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PAN-EUROPEAN STRATEGY TO PHASE OUT LEADED PETROL

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EXECUTIVE SUMMARY

Human exposure to lead is a serious environmental problem. Even low levels of exposure retards the mental and physical development of children and can cause heart attacks and premature death among adults. In many urban areas traffic is still the most important source of lead emissions. There is a direct relationship between ambient air concentrations and blood lead levels. Therefore, there are substantial benefits to be achieved from phasing out leaded petrol. The present strategy not only recommends a phase-out date for leaded petrol, namely 1 January 2005, but also intermediate target dates for limits on the lead content of petrol.

While it is both technically and economically feasible to phase out leaded petrol in Europe, there is a need to implement a number of measures to overcome restraints on a rapid phase-out. The strategy identifies such instruments and measures. Some countries have already worked out policies and measures for phasing out leaded petrol, including limits on lead content, tax incentives for unleaded petrol and information campaigns. Studies at specific refineries estimated the cost of the phase-out at US$ 0.01-0.03 per litre of petrol. Phasing out lead from petrol necessitates changes in the product mix of the refinery sector. In this connection, the fundamental issue is how to compensate in a cost-effective way for the loss of octane resulting from the removal of lead from petrol. There are no technical reasons for not using unleaded petrol in most vehicles.

In May 1996, the Committee on Environmental Policy set up an open-ended Task Force to prepare a proposal for a pan-European strategy to phase out leaded petrol, for consideration by the Committee and possible submission to the 1998 Ministerial Conference “Environment for Europe”.

The Task Force investigated the conditions and prospects for phasing out leaded petrol, including studies of literature on the subject, current use of leaded petrol and other relevant matters in each of the European countries, the development of national plans for phasing out leaded petrol in selected east European countries and a survey of the vehicle fleet in eastern Europe.

The Task Force also followed the negotiations on the draft protocol to the 1979 Convention on Long-range Transboundary Air Pollution on heavy metals. The strategy and the protocol are considered as highly complementary initiatives to limit lead emissions.

CONCLUSIONS AND RECOMMENDATIONS

A. Strategy objectives

1. **Overall objective.** The overall objective of a strategy to phase out lead in petrol is to improve the environment and health conditions in Europe. Lead is a hazardous, heavy metal and a known neurotoxin. Evidence from many countries suggests that human exposure to lead is one of the most serious environmental problems facing the population, especially children. Transport is the single most important source of lead emissions.

2. **Immediate objective.** The Task Force, therefore, recommends that the European Ministers of Environment adopt a pan-European strategy on the phase-out of lead in petrol aiming at completely phasing out lead as early as possible and by 1 January 2005 at the latest, and that the countries commit themselves to preventing a possible increase in the average content of benzene and other aromatics as a result of the lead phase-out. Thus:

(a) By 1 January 2005, leaded petrol will not be marketed in European countries.[1/2/]

(b) Furthermore, it is recommended that the countries commit themselves to:

- Seeking to obtain a market share of unleaded petrol of at least 80% by 1 January 2002 at the latest; and

- Setting a limit for the content of lead in leaded petrol of maximum 0.15 g/l by 1 January 2000[3/] at the latest, while the lead content of unleaded petrol shall not exceed 0.013 g/l.[4/]

B. Status of lead use in petrol in Europe

3. A major finding of the Task Force is that many central and east European countries have market shares of unleaded petrol that are higher than or equal to those that can be found in southern EU member States. Thus, the issue of lead phase-out is not solely an east European problem.

4. The 1996 market share of unleaded petrol in all of Europe has been estimated at 65%. Some west European countries have phased out lead completely, while others, notably south European countries, have market shares of 50% or less. By comparison many central and east European countries have similar or higher market shares (e.g. Hungary, Lithuania, Estonia and the Czech Republic). On the other hand, countries like Bulgaria and Romania still have market shares of less than 15%. In western Europe the general limit for the content of lead in leaded petrol is 0.15 g/l, but Greece (in the case of RON90) still maintains a limit of 0.40 g/l. The 0.15 g/l limit has also been introduced in most central and east European countries but a few countries still have higher limits.

5. Generally, the newly independent States have high limits (in the range of 0.15-0.37 g/l) for the content of lead in leaded petrol. Their market share of unleaded petrol appears to be very high. In this regard it should be mentioned, however, that such estimates are largely based on production figures. Typically, more than 75% of the petrol production in the newly independent States include low-octane petrol (less than RON90). Evidence from Ukraine and Kazakhstan, which probably applies to other newly independent States as well, indicates that the market share of unleaded petrol at the end user level is lower than the estimates based on production figures. The average octane of the petrol sold in Ukraine appears to be higher than the average octane of petrol produced and imported, indicating that lead is added somewhere in the distribution system. Furthermore, projections on future petrol demands indicate an increasing demand for high-octane petrol, which, in turn, necessitates either more use of leaded petrol or substantial modernizations of the refineries.

[1/] Armenia, the former Yugoslav Republic of Macedonia and the Russian Federation have indicated that they may have problems in meeting the target date and have called for a delay until 1 January 2008.

[2/] Turkey has indicated that it cannot meet the target date and has therefore reserved its position.

[3/] Turkey has indicated that it cannot attain this limit by the year 2000.

[4/] Romania has indicated (27 March 1998) that it would not be able to meet this commitment.

6. The findings of the Task Force also show that the lead phase-out is well under way throughout Europe, although progress differs significantly between countries. The findings clearly show the environmental and health benefits to be achieved by the removal of lead from petrol. The results, furthermore, prove that it is both technically and economically feasible to accelerate this process.

C. Means of implementation

7. While it is technically and economically feasible to phase out lead from petrol in Europe, the findings also show that there is a need for implementing a number of measures to overcome important restraints on a rapid phase-out. It is very important to note that these instruments crave an effort by the national governments, national stakeholders (refineries and petrol distributors in particular) and the international community (e.g. donors and international financing institutions). Country strategies play an important role in defining the necessary actions.

8. **Country strategies to phase out lead in petrol.** Lead phase-out may be a complicated issue in some countries, and measures need to be taken to overcome different obstacles to a rapid lead phase-out. Framing a country strategy and/or action plan to phase out lead in petrol is an important way to ensure that the lead phase-out is achieved at the necessary costs only; in particular in countries with a highly complex fuel sector. Thus, the strategy identifies the appropriate mix of instruments needed to achieve the phase-out. A strategy should pay particular attention to the issues below; to the important country-specific features; and to an assessment of the costs (private costs and socio-economic costs) and benefits of various options for the phasing out of lead in petrol. Framing and implementing an integrated and comprehensive strategy such as this could also prove to be an important way to improve the access of refineries to commercial and other external financing. The active involvement of major stakeholders in the framing of the strategy is important to ensure its actual implementation. In particular, it is crucial that **refinery modernization plans** are integrated into the strategy, and that allowance is made for possible revisