from 1972-1982 with a gradual reduction in the maximum lead content in petrol. The lead emissions from vehicles decreased from 1,530 tonnes in 1970 to 502 tonnes in 1985. This was supported by introducing a limit for the benzene content in petrol of 5% v/v.

Phase 2 beginning in 1985 with the aim of preparing for cars equipped with catalytic converters, implied the introduction of unleaded petrol.

The legal basis consisted in requiring that all petrol with RON below 97 had to be unleaded with a requirement for differentiation between pump nozzles for unleaded and leaded petrol at the petrol stations. The transition period was less than one year and no new investments had to be undertaken.
By introducing a tax differentiation scheme in 1985, which was fiscally neutral, the relative prices at the pump were changed in favour of unleaded petrol as indicated in Table 17.3.

Table 17.3 *Effect on relative consumer prices of taxation scheme. Switzerland*

	Relative prices at pump		
Price indices	Leaded regular	Unleaded	Leaded premium
Basis price	96	-	100
Unleaded introduced	-	102	100
With tax incentive	-	98	102

This scheme increased the demand for unleaded petrol and persuaded the owners of filling stations to introduce unleaded.

To support the introduction of unleaded petrol and the phase-out of leaded petrol a list of car models which can use unleaded petrol is displayed at each petrol station.

Switzerland does not use additives for valve seat protection. Therefore, cars which do not have hard valve seats must use leaded petrol.

18 United Kingdom

18.1 **Environmental Pressure and Health Effect**

In 1995 1,067 tonnes of lead were emitted from vehicles, which correspond to 73% of total lead emissions. The emissions from vehicles declined by 51% over the period, while the total emissions from all sources declined by 46%.

Table 18.1 *Vehicular Lead Emissions, 1990-1995.*

Vehicular lead emissions	1990	1991	1992	1993	1994	1995
Total lead emissions (tonnes)	2,185	1,949	1,737	1,534	1,295	1,067
Share of total emissions (%)	81	79	77	75	74	73
Emissions/km^2 (kg)	8.9	8.0	7.1	6.4	5.4	4.4
Emissions per 1,000 inhabitants (kg)	38.1	33.9	30.3	26.7	22.6	18.6

Average annual air lead concentrations in London declined from 0.38 µg/m^3 in 1990 to 0.244 µg/m^3 in 1994. A similar trend can be observed in cities like Manchester, Cardiff and Motherwell.

Samples taken in 1995/96 showed blood lead concentrations of 4.5 µg/dl for males, 3.1 µg/dl for females, and 1.9-2.5 µg/dl for children aged 15 or lower. 95% of the population had blood lead levels below 10 µg/dl in 1995/96 and the concentrations were 60%-100% lower than in 1984-1987.

IQ has been observed to be inversely correlated with blood lead levels in children aged 2.

18.2 **Production and Consumption of Petrol**

No figures are available on imports, exports and consumption. However according to the World Bank(1996), the market share of unleaded petrol was 53% in 1995.

Production of unleaded petrol increased its share of total production from 41% in 1991 to 68% in 1996.

Figure 18.1 *Production of Leaded and Unleaded Petrol[18]. 1991-1996. UK (1,000 m³)*

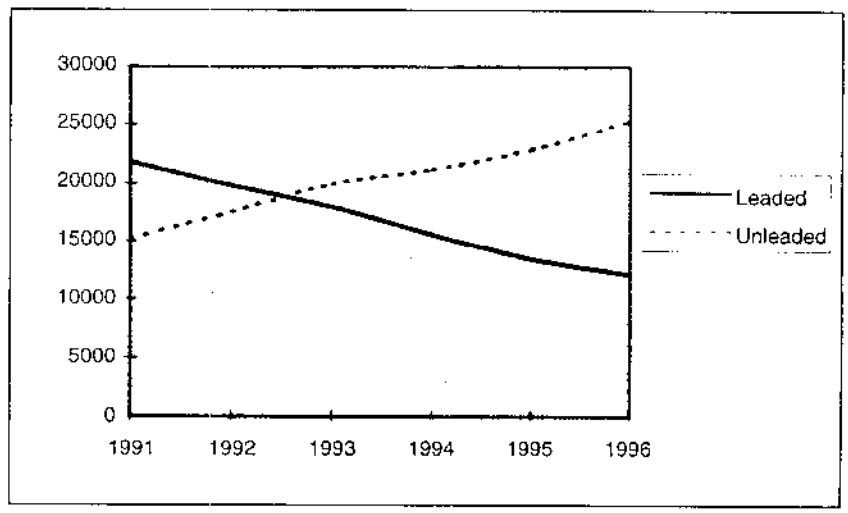


Table 18.2 *Supply Balance for Leaded and Unleaded Petrol. 1996. UK (1,000 m³)*

1,000 m³	Production	Import	Export	Consumption
Leaded petrol:	12,079	n.a.	n.a.	n.a.
Unleaded petrol:	25,316	n.a.	n.a.	n.a.

Three grades of petrol are produced in the UK; leaded RON97, unleaded RON95, and unleaded RON98.

Maximum lead content in leaded and unleaded petrol are in accordance with EU standards, i.e. 0.15 g/l and 0.013 g/l respectively.

Retail prices of unleaded petrol have consistently been below retail prices of leaded petrol since 1991. In 1996, the difference in retail price between unleaded RON98 and leaded RON97 was about 1% in favour of the former, and the difference between retail prices of unleaded RON95 and leaded RON97 was 10%.

18.3 **Refining Industry**

There were 15 refineries in the UK in 1995, all privately owned. Three of the refineries were very small and did not produce petrol. One of the refineries are scheduled to be closed after a merger between the oil companies Elf and Gulf.

Almost all the major oil companies are present in the refining industry.

[18] The split of production between unleaded and leaded is estimated on the basis of total deliveries.

Most of the refineries were constructed over the period 1950-1970. All have been regularly and extensively upgraded and modernised throughout the years.

Large investments have been undertaken since the mid 1980s to cope with the increasing octane pool requirement resulting from the reduction in lead content (1985), the growth of unleaded petrol demand and the promotion of super unleaded petrol i.e. RON98. Examples of refinery investments are isomerisation units, alkylation and MTBE units.

As indicated in Table 18.3 below, the refinery industry has a relatively high catalytic cracking, reforming and up-grading capacity compared to the refining industries in other major European countries.

Table 18.3 *Refinery Processes. 1996. UK[19] (bbl/day)*

Refinery process	Capacity 1996
Atmospheric distillation	1,940,990
Thermal operations	94,700
Catalytic Cracking	484,550
Catalytic Reforming	333,700
Catalytic hydrocracking	55,500
Alkylation	103,700
Polymerisastion	16,969
Isomerisation	124,100
Oxygenates (e.g. MTBE)	3,700

Some companies have marketed a grade of unleaded petrol containing a valve seat recession additive based on sodium or potassium.

18.4 Vehicle Fleet

The number of vehicles was 23.2 million in 1995 corresponding to 0.4 vehicle per capita. The vehicle fleet increased by 3% over the period 1990-1995 due to an increasing number of passenger cars.

98% of the vehicle fleet is passenger cars and light duty trucks, of which 14% use diesel. The number of passenger cars using diesel has increased substantially, while the number of petrol driven passenger cars declined. The petrol driven part of the heavy duty vehicles fleet has been declining steadily since 1990 and amounted to 2% in 1995.

Emission standards requiring catalytic converters on new cars have been in force since 1993. In 1995, the share of petrol driven vehicles with catalytic converters was 28%. As the turnover rate

[19] Source: Oil and Gas Journal December 1996

is fairly high (9.1%), the share of vehicles with catalytic converter may continue to increase rapidly in the future[20].

Table 18.4 *The Vehicle Fleet,[1] 1990-1995, Great Britain.*[2]

Information	1990	1991	1992	1993	1994	1995
Number of vehicles('000)	22,510	22,505	22,885	22,820	23,210	23,221
Number of passenger cars ('000)	21,895	21,947	22,340	22,285	22,669	22,718
Number of vehicles/1,000 inhabitants	392	387	397	397	404	405
Average age passenger car (years)	6.0	6.2	6.4	6.7	7.0	7.1
Average age trucks (years)	-	-	7.1	5.8	6.3	6.5
Estimated turnover rate (%)	9.9	7.8	7.7	8.4	8.9	9.1
Share with catalytic converters, all vehicles (%)	-	-	4	11	17	24
Share with catalytic converters, all petrol driven vehicles (%)	-	-	5	12	19	28

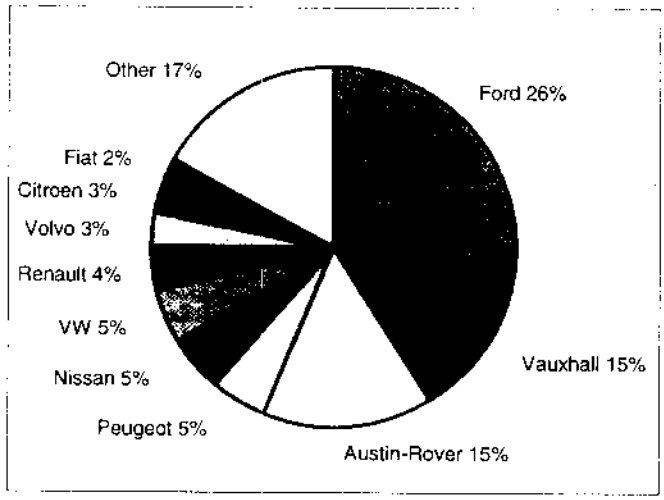
Note: Data in the vehicle fleet are for Great Britain only.

Table 18.5 *The vehicle fleet according to fuel type. 1990-1995 Great Britain*

Information	1990	1991	1992	1993	1994	1995
Passenger cars						
% petrol driven (%)	94	93	92	90	88	86
% diesel driven (%)	6	7	8	10	12	14
Heavy duty vehicles & busses						
% petrol driven (%)	7	5	5	4	4	2
% diesel driven (%)	93	95	95	96	96	98
All vehicles						
% petrol driven (%)	92	91	90	88	86	85
% diesel driven (%)	8	9	10	12	14	15

[20] The number of cars with catalytic converters increased from 5.4 million in 1995 to 7.1 million in 1996.

Figure 18.2 *The Ten most Common Vehicles (%)*



18.5 Distribution System

In 1996, there were 14,708 petrol stations in the UK. The number of petrol stations have decreased from 17,969 in 1993. All stations are privately owned, offer unleaded petrol and differentiates between pump nozzles for unleaded and leaded petrol.

The number of stations having vapour recovery installations (stage 1) increased from 1,439 in 1993 to 3,844 in 1996, while less than 400 stations had stage II installations in 1996.

18.6 Policies and Instruments

The market share of unleaded petrol has increased from nil in 1986 to 53% in 1995.

The approach followed by UK was to reduce the lead content in petrol in 1985 followed by the introduction of unleaded petrol in 1988. Quality standards for petrol with respect to lead content and benzene content is similar to the present EU standards.

Tax differentiation between leaded and unleaded petrol has been used to promote unleaded petrol throughout the 1990s. Hence, retail prices for the unleaded RON98 has consistently been 1-3% lower than the retail price of the leaded RON97 during the 1990s. The unleaded RON95 has been 7-11% cheaper than the leaded RON97 over the same period.

Emissions standards requiring the use of catalytic converters on new cars were introduced in 1993 and the share of the vehicle fleet equipped with catalytic converter increased rapidly thereafter and is expected to continue its rapid increase inter alia due to the high turnover rate in the fleet.
Some of the oil companies add a lubricating additive to the marketed petrol.

Furthermore, information campaigns by the government and by the petrol companies have been carried out.

19 Albania

19.1 Environmental Pressure and Health Effects

Ambient air lead concentrations in Tirana and Berati were 0.233 µg/m^3 and 0.536 µg/m^3 respectively in 1990. The limit value for air lead concentrations is 1.5 µg/m^3.

Mean blood lead levels in six year old children was 28.2 µg/l (+/- 13.1 µg/l) in Tirana and 14.1 µg/l (+/- 3.07 µg/l) in Berati.

19.2 Production and Consumption of Petrol

According to the data sheets received from Albania, only unleaded petrol is produced and consumed in Albania. However, during the last three years a small amount of leaded petrol has been imported and consumed, which is not reflected in the Table 19.1 below.

Table 19.1 *Supply Balance for Leaded and Unleaded Petrol. 1996. Albania (1,000 m^3)*

1,000 m^3	Production	Import	Export	Consumption
Leaded petrol	0		0	
Unleaded petrol	50	52	30	72

RON75 accounted for 46% of the petrol consumed in 1996. Imported RON90 accounted for the remaining 54% of petrol consumption.

The production in 1996 consisted of RON55 and RON75. All production of RON55 is exported.

The maximum lead content in leaded petrol is 0.15 g/l for RON75 and 0.0005 g/l for RON55. The actual lead content in RON75 is below 0.013 g/l.

19.3 Refining Industry

Albania has one small state owned refinery with a total primary distillation capacity of 1 million tonnes of crude oil per year constructed in 1978. The capacity utilisation was 20% in 1996. The refinery has conversion and up-grading facilities. In order to produce unleaded RON87-89 petrol, the existing reformer catalyst was replaced in 1996.

There is no octane surplus in Albania.

19.4 **Vehicle Fleet**

The total vehicle fleet amounted to 111,700 in 1996 compared to 17,700 in 1990. The number of cars per 1,000 inhabitants was 35 in 1996.

The number of passenger cars has increased from less than 4,000 in 1990 to 77,400 in 1996 corresponding to 69% of the total vehicle fleet.

Table 19.2 *The Vehicle Fleet. 1990-1996. Albania.*

Information	1990	1991	1992	1993	1994	1995	1996
Number of vehicles ('000)	17.7	22.0	48.1	79.6	95.3	109.7	111.7
Number of passenger cars ('000)	3.9	7.0	30.1	60.0	74.5	84.7	77.4
Number of cars/1,000 inhabitants	6	7	15	25	30	34	35

The most common car makes are Fiat, Opel, Volvo, Renault and Mercedes-Benz i.e. Western car makes, which most likely need high octane petrol currently not produced in Albania.

19.5 **Distribution System**

In 1996, there were 40 petrol stations in Albania, all of them state owned.

The number of fuel pumps per station is one. All petrol stations offer unleaded petrol.

20 Bulgaria

20.1 **Environmental Pressure and Health Effect**

In 1996 136 tonnes of lead were emitted from vehicles corresponding to 54% of the total lead emissions. The lead emissions from vehicles declined by 33% from 1990 to 1996, while the lead emissions from all sources declined by 43% over the same period.

The national average lead emission from vehicles per 1,000 inhabitants was 16.2 kg in 1996. In cities with heavy road traffic emissions are higher. In 1995, 67 tonnes of lead were emitted from vehicles in Sofia corresponding to 56 kg per 1,000 inhabitants.

The ambient air lead concentrations were measured in Sofia, Pernrk, Plovdiv, and Kardjali. In all these areas the ambient air lead concentrations (peak values) declined over the period 1990-1995. Kardjali had an ambient air lead concentration of 1.2 $\mu g/m^3$ until 1992. The level in 1995 was 0.7 $\mu g/m^3$. Sofia ranks the lowest with 0.3 $\mu g/m^3$ in 1990 and 0.2 $\mu g/m^3$ in 1995.

The blood lead levels have been measured for children. In 1995-1996, the mean national blood lead level was 15.0 µg/dl. In 1991 the levels were 4.1-15.1 µg/dl in Kritehim and 6.5-41.3 µg/dl in Kourtovo/ Konare.

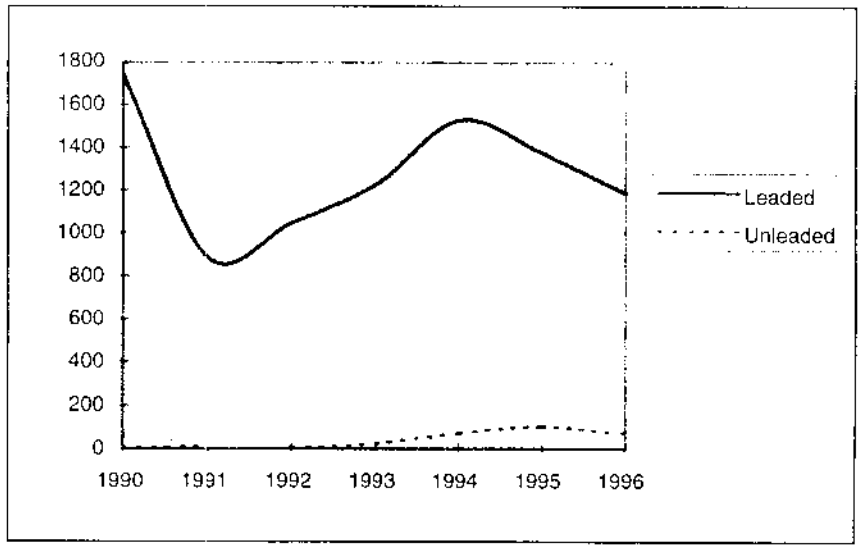
Table 20.1 *Vehicular Lead Emissions. 1990-1996. Bulgaria*

Vehicular lead emissions	1990	1991	1992	1993	1994	1995	1996
Total lead emissions (tonnes)	199	102	118	139	172	157	136
Share of total emissions (%)	46	-	-	-	-	55	54
Emissions/km^2 (kg)	1.8	0.9	1.1	1.3	1.6	1.4	1.2
Emissions per 1,000 inhabitants (kg)	23.0	11.6	13.9	16.5	20.4	18.3	16.2

20.2 **Production and Consumption of Petrol**

In 1996 the market share of unleaded petrol was 6% up from a level of less than 1% in 1990. The total petrol consumption decreased by 25% over the period.

Figure 20.1 *Consumption of Leaded and Unleaded Petrol. 1990-1996. Bulgaria (1,000 m³)*



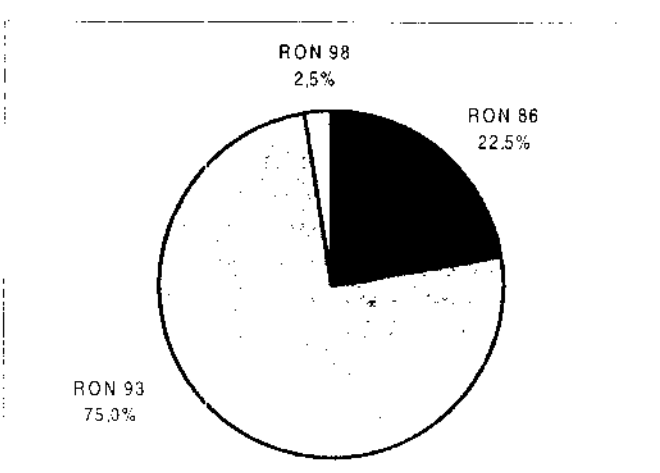
The consumption of leaded petrol in 1996 was mainly RON93, which by the beginning of the decade replaced RON86 as the dominant leaded grade. The unleaded grade is RON95, which replaced RON93 in 1996.

According to Table 20.2 below, Bulgaria is a net exporter of petrol primarily of unleaded petrol. The production share of unleaded petrol was 25% as opposed to a market share of 6% for unleaded petrol in 1996.

Table 20.2 *Supply Balance for Leaded and Unleaded Petrol. 1996. Bulgaria (1,000 m³)*

1,000 m^3	Production	Import	Export	Consumption
Leaded petrol	1,225	0	40	1,185
Unleaded petrol	429	0	357	72

Figure 20.2 *Distribution of Leaded Petrol Consumption on Different RON Qualities. 1995. (%)*



The maximum lead content in leaded petrol is 0.15 g/l for all RON qualities.

20.3 **Refining Industry**

There are three refineries in Bulgaria: Neftochim, Plama and a refinery in Rouse. Plama became private property in 1996. Neftochim dominates the production of petrol, while a smaller quantity is produced at Plama. Only Neftochim produces unleaded petrol. Neftochim is equipped with catalytic reformer, alkylation, isomerisation, fluid catalytic cracking (FCC) and uses MTBE blend stock. The other refineries are less technically advanced. Some of the facilities at Neftochim need modernisation.

The primary distillation capacity of Neftochim is 12 million tonnes per year[21] with a utilisation of about 60% in 1996. The FCC unit is small compared to the total distillation capacity. However, at the current capacity utilisation the FCC unit is used fully. The actual production of petrol has been close to the capacity of 1.25 million tonnes per year since 1994. The surplus production of petrol is exported. The product slate is determined by domestic fuel oil demand.

The refinery in Plama has a crude distillation capacity of 1.2 million tonnes and should be able to produce 200,000 tonnes of petrol. In 1996, the refinery produced a very small amount of petrol.

With the existing facilities in Bulgaria, 45% of the petrol produced can be unleaded. This indicates a potential for a fairly rapid increase in the market share of unleaded petrol, as the refineries are capable of meeting increasing demand up to this level without having to undertake major investments.

Studies undertaken under the National Programme for Implementing Unleaded Petrol in Bulgaria show that the future production of unleaded petrol may reach 100% of the total production in the year 2000 if the following projects are undertaken:

- Neftochim: Revamp of FCC unit to increase capacity and the octane level with an investment cost of USD 25 million. Revamps and replacements of reformers at an estimated investment cost of USD 50 million.
- Plama: Revamp of reformer (USD 20 million) and isomerisation unit (USD 15 million)

The total estimated cost of the programme amounts to USD 110 million.

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[21] Chem systems 1996: Feasibility study for increasing the supply of unleaded petrol in Bulgaria, A phase II report for the World Bank..

Table 20.3 *Refinery Processes, 1996, Bulgaria*[27] *(bbl/day)*

Refinery process	Capacity 1996
Atmospheric distillation	300,000
Thermal operations	30,000
Catalytic Cracking	30,000
Catalytic Reforming	14,000
Catalytic hydrocracking	
Alkylation/polymerisation	5,000
Isomerisation/aromatics	-
Oxygenates (e.g. MTBE)	1,200

20.4 **Vehicle Fleet**

In 1996, there were 2.031 million vehicles in Bulgaria corresponding to 0.24 vehicles per capita. Passenger cars and light duty vehicles accounted for 95% of the vehicle fleet. 91% of the total vehicle fleet used petrol.

On average, both passenger cars and trucks are about 15 years old. 75% of the passenger cars have been running for more than 10 years.

Studies and projections for the vehicle fleet development in Bulgaria shows that the number of new cars will increase in the future, but only moderately in the coming 5 years, many of the aged cars will be scrapped and more second hand cars aged from 5 to 10 years will be in use.

Studies of the vehicle fleets' petrol requirements do not indicate any major problems in using unleaded petrol. Hence, total petrol consumption in 2001 is estimated at 1.4 million tonnes and 95% of the vehicles will be able to use unleaded petrol.

Table 20.4 *The Vehicle Fleet, 1996, Bulgaria*

Information	1996
Number of vehicles('000)	2,031
Number of passenger cars ('000)	1,936
Number of vehicles/1,000 inhabitants	241
Average vehicle age (years)	15
Share with catalytic converters, all vehicles (%)	-
Share with catalytic converter, all petrol driven vehicles (%)	-

[27] World Bank 1997: Phasing out lead from petrol in Central and Eastern Europe, annex A., Ed. Magda Lovei.

Table 20.5 *The vehicle fleet according to fuel type. 1996 Bulgaria*

Information	1996
Passenger cars	
% petrol driven (%)	93
% diesel driven (%)	7
Heavy duty vehicles & busses	
% petrol driven (%)	42
% diesel driven (%)	58
All vehicles	
% petrol driven (%)	91
% diesel driven (%)	9

The most common vehicles in Bulgaria are: Lada, Moskvich, Skoda and Wartburg. More than 140 different car makes are registered to be in use in Bulgaria.

A comparative analysis using leaded RON93 and unleaded RON93 in some of the most popular car makes showed that it made no difference to valve seat conditions in Lada 2101 and Volga, if unleaded petrol was used. However, a moderate increase of 3-4% in the fuel consumption was observed for Lada makes.

The Moskvich showed a tendency towards increased valve seat recession and reduced power of the engine, when unleaded petrol was used.

20.5 **Distribution System**

In 1996, there were 1,170 petrol stations in Bulgaria with an average of 4-5 fuel pumps per station. The petrol stations differentiates between pump nozzles for leaded and unleaded petrol and 13 gas stations (or 1%) have vapour recovery installations. In 1996, 38% of the petrol stations were state owned.

20.6 **Policies and Instruments**

The market share of unleaded petrol is very low in Bulgaria. The maximum lead content in leaded petrol is 0.15 g/l for all RON qualities. The limit for benzene content is 5% v/v.

However, the market share of unleaded petrol should be able to increase rapidly given the characteristics of the vehicle fleet and the domestic refinery industry.

A major factor behind the low market share of unleaded petrol is that the retail price of the unleaded grade RON95 is 15% higher than the price of the popular leaded grade RON93.

Bulgaria uses tax differentiation between unleaded and leaded petrol. Unleaded petrol grades are taxed (excise duty) 10% lower than leaded grades with the same octane number. However, the most popular leaded grade in Bulgaria is RON93 with an excise tax actually lower than that for the high octane unleaded RON95. Hence, the current tax structure counteract increased use of unleaded petrol given the current grade structure.

Furthermore, the current set-up does not stimulate the refinery to sell its unleaded petrol on the domestic market.

Bulgaria is currently preparing an Action Plan to phase-out lead in petrol with the following main activities:

- Revamps of refineries. 1998-2000.
- Introduction of economic incentives for consumers (and producers) for using unleaded petrol. A reconsideration of the current regime of excise duties has been proposed to ensure that the excise duty on unleaded petrol is 20% lower than that for leaded grades with similar octane. 1998-1999
- Limitations on import of cars that cannot use unleaded petrol, aiming at a gradual phase-out of cars requiring only leaded petrol. 1998.
- Information campaigns. 1998-2000.
- Prohibition of import and production of leaded petrol. 2003.

Bulgaria consider the major constraint for fulfilling the plan to be to obtain necessary financing for the revamps and investments at the refineries.

21 Croatia

21.1 Environmental Pressure and Health Effect

In 1995, 259 tonnes of lead were emitted from vehicles corresponding to 90 % of total lead emissions. The total lead emissions in Croatia declined by 39% over the period from 1990 to 1995, while the lead emissions from vehicles declined by 43% over the same period.

Ambient air lead concentrations have been measured in hot spot areas such as city centres with very busy traffic (Zagreb and Rijeka). The maximum short term measurements in Zagreb varied between 1.44-2.86 µg/m^3 in the period from 1990 to 1995, while the concentrations in Rijeka were well below 1 µg/m^3 in 1994 and 1995.

The average 24 hour ambient air lead concentration in Zagreb was 0.9 µg/m^3 in 1991, but decreased to 0.51 µg/m^3.

Table 21.1 *Vehicular Lead Emissions. 1990, 1995. Croatia*

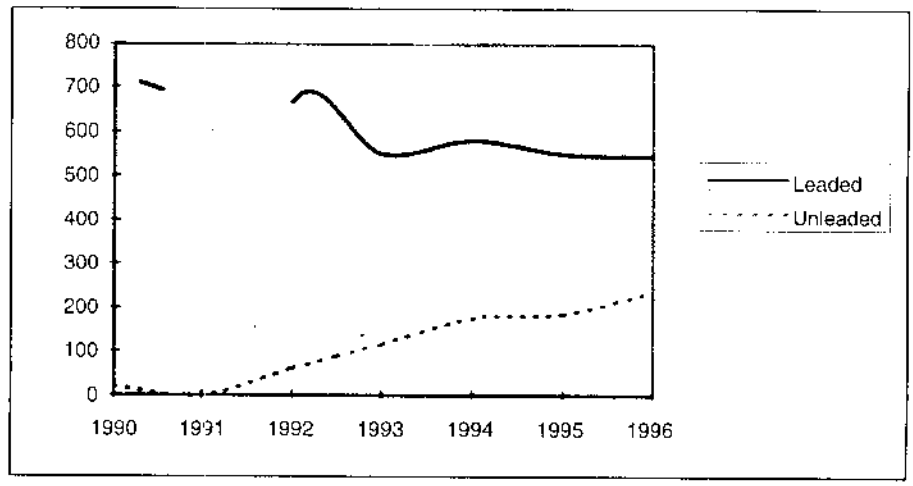
Vehicular lead emissions	1990	1995
Total lead emissions (tonnes)	454	258
Share of total emissions (%)	97	90
Emissions/km^2 (kg)	8.0	4.5
Emissions per 1,000 inhabitants (kg)	94.7	53.9

A number of studies have been undertaken on blood lead levels for the inhabitants in the city centre of Zagreb. The studies show a decline in the blood lead level for men from a mean of 15 µg/dl in 1981 to a mean of 10.9 µg/dl in 1989, and for children from 8.6 µg/dl to 7.1 µg/dl over the same period. The mean blood lead level of women was 8.3 µg/dl in 1981.

21.2 Production and Consumption of Petrol

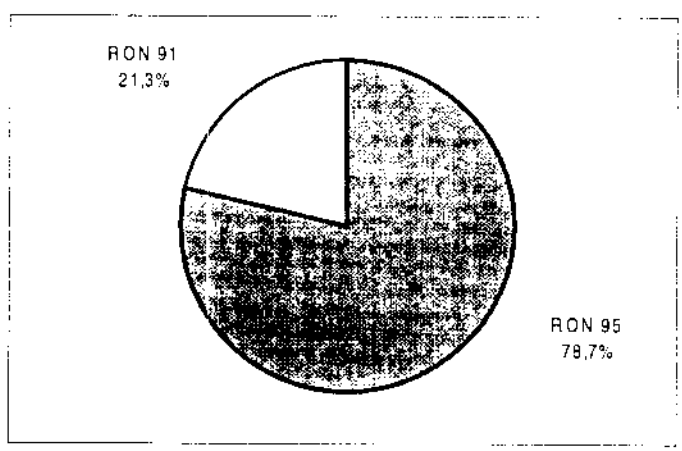
The total petrol consumption declined between 1990 and 1993, but increased in the years thereafter back to the level of 1990. The market share of unleaded petrol increased from 2.5% in 1990 to 30% in 1996, while the consumption of leaded petrol has remained almost constant in recent years.

Figure 21.1 *Consumption of Leaded and Unleaded Petrol. 1990-96. Croatia (1,000 m³)*



The consumption of leaded petrol was entirely of RON98 in 1996. For the unleaded grades RON95 dominates the consumption as indicated in Figure 21.2 below.

Figure 21.2 *Distribution of Unleaded Petrol Consumption on Different RON Qualities. 1996. Croatia (%)*



Production of leaded petrol decreased substantially from 1.9 million m³ in 1990 to 870,000 m³ in 1992, but has remained at that level since. The export of leaded petrol has shown a similar trend. The production of leaded RON86 ended in 1994.

Since 1995 Croatia has produced unleaded petrol containing lubricating additives (RON95) but only for export purposes.[23] 45% of total petrol production was exported in 1996 mainly leaded RON98 and unleaded RON95 containing the lubricating additive.

The production of unleaded petrol with no lubricating additive has recently declined from its peak of 395,000 m³ in 1994 to 295,000 m³ in 1996. However, the export of this type of petrol

[23] However, the production of unleaded petrol containing lubricating additives were stopped in 1997.

declined even more implying that a larger share is marketed at the domestic market.

Table 21.2 *Supply Balance for Leaded and Unleaded Petrol. 1996. Croatia (1,000 m³)*

1,000 m³	Production	Import	Export	Consumption
Leaded petrol:	860	-	315	545
Unleaded petrol containing lubricating additives	280	-	280	0
Unleaded petrol:	295	-	60	235

In 1996, the maximum lead content allowed in leaded petrol was 0.6 g/l with an average actual lead content of 0.5 g/l. In 1997, Croatia has implemented new maximum limits for the lead content in petrol. The maximum lead content in imported petrol has been fixed at 0.15 g/l., while domestic producers are allowed to add 0.5 g/l.

21.3 **Refining Industry**

Croatia has three refineries. The refineries are state-owned. One of the refineries Rafinerija Zagreb is very small and not involved in petrol production.

Petrol production is based on catalytic reforming, isomerisation, and fluid catalytic cracking (FCC) units. In 1996, the average capacity utilisation was 53% for crude oil distillation, 49% for conversion processes(catalytic cracking, visbreaking) and 65% for the reformers. The equipment is on average 25 years old and the latest revamp was carried out in 1976. A revamp of the FCC units and the isomerisation unit is expected to be completed in 1998. This will considerably reduce the production of leaded petrol.

Table 21.3 *Refinery processes. 1996. Croatia[24] (bbl/day)*

Refinery process	Capacity 1996
Atmospheric distillation	294,275
Thermal operations	17,230
Catalytic Cracking	32,000
Catalytic Reforming	37,400
Alkylation/polymerisation	
Isomerisation/aromatics	24,507
Oxygenates (e.g. MTBE)	

Forthcoming investment plans include alkylation and MTBE units.

[24] World Bank 1997: Phasing out lead from petrol in Central and Eastern Europe, annex A., Ed. Magda Lovei.

21.4 **Vehicle Fleet**

The vehicle fleet declined by 35% from 1990 to 1995.

In 1995, there were 810,000 vehicles in Croatia, which corresponds to 0.169 vehicle per capita. 85% of those were passenger cars. There were 68,000 heavy-duty trucks and buses, all of them diesel vehicles.

The registration of new cars were 87,000 in 1995 corresponding to about 10% of the fleet. The average age was 10 years for passenger cars and 15 years for trucks.

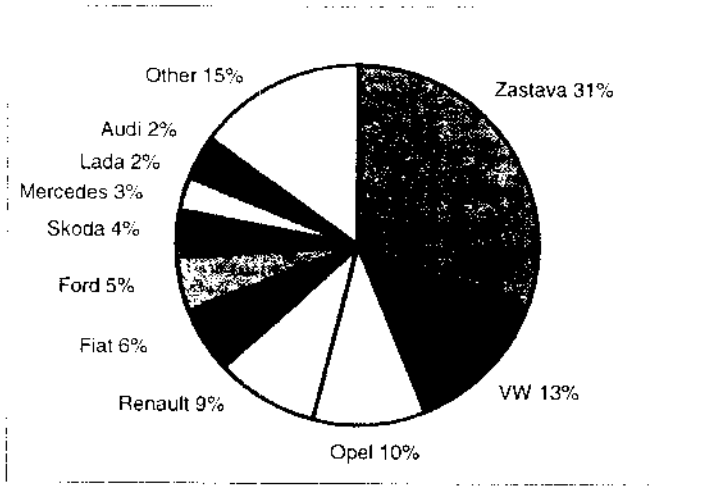
In 1995, 7% of the passenger cars were equipped with catalytic converters. Currently, there are no requirements for catalytic converters, but in 1997 import of passenger cars without catalytic converter will be banned.

Table 21.4 *The vehicle fleet. 1990-1995. Croatia*

Information	1990	1991	1992	1993	1994	1995
Number of vehicles('000)	1,238	1,171	1,102	743	826	810
Number of passenger cars ('000)	795	736	670	646	698	685
Number of vehicles/1,000 inhabitants	258	244	230	155	172	169
Petrol driven passenger cars as % of all passenger cars (%)						
Diesel driven heavy trucks as % of all heavy trucks (%)	100	100	100	100	100	100
Average age passenger car (years)						10
Average age heavy trucks (years)						15
Share with catalytic converters, all vehicles (%)						6
Share with catalytic converter, all passenger cars (%)	3	3	3	5	6	7

In 1995, at least 37% of the vehicle fleet originated from CEE countries.

Figure 21.3 The Ten Most Common Vehicles (%)



21.5 Distribution System

In 1995, there were 192 tank distribution lorries and 391 petrol stations. Since 1992, all of the petrol stations have offered unleaded petrol and have differentiation of pump nozzles for leaded and unleaded petrol. On average, there are 6 fuel pumps per station.

Only 4 stations have a vapour recovery installation for tank filling (Stage I) and 1 station for car filling (Stage II).

More than 70% of all gas stations are state owned.

21.6 Policies and Instruments

In 1996, the market share of unleaded petrol reached 30%. By the year 2005 the market share of unleaded petrol is expected to reach 85%.

Croatia allowed an average lead content of 0.4-0.5 g/l in all petrol marketed in Croatia until mid-1997, after which the maximum lead content in petrol was reduced to 0.15 g/l. However, domestic refineries are still allowed to add up to 0.5 g/l of lead. The limit applied for benzene is 5% v/v.

By the year 2004, Croatia expects to comply with the petrol quality standards in force in the EU.

To increase the consumption of unleaded petrol a tax differentiation scheme has been in force throughout the 1990s. The consumer price difference was 10% in 1991 in favour of unleaded petrol (RON95/leaded RON98), but the price difference in favour of RON95 declined to 4.1% in 1996.

Furthermore, from 1997 imports of passenger cars without catalytic converters will be banned. However, the primary problem

with respect to the car park is the requirement for using RON98 in old cars.

The major obstacle for phasing out lead of petrol and reach the goals set forth above is the availability of funds necessary for the reconstruction of the refineries. An ongoing revamp of the refineries is expected to be completed in 1998. However, international investment support from international financial institutions is deemed to be crucial for lead phase-out.

22 Cyprus

22.1 Environmental Pressure and Health Effect

No information about actual lead emissions and health effects has been provided. Cyprus applies a limit value for air lead concentrations of 150 µg/m^3.

22.2 Production and consumption of petrol

Total petrol consumption increased by 20% over the period 1990-1996.

Unleaded petrol was introduced in 1991 and attained a market share of 11% in 1996, which is expected to increase to 17% in 1997.

Figure 22.1 *Consumption of leaded and unleaded petrol, 1990-1996. Cyprus.*

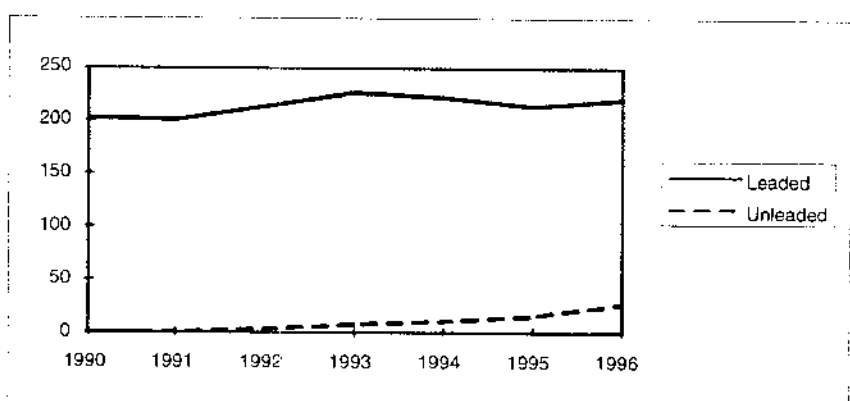


Table 22.1 shows that Cyprus has no domestic production of unleaded petrol. In addition to importing unleaded petrol, Cyprus imports about 45% of the leaded petrol consumed.

Production of petrol, which is almost entirely RON98, has declined by 25% over the period 1990-1996, but is expected to rebound in 1997 to its former levels, while the increasing trend in the import volumes experienced over the period 1990-1996 is expected to be reversed in 1997.

Table 22.1 *Supply balance for leaded and unleaded petrol. 1,000 m^3. 1996. Cyprus.*

1,000 m^3	Production	Import	Export	Consumption
Leaded petrol	126.2	101.1	0	227.3
Unleaded petrol	0	27.2	0	27.3

The maximum lead content allowed in leaded petrol is 0.4 g/l for the leaded RON98 and 0.15 g/l for the leaded RON92.

The unleaded petrol import is entirely of RON95 and contains a lubricating additive.

22.3 Refining Industry

Cyprus has one refinery owned by the government (65%), Mobil (20%) and Petrolina (15%), which was constructed in 1972 and the last revamp was carried out in 1996. The refinery has a capacity of 26,000 bbl/day and relies on reforming for up-grading. Future investments projects envisaged include installation of a light nafta isomerisation unit.

Table 22.2 *Refinery processes. 1996. Cyprus*[25] *(bbl/day)*

Refinery process	Capacity 1996
Atmospheric distillation	26,000
Thermal operations	
Catalytic Cracking	
Catalytic Reforming	5,100
Catalytic hydrocracking	
Alkylation	
Polymerisation	
Isomerisation	
Oxygenates (e.g. MTBE)	

22.4 Policies and Instruments

Unleaded petrol containing lubricating additives was introduced in 1991 and attained a market share of 11% in 1996. The maximum lead content in the dominating grade RON98 is 0.4 g/l and no benzene limit has been established for petrol marketed in Cyprus.

[25] Source: Oil and Gas Journal December 1996.

23 The Czech Republic

23.1 Environmental Pressure and Health Effect

In 1995, 227 tonnes of lead were emitted from vehicles corresponding to 79% of total lead emissions. The total lead emissions in the Czech Republic declined by 16% in the period from 1993 to 1995, while the vehicular lead emissions declined in 1994 but increased to its level of 1993 in 1995.

Table 23.1 *Vehicular Lead Emissions, 1993-1995. The Czech Republic*

Vehicular lead emissions	1993	1994	1995
Total lead emission (tonnes)	229	165	227
Share of total lead emissions (%)	67	55	79
Emissions/km^2 (kilo)	2.9	2.1	2.9
Emissions per 1000 inhabitants (kilo)	22.2	16.1	22.0

Ambient air lead concentrations are monitored in the major cities. In general, the concentration values are in the range of 0.014-0.05 µg/m^3. Particularly in Prague, but also in other major cities, the values declined from 1993 to 1995.

Comparing the developments in ambient air lead concentrations in selected cities with the developments in total lead emissions, the latter has declined less than the former. This may indicate important local developments. For instance, that important local sources of emission have ceased their activities.

Numerous studies investigating blood lead levels have been carried out in heavily polluted areas e.g. Prague, Pøibram and Silesia. Attention was paid mainly to children (0-14 years of age) recognised as the high-risk group. In general, blood lead levels in children did not exceed 10 µg/dl, except in "hot spot" areas e.g. close to a lead smelter. For adults, values within a range of 6-25 µg/dl were observed. Levels of 20-30 µg/dl were observed for lead smelter workers.

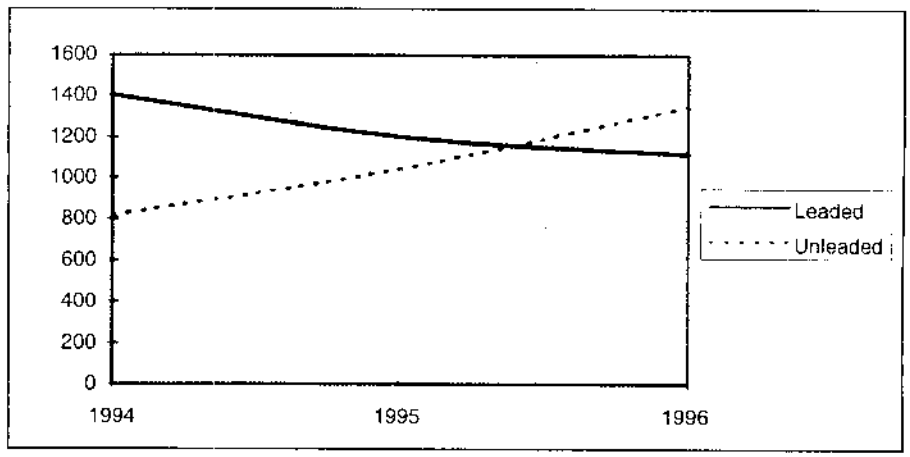
None of the studies observed adverse health effects that could be clearly attributed to vehicle lead emissions. However, it is well understood, that lead phase out will decrease the environmental exposure of the general population and improve health.

23.2 Production and Consumption of Petrol

From 1994 to 1996, the total petrol consumption increased by 11%. In this period consumption of leaded petrol decreased by

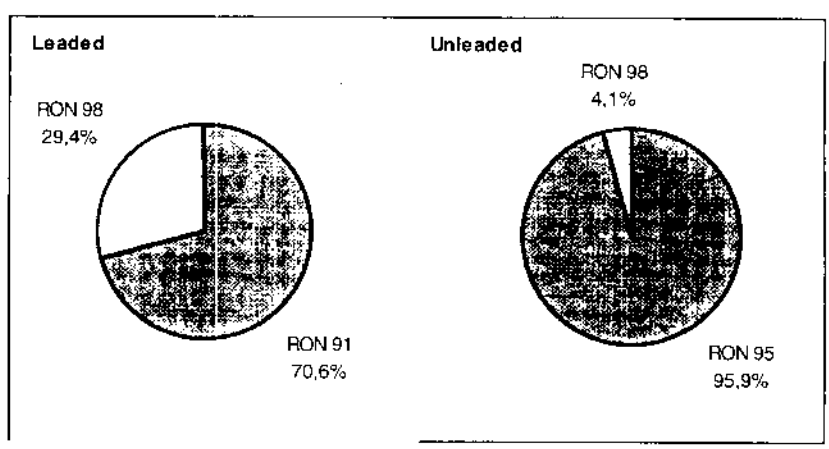
21%, while the consumption of unleaded petrol increased by 65%. In 1996, the market share of unleaded petrol was 55% compared to 37% in 1994.

Figure 23.1 *Consumption of Leaded and Unleaded Petrol, 1994-1996. The Czech Republic.*



As shown in Figure 23.2 the consumption of unleaded petrol is mainly RON95. However, unleaded RON98 was introduced in 1996. Leaded petrol consumption includes approximately 71% RON91.

Figure 23.2 *Distribution of Petrol Consumption by different RON Qualities. 1996. The Czech Republic (%)*



As indicated in Table 23.2, the Czech Republic is a net importer of both leaded and unleaded petrol. The imports of unleaded petrol accounts for 43% of the unleaded petrol consumption and the leaded petrol import for 21% of the leaded petrol consumed. While import of unleaded petrol has increased by 37% since 1994, the production of unleaded petrol increased by 90%.

Table 23.2 *Supply Balance for Leaded and Unleaded Petrol. 1996. The Czech Republic (1,000 m³)*

1,000 m³	Production	Import	Export	Consumption
Leaded petrol	878	237	< 2	1,115
Unleaded petrol	771	576	0	1,347

The Czech Republic had no petrol export of any significance in 1996 and do not expect to export petrol in the future.

However, there is a considerable cross border trade, which does not appear in the import and export figures.

The maximum lead content in leaded petrol is 0.15 g/l for leaded petrol and 0.013 g/l for unleaded petrol. These standards correspond to the EU limits. The actual lead content of the normal RON91 produced at Kralupy-refinery is 0.14 g/l and 0.13 g/l for RON96. For the unleaded RON95 the lead content is less than 0.013 g/l.

The quality of the petrol produced at Kralupy is summarised in the Table 23.3 below.

Table 23.3 *Quality of petrol produced at Kralupy refinery 1995*

	RON91 normal	RON96 Super	RON95 natural
Density (kg/m³)	725.4	745.3	746.3
MTBE (% vol)	8.5	8.3	14.5
Benzene (% vol)	1.1	1.5	1.6
Aromatics (%)	33.9	42.6	44.5
Pb (g/l)	0.14	0.13	<0.013
Olefins (% vol)	0.2	0.2	0.4

23.3 **Refining Industry**

There are four refineries in the Czech Republic.

Litvinov is a complex refinery with hydro-cracking. Kralupy is a simpler refinery, which intends to complete a new cracker plant during the next 2-3 years. Koramo and Paramo produce lubricants and special products. The state is a minor shareholder of the refinery industry. Under the current circumstances the refinery production figures are confidential.

Blending with MTBE is currently the most utilised lead replacement option. The addition percentage is 8.5-15 % vol. MTBE is produced at the Kralupy refinery. The production of MTBE and the domestic production of unleaded petrol is expected to increase in the future.

Table 23.4 *Refinery processes. 1996. The Czech Republic*[26] *(bbl/day)*

Refinery process	Capacity 1996
Atmospheric distillation	187,139
Thermal operations	
Catalytic Cracking	-
Catalytic Reforming	24,798
Catalytic hydrocracking	22,000
Alkylation/polymerisation	-
Isomerisation/aromatics	2,700
Oxygenates (e.g. MTBE)	2,063

A lubricating additive is used to substitute for lead. It is produced in Slovakia and is available in limited quantities in the Czech Republic.

Privatisation

The privatisation of the oil sector in the Czech Republic was initiated in 1992/93 with the sale of a number of the petrol stations owned by the state-monopoly distributor Benzina Praha. In the second stage of the privatisation initiated in 1994, the four refineries were transformed into joint stock companies. 40% of the shares were transferred to the Fund For National Property (FNM). The remaining 60% were available for voucher-privatisation, banks, private investors etc. Furthermore, Benzina Praha was split into two separate enterprises; One enterprise, Benzina Praha a.s., having primary responsibility for petrol station operations and the other, Ceske Produktovody a Ropovody Praha a.s. having primary responsibility for the operations of product pipelines and terminals.

The enterprise Petrotrans AG was formed in the beginning of 1993 with the aim of managing operations of the Czech part of the Druzba crude oil pipeline. Afterwards, the company merged with Chemopetrol-IKL Gmbh, the enterprise undertaking the construction of the pipeline Ingolstadt-Kralupy-Litvinov, under the name Mero CR AG. The latter operates the new pipeline. The construction of the new pipeline mainly financed by FNM has allowed the refinery industry to diversify its crude oil supplies and obtain crude oil of the desired quality at world market prices. The project is seen as the Government's major project to date with respect to economic transformation.

In September 1994, the Government approved the initiation of negotiations with the international oil companies Shell, Conoco and Agip concerning their participation in the refineries Litvinov and Kralupy. Furthermore, it was decided to reorganise the refinery and oil product complex to improve the financial and competitive situation of the sector. Consequently, a new holding com-

[26] World Bank 1997: Phasing out lead from petrol in Central and Eastern Europe, annex A., Ed. Magda Lovei.

pany, Unipetrol AG, for the main producers and distributors of oil products has been established. Furthermore, a new company, Ceska Refinarska AG, was created having the overall control of the refineries Litvinov (owned by Chemopetrol AG) and Kralupy (owned by Kaucuk AG).

An agreement was reached in November 1995 between the holding company Unipetrol AG, Chemopetrol AG, Kaucuk AG, and Ceska Refinarska AG on the one hand and the international oil companies on the other hand concerning the ownership structure of the joint refinery company, Ceska Refinarska AG. Through an increase in the share capital of USD 173 million, the foreign partners obtained 49% of the share capital in the Ceska Refinarska AG. Shell holds 16.3 %, Conoco 16.3% and Agip 16.3% of the shares. The remaining 51% is owned by Unipetrol AG.

The holding company controls Chemopetrol (100%), Kaucuk Group (100%), Benzina (90%) and finally Ceska Refinarska (51%).

The market for oil products in the Czech Republic has been liberalised and the competition from foreign producers is strong as evidenced by the substantial imports of petrol (and diesel) combined with the low capacity utilisation at the domestic refineries.

However, the new structure of the oil product industry and the forming of the refinery joint venture involving the two largest refineries in the Czech Republic and foreign partners is expected to improve the situation by bringing in foreign know-how and capital.

In a lead phase-out context, this may accelerate the modernisation of the refineries and thereby facilitate the phase-out of lead in petrol. A three-year modernisation plan was elaborated by the end of 1996, which also will address the lead issue.

23.4 **Vehicle Fleet**

The total number of vehicles in the Czech Republic was approximately 3.4 million in 1995 corresponding to 0.326 per inhabitant. The vehicle fleet increased by 30% over the period 1990-1995 due to an increasing number of passenger cars. However, the Czech Republic does not apply tax on vehicles according to weight and consequently there are no annually statistic for the vehicle fleet. The figures of the vehicle fleet could therefore be encumbered with some uncertainty.

93% of the vehicle fleet in 1995 was passenger cars, of which 94% were petrol driven according to local estimates.

Catalytic converter requirements on new cars have been in force since October 1993. The number of cars with catalytic converters increased from less than 1% in 1992 to 11.5 % of the total vehicle fleet in 1995.

The estimated turnover rate was 5.7% in 1995 compared to 4.8% in 1993. The average age of a passenger car was 13.9 years in 1995. The fairly low turnover rate of the vehicle fleet implies that it might take some time before the full effect from the catalytic converter requirement is obtained.

Approximately 800,000 cars are estimated by the authorities to require lubricating additives as a consequence of their soft valve seats. Nearly all of them use leaded petrol for the moment.

Table 23.5 *The Vehicle Fleet. 1990-1995, the Czech Republic*

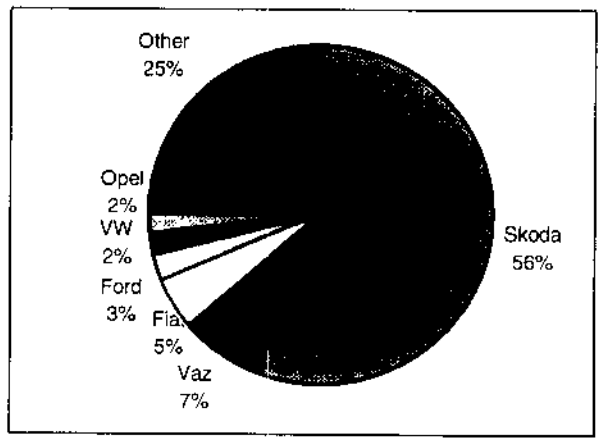
Information	1990	1991	1992	1993	1994	1995
Number of vehicles('000)	2,594	2,669	2,764	2,923	3,194	3,359
Number of passenger cars ('000)	2,367	2,436	2,522	2,697	2,967	3,113
Number of vehicles/1,000 inhabitants	252	259	268	284	310	326
Average age passenger car (years)					14.2	13.9
Average age heavy trucks (years)					13.0	10.6
Estimated turnover rate (%)						
- Passenger cars				4.8	4.5	5.7
- Trucks				3.8	5.1	5.7
Share with catalytic converters, all vehicles (%)	<1	<1	<1	5	7.5	11.5
Share with catalytic converter, all passenger cars (%)				5	8	12

Table 23.6 *The vehicle fleet according to fuel type. 1995 Czech Republic*

Information	Estimate 1995
Passenger cars	
% petrol driven (%)	94
% diesel driven (%)	6
Heavy duty vehicles & busses	
% petrol driven (%)	0
% diesel driven (%)	100
All vehicles	
% petrol driven (%)	88
% diesel driven (%)	12

CEE brands dominate the vehicle fleet with a market share of approximately 70%. Skoda is the single most popular car (56%) as shown in Figure 23.3.

Figure 23.3 *The most Common Vehicle. The Czech Republic*[27]*. (%)*



23.5 **Distribution System**

In 1995, there were 2,317 tank distribution lorries in the Czech Republic and 1,346 petrol stations. The number of petrol stations almost doubled in the period from 1990 to 1995. Most of newly established petrol stations do not lack behind West-European petrol stations in terms of service etc.

The average number of fuel pumps per station is 6 and the stations differentiates between pump nozzles for leaded and unleaded petrol.

95 % of the stations offer unleaded petrol. The figures for 1993 and 1994 were 25% and 75% respectively.

The ownership structure of the petrol stations is diverse. The major retailer is Benzina AG with 20% of the petrol stations, followed by foreign oil companies (Shell, Aral, Conoco etc.) having 16% of the petrol stations.

However, a major task will be the modernisation including satisfying environmental standards and requirements of the older segment of the petrol stations, which amounts to 33-38% of the total number of petrol stations of which the major part was not included in the privatisation scheme.

23.6 **Policies and Instruments**

In 1996, the market share of unleaded petrol was 55%. However, currently there are no indications of existing or forthcoming pol-

[27] The category "other" contains different brands which have a market share of less than two percent.

icy plans to support the continuation of the process of phasing out lead in petrol.

Limits for lead content (and benzene content) similar to the EU standards have been in force throughout the 1990s, which has assisted in limiting the environmental pressure from the consumption of leaded petrol.

Furthermore, emission standards requiring catalytic converters on new cars was introduced in 1993 and catalytic converters with homologation EU 93/59 has been required on new imported cars since January 1997. However, the turnover of the vehicle fleet appears to be modest and the effect from the catalytic converter requirement will consequently require some time to take effect.

All cars for business purposes pay road taxes. However, all cars with homologation EU 93/59 will be exempted from paying the road tax.

The Czech Republic does not otherwise apply tax differentiation schemes e.g. between leaded and unleaded petrol. Anyway, unleaded petrol has become marginally cheaper in relative terms over the period 1991-1995.

The ability of domestic refineries to increase the production of unleaded petrol may to some extent be a limiting factor for accelerating the phase-out of leaded petrol. The recent restructuring of the industry should ceteris paribus facilitate increased production of unleaded petrol.

A recent study indicates that the distribution system is not considered an obstacle for a rapid lead phase out of petrol in the Czech Republic.

24 Estonia

24.1 **Environmental Pressure and Health Effect**

In 1995, 40 tonnes of lead were emitted from vehicles, which corresponded to 77 % of total lead emissions. From 1990 to 1995, the lead emission from vehicles declined by 75%. However, there was a considerable increase in the lead emission from vehicles between 1993 to 1994 due to a substantial increase in the number of vehicles (in particular old Western cars) and an increase in the import of leaded petrol from Russia.

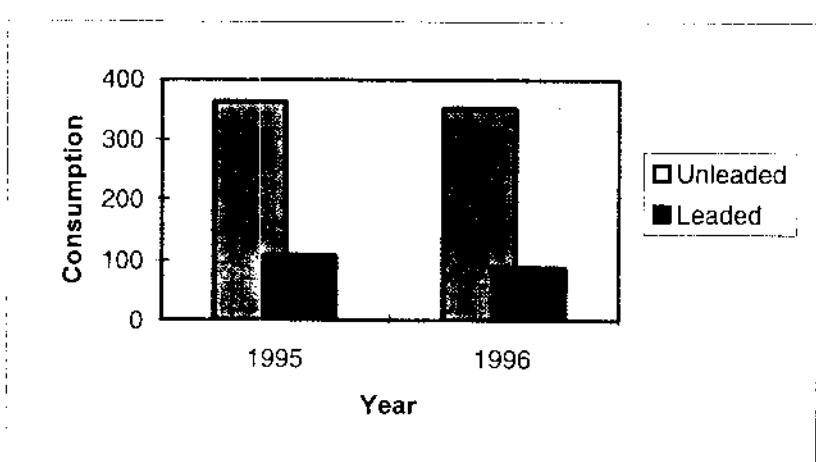
Table 24.1 *Vehicular Lead Emissions. 1990-1995. Estonia*

Vehicular lead emissions	1990	1991	1992	1993	1994	1995
Total lead emissions (tonnes)	160	130	60	70	120	40
Share of total emissions (%)	87	86	75	81	90	77
Emissions/km^2 (kg)	3.6	2.9	1.3	1.6	2.7	0.9
Emissions per 1,000 inhabitants (kg)	100	81	37	47	80	27

24.2 **Production and Consumption of Petrol**

From 1995 to 1996, the petrol consumption declined by approximately 2%. At the same time, the market share of unleaded petrol increased from 77% to 80%. However, in the cities the market share of unleaded petrol is more likely about 90%. The leaded petrol is primary consumed in the country side - the agricultural sector.

Figure 24.1 *Consumption of Leaded and Unleaded Petrol. 1995-1996. Estonia (1,000 m^3)*



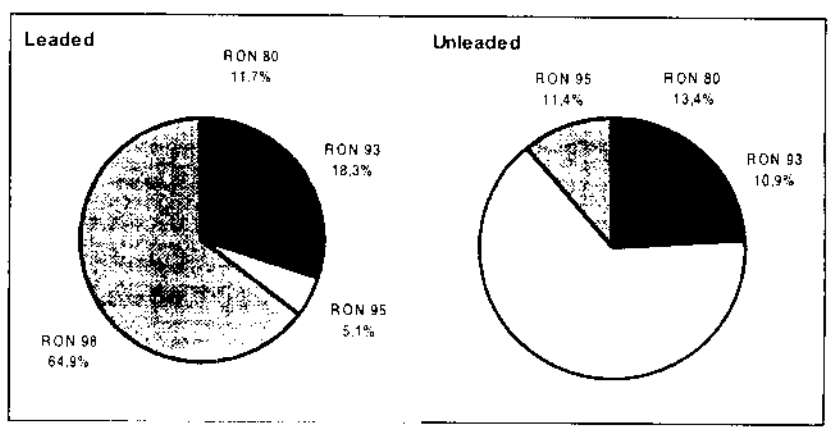
As it appears from Table 24.2 the supply of petrol is provided by import alone. The limit for lead content in leaded petrol is 0.15 g/l and 0.013 g/l for unleaded.

Table 24.2 *Supply Balance for Leaded and Unleaded Petrol. 1996. Estonia (1,000 m^3)*

1,000 m^3	Production	Import	Export	Consumption
Leaded petrol	-	88	-	88
Unleaded petrol	-	364	-	364

In 1996, the consumption of leaded petrol was mainly RON98, but still RON 80 was consumed. The consumption of unleaded petrol was mainly RON95, but also RON80 was consumed.

Figure 24.2 *Distribution of Petrol Consumption on Different RON Qualities. 1996. Estonia (. %.)*



24.3 **Refining Industry**

There is no refining industry in Estonia.

24.4 **Vehicle Fleet**

In 1996, there were 358,000 vehicles in Estonia, corresponding to 0.239 vehicles per capita. 81% of the total vehicle fleet were passenger cars.

Table 24.3 *The Vehicle Fleet. 1996, Estonia*

Information	1995
Number of vehicles('000)	358.1
Number of passenger cars ('000)	291.7
Number of vehicles/1,000 inhabitants	239

90% of the passenger cars and light duty vehicles are petrol driven, while almost half of the heavy duty vehicles use petrol.

Table 23.4 *The vehicle fleet according to fuel type. 1995 Estonia*

Information	Estimate 1995
Passenger cars	
% petrol driven (%)	90
% diesel driven (%)	10
Heavy duty vehicles & busses	
% petrol driven (%)	46
% diesel driven (%)	54
All vehicles	
% petrol driven (%)	87
% diesel driven (%)	13

24.5 **Distribution System**

In 1996, there were 570 petrol stations in Estonia, all privately owned. The gaspline stations had on average 5 fuel pumps, and all stations differentiated between pump nozzles for leaded and unleaded petrol.

24.6 **Policies and Instruments**

The market share of unleaded petrol was 80% in 1996, but approximately 90% in the cities. The leaded petrol is mainly used in the primary sector (agriculture), and it is assessed that it will be costly to dispose of this leaded petrol consumption.

Limits for lead content (and benzene) in petrol marketed in Estonia are in accordance with the EU standards.

The government expects a complete phase out of lead in petrol no later than in 2005 most likely earlier.

Tax differentiation has been used to promote the use of unleaded petrol. A requirement for catalytic converters on new cars will be introduced in 1998 to support the phase-out process.

25 Hungary

25.1 Environmental Pressure and Health Effect

In 1995, lead emissions from all sources were 151 tonnes corresponding to 14.6 kg per 1,000 inhabitants. Over the period 1990-1995, the total lead emissions declined by 76%. No information has been provided concerning the emissions from vehicles.

Ambient air lead concentrations have been measured in Budapest, Pécs, Mishole and Debrecen each year from 1993 to 1996. In all four areas, ambient air lead concentrations show a declining trend with ambient air lead concentrations reaching levels of 0.3 $\mu g/m^3$ or lower in 1996. The limit value for air lead concentration is 0.3 $\mu g/m^3$

The blood lead levels were measured over the period 1992-1996 in Budapest and nationally. At the national level, the mean blood lead level concentrations were 6.2 µg/dl in 1995. In Budapest, the mean blood lead level was 6.5 µg/dl in 1996 against 11.9 µg/dl in 1992.

The health benefits from reducing lead in petrol have been estimated on the basis of observations for lead content in petrol and blood lead levels as shown in Table 25.1.

Table 25.1 *Lead Content in Petrol and Blood Lead Levels*

Year	Pb in petrol (g/l)	Blood lead µg/dl
1985	0.7	22.1
1995	0.15	6.2

25.2 Production and Consumption of Petrol

The information forwarded by Hungary shows a total petrol production of 3.141 million m^3 in 1995 up from 3 million m^3 in 1991.

The market share of unleaded petrol (RON91, 95 and 98) was 49% in 1995 and increased to 64% in 1996[28]. The market share of the various petrol qualities in 1996 was:

- Unleaded grades:
  - RON91 19%
  - RON95 42%
  - RON98 2%
- Leaded grades:

[28] These figures do not include exports.

RON92	19%
RON98	27%

In 1997, the leaded RON92 grade was phased out.

Retail prices in 1996 were lower for leaded RON98 compared to the unleaded RON98.

The maximum lead content in petrol is 0.15 g/l for leaded petrol and 0.013 g/l for unleaded petrol. The average actual lead content is 0.12-0.13 g/l in leaded petrol and 0.005-0.095 g/l for unleaded petrol.

According to government plans, the production of leaded petrol will be phased out in the year 2000.

25.3 **Refining Industry**

There are two refineries in Hungary, Danuba and Tisza. The crude oil distillation capacities are 160,000 bbl/day and 51,000 bbl/day respectively.

The refineries were constructed in the 1960s, but the process units are revamped every 2-4 years. Forthcoming investment plans include delayed cooking, sulphur recovery, isomerisation and a hydrocracking unit.

The technical options to replace lead in petrol at the Danube refinery are to increase MTBE and alkylate production by using FCC catalyst and isomerisation.

One project is currently undertaken in the refining industry concerning the production of a non-lead lubricating additive. The project is expected to be completed in 1998 and the petrol containing the new lubricant will be marketed in 1999. Detergent additives are currently used as additives in petrol.

The Hungarian refinery industry is able to produce sufficient unleaded petrol to meet domestic demand. The conditions in the refining industry are therefore not seen as a constraint for lead phase-out.

Table 25.2 Refinery processes. 1996. Hungary[29] (bbl/day)

Refinery process	Capacity 1996
Atmospheric distillation	232,000
Thermal operations	14,000
Catalytic Cracking	24,000
Catalytic Reforming	29,600
Catalytic hydrocracking	
Alkylation/polymerisation	3,300
Isomerisation/aromatics	9,800
Oxygenates (e.g. MTBE)	1,860

25.4 **Vehicle Fleet**

In 1995, there were 2.53 million vehicles in Hungary, which corresponds to 0.25 per capita. From 1990 to 1995, the total vehicle fleet increased by 16% mainly due to an increasing number of passenger cars.

Passenger cars accounted for 96% of the total vehicle in 1995. 89% of the passenger cars used petrol. An increasing number of passenger cars are diesel driven. There were 91,200 heavy-duty trucks and buses of which 87% were diesel driven. In general, the share of diesel driven vehicles has been increasing from about 6% of the total vehicle fleet in 1990 to 14% in 1995.

From 1990 to1995, the average age of passenger cars increased from 9.1 to 11.2 years and for trucks the average age increased from 7.5 to 9.3 years. In 1995, the estimated turnover rate for passenger cars was 2.7%.

In 1996, Hungary introduced requirements for catalytic converters on new cars. The number of passenger cars equipped with catalytic converters increased from 134,000 in 1992 to 295,000 in 1995 corresponding to 12% of the vehicle fleet. Hungary has also introduced a scheme which provide a financial incentive for car owners to install catalytic converter.

[29] World Bank 1997: Phasing out lead from petrol in Central and Eastern Europe, annex A., Ed. Magda Lovei.

Table 25.3 *The Vehicle Fleet, 1990-95, Hungary*

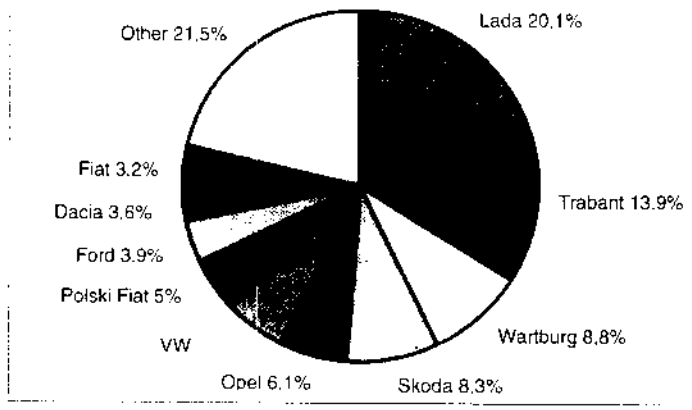
Information	1990	1991	1992	1993	1994	1995
Number of vehicles('000)	2,179	2,252	2,324	2,351	2,459	2,534
Number of passenger cars ('000)	2,096	2,153	2,230	2,258	2,369	2,443
Number of vehicles/1,000 inhabitants	210	217	226	228	239	246
Average age passenger car (years)	9.1	9.7	10.0	10.3	10.9	11.2
Average age heavy trucks (years)	7.5	7.8	8.3	8.9	9.2	9.3
Estimated turnover rate (%)				2.5	2.2	2.7
Share with catalytic converters, all vehicles (%)			5	7	9	12
Share with catalytic converter, all petrol driven passenger cars (%)			6	8	10	14

Table 25.4 *The vehicle fleet according to fuel type, 1990-1995 Hungary*

Information	1990	1991	1992	1993	1994	1995
Passenger cars						
% petrol driven (%)	97	95	93	92	90	89
% diesel driven (%)	3	5	7	8	10	11
Heavy duty vehicles & busses						
% petrol driven (%)	25	18	16	14	12	13
% diesel driven (%)	75	82	84	86	88	87
All vehicles						
% petrol driven (%)	94	92	89	89	87	86
% diesel driven (%)	6	8	11	11	13	14

In 1995, the share of the vehicle fleet made in CEE countries was almost 60%.

Figure 25.1 *The Ten Most Common Vehicles. 1995. Hungary (%)*



25.5 **Distribution System**

Hungary has provided information on the 6 major petrol distributors covering 60% of the market. On the basis of these figures, the number of petrol stations can be estimated at 850.

All the six major distributors offer unleaded petrol. The stations have an average of 4-5 fuel pumps per station and differentiate between pump nozzles for leaded and unleaded petrol.

In general more than 50% of the stations have vapour recovery installations stage I and II.

All petrol stations are privately owned.

A lubricating additive to protect against valve seat recession is available at the petrol stations.

25.6 **Policies and Instruments**

No national programme for phasing out lead in Hungary has been approved, but the government plans to phase out the production of leaded petrol by the year 2000. The market share of unleaded petrol was 64% in 1996. Major steps in the phase-out process have been the reduction of the lead content in petrol and the introduction of catalytic converters.

The maximum lead content in petrol was reduced in 1991 from 0.4 g/l to 0.15 g/l. The limit for the benzene content in petrol is 3% v/v, which is lower than the present EU standard.

Tax differentiation between unleaded and leaded petrol has also been applied. However, in 1996 the price difference in favour of unleaded petrol was modest and for the high grade RON98, the price per litre was higher for the unleaded grade.

Hungary introduced requirements for catalytic converters on new cars in 1996, which has supported the phase-out of lead in petrol.

To address the problem that the major constraint for a phase-out is the aged vehicle fleet, financial support has been granted for equipping cars with catalytic converters. A car equipped with a catalytic converter receives a tax allowance of 50% of the vehicle weight tax which is HUF 400-800 per 100 kg. weight.

In the year 2000, Hungary expects that only modern cars will be in use, of which those not equipped with catalytic converter, even at present are capable of using unleaded petrol. The systematic production and marketing of a petrol brand containing lubricating additives are envisaged in 1998/99.

Information campaigns and awareness building measures have been applied since 1992.

26 Latvia

26.1 Environmental Pressure and Health Effect

The ambient air lead concentrations (maximum monthly concentrations) have been measured for Riga, Daugavpils, Liepaja and Jurmala. The values range between 0.004 and 0.5 µg/m^3 over the period 1990-1996. The highest values have been measured in Riga. With a few exceptions, the ambient air lead concentrations have declined over the period.

Blood lead level concentrations were measured in 1990 for 49 children in Liepaja and Riga and Aluksne. The mean BLL in all the children was 53 µg/l (+/-20.3 µg/l). The observed values ranged between 20-103 µg/l. Girls generally had lower BLL than boys included in the study. The highest mean BLL was found in boys in Riga and amounted to 72 µg/l.

The above mentioned study did not indicate any general environmental lead pollution in Latvia of a magnitude, which can be assumed to have a significant impact on the health of children. Furthermore, the observed blood lead levels were lower than observations from studies in a number of West-European countries during the 1980s.

26.2 Production and Consumption of Petrol

Latvia imports all petrol, but has no specific statistics on imports divided between leaded and unleaded petrol. However, it is estimated, that the market share of unleaded petrol was 60-65% in 1996.

In 1995, the import of petrol was 608,000 m^3.

The petrol sold in Latvia includes the petrol grades; MON76, RON92, RON93, RON95 and RON98.

The maximum lead content in leaded petrol is 0.15 g/l and the average lead content in petrol range between 0.01 g/l and 0.11 g/l. The companies which import the petrol are responsible for ensuring the quality standard of the petrol.

26.3 Refining Industry

There is no refining industry in Latvia.

26.4 The Vehicle Fleet

In 1996, there were 470,000 vehicles in Latvia, corresponding to 0.188 per capita. 83% of the total vehicle fleet consisted of passenger cars of which 97% were petrol driven. A rather high share, 68%, of the heavy duty vehicles were petrol driven in 1996.

The average vehicle age is above 10 years for both passenger cars and heavy vehicles.

In 1995, Latvia introduced emissions standards requiring catalytic converters on new cars, but there are no statistics yet on the number of passenger cars equipped with catalytic converters.

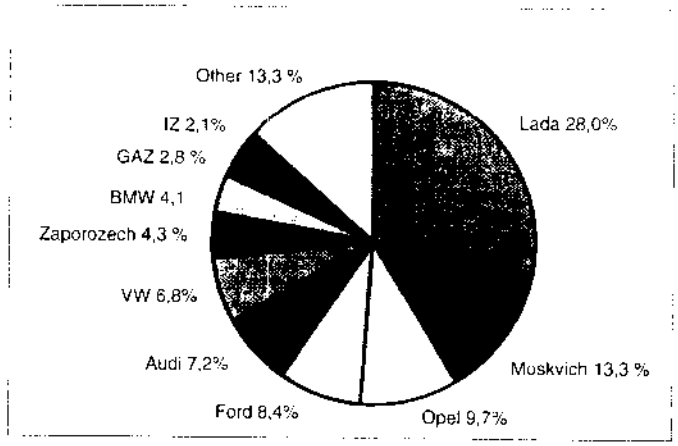
Table 26.1 *The Vehicle Fleet. 1990-1996. Latvia (1,000 vehicles)*

Information	1990	1991	1992	1993	1994	1995	1996
Number of vehicles('000)	361.7	411.8	433.3	439.6	425.2	432.5	470.0
Number of passenger cars ('000)	294.4	341.2	362.7	379.1	365.8	363.9	391
Number of vehicles/1,000 inhabitants	134	153	160	163	170	175	188
Average age passenger car (years)							>10
Average age heavy trucks (years)							>10

Table 26.2 *The vehicle fleet according to fuel type. 1995-1996 Latvia*

Information	1994	1995
Passenger cars		
% petrol driven (%)	98	97
% diesel driven (%)	2	3
Heavy duty vehicles & busses		
% petrol driven (%)		68
% diesel driven (%)		32
All vehicles		
% petrol driven (%)		92
% diesel driven (%)		8

Figure 26.1 *The Ten most Common Vehicles. 1996. Latvia (%)*



26.5 **The Distribution System**

In 1996, there were 659 petrol stations in Latvia. 96% of the stations were privately owned. 98% offer unleaded petrol and approximately 20 petrol stations have vapour recovery installations.

26.6 **Policies and Instruments**

The market share of unleaded petrol was an estimated 60-65% in 1996. Latvia intends to phase out lead in petrol by the year 2000 and has prepared an action plan for this purpose.

The major obstacle is that the tax system (from a distributional point of view) gives preferential treatment to old used cars, the weak institutional capacity to undertake such a task and lack of relevant legislation.

Latvia has introduced maximum limits for lead content in accordance with EU standards (however, there are no standards for the benzene content), a maximum value for air lead concentrations of 0.3 $\mu g/m^3$, requirements for catalytic converters (1995), and used information campaigns (1996).

In 1997, Latvia introduced tax differentiation between leaded and unleaded petrol.

The tax differentiation scheme is shown in Table 26.3 and as indicated, the difference in excise tax between leaded and unleaded petrol will gradually increase over the period 1997-2000.

Table 26.3 *Tax Differentiation Scheme between Leaded and Unleaded Petrol (Tax/litre).*

Year	Unleaded (LVL/litre)	Leaded (LVL/litre)
1.01.97	0.12	0.13
1.01.98	0.14	0.16
1.01.99	0.16	0.19
1.01.2000	0.18	0.21

27 Lithuania

27.1 Environmental Pressure and Health Effect

In 1995, 10.1 tonnes of lead were emitted from vehicles down from 24.5 tonnes in 1994. The vehicular lead emissions accounted for 59% of total lead emissions in 1995.

The average concentration of lead in urban air in 1995 ranged between 0.099 μg/m^3 in Vilnius and 0.113 μg/m^3 in Panevezys. Since 1992, the concentrations in the major cities have been increasing except for Klaipeda, where ambient air lead concentration decreased from 0.092 μg/m^3 in 1991 to 0.015 μg/m^3 in 1995.

Ambient air lead concentrations were also measured near a highway with the following results:

Intensity of traffic (cars per hour)	Distance from highway (metres)	Concentration of lead (μg/m^3)
450	3	3-9
450	30-40	0.8-1
600	5	2-3
80	3	0.3-1

Blood lead levels were measured in the city of Siauliai and showed mean blood lead levels of 6.3 μg/dl (maximum observed 14.2 μg/dl) for children and 1.6 μg/dl (maximum observed 3.1 μg/dl) for pregnant women.

Table 27.1 *Vehicular Lead Emissions, 1990-95, Lithuania*

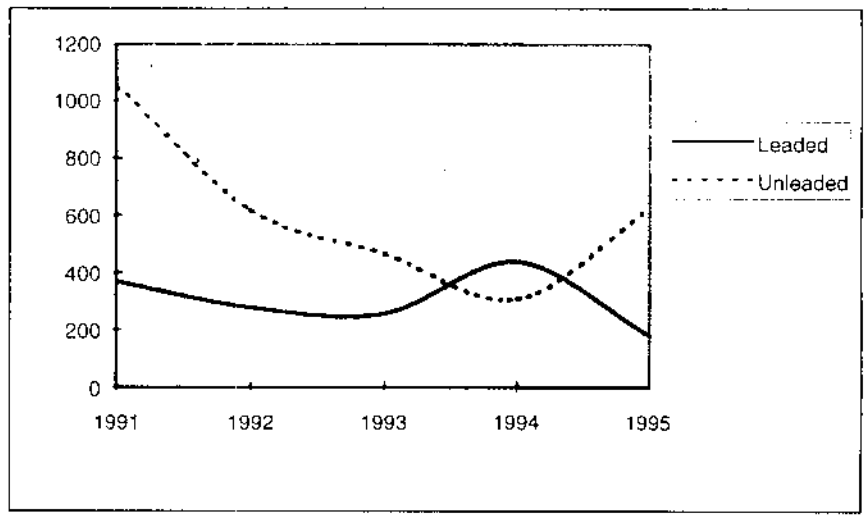
Vehicular lead emissions	1990	1991	1992	1993	1994	1995
Total lead emissions (tonnes)	17.6	20.7	15.6	14.4	24.5	10.1
Share of total emissions (%)	38%	42%	48%	51%	74%	59%
Emissions/km^2 (kg)	4.8	5.6	4.2	3.9	6.6	2.7
Emissions per 1,000 inhabitants (kg)	4.7	5.5	4.2	3.9	6.6	2.7

27.2 Production and Consumption of Petrol

The market share of unleaded petrol was 78% in 1995 and 98% in the first half of 1996.

The market share was declining until 1994 most likely as the result of declining demand for the MON76 grade.

Figure 27.1 *Consumption of Leaded and Unleaded Petrol, 1990-95, Lithuania (1,000 m³).*



Until the end of the 1980s, leaded RON93 petrol with a lead content of 0.35 g/l and unleaded MON76 were consumed in Lithuania. MON76 accounted for more than 70% of consumption. In 1989, the production of a new petrol grade of RON92 with a lead content less than 0.15 g/l was started.

From July 1995 only unleaded petrol grades have been produced in Lithuania. In 1996, production of unleaded petrol RON98 started. Hence, the unleaded grades MON76, RON92, RON95 and RON98 are currently produced in Lithuania.

Table 27.2 *Supply Balance for Leaded and Unleaded Petrol, 1995, Lithuania (1,000 m³)*[40]

1,000 m^3	Production	Import	Export	Consumption
Leaded petrol	345	..	..	180
Unleaded petrol	799	..	..	624

As indicated in Table 26.2 Lithuania had net-exports of petrol in 1995.

The net-export of leaded petrol declined significantly from about 0.5 million m^3 in 1994 to about 167,000 m^3 in 1995, while the export of unleaded petrol has been in the range 418,000-742,000 m^3 per year since 1993.

In 1995, about 50% of the petrol was imported by the West-European oil companies Statoil, Neste and Shell. Since the beginning of 1996, this petrol import has been 100% unleaded. Imported high octane petrol contains a potassium based additive instead of lead.

[40] There are minor differences (+/- 10%) between different sources.

Maximum lead content in unleaded petrol is 0.013 g/l and 0.15 g/l for leaded petrol in accordance with the EU limits. The average actual lead content in leaded petrol has declined gradually from 0.14 g/l in 1990 to 0.08 g/l in 1995.

27.3 **Refining Industry**

Lithuania has one refinery JSC "Mazaikia Nafta". Crude oil is supplied by pipeline and to a lesser extent by railway. Feedstock, a mixture from Siberia and Volga-Ural oil fields, is supplied by the "Druzhba" pipeline.

The first stage of the refinery was constructed in 1980, the second one in 1984. It was basically a hydroskiming refinery with catalytic reforming, diesel, kerosene, LPG unit and sulphur recovery.

In 1982, a bitumen unit was added. To achieve higher depth of refining and meet the shift in demand from heavy to light products i.e. petrol and diesel, it was decided in the mid-1980s to add conversion capacity. The complex KT-1 produces LPG, petrol, diesel and fuel oil components from atmospheric residue. The complex was completed in 1989 and included the construction of vacuum distillation and visbreaking with vacuum gas oil LPG and MTBE units together with a hydrogen unit and a new sulphur recovery plant.

A three-staged ten year upgrading programme for the refinery has been prepared.

In the nearest future it is planned to install an alkylation and a light naphta isomerisation unit, which will produce petrol components with high octane number.

The capacity utilisation of the facilities was 30-50% in 1995.

Table 27.3 *Refinery Processes. 1996. Lithuania*[31] *(bbl/day)*

Refinery process	Capacity 1996
Atmospheric distillation	263,420
Thermal operations	29,525
Catalytic Cracking	43,692
Catalytic Reforming	25,741
Catalytic hydrocracking	
Alkylation	
Isomerisation	
Oxygenates (e.g. MTBE)	1,061

[31] World Bank 1997: Phasing out lead from petrol in Central and Eastern Europe, annex A., Ed. Magda Lovei.

27.4 **Vehicle Fleet**

The total number of vehicles was 860,000 in 1995, an increase of 37% compared to 1990 mainly due to an increasing number of passenger cars. Petrol driven passenger cars still accounted for 95% of the passenger cars in 1995 though the share has been declining in recent years.

By the beginning of the decade, the major part of the heavy trucks and busses were petrol driven. However, the number of petrol driven trucks and busses using petrol has declined, while the number using diesel has increased. As a result the major part of these vehicles used diesel in 1995.

The average vehicle age has been increasing over the period. The average age of a passenger car was 8.8 years in 1990, but increased to 12 years in 1995.

The estimated turnover rate was a modest 3.1% for passenger cars in 1995 and even lower for trucks and busses.

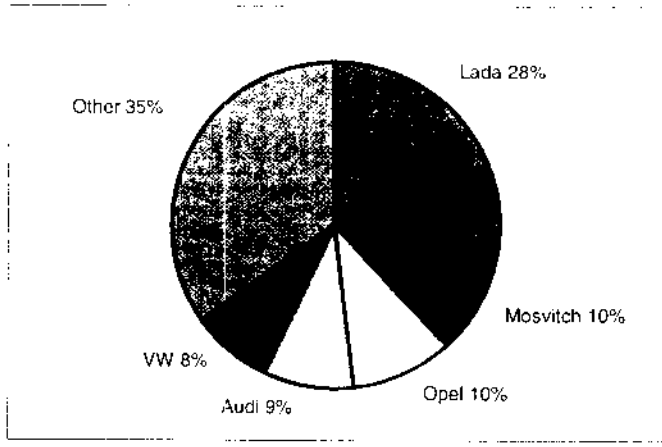
Table 27.4 *The Vehicle Fleet. 1990-1995, Lithuania*

Information	1990	1991	1992	1993	1994	1995
Number of vehicles('000)	629	667	699	734	794	860
Number of passenger cars ('000)	511	548	581	617	676	728
Number of vehicles/1,000 inhabitants	169	179	187	197	213	231
Average age passenger car (years)	8.8	9.9	10	10	10	12
Average age heavy trucks (years)	8	9	9	10	10	10
Estimated turnover rate passenger cars(%)						3.1
Estimated turnover rate trucks(%)						1.6

Table 27.5 *The vehicle fleet according to fuel type. 1990-1995 Lithuania*

Information	1990	1991	1992	1993	1994	1995
Passenger cars						
% petrol driven (%)	99	99	99	98	96	95
% diesel driven (%)	1	1	1	2	4	5
Heavy duty vehicles & busses						
% petrol driven (%)	58	57	56	50	54	40
% diesel driven (%)	42	43	44	50	46	60
All vehicles						
% petrol driven (%)	91	91	92	90	90	87
% diesel driven (%)	9	9	8	10	10	13

Figure 27.2 *The Most Common Vehicles, 1995, Lithuania*



27.5 Distribution System

The total number of petrol stations in 1995 was 620 and increased to 650 stations in 1996. The average number of fuel pumps per station was 6 in 1995.

All stations offer unleaded petrol and differentiate between pump nozzles for leaded and unleaded petrol.

The number of stations with vapour recovery installations numbered 40 or less than 10% of the stations in 1996.

All petrol stations are privately owned.

27.6 Policies and Instruments

In 1996, the market share of unleaded petrol is expected to reach 98% and Lithuania plans to ban the consumption of leaded petrol in 1997.

This has been achieved without using any of the more traditional policy measures to support the phase-out of lead in petrol e.g. Lithuania does not apply emission standards requiring catalytic converters on new cars, nor is tax differentiation between leaded and unleaded petrol used.

The maximum lead content in leaded petrol was reduced by the end of the 1980s and the requirements with respect to the lead content in leaded and unleaded petrol have been in accordance with EU standards since. Lithuania apply a benzene limit of 5% v/v.

28 Poland

28.1 **Environmental Pressure and Health Effect**

In 1995, 400 tonnes of lead were emitted from vehicles, which corresponded to 39% of total lead emissions. The total lead emissions from all sources declined by 26 % between 1991 and 1995, while the lead emissions from the vehicle fleet decreased by 40%.

Table 28.1 *Vehicular Lead Emissions. 1991-1995. Poland*

Vehicular lead emissions	1991	1992	1993	1994	1995
Total lead emissions (tonnes)	670	480	290	280	400
Share of total emissions (%)	48	46	28	27	39
Emissions/km^2 (kg)	2.1	1.5	0.9	0.9	1.3
Emissions per 1,000 inhabitants (kg)	17.5	12.5	7.5	7.3	10.4

In general, ambient air lead concentrations appear to have remained stable or declined since 1990. The average daily concentrations measured at four sites (Katowice, Chorzon, Pszczyna and Kode) in 1991 were in the range 0.8-1.162 µg/m^3. In 1996, the concentrations were 0.552-0.885 µg/m^3.

Extensive research on blood lead levels in Poland was undertaken over the period 1992-1994 comparing the BLLs in children and adults in two distinct samples. Group I represented people living in five Polish towns with no large industrial lead emitters and Group II people living in the vicinity of zinc and copper mills.

The table below summarises the results of the surveys. All figures are in µg/dl.

Table 28.2 *Studies on Blood Lead Levels in Poland (µg/dl)*

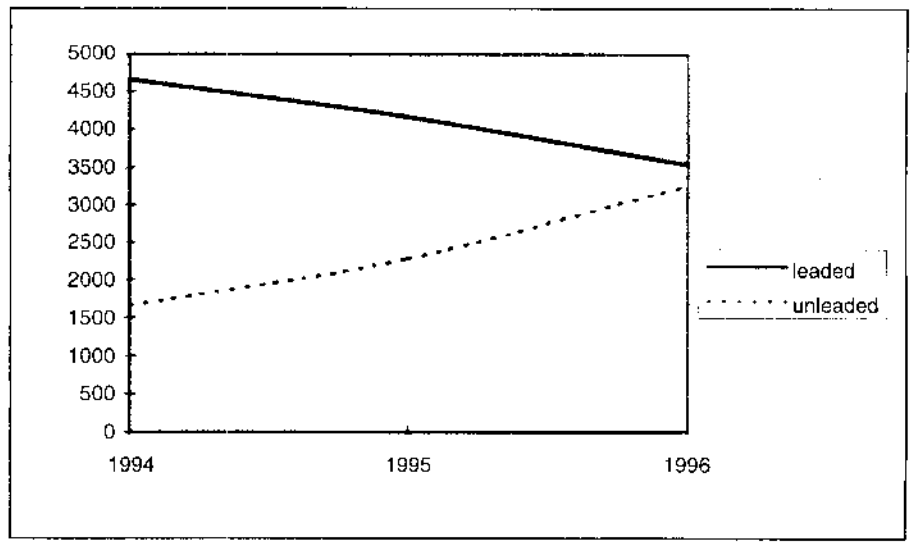
Group	Males	Females	Children
I	4.25-7.68	2.38-4.83	2.39-6.25
II	9.85-14.90	4.94-10.50	7.37-11.40

28.2 **Production and Consumption of Petrol**

The market share of unleaded petrol was 48% in 1996 compared to 26% in 1994. Total petrol consumption increased by 8% over the period 1994-1996. The consumption of unleaded petrol almost

doubled, while the consumption of leaded petrol decreased by 24%.

Figure 28.1 *Consumption of Leaded and Unleaded Petrol. 1994-96. Poland (1,000 m³)*



Consumption of unleaded petrol was almost entirely RON95, while the consumption of leaded petrol mainly was RON94.

The total petrol production increased from 2.8 million m^3 in 1991 to 5.6 million m^3 in 1996 corresponding to an increase of 99%. The production of leaded petrol increased by 27% from 1991 to 1996, but the production peaked in 1993 and has been falling since. The production of unleaded petrol increased from close to nil in 1991 to 2.052 million m^3 in 1996 and accounted for 37% of the total petrol production in 1996.

Figure 28.2 *Distribution of Petrol consumption on Different RON Qualities. 1996. Poland (%)*

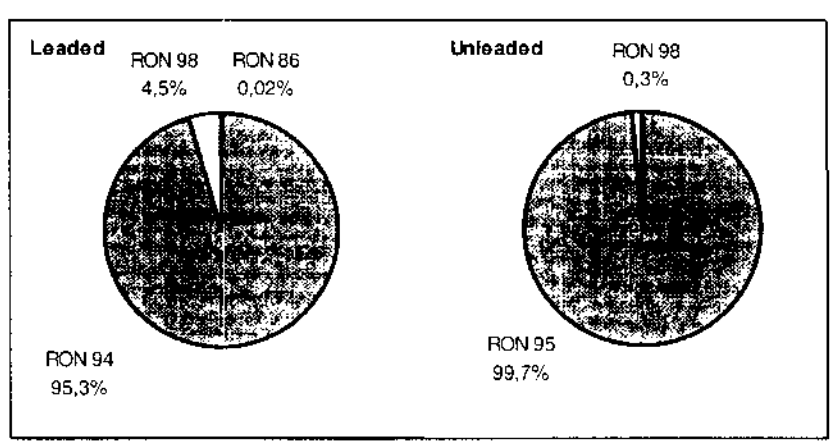


Table 28.3 *Supply Balance for Leaded and Unleaded Petrol. 1996. Poland (1,000 m³)*

	Production	Import	Export	Consumption
Leaded petrol	3,537	3	..	3,540
Unleaded petrol	2,052	1,208	..	3,260

The maximum lead content in all leaded petrol is 0.15 g/l and for unleaded petrol it is 0.013 g/l. The actual average lead content in leaded petrol increased from 0.075 g/l in 1993 to 0.13 g/l in 1996.

The maximum lead content in petrol was reduced from 0.3 g/l to 0.15 g/l in 1992.

28.3 **Refining Industry**

Poland has 7 refineries. One refinery, the Petrochemia complex, accounts for 74% of the total primary distillation capacity of 352,000 bbl/day. The other major refinery is Gdansk with a capacity of 60,000 bbl/day. The remaining five refineries are very small and use simple technologies. The Petrochemia refinery is a conversion refinery, while the Gdansk refinery is a hydro-skimming refinery (catalytic reforming).

In general, the plants had a high capacity utilisation of their primary distillation capacity ranging from 67 % to 98 % in 1996.

All refineries are state owned and were constructed in the 1950s and 1960s. Recently, some of the plants were revamped, which improved the upgrading capacity (reforming). Poland furthermore considers installing hydro cracking and isomerisation units.
To enhance the octane level reformer severity has been increased to produce reformate with a higher octane number. Furthermore, MTBE is added to increase the octane number of unleaded petrol.

Table 28.4 *Refinery Processes. 1996. Poland[32] (bbl/day)*

Refinery process	Capacity 1996
Atmospheric distillation	352,000
Thermal operations	
Catalytic Cracking	46,000
Catalytic Reforming	39,000
Catalytic hydrocracking	
Alkylation/polymerisation	3,000
Isomerisation/aromatics	4,270
Oxygenates (e.g. MTBE)	1,600

[32] World Bank 1997: Phasing out lead from petrol in Central and Eastern Europe, annex A., Ed. Magda Lovei.

There is no octane surplus in Poland and the poor octane pool of Polish refineries is seen by the Polish authorities as a major constraint to accelerate the phase-out of lead in petrol.

A potassium based lubricating additive is added to a small part of the unleaded RON95 petrol consumed.

28.4 **Vehicle Fleet**

In 1996, there were 9.4 million vehicles in Poland corresponding to 0.24 per inhabitant. Since 1990, the vehicle fleet has increased by 45% due to an increasing number of passenger cars.

The number of petrol driven passenger cars increased by 43%, while the number of diesel driven passenger cars more than doubled and accounted for 8% of all passenger cars and light duty vehicles in 1996.

The number of trucks and buses increased more modestly over the period 1990-1996. The composition of this part of the fleet changed towards less heavy vehicles using petrol. About 18% of the heavy vehicles used petrol in 1990 declining to 10% in 1996.

The turnover rate was 4% in 1995 and the average age of the vehicle fleet was 10-12 years. The relatively old vehicle fleet is considered a major constraint to the phase-out of lead in petrol.

Poland introduced emissions standards requiring catalytic converters on new cars in 1995 and 7% of the petrol driven cars had catalytic converters in 1996.

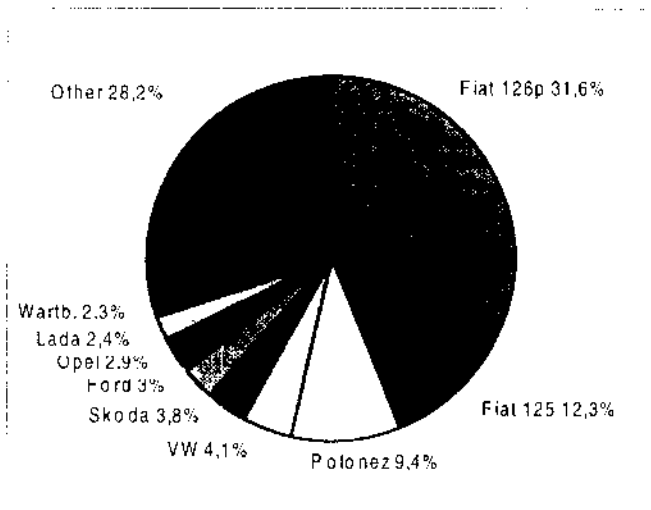
Table 28.5 *The Vehicle Fleet. 1990-96. Poland*

Information	1990	1991	1992	1993	1994	1995	1996
Number of vehicles('000)	6,482	7,441	7,891	8,179	8,634	9,044	9,400
Number of passenger cars ('000)	5,941	6,872	7,311	7,610	8,043	8,452	8,800
Number of vehicles/1,000 inhabitants	170	194	205	212	224	234	244
Average age passenger car (years)			10	10-11	10-11	10-11	10-11
Average age heavy trucks (years)			12	11-12	11-12	11-12	11-12
Estimated turnover rate passenger cars(%)						4	
Share with catalytic converter, all vehicles %					1	2	6
Share with catalytic converter, all petrol driven vehicles (%)					1	3	7

Table 28.6 *The vehicle fleet according to fuel type. 1990-1996 Poland*

Information	1990	1991	1992	1993	1994	1995	1996
Passenger cars							
% petrol driven (%)	95	94	94	94	93	92	92
% diesel driven (%)	5	6	6	6	7	8	8
Heavy duty vehicles & busses							
% petrol driven (%)	18	18	14	14	12	11	10
% diesel driven (%)	82	82	86	86	88	89	90
All vehicles							
% petrol driven (%)	89	88	88	88	87	87	87
% diesel driven (%)	11	12	12	12	13	13	13

Figure 28.3 *The Ten Most Common Vehicles. Poland (%)*



28.5 **Distribution System**

In 1996, Poland had 5,150 petrol stations compared to 3,900 in 1994. 97% of the stations offer unleaded petrol. On average, there are 5.7 fuel pumps per station with differentiation of pump nozzles between leaded and unleaded petrol.

The petrol stations were 100% state-owned in 1990, but in 1996 the major share, 72%, of the petrol stations were private enterprises.

30% of the state owned petrol stations had vapour recovery installation for tank filling and 11% for car filling.

28.6 **Policies and Instruments**

Poland aims to remove leaded petrol gradually before year 2000. The market share of unleaded petrol increased from 26% in 1994 to 48% in 1996 and the consumption of leaded petrol declined by 24% over the period implying reduced environmental pressure from lead in petrol. However, the leaded RON94 petrol continue to dominate consumption and production of petrol and the average actual lead content in leaded petrol has increased in recent years.

The phase-out of lead in petrol was initiated in 1992 with a reduction in the maximum lead content in leaded petrol from 0.3 g/l to 0.15 g/l and the introduction of unleaded petrol. The current limit for the content of benzene in petrol is 5% v/v.

This initiative was supported by information campaigns in 1992 focusing on the types of vehicles, which could use unleaded petrol followed up by an information campaign in 1993 on the possibility of using mixed fuel (leaded and unleaded) in cars with soft valve seat.

However, the reaction in the petrol market seem to have been relatively modest. The production of leaded RON94 petrol almost doubled from 1991 to 1993. The unleaded petrol production also increased, but less in absolute terms.

The lead phase-out seem to have gained momentum especially from 1995/1996 as Poland introduced emissions standards requiring catalytic converters on new cars in 1995, introduced tax differentiation between unleaded and leaded petrol in 1995 and as a new petrol type containing lubricating additives was marketed in 1996 supported by information campaigns.

The retail price difference in favour of unleaded RON95 compared to leaded RON94 was 4% in 1995 and 2.5% in 1996.

The Polish refineries have not been able to follow the surge in the demand for unleaded petrol. The production of unleaded petrol remained almost constant from 1995 to 1996, while the imports of unleaded petrol increased substantially from 1995 to 1996.

The major constraints for accelerating the phase-out of lead in petrol is considered to be the poor octane pool of the Polish refineries and the relatively old vehicle fleet.

29 Romania

29.1 Environmental Pressure and Health Effect

The ambient air lead concentrations in Copsa Mica, Bucuresti, Baia Mare, Medias and Zlatna varied significantly over the period 1990-1995, but have in general declined. The ambient air lead concentrations were 45-60.58 µg/m^3 in 1990 and 7.63-14.70 µg/m^3 in 1995. Except for two areas: Baia Mare and Medias, the ambient air lead concentrations have declined over the period. In Baia Mare the lead concentration increased from 5.45 µg/m^3 in 1990 to 13.34 µg/m^3 in 1995.

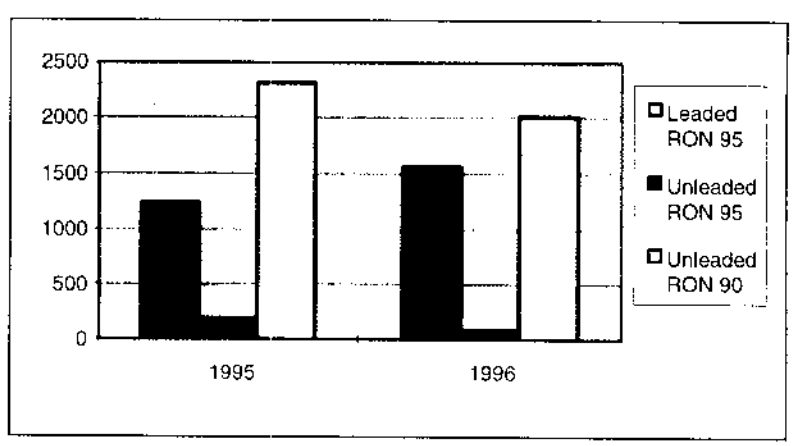
Blood lead levels have been measured for children in six areas of Bucharest. The measurements indicate blood lead concentrations of 17.10-21.93 µg/dl. In the centre of Bucharest the blood lead concentration in children was 20.2 µg/dl.

The negative health effects from lead in petrol have been identified as IQ loss, lower concentration and neurological effects.

29.2 Production and Consumption of Petrol

From 1995 to 1996, the market share of unleaded petrol decreased from 13% to 5%. The domestic consumption of leaded and unleaded petrol is RON95. Romania has a substantial production of unleaded RON90 petrol, which is exported.[33].

Figure 29.1 *Production of Leaded and Unleaded Petrol. 1995-1996. Romania (1000 m^3 per year)*



The supply balance for leaded and unleaded petrol is given in Table 29.1:

[33] The data sheet indicates a substantial export of unleaded RON90, but no production. It has been assumed that these amounts are produced in Romania.

Table 29.1 *Supply Balance for Leaded and Unleaded Petrol, 1996, Romania (1,000 m³)*

1000 m³	Production	Import	Export	Consumption
Leaded petrol:				
RON 95	1,557	0	0	1,557
Unleaded petrol:				
RON 90	2,008	0	2,008	0
RON 95	85	0	0	85

The maximum lead content allowed in leaded petrol was 0.4 g/l from 1990 to 1995. The maximum lead content in leaded petrol was reduced to 0.32 g/l in 1996.

The maximum lead content in unleaded petrol is 0.013 g/l and was introduced in 1993.

29.3 **Refining Industry**

In 1996 there were 10 refineries in Romania, of which five were small and specialised in non-petrol products.

The designed crude distillation capacity of 34 million tons per year (700,000 bbl/day) was restructured to 22 million tons per year (440,000 bbl/day) processing capacity of which 17.5 million tons (350,000 bbl/day) of crude oil are processed on streams, that produce petrol.[34] All five refineries are conversion refineries relatively well-equipped with conversion and upgrading facilities to produce light products. The refineries are relatively small compared to Western European standards. Only two of the refineries have a crude oil distillation capacity above 100,000 bbl/day.

The conversion capacity of the Romanian refineries are inconsistent with domestic demand as the refineries are capable of producing more light products than demanded by the Romanian consumers. Hence, the export of unleaded petrol. The inconsistency is also evidenced by the import of heavy products (fuel oil), cf. Abt (1995).

This characteristic of the refineries may facilitate the phase-out of leaded petrol on the supply side.

Presently, the technical options for lead replacement are utilisation of reformer severity, FCC petrol, isomerate petrol and blending oxygenates (MTBE) into the petrol pool.

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[34] The contraction in crude distillation capacity in the beginning of the 1990's followed the breakdown of bilateral trade deals and domestic economic activity, which reduced demand for refined products to 11.5 million ton per year in 1992. The refinery industry as a consequence reduced its capacity, cf. Abt (1995) "Phasing out lead from petrol feasibility and cost, A study of the refining sector in Romania".

Table 29.2 Refinery Processes, 1996, Romania[35] (bbl/day)

Refinery process	Capacity 1996
Atmospheric distillation	655,434
Thermal operations	131,072
Catalytic Cracking	109,792
Catalytic Reforming	97,082
Catalytic hydrocrackir.g	1,534
Alkylation/polymerisation	2,300
Isomerisation/aromatics	20,003
Oxygenates (e.g. MTBE)	1,310

Actually, the RON of the petrol produced is 90.

In the near future by revamping of some installations, the RON number is intended to increase by:

- reformer severity with 6 units;
- FCC with 1-2 units and;
- isomerate and blending oxygenates with maximum 5 units.

All refineries are 51% state owned and 49% privately owned.

29.4 **Vehicle Fleet**

In 1996, there were 2.77 million vehicles in Romania corresponding to 0.12 vehicle per capita. The vehicle fleet increased by 79% and the number of passenger cars by 85% from 1990 to 1996. In 1996, passenger cars accounted for 87% of the vehicle fleet compared to 83% in 1990. About 91% of all passenger cars and 35 % of all heavy vehicles were petrol driven as of 1994.

In 1996, the turnover rate for passenger cars was 8.1% and for trucks 6.9%. The average age was 11.5 years for passenger cars and 9.6 years for trucks in 1995.

The share of passenger cars with catalytic converters is below 1%. There is no requirement for the use of catalytic converters.

[35]World Bank 1997: Phasing out lead from petrol in Central and Eastern Europe, annex A., Ed. Magda Lovei.

Table 29.3 *The Vehicle Fleet, 1990-96, Romania*

Information	1990	1991	1992	1993	1994	1995	1996
Number of vehicles('000)	1,551	1,699	1,876	2,098	2,350	2,552	2,772
Number of passenger cars ('000)	1,292	1,432	1,593	1,793	2,020	2,197	2,392
Number of vehicles/1,000 inhabitants	69	73	82	92	104	113	123
Average age passenger car (years)						11.5	
Average age heavy trucks (years)						9.6	
Estimated turnover rate passenger cars(%)		9.7	10.1	11.1	11.2	8.1	8.1
Share with catalytic converter, all vehicles %						0.1	0.2
Share with catalytic converter, all petrol driven vehicles (%)						0.1	0.2

Table 29.4 *The vehicle fleet according to fuel type, 1994 Romania*

Information	1994
Passenger cars	
% petrol driven (%)	91
% diesel driven (%)	10
Heavy duty vehicles & busses	
% petrol driven (%)	35
% diesel driven (%)	65
All vehicles	
% petrol driven (%)	83
% diesel driven (%)	17

The data sheets indicate that almost the whole vehicle fleet originate from CEE countries. A major share of the vehicle fleet is made by the local manufacturers Daewoo and Dacia.

29.5 **Distribution System**

In 1996, Romania had 1,186 petrol stations corresponding to a doubling of the number of petrol stations since 1990. On average, there are 4 fuel pumps per station and since 1992, there have been differentiation of pump nozzles between leaded and unleaded

petrol. The percentage of petrol stations offering unleaded petrol increased from 1% in 1992 to 35% in 1996.

In 1996, 20 petrol stations had vapour recovery installation for tank filling (Stage I) and 15 petrol stations for car filling (Stage II).

About 50% of the petrol stations were state-owned in 1996.

29.6 Policies and Instruments

The market share of unleaded petrol is very low and the maximum lead content in petrol is high. The limit on the benzene content in petrol is similar to the present EU standard. However, recently a plan for the phase-out of lead in petrol has been prepared.

The plan for phase-out of lead in petrol for the period 1997-2003 contains the following stages:

- Production and commercialisation of petrol with reduced lead content of 0.32 g/l starting in July 1997;
- Research on vehicles and engine performance regarding the consumption of petrol with lead content 0.15 g/l and unleaded petrol to be financed by external sources, 1997-1999;
- Lead content reduction from 0.32 g/l to 0.15 g/l by modifying refinery sector technology, 1999-2001;
- Catalytic converters to become mandatory for imported cars, 1998;
- Catalytic converters to become mandatory for cars produced in Romania, 1999-2000;
- Total phase-out of lead from petrol used by existing cars, 2001-2003.

To further support lead phase-out, Romania contemplates the introduction of economic incentives to promote "green vehicles" using unleaded petrol, reducing customs duties for imported cars with catalytic converters and using tax differentiation to change the relative prices of petrol in favour of unleaded grades[36].

The estimated cost of phasing out lead in petrol is an estimated USD 80-100 million primarily in the form of refinery investment cost.

The requirement for catalytic converters on locally produced cars will be made effective by the end of 1997.

[36] By the beginning of 1997, the unleaded petrol was in fact already 3.3% cheaper than leaded.

30 Slovakia

30.1 Environmental Pressure and Health Effect

In 1994, the vehicular lead emissions were 21.1 tonnes, which corresponded to 23% of the total lead emissions. The vehicular lead emissions approached nil thereafter as Slovakia phased out lead in petrol.

Table 30.1 *Vehicular Lead Emissions, 1990, 1992 and 1994, Slovakia*

Vehicular lead emissions	1990	1992	1994
Total lead emissions (tonnes)	75	96.8	21.1
Share of total emissions (%)	45	53	23
Emissions/km^2 (kg)	1.5	2.0	0.4
Emissions per 1,000 inhabitants (kg)	23.4	33.2	3.6

In the city of Richňava, the ambient air lead concentration was 0.53 µg/m^3 in 1991, but declined to 0.2 µg/m^3 in 1995. Similar trends can be made for the other three cities covered by the data sheet; Bratislava, Bystrica, Ruzomberok.

The lead intake by way of food intake was measured for adults and children over the period 1990-1994. The results showed that the lead intake amounted to 1/3 of the tolerable weekly intake of 25 µg/kg as determined by the FAO/WHO except for children with vegetarian food where the weekly intake was 43% of the tolerable intake.

The blood lead level in the population of Bratislava over the period 1986-1990 is given in Table 30.2 below.

Table 30.2 *Blood lead levels in Bratislava 1986-1990.*

Sex	Age	Smoking	Number in sample	Average concentration (µg/dl)	
				Arithmetic average	Geometric average
Females	18-35	Yes	28	7.0	5.8
	18-35	No	28	6.9	5.8
	> 36	Yes	22	4.1	3.1
	> 36	No	35	3.2	2.3
Females	18-35	Yes	40	10.2	6.8
	18-35	No	30	8.9	5.8
	> 36	Yes	32	10.0	8.8
	> 36	No	30	10.3	8.0

The results indicate that adults in Bratislava were not exposed to lead in an amount, which could have potential adverse health effects.

However, for children even low blood lead levels in the long run may cause a deterioration in physical functions. In the mid-1990s, results on the blood lead levels in 395 children aged 9-10 living permanently in Bratislava revealed that the concentrations were in the range 1.1-13.5 µg/dl and adverse effects may be observed at a level of 4 µg/dl. The adverse effects were in the form of lower intelligence performance, while no significant effects were observed with respect to motoric and concentration activities.

The study also revealed that the negative effects from lead exposure depend on other living conditions as health and psycho-social circumstances.

Further studies in Middle and North Slovakia in 1995 and 1996 indicated mean blood lead levels of 4.5 µg/dl and 3.04 µg/dl respectively.

30.2 **Production and Consumption of Petrol**

Slovakia has managed to phase out lead in petrol over a very short period. In 1992, the market share of unleaded petrol was 6%, but in 1995 the market share was 100%.

Petrol consumption has increased slightly from 1990 to 1996. Still, in 1996 the petrol consumption per inhabitant was low compared to other CEE countries.

Figure 30.1 *Consumption of Leaded and Unleaded petrol. 1990-1996. Slovakia[37] (1000 m³)*

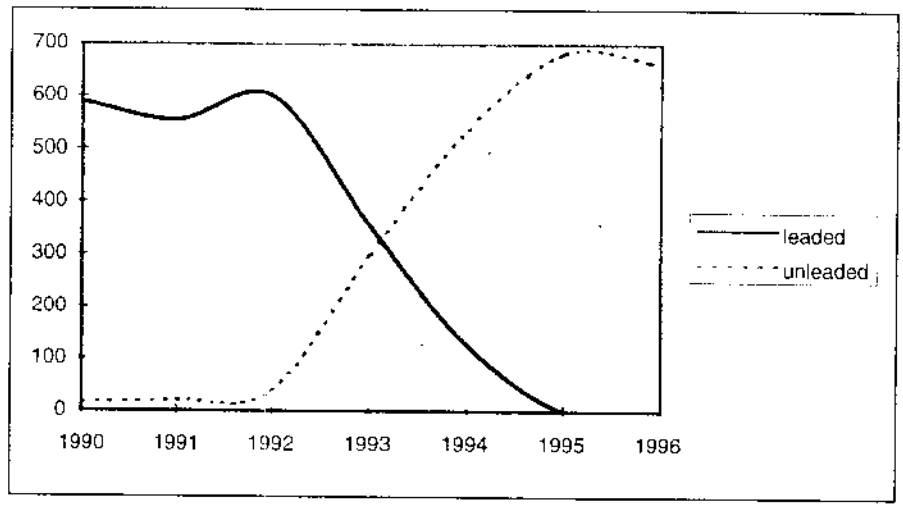
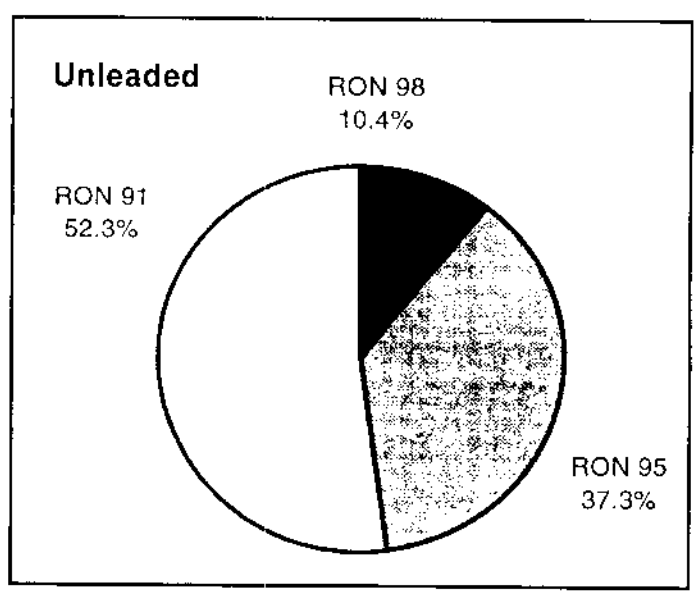


Figure 30.2 shows the distribution of petrol consumption of the different RON qualities. RON91 is the most common petrol grade, but also the consumption of RON95 is high.

Figure 30.2 *Distribution of Petrol Consumption on Different RON Qualities.1996. Slovakia (%)*



[37] This development is estimated from the supply balance.

Table 30.3 *Supply Balance for Leaded and Unleaded Petrol. 1996. Slovakia (1,000 m^3)*

1,000 m^3	Production	Import	Export	Consumption
Leaded petrol	41	0	41	0
Unleaded petrol	1.089	0	427	662

A small amount of leaded RON91 is still produced, but only for exports. The production of leaded RON96 was discontinued in 1994.

Slovakia also exports unleaded petrol. 39% of the production of unleaded petrol are exported. The export of unleaded petrol is mainly RON95 (63%).

Slovakia started production of unleaded RON98 in 1994.

The maximum lead content allowed in petrol has been 0.15 g/l for leaded petrol and 0.013 g/l for unleaded petrol throughout the period under consideration 1990-1996. The actual lead content in leaded petrol was 0.13 g/l in 1994.

The gradual reduction of the lead content in petrol was undertaken already during the 1980s.

30.3 **Refining Industry**

There is one refinery in Slovakia, JSC Slovnaft. The refinery was privatised in 1992/93. By the beginning of 1995, the major shareholder was the National Property Fund with 73% of the shares. Banks and institutional investors had approximately 20% of the shares.

Major investments were undertaken in the period from 1986 to 1992 (cracking units and isomerisation units). As a result of the availability of advanced technology, the refinery had a substantial over capacity to produce high octane petrol components.

The phase-out of lead use on the supply-side was carried out in a number of stages.

The first phase consisted of decreasing the lead content in petrol from 0.7 g/l to 0.4 g/l in 1983. This was accomplished by increasing reformer severity of heavy naphtha and optimisation of refinery operations, which implied an increase in the RON of reformate from 89 to 91-92. A further reduction to 0.25 g/l was achieved in 1986 by distillation range optimisation of light naphtha combined with increasing the RON of reformate to 94 and the use of MTBE (10 % vol.). This also made the production of unleaded RON91 possible.

In 1989, initiatives were taken to increase the complexity of crude oil processing and increase the production of unleaded petrol. A

hydrocracking unit of heavy oil distillates was put into operation in 1989 from which light hydrocrackate (RON80) and heavy hydrocrackate by reforming were converted to reformate with RON96-98. This investment facilitated a reduction in the lead content of leaded petrol to 0.15 g/l and at the same time provided the conditions for production of RON95 unleaded petrol.

In 1992, an isomerisation unit of light naphtha was put into operation resulting in an increase in the RON of this component from 70 to 84, which made it possible to produce only unleaded petrol at the refinery without increasing reformer severity (and therefore without increased aromatics content).

Table 30.4 *Refinery Processes. Slovakia*[38] *(bbl/day)*

Refinery process	Capacity 1996
Atmospheric distillation	115,000
Thermal operations	
Catalytic Cracking	
Catalytic Reforming	22,270
Catalytic hydrocraking	16,970
Alkylation/polymerisation	5,200
Isomerisation/aromatics	10,201
Oxygenates (e.g. MTBE)	

The refinery also produces the additive, which provides the lubrication effect for engines with soft valve seats. The additive can be applied in cars with or without catalyst. The total investment cost of the isomerisation and the unit for producing the lubricating additive was USD 25 million corresponding to USD 0.02 litre of petrol.

30.4 **Vehicle Fleet**

In 1996, there were 1.2 million vehicles in Slovakia corresponding to 0.23 vehicles per capita. The vehicle fleet increased by 18% from 1990 to 1996 primarily due to an increasing number of passenger cars and light duty vehicles.

88% of the total vehicle fleet in 1996 was passenger cars and light duty vehicles compared to 86% in 1990. 97% of the passenger cars was petrol driven in 1996 compared to 96% in 1990. Though a switch to diesel use can be observed for the heavy trucks, the overall share of the vehicle fleet using diesel as fuel declined to 14% in 1996.

The average age of the vehicle fleet was high, between 13-15 years, in 1995 and the turnover rate in the vehicle fleet has been modest, though it has increased sharply since 1994.

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[38] World Bank 1997: Phasing out lead from petrol in Central and Eastern Europe, annex A., Ed. Magda Lovei.

In October 1993, emissions standards requiring catalytic converters was introduced. The share of the vehicle fleet equipped with catalytic converters amounted to 14% in 1996.

Table 30.5 *The Vehicle Fleet, 1990-1996, Slovakia*

Information	1990	1991	1992	1993	1994	1995	1996
Number of vehicles('000)	1,035	1,070	1,119	1,155	1,154	1,176	1,217
Number of passenger cars ('000)	898	929	971	1,012	1,011	1,033	1,074
Number of vehicles/1,000 inhabitants	195	202	211	218	218	222	230
Average age passenger car (years)						14.8	
Average age heavy trucks (years)						13.0	
Estimated turnover rate (%)	4.7	3.6	5.4	5.3	2.7	4.0	6.9
Share with catalytic converter, all vehicles %					3	7	14
Share with catalytic converter, all petrol driven vehicles (%)					4	8	17

Table 30.6 *The vehicle fleet according to fuel type, 1990-1996 Slovakia*

Information	1990	1991	1992	1993	1994	1995	1996
Passenger cars							
% petrol driven (%)	96	96	97	97	97	97	97
% diesel driven (%)	4	4	3	3	3	3	3
Heavy duty vehicles & busses							
% petrol driven (%)	6	6	5	5	5	3	2
% diesel driven (%)	94	94	95	95	95	97	98
All vehicles							
% petrol driven (%)	84	84	85	85	85	86	86
% diesel driven (%)	16	16	15	15	15	14	14

The most common vehicles in Slovakia are Skoda and Lada, i.e. cars made in CEE countries.

30.5 **Distribution System**

In 1996 there were 465 petrol stations in Slovakia, which is an increase of 60% compared to 1990. All the stations are privately owned.

On average, there are 5 to 10 fuel pumps per station and there are differentiation between pump nozzles for leaded and unleaded petrol. The number of petrol stations offering unleaded petrol increased gradually from 14% in 1990 to 100% in 1994.

14 petrol stations or 3% of all petrol stations had vapour recovery installations by the end of 1996.

30.6 **Policies and Instruments**

After the gradual reduction in the lead content of petrol during the 1980s and the up-grading of the refinery, Slovakia phased out lead in petrol over a short time horizon.

The major constraint for the phase-out of lead in the beginning of the 1990s was the composition of the vehicle fleet. In 1992, 55-60% of the vehicle fleet in Slovakia was estimated to have soft valve seats. Hence, the only possible solution was to apply an adequate additive to protect the exhaust valve seats from wear. Furthermore, unleaded petrol was only available at limited number of petrol stations.

On the supply side, an isomerisation unit was installed as the final step towards 100% unleaded petrol production and to cope with the constraint in relation to the vehicle fleet, the refinery began production of a lubricating additive.

In order to overcome the reluctance on the demand side regulatory measures in relation to the vehicle fleet, tax differentiation between unleaded and leaded petrol and awareness building measures were used.

In order to accelerate the switch to unleaded petrol, a tax differentiation scheme between unleaded and leaded petrol had been introduced in 1990, but the effects were negligible as it only just compensated for the higher production price of unleaded petrol. The extent of tax differentiation was revised in 1992/93 in order to favour unleaded petrol. The consumption tax on unleaded petrol was 10-15% lower than that on leaded grades from 1992 to 1994 and combined with the increased efficiency of the refinery, the result was retail prices for unleaded petrol 2-3% lower than the retail price of leaded petrol.

Emission standards requiring the use of catalytic converters on new cars were implemented in October 1993 and has been supplemented with requirements that new vehicles shall be able to use unleaded petrol without lubricating additives and imported cars should not have been manufactured before 1985. To support

the switch to "green vehicles", the road tax is reduced by 25% for imported cars equipped with catalytic converter and the VAT on catalytic converters is only 6% compared to the general level of 25%.

The shift from leaded to unleaded petrol did not require further investments in the distribution infrastructure. The same storage terminals and transportation modes (pipeline, rail and tankers) were used after a clean-up. The switch was undertaken gradually in a co-ordinated effort between Slovanaft, the major distributor, Benzinol, and the authorities.

As of mid-1997, the authorities intended to ban the use of leaded petrol, as private distributors were beginning to market leaded petrol.

31 Slovenia

31.1 Environmental Pressure and Health Effect

A considerable reduction in lead emission from vehicles was realised in Slovenia in the period 1990-1996, particularly in 1995 after the introduction of a new petrol quality standard. In 1995, the maximum lead content in petrol was changed from 0.6 g/l to 0.15 g/l.

As a result of the rapid increase in petrol consumption, the lead emissions in the beginning of the 1990s remained constant at a high level even though unleaded petrol gained a considerable market share

Table 31.1 *Vehicular lead emissions. 1990-1996. Slovenia*

Vehicular lead emission	1990	1991	1992	1993	1994	1995	1996
Total lead emissions (tonnes)	445	386	390	398	393	183	101
Emission/km^2 (kg)	22.3	19.3	19.5	19.9	19.7	9.2	5.1
Emission per 1,000 inhabitants (kg)	223	193	195	199	197	92	51

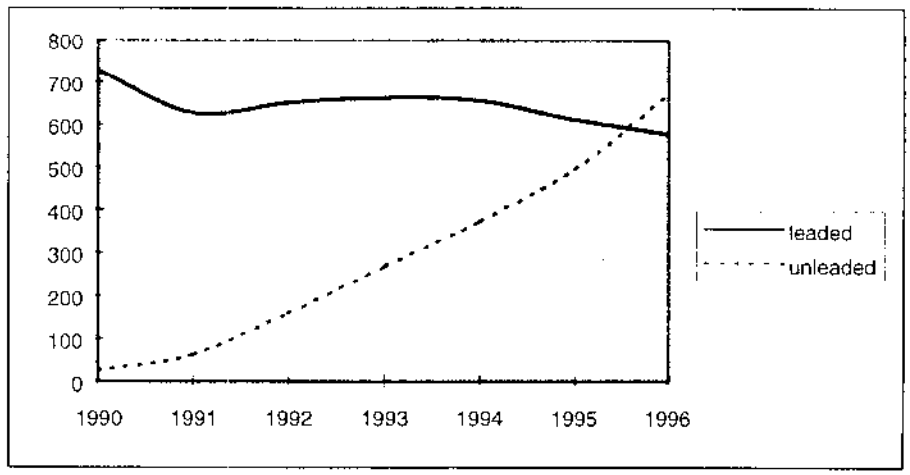
In general, ambient air lead concentration is highest along the major motor highways and in the major cities in Slovenia. Ljubljana accounted for 20-25% of lead emissions in the beginning of the 1990s, but its share fell to 10-15% in 1995/1996.

The ambient air lead concentrations in Trbovlje, Zagorje and Hrastnik declined from a level of 0.25-1.5 µg/m^3 in 1991 to 0.1-0.3 µg/m^3 in 1993.

31.2 Production and Consumption of Petrol

Petrol consumption in Slovenia has increased by approximately 66% from 1990 to 1996. In this period, the market share of unleaded petrol increased from less than 5% to 54%. The consumption of leaded petrol has declined moderately in absolute terms.

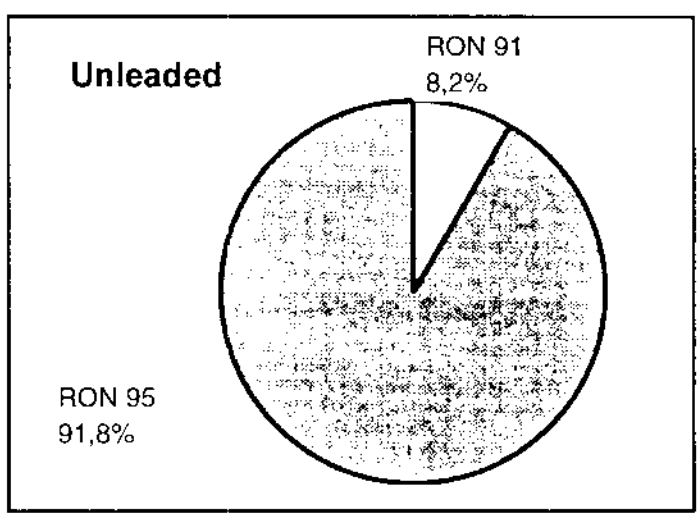
Figure 31.1 *Consumption of Leaded and Unleaded Petrol. 1990-1996. Slovenia (1,000 m³)*



The annual petrol consumption is approximately 620 m^3 per 1.000 inhabitants. The relatively high consumption level compared even to West-European countries may be due to the relatively low retail price of petrol in Slovenia compared to neighbouring countries and consequently a considerable cross-border trade.

The unleaded petrol consumption is mainly RON95, while all leaded petrol consumption is RON98.

Figure 31.2 *Distribution of Petrol Consumption on Different RON Qualities.%. (1996). Slovenia*



The imports of petrol (both leaded and unleaded) increased considerable in the period 1990-1996, while the domestic production of petrol declined by 4%. Consequently, 92% of the petrol consumed in Slovenia in 1996 was imported.

Table 31.2 *Supply Balance for Leaded and Unleaded Petrol. 1996. Slovenia (1,000 m³)*

1,000 m³	Production	Import	Export	Consumption
Leaded petrol	38	539	0	577
Unleaded petrol	67	605	0	672

Before 1995 (while the country was in transition), there were no standards in Slovenia to regulate the quality of oil derivatives. For domestic producers the maximum lead content allowed in leaded petrol was 0.60 g/l. This was reduced to 0.5 g/l for domestic producers and 0.15 g/l for imported petrol in 1995. From the beginning of 1996, the maximum lead content in domestically produced petrol corresponds to the EU-standard of 0.15 g/l.

31.3 **Refining Industry**

Slovenia has one refinery. The refinery produces only virgin naphtha. The refining process consists of crude oil distillation (capacity 12,000 bbl/day) and includes no conversion or upgrading processes. Therefore, the virgin naphtha has to be further processed in other neighbouring refineries. Further, imported additives are added to the petrol.

The plant is 24-30 years old with a current capacity utilisation of 55%. In 1994, a reconstruction of the NaOH treatment of virgin naphtha and petrol was carried out to purify the feedstock. Still, the refinery is small and simple, and major investments must be undertaken in order to supply the market with sufficient unleaded petrol. The refinery is planned to be entirely reconstructed within the next 5 years. The government has a 45% stake in the refinery.

Table 31.3 *Refinery Processes. 1996. Slovenia*[39] *(bbl/day)*

Refinery process	Capacity 1996
Atmospheric distillation	12,000
Thermal operations	
Catalytic Cracking	
Catalytic Reforming	
Catalytic hydrocraking	
Alkylation/polymerisation	
Isomerisation/aromatics	
Oxygenates (e.g. MTBE)	

Presently, detergent additives have been added to a smaller part of the unleaded petrol RON 95, but in order to solve the problem of soft valve seats in part of the vehicle fleet lubricating additives must be added to the unleaded petrol.

[39] World Bank 1997: Phasing out lead from petrol in Central and Eastern Europe, annex A., Ed. Magda Lovei.

31.4 **Vehicle Fleet**

In 1996, there were 851,000 vehicles in Slovenia, which corresponds to 0.42 vehicle per capita. The vehicle fleet increased by 14% from 1992 to 1996.

The composition and structure of the vehicle fleet with respect to the consumption of different fuel types remained stable over the period.

The turnover rate almost doubled from 1992 to 1993 and has remained at about 7-8% since. The average age on passenger cars declined from 8.9 years in 1993 to 6.5 years in 1996, and for trucks the average age declined from 9.9 to 7.3 years.

Still, the main obstacle to phasing out lead in petrol is a considerable number of old cars with soft valve seats. The latter has been estimated to 25-40% of the vehicle fleet in Slovenia.

Since May 1994, import and sale of new vehicles without catalytic converters have been prohibited. However, the number of vehicles with such equipment is unknown.

Table 31.4 *The Vehicle Fleet (all vehicles), 1992-1996. Slovenia*

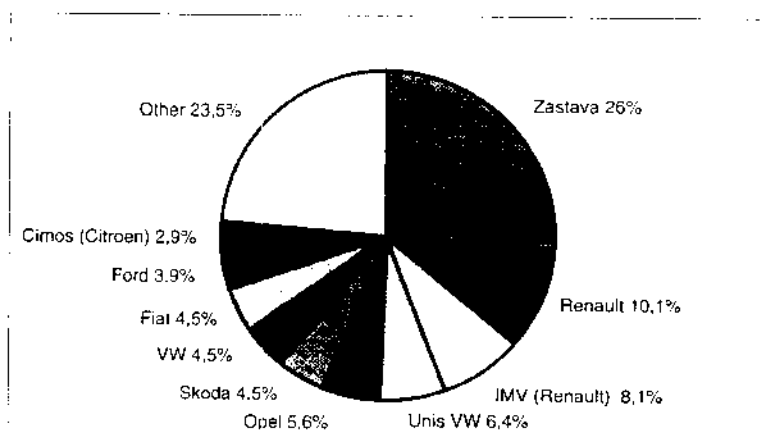
Information	1992	1993	1994	1995	1996
Number of vehicles('000)	746	793	762	813	851
Number of passenger cars ('000)	625	671	698	745	777
Number of vehicles/1,000 inhabitants	373	397	381	407	426
Average age passenger car (years)		8.9	8.1	7.3	6.5
Average age heavy trucks (years)		9.9	9.0	8.1	7.3
Estimated turnover rate (%)	4.7	8.3	7.0	8.6	8.0

Table 31.5 *The vehicle fleet according to fuel type. 1992-1996 Slovenia*

Information	1992	1993	1994	1995	1996
Passenger cars					
% petrol driven (%)	88	88	88	88	88
% diesel driven (%)	12	12	12	12	12
Heavy duty vehicles & busses					
% petrol driven (%)	0	0	0	0	0
% diesel driven (%)	100	100	100	100	100
All vehicles					
% petrol driven (%)	87	87	87	87	87
% diesel driven (%)	13	13	13	13	13

Approximately 30% of the vehicle fleet are originates from CEE countries.

Figure 31.3 *The Ten Most Common Vehicles (%)*



31.5 **Distribution System**

In 1996, there were 347 petrol stations in Slovenia, an increase of 30% since 1990. All petrol stations have offered unleaded petrol since 1995 and differentiate between pump nozzles for leaded and unleaded petrol. On average, there are 4-7 fuel pumps per station.

In 1996, 18% of stations had vapour recovery installations for tank filling (Stage I) and 2% for car filling (Stage II).

All petrol stations in Slovenia are owned by the companies PETROL, ÖMV-Istrabenz and INA. All three companies have been privately-owned stock companies since 1996.

31.6 **Policies and Instruments**

Since the introduction of unleaded petrol in 1988, the market share has increased to 54% in 1996. The objective of the Slovenian government is to completely phase-out leaded petrol by the year 2000 by the way of a ban on leaded petrol.

In order to attain this objective the government introduced tax differentiation in favour of unleaded petrol in 1991 to encourage the consumption of unleaded petrol. In 1994, catalytic converters on new cars became mandatory and in 1995, limits for lead content (and benzene) in petrol corresponding to EU-standards were adopted.

The considerable need for valve lubrication is a major obstacle for completing the phase-out of lead in petrol. A ban on lead in petrol requires sufficient unleaded petrol of RON98 with appropriate additives. Because of the present refinery structure in Slovenia (simple technology), the country is dependent on imports of unleaded petrol of high grade and there are insufficient blending facilities, where unleaded petrol with lubricating additive could be produced. However, the supply of high grade unleaded petrol in the Central European region is still not sufficient, and a considerable increase in the petrol price might be the result.

32 Turkey

32.1 Environmental Pressure and Health Effect

The lead emission from vehicles increased considerable over the period 1993-1996. In 1996, the lead emission from vehicles were 1,032 tonnes, which is more than a doubling since 1990.

Table 32.1 *Vehicular Lead Emissions. 1990-1996. Turkey*

Vehicular lead emissions	1990	1991	1992	1993	1994	1995	1996
Total lead emissions (tonnes)	484	423	544	703	834	1,033	1,032
Emissions/km^2 (kg)	0.6	0.5	0.7	0.9	1.1	1.3	1.3
Emissions per 1,000 inhabitants (kg)	7.9	6.9	8.9	11.5	13.7	16.9	16.9

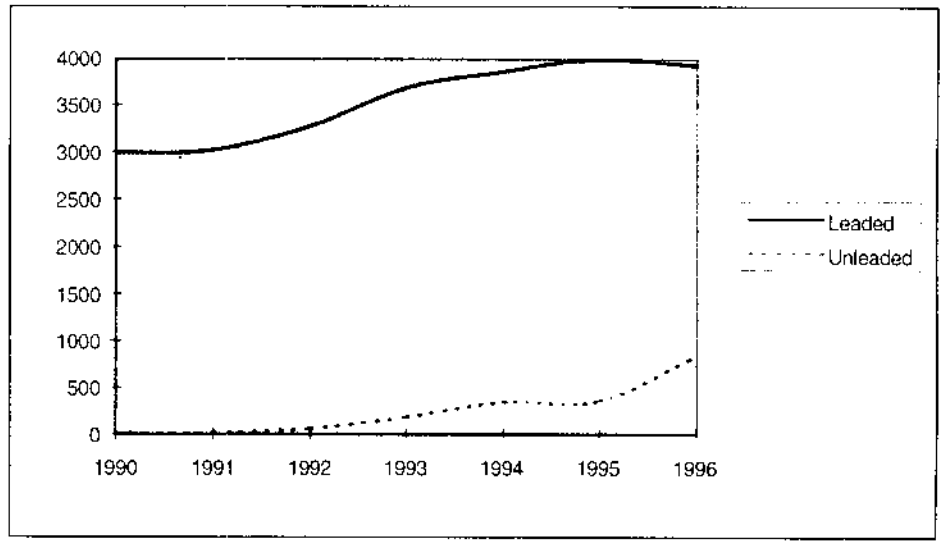
There is no information on blood lead level concentrations available, nor on health benefits from reducing lead in petrol.

32.2 Production and Consumption of Petrol

In 1996, the market share of unleaded petrol was approximately 18% compared to about nil in 1990. The consumption of petrol has increased by 58% from 1990 to 1996. Still, the consumption was a modest 78 m^3 petrol per 1,000 inhabitants in 1996.

As shown in Figure 32.1, the consumption of leaded petrol declined moderately between 1995 and 1996 at the same time as the consumption of unleaded petrol increased substantially. Hence, the consumption of leaded petrol may have peaked.

Figure 32.1 *Consumption of Leaded and Unleaded Petrol. 1990-1996. Turkey (1,000 m³)*



Turkey is almost self sufficient in leaded petrol as indicated in Table 32.2. However, production of unleaded petrol could not satisfy the increasing domestic demand for unleaded petrol in 1996 and as a result the import of unleaded petrol more than tripled from 1995 to 1996.

Table 32.2 *Supply Balance for Leaded and Unleaded Petrol. 1996. Turkey (1,000 m³)*

1,000 m³	Production	Import	Export	Consumption
Leaded petrol	3,816	102		3,918
Unleaded petrol	293	545		838

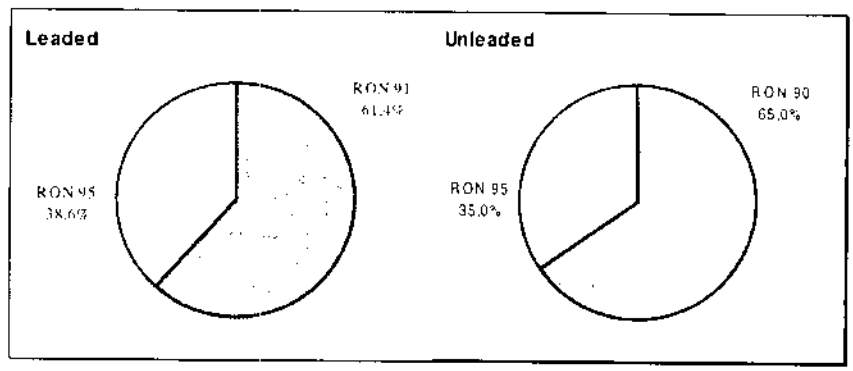
The domestic production of leaded petrol is RON91 and RON95. The imports of leaded petrol is RON91. The domestic production of unleaded petrol is all RON 95, whereas the imports of unleaded petrol is RON90.

The maximum lead content in leaded petrol is 0.15 g/l for RON91 and 0.40 g/l for RON95. The maximum lead content allowed in petrol has remained unchanged throughout the 1990s.

The average actual lead content was 0.13 g/l for RON91 and 0.33 g/l for RON95 in 1996. The actual lead content has increased from 0.1 g/l for RON91 and 0.2 g/l for RON95 in 1991.

For unleaded petrol the maximum lead content is 0.013 g/l.

Figure 32.2 *Distribution of Petrol Consumption on Different RON Qualities. 1996. Turkey (%)*



32.3 **Refining Industry**

There are five refineries in Turkey, four of which are state owned and accounts for 84% of crude oil distillation capacity (TÜPRAS Petroleum Refineries Corp.). The two largest refineries, Aliaga-Izmir and Izmit, accounted for about 2/3 of the total crude oil distillation capacity and all cracking capacity by the end of 1996. The refineries rely almost entirely on reforming for up-grading purposes and the reforming capacity is limited in a West-European perspective.

The age of equipment at the TÜPRAS refineries ranges between 11 and 36 years. The latest revamp at one of the oldest refineries was undertaken in 1996/1997.

To improve the upgrading capacity, the state-owned refinery organisation has one isomerisation unit under construction, and two more isomerisation units at the planning stage. Furthermore, two reformer and three desulphation units are at the planning stage.

For lead replacement, TÜPRAS is increasing its reformate and isomerate production by undertaking the investments indicated above. MTBE will be purchased if necessary to reach the required octane levels.

Table 32.3 Refinery Processes. 1996. Turkey[40] (bbl/day)

Refinery process	Capacity 1996
Atmospheric distillation	683,095
Thermal operations	24,340
Catalytic Cracking	37,740
Catalytic Reforming	64,757
Catalytic hydrocraking	54,000
Alkylation/polymerisation	
Isomerisation/aromatics	5,030
Oxygenates (e.g. MTBE)	

32.4 Vehicle Fleet

In 1994, there were 3.8 million vehicles in Turkey of which 2.8 million (or 74%) were passenger cars[41] corresponding to 62 vehicles per 1,000 inhabitants.

In 1994, there were 241,788 new registrations of passenger cars and 1,308 new busses were registered.

32.5 Distribution System

There is differentiation between pump nozzles for leaded and unleaded petrol.

32.6 Policies and Instruments

The market share of unleaded petrol was a modest 18% in 1996 and the consumption of the leaded RON95 with high lead content has more than doubled since 1991 and accounts for a large share of consumption implying increased environmental pressure. A limit for the content of benzene in petrol of 5% v/v was introduced in 1995.

However, there is a political commitment to phase out lead, and Turkey has set itself ambitious goals in a lead phase-out perspective.

A Protocol for 1995-2000 was prepared in 1995 by the Ministry of Environment and Ministry of Industry adopting the requirement for catalytic converters. Thus by the year 2000, all vehicles should be equipped with catalytic converters.

The government has furthermore supported the phase-out of lead in petrol by introducing tax differentiation in favour of unleaded petrol. However, the resulting price difference between leaded and unleaded petrol has so far been small.

[40] Oil & Gas Journal December 1996

[41] Source: United Nations 1996: Annual bulletin of transport statistics.

Finally, the government is currently preparing an information campaign promoting the use of unleaded petrol.

On the supply side, the major producer, TÜPRAS, expects a complete phase-out of leaded petrol production in 2003.

33 Armenia

33.1 Environmental Pressure and Health Effect

Vehicular lead emissions account for the major share of overall atmospheric lead emissions, and in many urban areas more than 90% of ambient air lead pollution has been estimated to originate from the use of leaded petrol.

The total lead emissions are given in Table 33.1 below. However, the figures seem very low taken into account that all petrol consumed in Armenia is leaded. The lead emissions approximated by the volume of leaded petrol consumed times the actual lead content of the petrol suggest that lead emissions may be at least 50 tonnes per year corresponding to about 13 grams per capita.

Table 33.1 *Total Lead Emissions. 1993-1995. Armenia*

Lead emissions	1993	1994	1995
Total lead emissions (tonnes)[12]	0.791	0.340	0.256
Emissions/km^2 (kg)	0.03	0.01	0.01
Emissions per 1,000 inhabitants (kg)	0.21	0.09	0.07

Information on ambient air lead concentration was provided for 1990 and 1991. The concentrations in Jerevan were 1-3 µg/m^3 in 1989-91.

33.2 Production and Consumption of Petrol

Armenia has no refineries and produce no petrol. All petrol import consist of leaded petrol.

Table 33.2 *Imports of Leaded Petrol. 1994-1996. Armenia*

Year.	1994	1995	1996
Imports, 1,000 m^3	35	202	311

33.3 Vehicle Fleet.

The vehicle fleet in Armenia amounted to 347,000 vehicles in 1996. Since 1992, the vehicle fleet has been decreasing.

[12] *Table 33.1* concern the *total* lead emission because information on lead emission from vehicles is not available.

Table 33.3 *The Vehicle Fleet. 1990-1996. Armenia*

Information	1990	1991	1992	1993	1994	1995	1996
Number of vehicles ('000)	370	388	389	382	359	352	347
Number of cars/1,000 inhabitants	104	106	105	103	94	93	93

Cars with soft valve seats comprise a substantial share of the vehicle fleet in Armenia.

33.4 **Policies and instruments**

Even though the market share of unleaded petrol is nil, the phase-out of lead in petrol appear to be feasible in Armenia.

As Armenia does not have any refineries, the measures will have to be focused on the gradual shift in the share of vehicles using leaded petrol towards vehicles using unleaded petrol (or diesel).

At present, Armenia does not apply any economic incentive measures nor any regulatory measures. However, the Department for Atmosphere Protection of the Ministry of Nature Protection has taken the initiative to create a working group including specialists from various ministries and the American University. The working group has prepared a proposal on a strategy to phase-out lead in petrol.

34 Azerbaijan

34.1 Environmental Pressure and Health Effect

The emission of lead by vehicles was 126.7 tonnes in 1996, a substantial increase since 1994. About 40-50% of the vehicular lead emission originate from motor transport in Baku. Motor transport accounts for the major share of lead emissions in Azerbaijan.

However, it is forecasted that no lead was added to the petrol in 1997 and as a result lead emissions from vehicles approached nil in 1997.

Measurements of ambient air concentrations of lead along the major roads in 1996 indicated high values. Along the main roads of Baku, the maximal momentary ambient air concentrations of lead amounted to 11-15 $\mu g/m^3$ in 1996.

Table 34.1 *Vehicular Lead Emissions. 1994-96. Azerbaijan*

Vehicular lead emissions	1994	1995	1996
Total lead emissions (tonnes)	62.3	33.6	126.7
Share of total emissions (%)			
Emissions/km^2 (kg)	0.9	0.5	1.9
Emissions per 1,000 inhabitants (kg)	8.8	4.2	15.8

34.2 Production and Consumption of Petrol

The market share of unleaded petrol was about 28% in 1996, but increased to an estimated 100% in 1997. The consumption of petrol amounted to 964,000 m^3 in 1996 corresponding to a decline of 30% compared to the average annual consumption over the period 1992-1994. The petrol is supplied by domestically produced petrol as import and export of petrol is negligible[43].

The declining demand for petrol implied that the octane specifications could be met without adding lead to the petrol in 1997.

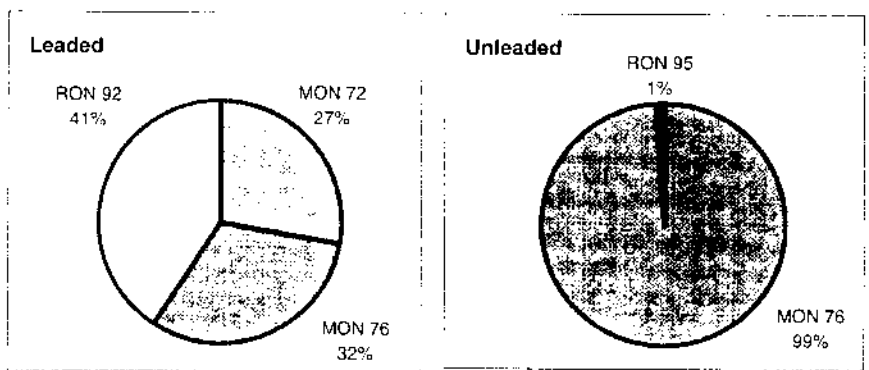
[43] A small amount of high quality RON95 is reportedly being imported from Romania.

Table 34.2 *Supply Balance for Leaded and Unleaded Gasoline. 1996. Azerbaijan (1,000 m³)*[44]

1,000 m³	Production	Import	Export	Consumption
Leaded petrol	521	-	-	521
Unleaded petrol	202	-	-	202

The petrol qualities consumed and produced is mainly low octane MON72 and MON76.

Figure 34.1 *Distribution of Petrol Consumption on Different RON Qualities. 1996. Azerbaijan (%)*



The consumption of unleaded petrol is almost entirely MON76, while the dominating leaded grade is RON92, though low octane leaded petrol also holds a significant market share.

The maximum lead content in unleaded petrol is 0.013 g/l, while the maximum content for leaded petrol is 0.17 g/l for the MON72 and MON76 and 0.12 g/l for RON92.

34.3 **Refining Industry**

There are two refineries in Azerbaijan; Azerneftyanadjag (capacity: 8 million tonnes of crude oil annually) and Azerneftyag (capacity: 6 million tonnes of crude oil annually). Both refineries are state-owned and controlled by the State Oil Company, SOCAR.

Azerneftyanadjag, constructed in 1953, is a conversion refinery and the major domestic producer of petrol. The other refinery, which is over 100 years old, is a simple topping refinery, which mainly produces heavy fuel oil. The refineries process only domestically extracted Azeri crude oil. The refineries operate at 50-60% of their capacity as the economic downturn has reduced the demand for refined products, especially from agriculture, and the

[44] Source: Lead Phase-out from gasoline in Azerbaijan, Kazakhstan and Uzbekistan. A draft report prepared for the Danish Ministry of Environment, March 1998, Chem Systems. The latter report constitutes the main information source for the country description.

refineries ability to fulfil international product quality standards is limited.

There is still a relatively high demand for heavy fuel oil and as a result the depth of refining is relatively low at 61%.

The production facilities are in need of revamps and upgrading. At Azerneftyanadjag, Hitachi of Japan has been involved in the planning of a revamp of the refinery. Furthermore, the refinery has developed an isopropyl ether, which can be used for enhancing the octane level of gasoline. However, funding for further development is needed.

Lead (TEL) is imported from the UK.

Table 34.3 *Refinery processes. 1996. Azerbaijan (bbl/day)*

Refinery process	Capacity 1996
Atmospheric distillation	441,808
Thermal operations	38,529
Catalytic Cracking	32,986
Catalytic Reforming	24,466
Catalytic hydrocracking	
Alkylation/polymerisation	930
Isomerisation/aromatics	
Oxygenates (e.g. MTBE)	

34.4 **Vehicle Fleet**

In 1996 there were 377,600 vehicles in Azerbaijan. The major part of the vehicle fleet has been produced in the former Soviet Union, is old and in need of repair. An estimated 10-15% of the fleet is constituted by imported foreign cars.

It has been estimated that 75% of the fuel used for motor transport is petrol. Consumption of diesel accounts for the remaining 25%.

Azerbaijan has no catalytic converter requirements.

Table 34.4 *The Vehicle Fleet. 1996. Azerbaijan*

Information	1996
Total number of vehicles	377,600
Total number of passenger cars	268,600
Number of cars/1,000 inhabitants	47
Average age, all vehicles(years)	>10

34.5 Distribution System

In 1996, there were about 800 petrol stations in Azerbaijan. All stations are privately owned.

There is no differentiation between filling pistols for unleaded and leaded petrol and no vapour recovery installations are in place.

Transportation of petrol from the refineries to the ten storage terminals of the State Oil Supply Company is carried out by rail or road. From the terminals, the petrol is sold to individual customers and petrol stations. Throughout the distribution chain, the four different petrol grades are segregated.

34.6 Policies and Instruments

The market share of unleaded petrol reached 100% in 1997 compared to 28% in 1996. The increased market share of unleaded petrol was the result of the economic decline in Azerbaijan, which reduced the octane demand.

However, future economic growth and increased gasoline demand implies that the refineries will have to produce larger amounts of high octane petrol than is the case today. This may result in increased use of lead in order to enhance the octane levels of domestically produced gasoline unless new investments at the refineries are undertaken. Chem Systems (1997) has estimated that the investment cost related to the technological upgrading of the refineries and the phase-out of lead amounts to USD 20-30 million.

35 Belarus

35.1 Environmental Pressure and Health Effect

In 1995, 109 tonnes of lead were emitted from vehicles corresponding to 89% of total lead emissions from all sources. In 1990-95, the total lead emission from all sources declined by 84%.

Ambient air lead concentrations in Minsk in 1994 and 1995 were 0.3-0.4 $\mu g/m^3$.

Table 35.1 *Vehicular Lead Emissions. 1990-1995. Belarus*

Vehicular lead emissions	1990	1991	1992	1993	1994	1995	1996
Total lead emissions (tonnes)	733	450	96	322	301	109	9.3
Share of total emissions (%)	98	96	81	94	94	89	38
Emissions/km^2 (kg)	3.5	2.2	0.5	1.5	1.5	0.5	0.04
Emissions per 1,000 inhabitants (kg)	71.2	43.7	9.3	30.9	28.9	10.5	0.9

35.2 Production and Consumption of Petrol

The consumption of petrol declined by 3% from 1993 to 1995 and a further decline of 26% occurred in 1996. However, the consumption of unleaded petrol almost doubled over the period and the market share of unleaded petrol has increased from 57% in 1993 to 97% in 1996.

The unleaded petrol consumption is mainly MON76, but RON 92 is expected to gain market share in the future.

The consumption of unleaded petrol containing lubricating additives (imported) ended in 1995.

Figure 35.1 *Consumption of Leaded and Unleaded Petrol. 1993-1996. Belarus (1,000 m³)*

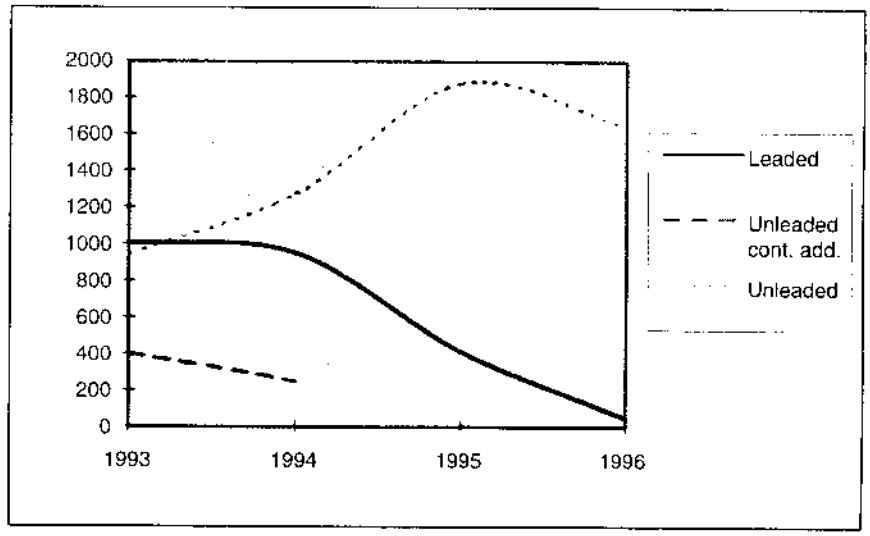


Table 35.2 *Supply Balance for Leaded and Unleaded Petrol. 1996. Belarus (1,000 m³)*

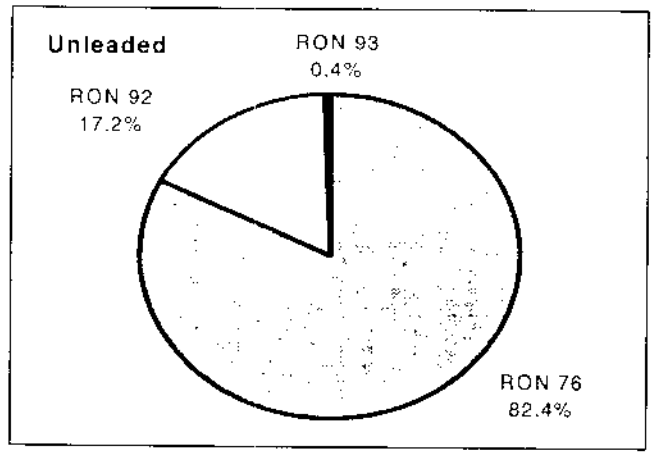
1,000 m³	Production	Import	Export	Consumption
Leaded petrol	164	0	116	48
Unleaded petrol	2,212	0	573	1,639

The production of leaded petrol declined from 825,000 m³ in 1993 to 164,000 m³ in 1996, while the production of unleaded petrol increased by 43% over the same period.

The relatively modest consumption of leaded petrol consisted of RON93.

The unleaded petrol export was mainly MON76 and almost 25% of production is exported.

Figure 35.2 *Distribution of Unleaded Petrol Consumption on Different RON Qualities, 1996, Belarus %*



In 1996, the maximum limit for lead content in leaded petrol of RON93 was 0.37 g/l. The limits for lead content in other petrol grades was 0.17 g/l for MON76 and 0.15 g/l for RON92.

35.3 **Refining Industry**

There are two refineries in Belarus. The available production technology at both refineries are catalytic reforming, direct blending into petrol, and direct blending in larger proportions. In 1996, the total crude oil processing capacity was 36 million tonnes per year, while the total crude oil processed was 14 million tonnes compared to 26 million tonnes at the beginning of the decade. Thus, the amount of crude oil processed has declined by approximately 50% since 1990.

Construction of complexes for deep petroleum refining with organisation of MTBE production is planned and projects for enterprise reconstruction are under preparation including projects for upgrading by isomerisation. Finally, the search for investors for two fluid catalytic cracking units is on-going.

Table 35.3 *Refinery Processes, 1996, Belarus*[45] *(bbl/day)*

Refinery process	Capacity 1996
Atmospheric distillation	724,967
Thermal operations	
Catalytic Cracking	
Catalytic Reforming	98,108
Catalytic hydrocraking	
Alkylation/polymerisation	1,003
Isomerisation/aromatics	9,687
Oxygenates (e.g. MTBE)	

[45] World Bank 1997: Phasing out lead from petrol in Central and Eastern Europe, annex A., Ed. Magda Lovei.

35.4 **Vehicle Fleet**

In 1995, the number of vehicles was 1.281 million corresponding to 0.124 vehicles per capita. The vehicle fleet has increased by 38% since 1990 mainly due to an increasing number of passenger cars. In 1995, 78% of the vehicles were passenger cars compared to 66% in 1990. Almost all passenger cars are petrol driven.

Of the heavy duty vehicles, 76% were petrol driven and this is likely to be one of the reasons for the dominance of MON76 petrol on the market. However, the number of heavy trucks is declining especially the number of petrol driven trucks. Furthermore, a larger share of the heavy truck fleet is diesel driven in comparison with the situation at the beginning of the decade.

The registration of new cars declined by 59% from 1992 to 1995 resulting in an estimated turnover rate below 1% in 1994 and 1995. In the latter year, the registration of new vehicles amounted to 6,100. The average age for passenger cars is 18.5 years and for trucks 10.5 years.

There are no passenger cars with catalytic converters and it is not a requirement to have catalytic converters on new cars.

Table 35.4 *The Vehicle Fleet. 1990-1995. Belarus*

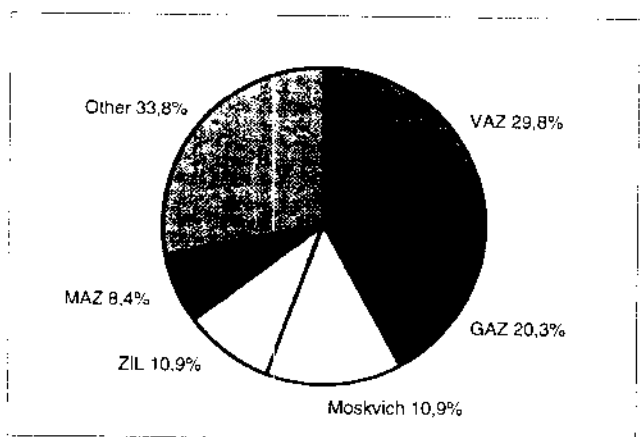
Information	1990	1991	1992	1993	1994	1995
Number of vehicles('000)	929	983	1,061	1,110	1,217	1,281
Number of passenger cars ('000)	615	689	758	809	911	991
Number of vehicles/1,000 inhabitants	90	95	103	108	118	124
Average age passenger car (years)	12.0	13.0	14.5	16.3	17.2	18.5
Average age heavy trucks (years)	8.0	8.2	8.5	8.9	9.8	10.5
Estimated turnover rate (%)			1.4	1.1	0.5	0.5

Table 35.5 *The vehicle fleet according to fuel type. 1990-1995. Belarus*

Information	1990	1991	1992	1993	1994	1995
Passenger cars						
% petrol driven (%)	100	100	100	100	99	99
% diesel driven (%)	0	0	0	0	1	1
Heavy duty vehicles & busses						
% petrol driven (%)	85	80	79	77	77	76
% diesel driven (%)	15	20	21	23	23	24
All vehicles						
% petrol driven (%)	95	94	94	94	94	94
% diesel driven (%)	5	6	6	6	6	6

The vehicle fleet originates from Eastern Europe.

Figure 35.3 *The Five most Common Vehicles. 1995. Belarus (%)*



35.5 **Distribution System**

In 1996, there were 2,896 petrol stations in Belarus and 1,938 tank distribution lorries. Almost all petrol stations are state owned. On average, there are five fuel pumps per station, but without any differentiation between pump nozzles for leaded and unleaded and without any vapour recovery installations.

35.6 **Policies and Instrument**

The market share of unleaded petrol has increased substantially from 57% in 1993 to 97% in 1996. However, Belarus still allows up to 0.37 g/l of lead in petrol and have no limits for the content of benzene in petrol.

According to a resolution of the Council of Ministers from 1990, lead in petrol should have been phased out by 1992. It is now expected to be accomplished in 1997 or 1998.

However, the data sheets do not indicate the use of any of the usual policy measures to support lead phase-out e.g. tax differentiation between leaded and unleaded petrol. The applied policy measures are a limit value for air lead concentrations of 0.3 $\mu g/m^3$ and information campaigns undertaken in 1996.

However, a major constraint in the longer term for the phase-out of lead in petrol may be the increasing octane requirement of the vehicle fleet (70% of the vehicle fleet currently uses MON76) as the economy rebounds. The refineries may be unable to fulfil this demand for octane given their current facilities without resorting to the use of lead.

36 Georgia

36.1 Environmental Pressure and Health Effect

The total lead emission from vehicles declined by 59% from 328 tonnes in 1990 to 135 tonnes in 1996. However, an increase of 19% was observed from 1995 to 1996. Vehicular lead emissions were estimated at 25 grams per capita in 1996.

Ambient air lead lead concentrations in Tblisi, Kutaisi, Rustavi, and Zestaponi were in the range of 0.2µg/m^3 to 0.86 µg/m^3 in 1991. However, given the significant decline in vehicular lead emissions, these values are likely to have declined substantially.

Mean blood level concentrations are 38.2 µg/dl.

Table 36.1 *Vehicular Lead Emissions, 1990, 1995 and 1996, Georgia*

Vehicular lead emissions	1990	1995	1996
Total lead emissions (tonnes)	328	113	135
Emissions/km^2 (kg)	4.68	1.61	1.93
Emissions per 1,000 inhabitants (kg)	60.7	20.9	25.0

36.2 Production and Consumption of Petrol

Since January 1995, there has been no petrol production in Georgia.

The data sheets indicate that the use of unleaded petrol corresponds to more than 95% of total petrol use in 1996. The corresponding figure in 1995 was 75%.

Table 36.2 *Supply Balance for Leaded and Unleaded Petrol, 1996, Georgia (1,000 m^3)*

1,000 m^3	Production	Import	Export	Consumption
Leaded petrol	0	12	3	9
Unleaded petrol	0	438	2	436

In 1990-1996, the maximum lead content in leaded petrol was 0.37 g/l for MON72, MON76, RON93 and RON95.

The imported unleaded petrol is of fairly low grades (maximum of RON90). This is considered the main reason for the fast penetration of unleaded petrol in the Georgian market, because the

price per litre is lower than for the leaded grades available on the market (which have higher RON numbers).

36.3 **Refining Industry**

Since January 1995, the only Georgian refinery has been out of operation. The refinery is state owned.

The one refinery in Georgia was built between 1927-1930. The main process units of the refinery are: two atmospheric distillation units (1929-930), two vacuum distillation units (1970s) and one petrol reforming unit (1970).

The refinery was up-graded in 1997.

Table 36.3 *Refinery Processes, 1996, Georgia*[46] *(bbl/day)*

Refinery process	Capacity 1996
Atmospheric distillation	106,436
Thermal operations	
Catalytic Cracking	
Catalytic Reforming	10,276
Catalytic hydrocraking	
Alkylation/polymerisation	
Isomerisation/aromatics	
Oxygenates (e.g. MTBE)	

36.4 **The Vehicle Fleet**

In 1995, there were 467,000 vehicles in Georgia, which corresponds to 87 vehicles per 1,000 inhabitants. Of the total vehicle fleet, 77.5% were passenger cars. In 1996, the vehicles fleet declined to 418,000 corresponding to decrease of 11% compared to 1995.

Table 36.4 *The Vehicle Fleet, 1995-1996, Georgia*

Information	1995	1996
Total number of vehicles,('000)	467	418
Number of passenger cars ('000)	362	
Number of vehicles per 1,000 inhabitants	87	77
Average vehicle age (years)	10-15	10-15

In 1995 and 1996, the average vehicle age was estimated at 10-15 years. The registration of new cars corresponded to 1% of the total vehicle fleet in 1995. The figure increased to 1.5% in 1996.

[46] World Bank 1997: Phasing out lead from petrol in Central and Eastern Europe, annex A., Ed. Magda Lovei

The most represented vehicles in Georgia are: VAZ, GAZ, KA-MAZ, BMW and Mercedes.

There are no emission standards requiring catalytic converters on new cars.

36.5 The Distribution System

In 1996, there were 845 petrol stations in Georgia. On average, there are 2 fuel pumps per station, but no differentiation of pump nozzles between leaded and unleaded petrol. Most of the petrol stations are privately owned.

36.6 Policies and Instrument

The current market share of unleaded petrol is 98%. The main reason is presumably that the unleaded petrol is cheaper than the leaded petrol with a higher RON. It is highly uncertain how future sales will develop as the economy grow and the vehicle fleet is renewed . The phase-out of lead is not well-anchored e.g. there are no technical or regulatory hindrances for consumers to shift to leaded petrol.

Georgia indicates that the main obstacles to the development of a plan to phase out lead in petrol is the lack of appropriate legislation and an insufficient regulatory system.

37 Kazakstan

37.1 Environmental Pressure and Health Effects

In 1993, the lead emissions from all sources amounted to 1,509 tonnes. The emissions decreased by 15% compared to 1990. Other information sources indicate that recent figures for 1996 for the annual lead emissions from vehicles is 380 tonnes.

Ambient air lead concentrations in 1996 were measured for a number of different locations in Kazakhstan. For Almaty, Akmola, Zhambyl and Karagand the concentrations were below 0.12 $\mu g/m^3$, while the concentrations in Shymkent, Ust-Kamenogorsk and Balkhash were in the range 2.18-4.26 $\mu g/m^3$.

The ambient air lead emissions standard is 0.3 $\mu g/m^3$.

37.2 Production and Consumption of Petrol

The production of petrol amounted to 2.3 million tonnes in 1996, up from 2.1 million in 1995.

Table 37.1 *Petrol production 1996. Kazakhstan (1,000 tonnes/year)*

Refinery	Crude oil processed (1,000 tonnes/year)	Depth of light hydrocarbon processing (%)	Commercial petrol production (1,000 tonnes/year)			
			AI-93	AI-91	AI-76	A-80
Atyrau	4,469	70	26.8	1.1	462.4*	
Shymkent	3,744	62-65		19.0	88.8	784.2
Pavlodar	2,936	40-45		29.4	700.8	197.9

Lead is only added to the AI-76 produced at Atyrau-refinery. The lead content is 0.17 g/l, which is also the maximum allowed content. Hence, unleaded petrol accounted for 80% of the total petrol production in 1996. However, the production remains dominated by AI-76 and A-80, which accounted for 97% of the production in 1996.

Kazakhstan had a small net-export of petrol in 1996 (70,000 m^3) and a small net-import (50,000 m^3) in 1995. Hence, the market share of unleaded petrol may be approximated by the production share of unleaded petrol. The market share of unleaded petrol was approximately 80% in 1996 and unchanged compared to 1995.

Table 37.2 *Supply Balance for Leaded and Unleaded Petrol. 1996. Kazakhstan (1,000 m³)*

1,000 m³	Production	Import	Export	Consumption
Leaded petrol	616			
Unleaded petrol	2,462			

37.3 **Refining Industry**

Kazakhstan has 3 refineries, Atyrau, Shymkent and Pavlodar, with a total primary distillation capacity of 393,000 bbl/day with a capacity utilisation of about 60% in 1996. In 1996, Shymkent and Pavlodar produced only unleaded petrol.

The depth of refining is very low at 45% (lower than in Russia)

Table 37.3 *Refinery Processes. 1996. Kazakhstan[47] (bbl/day)*

Refinery process	Capacity 1996
Atmospheric distillation	393,611
Thermal operations	55,068
Catalytic Cracking	38,356
Catalytic Reforming	59,452
Catalytic hydrocraking	
Alkylation/polymerisation	1,003
Isomerisation/aromatics	
Oxygenates (e.g. MTBE)	

37.4 **Vehicles fleet**

The number of vehicles in Kazakhstan amounted to 1.4 million in 1996, a minor increase in compared to 1990.

The number of heavy duty vehicles has declined by 25-30% since 1990 and amounted to 295,000 in 1996. The major part of these vehicles are petrol driven (60-70%). On the other hand, the number, the number of passenger cars increased by 20% over the period and amounted 1 million in 1996.

37.5 **Policies and instruments**

The market share of unleaded petrol is about 80% according to the official statistics.

However, there is an uncontrolled black market in Kazakhstan dealing in imported lead additives. The lead is among other things

[47] World Bank 1997: Phasing out lead from petrol in Central and Eastern Europe, annex A., Ed. Magda Lovei.

added, when petrol is transported by rail, and then later sold at the filling stations as petrol with a higher octane rating. An inspection carried out by the authorities in Almaty showed that of 280 petrol filling stations, 227 stations marketed leaded petrol suggesting that the market share of leaded petrol is far higher than indicated by the official figures. Furthermore, the actual lead content of the petrol at some of the stations was as high as 0.94 g/l.

38 Republic of Moldova

38.1 **Environmental Pressure and Health Effect**

In 1996, lead emissions from vehicles amounted to 65 tonnes corresponding to 15 grams per capita.

No information has been provided on actual ambient air lead concentrations.

38.2 **Production and Consumption of Petrol**

Moldova imports all its petrol. The petrol consumption declined by 75% from 1990 to 1996.

Table 38.1 *Petrol Consumption. 1990-95. Moldova. (1,000 m^3)*

1,000 m^3	1990	1991	1992	1993	1994	1995	1996
Petrol consumption:	1,084	881	492	282	215	347	287

There is no reliable information concerning the import share of unleaded petrol and thereby in consumption. Information from the Custom Service indicates that approximately 50% of all petrol imported is unleaded.

The maximum allowed lead content in leaded petrol has been 0.17-0.37 g/l throughout the 1990s.

38.3 **Refining Industry**

There is no refinery industry in Moldova.

38.4 **Vehicle Fleet**

In 1996, there were 254, 000 vehicles in Moldova corresponding to 59 vehicles per 1,000 inhabitants. Since 1990, the vehicle fleet has declined by 26% primarily due to fewer passenger cars. However, after years of decline, the vehicle fleet increased moderately from 1995 to 1996.

70% of the fleet was passenger cars in 1996 of which 97% were petrol driven. 30% of the fleet consisted of heavy-duty trucks and buses, 20% of which were diesel driven.

The average age of the vehicle fleet is 15 years.

Table 38.2 *The Vehicle Fleet (all vehicles). 1990-1996. Moldova.*

Information	1990	1991	1992	1993	1994	1995	1996
Number of vehicles ('000)	297	307	282	238	241	235	254
Number of passenger cars ('000)	209	218	187	166	170	165	174
Vehicles per 1,000 inhabitants	68	71	66	55	56	55	59
Average vehicle age (years)	12-15	12-15	12-15	15	15	15	

Table 38.3 *The vehicle fleet according to fuel type. 1990-1995, Moldova*

Information	1990	1991	1992	1993	1994	1995
Passenger cars						
% petrol driven (%)	100	100	99	99	98	97
% diesel driven (%)	0	0	1	1	2	3
Heavy duty vehicles & busses						
% petrol driven (%)	80	79	76	80	80	80
% diesel driven (%)	20	21	24	20	20	20
All vehicles						
% petrol driven (%)	94	94	92	93	93	92
% diesel driven (%)	6	6	8	7	7	8

The ten most represented vehicles are in descending order: VAZ, Moskvich, GAZ, ZAZ, Opel, Volkswagen, Ford, Audi, Mercedes and BMW.

38.5 **Distribution System**

No information on the distribution system has been provided.

38.6 **Policies and Instruments**

The estimated market share for unleaded petrol was 50% in 1996. Moldova applies a limit for the lead content in petrol of 0.17 g/l-0.37 g/l and has no restrictions concerning the content of benzene in petrol.

According to the National Environmental Plan for Moldova, a complete phase-out of lead in petrol is expected in 1998. In relation to the current situation in the petrol market, this indicates that the import of leaded petrol will have to be controlled effectively.

39 Russia

39.1 Environmental Pressure and Health Effect

In 1995, the total lead emission from all sources was estimated to 4,615-5,810 tonnes. The lead emission from vehicles were 4,000 tonnes corresponding to 69-87% of the total lead emission.

Figures on annual lead emissions from vehicles are provided for six areas. In the city of Moscow, lead emission from vehicles was 43.8 tonnes or about 1% of all lead emissions in Russia compared to 14 tonnes in the surrounding Moscow-region in 1995. In the city of St. Petersburg, the lead emission from vehicles was 63.1 tonnes in 1995 compared to 22.3 tonnes in the region surrounding the city. In the Samara and the Republic Bashkortostan, the lead emission from vehicles were 139-148 tonnes in 1995.

Ambient air lead concentrations in six cities; Moscow, Vladimir, Komsomolsk-upon-Amur, Krasnodar, Novgorod, and Tumen, were in the range 0.01-0.5 $\mu g/m^3$ measured as mean concentration values over the period 1989-1993. The lowest mean value was observed in Moscow.

Table 39.1 *Vehicular Lead Emissions, 1995, Russia*

Vehicular lead emissions	1995
Total lead emissions (tonnes)	4,000
Share of total emissions (%)	69-87
Emissions/km^2 (kg)	0.23
Emissions per 1,000 inhabitants (kg)	27.0

Studies investigating blood lead levels in local areas showed mean blood lead level for adults in St. Petersburg of 3.9 µg/dl (± 0.45). Significantly higher levels of 49.6 µg/dl (±7.8) were observed for accumulator plant workers.

For children living near the accumulator plant, the blood lead level was 16.8 µg/dl (± 0.4), whereas in the Kemerovo region the blood lead level in children was found to be somewhat lower, 9.9 µg/dl (± 0.5). Finally, in Saratov the blood lead level in children was 8.59 µg/dl (+/- 4.3) in 1995.

According to the white paper on "Lead Contamination of the Environment in the Russian Federation and its Effect on human Health" published by the State Committee for Environmental Protection of the Russian Federation in 1997, the annual environmental loss from atmospheric pollution by emissions from auto transport for Russia in total amounts to USD 2.7 billion. A total phase-out of lead would reduce the loss by USD 1.44 billion.

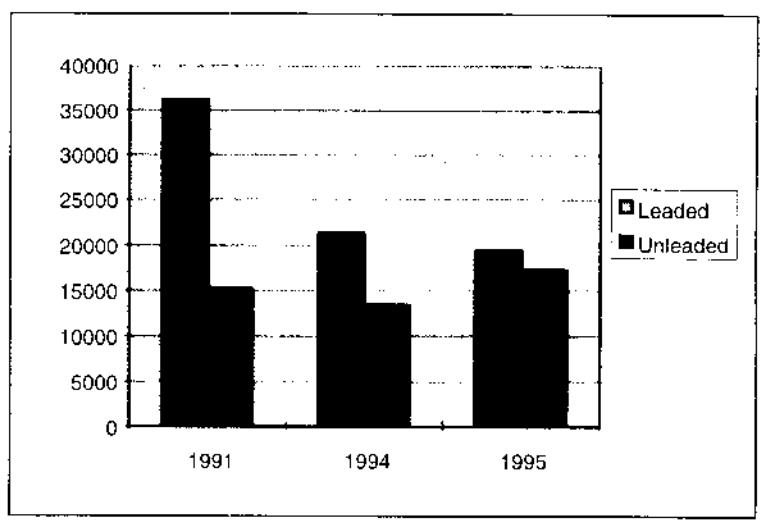
A gradual introduction of catalytic converters thereafter would reduce the loss by another USD 0.8 billion as a result of reduced emissions of hydrocarbons, carbon monoxide etc.

39.2 Production and Consumption of Petrol

In 1995, total petrol production was 36.5 million m^3 of which 47% was unleaded.

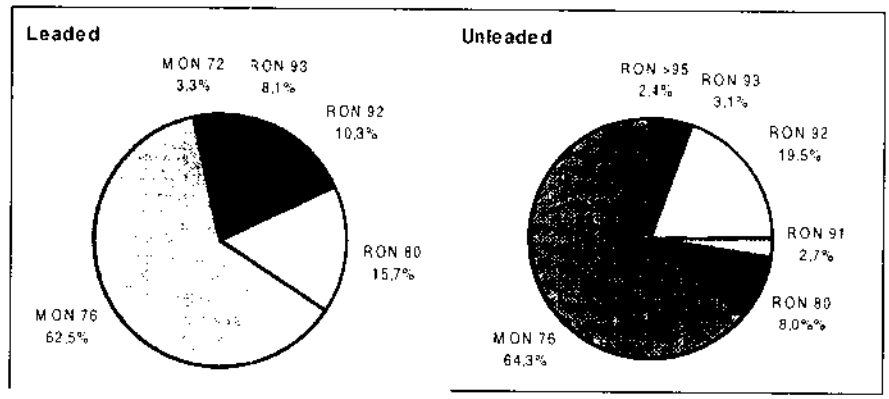
As indicated in Figure 39.1, the production of petrol declined by 32% from 1991 to 1995. Over the same period the share of unleaded petrol production increased from 30% to 47%. Hence, the production of unleaded petrol has increased slightly in absolute terms, while the production of leaded petrol has decreased by almost 50%.

Figure 39.1 *Production of leaded and unleaded petrol. 1991, 1994 and 1995. Russia (1,000 m^3)*



For leaded petrol, MON76 was the most common petrol quality in 1995 accounting for 63% of production. However, the production share of MON76 has declined since 1991 in favour of RON80 and RON92. The production of unleaded petrol is mainly MON76 followed by RON92.

Figure 39.2 *Distribution of Petrol Production on Different RON Qualities. 1995. Russia (%)*



In 1995, the total exports of leaded and unleaded petrol was 3.3 million m^3. The data sheet does not differentiate between the exports of the two types of petrol.

Table 39.2 *Supply Balance for Leaded and Unleaded Petrol. 1995. Russia (1,000 m^3)*

1,000 m^3	Production	Import	Export	Consumption
Leaded petrol	19,371	..	..	..
Unleaded petrol	17,220	..	..	..

Russia has indicated the maximum lead content in petrol to be 0.17 g/l-0.37 g/l. However, new standards are under preparation taking into account international experiences and norms.

39.3 **Refining Industry**

There are 26 refineries in Russia[48]. All of them are joint stock companies.

The Russian refineries have a total primary distillation capacity of about 300-330 million tons per year[49] with a capacity utilisation of 50-55% in 1995 indicating excess crude oil distillation capacity. The production of refined oil products began declining in the late 1980s. There is substantial variation in the size of the refineries ranging from about 100,000 bbl/day up to more than 600,000 bbl/day.

The Russian refineries have lower reforming and upgrading capacity relative to their primary distillation capacity compared to refineries in Western Europe. The difference is even more outspoken with respect to conversion capacity (less than a third of Western Europe). Furthermore, most of the refineries are old, energy intensive and in need of revamp. The capacity utilisation

[48] There is some inconsistencies between different sources.

[49] Oil and Gas Journal March 25, 1996.

rates for the cracking and up-grading refinery processes were also a modest 50-60% by the mid-1990s.

The lacking conversion capacity implies a surplus of heavy fuel oils and the refineries experience difficulties producing the high octane petrol and diesel in the increasing volumes demanded. The depth of processing is an estimated 63% in Russia i.e. heavy fuel oils accounts for 37% of the product slate compared to less than 20% in Western Europe and less than 10% in the U.S.[50]

Over the period 1993-1994, USD 1.5 billion was used for investments in the refinery industry, cf. Oil and Gas Journal March 1996. However, financial instability and payment arrears in the Russian industry in general made the construction activities difficult.

Among the investments completed over the period 1993-1995 were catalytic cracking complexes at the Ufimsky and Omsky refineries, selective purification units at the Novokuibyshevsky refinery, vacuum distillation at the Novo-Yaroslavsky and Aginsky refineries, and hydrorefining units at the Norsi and Orsky refineries.

Table 39.3 *Refinery Processes. 1996. Russia[51] (bbl/day)*

Refinery process	Capacity 1996
Atmospheric distillation	6,720,905
Thermal operations	503,067
Catalytic Cracking	379,533
Catalytic Reforming	843,447
Catalytic hydrocraking	38,356
Alkylation/polymerisation	11,735
Isomerisation/aromatics	70,898
Oxygenates (e.g. MTBE)	2,625

For the period 1996-2000, the subprogram "Reconstruction and modernisation of Enterprises within Oil Refining Industry" outline the introduction of new capacities, which will imply an increase in the production of unleaded petrol up to 65% and increase the depth of processing to 73-75%.

- New preliminary processing units with a capacity of 36.6 million tonnes of crude oil per year of which 10.6 million tonnes is new processing capacity. The remaining capacity addition is merely replacement of outdated capacity;
- 7 new units of catalytic cracking and 3 reconstructed plants with total capacity of 13.2 million tonnes;
- 8 units of hydrocracking and reconstruction of one existing unit with a capacity of 13.2 million tonnes;

[50] Abt (1996): Costs and Benefits of removing lead from petrol in Russia, prepared for US EPA.

[51] World Bank 1997: Phasing out lead from petrol in Central and Eastern Europe, annex A., Ed. Magda Lovei

- 3 new units of cooking and reconstruction of 4 existing units with a capacity of 3 million tonnes;
- 11 new catalytic reformer units with a capacity of 9.3 million tonnes;
- 7 units for alkylation and isomerisation with a capacity of 2.1 million tonnes.

The programme envisage capital investments of USD 12-15 billion. Due to limited financial resources and decreased production, the fulfilment of the programme has been delayed by 2-3 years.

39.4 **Vehicle Fleet**

In 1995, there were 19.6 million passenger cars and light duty trucks in Russia. The total number of passenger cars and light duty trucks have increased by 51% from 1991 to 1995.

The major part of passenger cars are petrol driven. This is also the case with respect to the heavy trucks.

Less than 0.1% of the passenger cars was equipped with catalytic converters in 1996. The average age of light vehicles are 6 years, heavy trucks are on average 8 years and busses are on average 10 years old. The estimated turnover rates are 13%, 3% and 1.5%, respectively. In 1996, 2 million new light cars, 63,000 heavy trucks and 19,000 busses were registered.

There are no emission standards requiring catalytic converters on new cars.

Table 39.4 *The Vehicle Fleet. 1991-1995. Russia*

Information	1991	1992	1993	1994	1995
Number of passenger cars ('000)	13,008	13,903	16,462	17,545	19,600
Number of passenger cars/1,000 inhabitants	87	94	111	118	132
Average passenger car age (years)					6
Average age busses (years)					10
Average age heavy trucks (years)					8
Estimated turnover rate passenger cars (%)					13
Estimated turnover rate busses (%)					1.5
Estimated turnover rate heavy trucks (%)					3
Passenger cars with catalytic converters (%)					<0.1

Table 39.5 *The vehicle fleet according to fuel type. 1995 Russia*

Information	1995
Passenger cars	
% petrol driven (%)	98
% diesel driven (%)	2
Heavy duty vehicles	
% petrol driven (%)	72
% diesel driven (%)	28
Busses	
% petrol driven (%)	27
% diesel driven (%)	63

In Russia, the most common passenger and light duty vehicles are: VAZ, Moscvich, Volga Zaporozhets. For heavy trucks: GAZ, ZIL, KAMAZ and MAZ, and for busses: LIAZ, IKARUS and PAZ are the most common. Thus, the vehicle fleet to a large extent consists of domestically produced vehicles.

The fuel efficiency of the domestically produced vehicles lack behind foreign makes by as much as 20-30%.
It is expected, that domestically produced vehicles and the associated technology will equal international standards for fuel efficiency by 2003-2005. This should lower the fuel consumption of vehicles by 18-20%.

Other options for decreasing the lead emissions include broader use of internal combustion engines and the consumption of compressed natural gas and liquefied oil gas. A conversion of 10% of the vehicles in Russia to gaseous fuels, which are cheaper than petrol, would reduce the consumption of leaded petrol and lower lead emissions by 25%.

39.5 **Distribution System**

No information has been provided on the number of gas stations. There is no differentiation between pump nozzles for leaded and unleaded petrol.

39.6 **Policies and Instruments**

The production share of unleaded petrol was 47% in 1995 and the production of leaded petrol has declined substantially since 1991.

A white paper on lead pollution and the effects has been prepared outlining some of the strategy components and policy measures to be applied in the process of phasing out lead in petrol.

New standards for petrol quality are currently under preparation taking into account international experiences and norms.

Furthermore, Russia aims at lowering fuel consumption. Hence, domestically produced vehicles and the associated technology

will equal international standards for fuel efficiency by 2003-2005. This should lower the fuel consumption of vehicles by 18-20%.

Other options for reducing the lead emissions include the use of alternative car technologies e.g. the consumption of compressed natural gas and liquefied oil gas, which may result in substantial reductions in lead emissions.

On the supply side, Russia intends to increase production of unleaded petrol substantially. According to the Federal programme "Fuel and Energy" including the sub programme "Reconstruction and Modernisation of Industrial Oil Refining Enterprises", the production of unleaded petrol is expected to increase by 65% over the period 1996-2000.

40 Ukraine

40.1 Environmental Pressure and Health Effects

Total lead emissions estimated for all sources as well as the lead emissions from vehicles have declined significantly from 1990 to 1996 corresponding to a reduction of 75%. In 1996, 853 tonnes of lead were emitted from vehicles, which corresponds to 95% of total lead emissions. Thus, the transportation sector in Ukraine is the most important single source of lead emissions, even though the market share of unleaded petrol is high. This illustrates some uncertainties in the figures or indicates that only very few other sources for lead emissions exist in Ukraine. A critical assessment of the figures suggests that lead emission from vehicles was only about 250 tonnes.

In Table 40.1 the development in vehicular lead emissions in Ukraine is shown as stated in the data sheets.

Table 40.1 *Vehicular Lead Emissions, 1990-1996, Ukraine*

Vehicular lead emissions	1990	1991	1992	1993	1994	1995	1996
Total lead emissions (tonnes)	3,363	3,000	2,224	1,526	1,266	1,125	853
Share of total emissions (%)	92	93	93	94	95	95	95
Emissions/km^2 (kg)	5.56	4.97	3.68	2.53	2.10	1.86	1.41
Emissions per 1,000 inhabitants (kg)	64.9	57.8	42.8	29.3	24.5	21.9	16.6

The lead emissions from vehicles have been measured in two larger cities, Kiev and Sevastopol, in the periods 1990 -1996 and 1993-1996. The lead emitted from vehicles in Kiev declined from 98.1 tonnes in 1990 to 26.1 tonnes in 1996. In Sevastopol, the lead emissions from vehicles declined from 3.8 in 1993 to 3.2 tonnes in 1996.

Ambient air lead concentrations for 43 cities in Ukraine, indicated average levels of 0.1 µg/m^3 with maximum values below 1.0 µg/m^3.

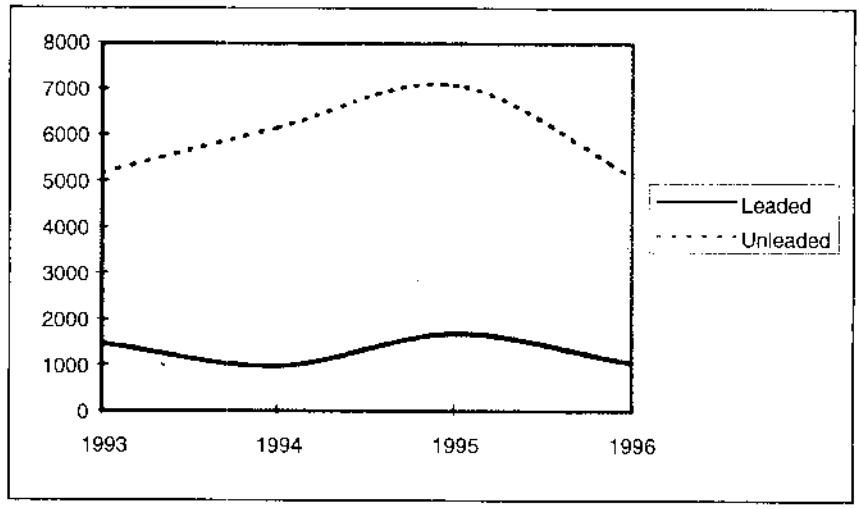
40.2 Production and Consumption of Petrol

From 1993 to 1996, petrol consumption has declined by 10%. From 1990 to 1993 consumption is likely to have declined as well. The consumption of leaded petrol have decreased. Thus the market share of unleaded petrol increased from 78% in 1993 to 84% in 1996. Total petrol consumption amounts to 107 m^3 per

1,000 inhabitants which is low compared to the Western countries.

In Figure 40.1 the development in the consumption of leaded and unleaded petrol is illustrated[52].

Figure 40.1 *Consumption of leaded and unleaded petrol. 1993-1996. 1,000 m³. Ukraine.*



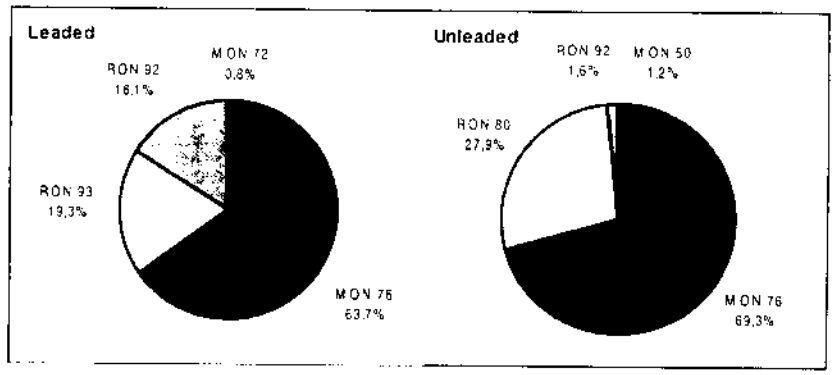
Petrol production in Ukraine declined from a total of 10.9 million m^3 in 1990 to 3.4 million m^3 in 1996. The share of unleaded petrol in the production increased from 79% in 1993 to 90% in 1996. The decline in petrol production is inter alia due to lack of markets for by-products such as diesel oil and other heavy fuels.

For leaded as well as for unleaded petrol, MON76 is the most important product type accounting for 65-70% of production. Other leaded petrol types include RON92, RON93 and MON72 with the latter produced in small amounts. For unleaded petrol, RON80 is the second most important product type, whereas MON50 and RON92 are produced in small amounts. Plans have been developed to upgrade all the refineries to be able to produce larger volumes of high octane unleaded petrol but funding has not yet been available to implement these improvements.

Figure 40.2 below shows the distribution of petrol production by different RON qualities.

[52] Import and export figures are only provided from 1993 to 1996. Therefore the development in consumption is only shown for this period. Furthermore, there is considerable uncertainty as to the exact figures for import and export.

Figure 40.2 *Distribution of Petrol Production on Different RON Qualities. 1996. Ukraine (%)*



The total imports of petrol increased by 37% from 1993 to 1996, and by 40% for unleaded petrol. Petrol imports are registered by customs as imports of unleaded and leaded petrol (lead content exceeding 0.013 g/litre) without specifying the exact lead content or the RON quality.

Because the import and export figures have not been specified into different RON qualities, it has not been possible to assess whether the net-import of petrol in Ukraine consist of high or mainly low octane petrol. However, according to local sources, 35% of total consumption consist of high octane petrol and 65% of low octane petrol. Combining this information with Table 40.2 below implies, that imports are mainly high octane unleaded petrol[53].

Table 40.2 *Supply Balance for Leaded and Unleaded Petrol. 1996. Ukraine (1,000 m^3)*

1,000 m^3	Production	Import	Export	Consumption
Leaded petrol	353	522	3	871
Unleaded petrol	3,074	1,770	234	4,610

In Table 40.3, the maximum and the average actual lead content in leaded petrol is indicated. RON93 has a high lead content. However, it should be noted that the production of leaded RON93 is small (19% of the total production of leaded petrol, which corresponds to 2% of total petrol production).

[53] or lead is added to the petrol without being registered implying a lower market share of unleaded petrol.

Table 40.3 *Maximum Lead Content Allowed and Average Actual Lead Content in Petrol, 1996, Ukraine*

	MON76	RON80	RON92	RON93
Maximum lead content (g/l)	0.17	0.15	0.15	0.37
Average actual lead content (g/l)	0.15	0.13	0.12	0.31

Other (non-lead) lubricating additives are not used in Ukraine.

In 1995, prices on refined products were liberalised.

Ukraine applies tax differentiation between leaded and unleaded petrol. Leaded petrol is taxed 50% higher than unleaded petrol. The prices provided in the data sheets are ex refinery prices. The data sheets indicate an ex factory price differentiation between leaded and unleaded petrol, where the price difference increases with higher octane levels. There is however no price differentiation between leaded and unleaded MON76. Taking into account the fact that prices are ex factory prices and that the level of taxation is small, the resulting consumer price difference between unleaded and leaded petrol is insignificant.

40.3 **Refining Industry**

There are 6 refineries in Ukraine, all incorporated as joint stock companies. The government remains the majority shareholder in one of the refineries.
Crude oil is being imported from the Samara region in Russia through pipelines to the 6 refineries and Ukraine is only supplying small quantities of crude oil.

The total primary distillation capacity of the refineries is 53 million tonnes of crude oil per year. The refining industry is dominated by two relatively large refineries with a capacity of 16-18 million tonnes per year. Four of the six refineries are conversion refineries, the remaining two simpler skimming refineries.

The refineries are relatively unsophisticated with respect to technology and product slate. The depth of refining (or conversion) is about 55%. Hence, the output of light products as petrol is relatively low and the output of heavy fuel oils is correspondingly high.

The low depth of refining is due to the low complexity of the refineries e.g. their secondary refining capacity (cracking, reforming etc.) is relatively low compared to their primary distillation capacity reflecting the historical demand profile for oil products in Ukraine.

Furthermore, the refineries are energy intensive and in need of revamps, especially the four smaller refineries.

The refinery throughput has decreased dramatically over the period 1990-1996 as reflected in the reduction in total petrol production. As a consequence, the overall production capacity utilisation of the refineries is down to around 25-30% from almost full capacity utilisation in 1989.

This is the result of the general economic recession, the misalignment between the product mix produced by the refineries and the demand that continues to grow as demand shifts toward lighter products, and finally a shortage in the supplies of crude oil caused by the decline in Russian crude oil production and the financially depressed situation of the refineries.

Due to financial problems, the lack of cash and working capital, the refineries are unable to buy crude oil on their own account and 70% of the crude oil is supplied under processing arrangements with commercial organisations.

Only two of the refineries produce leaded petrol as of the beginning of 1997.

A technical modernisation plan was approved by the government in 1993 and is expected to be implemented by the year 2000 (originally 1997). The aim of the plan is to satisfy the Ukrainian demand for refined products, produce fuel products for exports, improve the efficiency of the refineries and reduce emissions.

Under the plan Ukrainian refineries are envisaged to add new conversion and up-grading capacity, which will facilitate the production of 100% unleaded petrol at the current volume of petrol production and increase conversion to 72%. The total estimated costs of the programme is USD 1.5 billion.[54]

Most of the activities under the plan have been postponed and have not started yet due to the lack of financing. However, a revamp of the reformer at the largest refinery, Kremenchuk, in the Spring 1997 made it possible to produce only unleaded petrol at the refinery.

A critical issue for the phase-out of leaded petrol is, whether the refineries will or can meet an increasing demand for high octane petrol in the future without resorting to using lead.

In Table 40.4, the total capacity of refinery processes of all six refineries is shown.

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[54] However, the cost of reaching a complete phase-out of leaded petrol production in the year 2000 is USD 200-400 million.

Table 40.4 *Refinery Processes. 1996. Ukraine*[55] *(bbl/day)*

Refinery process	Capacity 1996
Atmospheric distillation	1,261,539
Thermal operations	39,468
Catalytic Cracking	60,545
Catalytic Reforming	155,811
Catalytic hydrocraking	
Alkylation/polymerisation	
Isomerisation/aromatics	9,643
Oxygenates (e.g. MTBE)	

40.4 **Vehicle Fleet**

From 1990 to 1996, the vehicles fleet increased by 30%. In 1996, there were 6,100,000 vehicles corresponding to 121 cars per 1,000 inhabitants.

Table 40.5 *The Vehicle Fleet. 1990-1996. Ukraine*

Information	1990	1991	1992	1993	1994	1995	1996
Total vehicles, '000	4,700	5,000	5,330	5,600	5,800	6,000	6,100
Passenger cars & light duty trucks, '000	3,500	3,700	4,100	4,400	4,600	4,800	4,900
Heavy duty trucks & busses with, '000:	1,000	1,000	1,000	1,000	1,000	1,000	1,000
-petrol engine	800	800	800	700	700	700	700
-diesel engine	200	200	200	300	300	300	300
Other vehicles, '000	200	300	230	200	200	200	200
Number of cars per 1,000 inhabitants	91	96	102	107	112	117	121
Average vehicles age							
- passenger	..	..	5.7	6.9	6.8	7.0	7.0
- trucks			4.8	7.1	7.5	7.9	8.0

A high fraction of the vehicle fleet is heavy duty vehicles and busses (16% in 1996). Further, a high fraction of those are petrol driven. Thus, these vehicles are likely to account for a substantial share of the demand for MON76 petrol.

However, petrol consumption by private cars has increased, while petrol consumption by heavy trucks has plummeted due to the economic recession and the transition implying among other things a shift from heavy to light industry. Hence, spare transport capacity of heavy vehicles was approximately 60% in 1995. This part of the vehicle fleet accounted for the major part of petrol

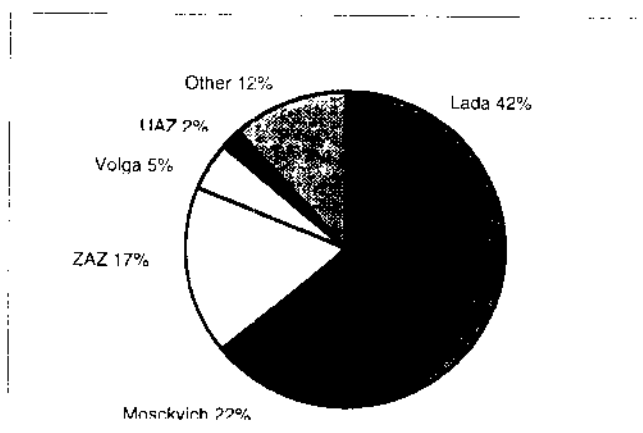
[55] World Bank 1997: Phasing out lead from petrol in Central and Eastern Europe, annex A., Ed. Magda Lovei

purchases until 1995, where the passenger car segment became the main consumer of petrol.

In 1997, Ukraine has made requirements for catalytic converters mandatory on all imported vehicles. From 2003, this regulation is intended to be extended to all vehicles in the country. However, given the low turnover rate of the vehicle fleet, the requirement for catalytic converters is not likely to have any significant impacts on the demand for unleaded petrol and lead emission in the near future.

Figure 40.3 illustrates that the main share of the vehicle fleet originates from CEE countries.

Figure 40.3 *The most Common Vehicles. Ukraine (%)*



Most of the vehicles have low compression ratios implying a low octane requirement, but also low fuel efficiency. Most of the cars have soft valve seats, but no evidence suggests that all NIS-manufactured vehicles cannot use unleaded petrol.

40.5 **Distribution System**

The major part of petrol sales in Ukraine is effected by distributors directly to large enterprises within industry and transportation.

The distribution sector is characterised by the emergence over the last years of a large number of independent petrol wholesalers and retailers, who have replaced the former centrally managed distribution carried out by Urknaftaproduct. The latter has a market share of 20-30% and approximately 2,500 petrol stations.

The private distribution system are in a transition phase with a very loose structure and a low degree of integration. There are no major nation wide "trade-mark" distributors, though some regional networks are emerging. The number of privately owned petrol stations is estimated to 2,500.

The petrol stations have 3-10 pumps per station on average.

There are no separate systems at the retail level for distribution of unleaded and leaded petrol. The same storage tanks and filling pistols are used for unleaded and leaded petrol at the retail level and the enforcement and monitoring of petrol quality standards can at best be characterised as weak. Hence, there is substantial uncertainty with respect to the petrol qualities at the retail level.

40.6 **Policies and Instruments**

The market share of unleaded petrol in Ukraine was 84% in 1996. However, the limit for lead content in petrol is 0.15-0.37 depending on the grade and there is no limit for the content of benzene.

Ukraine applies a tax differentiation scheme, but the resulting consumer price difference is small and the effectiveness of such an instrument is questionable in a context, where a dual distribution is absent and where quality standards at the pump are uncertain.

Ukraine will introduce regulatory measures in terms of making catalytic converters mandatory on all imported vehicles from 1997, and for all vehicles in 2003. An instrument that also requires a dual distribution system and effective enforcement of petrol quarterly standards.

A technical modernisation plan for the refineries was approved in 1993, but implementation has been delayed due to lack of finance and the general economic developments in the country.

A likely scenario is that the refineries in the future will supply only the part of the heavy truck fleet using petrol as it is this part of the petrol market, that requires the low octane petrol, while the refineries without further investment will be unable to satisfy the rapidly increasing demand for high octane petrol by passenger cars.

41 Uzbekistan

41.1 Environmental Pressure and Health Effects

In 1996, 300 tonnes of lead were emitted from vehicles, which correspond to 96% of total lead emissions. From 1990 to 1996, the lead emission from vehicles declined by 51%. The lead emissions from all sources showed a similar trend.

In general, ambient air lead concentrations declined over the period 1990-1996. In 1996, ambient air lead concentrations were below 0.1 $\mu g/m^3$.

Table 41.1 *Vehicular Lead Emissions, 1990-1996. Uzbekistan*

Vehicular lead emissions	1990	1991	1992	1993	1994	1995	1996
Total lead emissions (tonnes)	608	597	408	479	343	481	300
Share of total emissions (%)	97	96	97	98	97	97	96
Emissions/km^2 (kg)	1.4	1.3	0.9	1.1	0.8	1.1	0.7
Emissions per 1,000 inhabitants (kg)	29.7	28.6	19.2	21.8	15.2	21.4	13.3

41.2 Production and Consumption of Petrol

Limited information was available on production and consumption of petrol. Total petrol production was 1.6 million tonnes in 1993, but declined to 1.2 million tonnes in 1996. Approximately two-thirds of the production consisted of MON76. MON72 accounted for the remaining production.

The maximum lead content in leaded petrol is 0.17-0.37 g/l (MON76, RON93 and RON98) and for unleaded petrol it is 0.013 g/l (MON72, MON76, RON93, RON95 and RON98).

41.3 Refining Industry

A new oil-processing plant in the Bukhara region, which is currently under construction, will produce only unleaded petrol (391,000 tonnes of RON93 and 222,000 tonnes of MON76 annually). This facility will complement the two existing refineries with a total capacity of 174,000 bbl/day. The refineries have no conversion facilities. Uzbekistan plans to invest in further capacity for catalytic reforming in order to produce unleaded petrol.

Table 41.2 Refinery Processes. 1996. Uzbekistan[56] *(bbl/day)*

Refinery process	Capacity 1996
Atmospheric distillation	174,715
Thermal operations	27,252
Catalytic Cracking	
Catalytic Reforming	23,487
Catalytic hydrocraking	
Alkylation/polymerisation	
Isomerisation/aromatics	
Oxygenates (e.g. MTBE)	

41.4 Vehicle Fleet

The average vehicle age in Uzbekistan is 10-12 years. The major part of the vehicle fleet is produced by Daywoo in Uzbekistan or imported from the USA, Japan, Europe and Turkey.

There are no vehicles with catalytic converters. But according to "The Law On Atmosphere Protection in Uzbekistan" (December 1996), requirements for catalytic converters can be expected.

41.5 The Distribution System

There are 8,591 petrol stations in Uzbekistan[57]. The average number of fuel pumps per station is 4. No petrol stations offer unleaded petrol. By the end of 1995, 11% of the total number of petrol stations in Uzbekistan were privatised.

[56] World Bank 1997: Phasing out lead from petrol in Central and Eastern Europe, annex A., Ed. Magda Lovei.

[57] The figure seems very high and it is probably a misunderstanding of the question in the datasheet.

Appendix: Data sheets on the use of lead in petrol

If historic data are difficult to provide, please provide information on the most recent year. Furthermore, the highest priority should be given to the provision of data for the tables II.1, II.2, III and V.

Table I *Environmental Pressure and Health Effect*

	1990	1991	1992	1993	1994	1995 forecast	1996 guestimate
Total emissions of lead from *all* sources (total emissions in tonnes)							
Total emissions of lead from *vehicles* (total vehicle emissions in tonnes): - city _____ - city _____ - city _____ - city _____							
Ambient air lead concentration, max short term measurement ($\mu g/m^3$): - city _____ - city _____ - city _____ - city _____							

Textbox I.1 *Blood lead level concentrations*

Please specify any available information on blood lead concentrations in aduls and children, in mean value ($\mu g/dl$). Indicate year of measurements and whether these refer to national, regional or local levels

Textbox I.2 *Measurement of the ambient air and blood lead level concentrations*

Please specify the methodology for measuring the ambient air and the blood lead level concentrations

Textbox I.3 *Health benefits from reducing lead in petrol.*

The main conclusions from, or information provided in, assessments of health effects linked to vehicled lead emissions, if any

Note: Examples of health effects to be considered: IQ loss (children), neurological effects, mortality, fetal deaths, reduced birth weight etc.

Table II.1 *Refining industry*

Refinery name (Data of most recent year: *1995*)	Refinery process								
	Crude distillation[1]			Conversion process[2]			Upgrading[3]		
	Crude oil capacity (capacity in 1000 bbl*/day)	Crude oil processed (processed in 1000 bbl*/day)	Petrol production (production in 1000 m^3/year)	Crude oil capacity (capacity in 1000 bbl*/day)	Crude oil processed (processed in 1000 bbl*/day)	Petrol production (production in 1000 m^3/year)	Crude oil capacity (capacity in 1000 bbl*/day)	Crude oil processed (processed in 1000 bbl*/day)	Petrol production (production in 1000 m^3/year)
1. *Asfaltos Espanoles SA Tarragona*									
2. *Cia Espanola de Petroleos San Roque Algeciras*									
3. *Cia Espanola de Petroleos Santa Cruz de Tenerife*									
4. *Ertoil SA La Rabida*									
5. *Petromed Castellon de la Plana*									
6. *Petronor SA Vizcaya*									
7. *Repsol Petroleo SA Cartagena*									
8. *Repsol Petroleo SA La Coruna*									
9. *Repsol Petroleo SA Ciudad Real*									
10. *Repsol Petroleo SA Tarragona*									

Note 1. Crude distillation refers to the most simple refinery (like topping refinery) and is the precursor for all others. It comprise all kind of crude fraction in the petrol boiling range (light, medium and heavy naphtha)

Note 2. Conversion process refers to a more complex refinery (like hydro skimming refinery) and comprise the process where heavy refinery streams are converted into a spectrum of lighter, more valuable refinery streams, including a moderate quality, high octane blend stock (FCC petrol) and refinery gasses.

Note 3. Upgrading process refers to the refinery in which the octane rating of crude fractions and intermediate refinery streams is increased. Basically, there are three types of upgrading: reforming, isomerization and polymerisation

Note *. bbl for barrel

Text box II.1 *Qualitative statement on the current situation of the refineries*

Please specify any qualitative data on assessment of the current situation of the refineries:	
Age of equipment	
Last revamp[1] : year and other information	
Ownership[2]	
Existing or forthcoming investment plans	

Note 1: The latest year in which major repair and maintenance work has been carried out, qualitative assesment of the current state of repair and maintenance, and description of revamp.
Note 2: Organisational aspects (for example state or private ownership) and expected changes.

Table II.2 *Petrol production, import, export, lead content and prices*

	1990	1991	1992	1993	1994	1995 forecast	1996 guestimate
Productions of leaded petrol and different RON qualities: - RON__ (1000 m^3/year) - RON__ (1000 m^3/year) - RON__ (1000 m^3/year) - RON__ (1000 m^3/year) - RON__ (1000 m^3/year) - Total leaded production (1000 m^3/year)							
Productions of 'unleaded petrol containing lubricating additives' and different RON qualities: - RON__ (1000 m^3/year) - RON__ (1000 m^3/year) - RON__ (1000 m^3/year) - RON__ (1000 m^3/year) - RON__ (1000 m^3/year) - Total 'unleaded containing lubricating additives' production (1000 m^3/year)							
Productions of unleaded petrol and different RON qualities: - RON__ (1000 m^3/year) - RON__ (1000 m^3/year) - RON__ (1000 m^3/year) - RON__ (1000 m^3/year) - RON__ (1000 m^3/year) - Total unleaded production (1000 m^3/year)							

Table II.2 (continued) *Petrol production, import, export, lead content and prices*

	1990	1991	1992	1993	1994	1995 forecast	1996 guestimate
Imports of leaded petrol and different RON qualities: - RON__ (1000 m^3/year) - RON__ (1000 m^3/year) - RON__ (1000 m^3/year) - RON__ (1000 m^3/year) - RON__ (1000 m^3/year) - Total leaded petrol import (1000 m^3/year)							
Imports of 'unleaded petrol containing lubricating additives' and different RON qualities: - RON__ (1000 m^3/year) - RON__ (1000 m^3/year) - RON__ (1000 m^3/year) - RON__ (1000 m^3/year) - RON__ (1000 m^3/year) - Total 'unleaded containing lubricating additives' import (1000 m^3/year)							
Imports of unleaded petrol and different RON qualities: - RON__ (1000 m^3/year) - RON__ (1000 m^3/year) - RON__ (1000 m^3/year) - RON__ (1000 m^3/year) - RON__ (1000 m^3/year) - Total unleaded petrol import (1000 m^3/year)							

Table II.2 (continued): *Petrol production, import, export, lead content and prices*

	1990	1991	1992	1993	1994	1995 forecast	1996 guestimate
Exports of leaded petrol and different RON qualities: - RON__ (1000 m^3/year) - RON__ (1000 m^3/year) - RON__ (1000 m^3/year) - RON__ (1000 m^3/year) - RON__ (1000 m^3/year) - Total leaded petrol export (1000 m^3/year)							
Exports of 'unleaded petrol containing lubricating additives' and different RON qualities: - RON__ (1000 m^3/year) - RON__ (1000 m^3/year) - RON__ (1000 m^3/year) - RON__ (1000 m^3/year) - RON__ (1000 m^3/year) - Total 'unleaded containing lubricating additives' export (1000 m^3/year)							
Exports of unleaded petrol and different RON qualities: - RON__ (1000 m^3/year) - RON__ (1000 m^3/year) - RON__ (1000 m^3/year) - RON__ (1000 m^3/year) - RON__ (1000 m^3/year) - Total unleaded petrol export (1000 m^3/year)							

Table II.2 (continued) *Petrol production, import, export, lead content and prices*

	1990	1991	1992	1993	1994	1995	1996
Max lead content allowed in petrol (g/l): - RON *all leaded* - RON *all unleaded* - RON___ - RON___ - RON___							
Average actual lead content in petrol (g/l): - RON___ - RON___ - RON___ - RON___ - RON___							
Consumer prices and different RON qualities (in national currency) a) leaded petrol: - RON *97* (*Pts*/litre) - RON___ (__/litre) - RON___ (__/litre) - RON___ (__/litre) - RON___ (__/litre) b) 'unleaded petrol containing lubricating additives': - RON___ (__/litre) - RON___ (__/litre) - RON___ (__/litre) - RON___ (__/litre) - RON___ (__/litre) c) unleaded petrol: - RON *95* (*Pts*/litre) - RON___ (__/litre) - RON___ (__/litre) - RON___ (__/litre) - RON___ (__/litre)							

Note: The following conversion factor is used: 1000 litre = m^3 = 5,49 barrel oil. If another unit is used, then please indicate the specific gravity: _____.

Text box II.2 *Lead replacement and octane surplus*

Please describe the technical options for lead replacement and the octane surplus (if any) at a national level and at the refinery level.	
Technical options as the present state of affairs[1]	
Describe and quantify the octane surplus level	

Note 1: Examples of technical options: - utilisation of the reformer severity increasing refinery production of high octane blend-stocks such as reformat - FCC petrol, alkylate, isomerate, blending oxygenates (as MTBE) into the petrol pool

Text box II.3 *Current status of additive use*

Please describe the current status of additive use (blends)

Note: Lubricating additives refer to: iron based compound, potassium, sodium, manganese, or other lubricating additives.

Table III *The vehicle fleet.*

	1990	1991	1992	1993	1994	1995 forecast	1996 guestimate
Total number of vehicles (in 1000 vehicle numbers): a) *Passenger cars and light duty trucks* with: - petrol engine - diesel engine b) *Heavy-duty trucks and busses* with: - petrol engine - diesel engine							
Passenger cars with catalytic converters (in 1000 numbers of cars)							
Average vehicle age: - passenger cars - trucks							
Registration of new cars (in 1000 numbers): - passenger - trucks							
Estimated turnover rate (in number of new vehicles in per cent of total number of vehicles)							
Ten most represented vehicles, divided into 'car makes' (in per cent), most recent year: 1. *Fasa-Renault* 2. *Ford* 3. *General Motors* 4. *Seat (VAG)* 5. *Peugeot-Talbot* 6. *Citroen* 7. *Volkswagen* 8. *Fiat* 9. *Nissan* 10. *Austin-Rover*							

Table IV *The distribution system*

	1990	1991	1992	1993	1994	1995 forecast	1996 guestimate
Tank distribution lorries (in total number of lorries)							
Gas stations (in total number of stations)							
Fuel pumps (in average number of fuel pumps per station)							
Differentiation of pump nozzles between leaded and unleaded petrol (yes/no)							
Percentage of the stations offering unleaded petrol (in per cent of total gas stations)							
Number of stations with vapour recovery installation (in number of stations) - Tank filling - Car filling							
Ownership of the gas stations (in number of stations): - State-owned - Private-owned - Other kind of ownership: 1)_____ 2)_____							

Table V *Policies and instruments*

	1990	1991	1992	1993	1994	1995	1996
Emission standards requiring catalytic converters on new cars (yes/no)							
Quality standards applying to unleaded petrol: - Benzene content (% vol/vol) - Aromatic content (% vol/vol) - Sulphur content (% mass/mass) - Olefins (% vol/vol) - Other *lead* - RON quality covered by the standards: ___							
Quality standards applying to leaded petrol: - Benzene content (% vol/vol) - Aromatic content (% vol/vol) - Sulphur content (% mass/mass) - Olefins (% vol/vol) - Other *lead* - RON quality covered by the standards: ___							
Limit values or values of concern for air lead concentrations ($\mu g/m^3$)							

Table V (continued) *Policies and instruments*

	1990	1991	1992	1993	1994	1995 forecast	1996 guestimate
Tax differentiation on unleaded petrol of leaded petrol prices and different RON quality: (in [consumer price of leaded petrol- consumer price of unleaded petrol]/ consumer price of leaded petrol): - RON____ - RON____ - RON____ - RON____							
Information campaign /awareness building measures (yes/no)							

Text box V.1 *Energy and transport taxation*

Please describe the different energy and transport taxes:	
Taxation on crude oil	
Excise duty on petrol	
VAT	
Road tax	
Other kind of transport taxation	

Text box V.2 *Policy plan and initiatives to accelerate phase-out of lead in petrol*

Please, describe if there are any plans for the phase-out of lead in petrol, and if "yes" describe when lead is expected to be phased out

Text box V.3 *Major obstacles (constraints) to accelerate phase-out of lead in petrol*

Please, describe if any major constraints to accelerate phase-out of lead in petrol have been observed.

Registreringsblad

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Titel:
UN/ECE Task Force to Phase Out Leaded Petrol in Europe

Undertitel: Country Assessment Report

Udførende institution(er):
COWI; Miljøstyrelsen

Resumé:
Markedsandelen for blyfri benzin i Europa er vurderet til ca. 65% i 1996, ca. 70% i Vesteuropa og ca. 50% i Østeuropa incl. det tidligere Sovjetunionen. Rapporten præsenterer resultaterne af en spørgeskemaundersøgelse om status for udfasning af bly i benzin i Europa. Et spørgeskema blev sendt til FN/ECEs medlemsstater dækkende emnerne : blyemissioner og sundhedseffekter, produktion, distribution og forbrug af blyholdig og blyfri benzin, egenskaber ved bilparken, raffinaderiteknologi og antal af raffinaderier samt landets regulering af bly i benzin, herunder planlagte tiltag for at fremme anvendelse af blyfri benzin. 39 lande er beskrevet.

Emneord:
benzin; forbrug; substitution; bilparken; udstødningsgasser; produktion; raffinaderier; spørgeskemaundersøgelser; styringsmidler; Europa; ECE; bly CAS 7439-92-1

Andre oplysninger:
Hører sammen med "Main Report" og "Regional Car Fleet Study", Miljøstyrelsen 1998. - De tre rapporter er tilgængelige på http://www.mem.dk/aarhus-conference/issues.

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Abstract:
The market share of unleaded petrol in Europe is estimated at 65% in 1996, in Western Europe approximately 70%, in Eastern Europe incl. the former Soviet Union approximately 50%. The report presents the results of a survey on the status of the phase-out of lead in petrol in Europe. A questionnaire submitted to the UN/ECE member countries covered the issues: emissions and health effects from lead, production, distribution and use of leaded and unleaded petrol, vehicle fleet features, refinery technology and number of refineries, and policies and measures applied to promote the use of unleaded petrol. Descriptions of 39 countries are included.

Terms:
petrol; consumption; phase-out; car fleet; emissions; production; refining industry; questionnaires; regulatory instruments; Europe; UN/ECE; lead CAS 7439-92-1

Supplementary notes:
Two supplementary publications: "Main Report" and "Regional Car Fleet Study", are published by the Danish Environmental Protection Agency, 1998. - The reports are available at:
http://www.mem.dk/aarhus-conference/issues

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Petrol station in Minsk, Belarus, taken by Ulla Blatt Bendtsen, Danish EPA

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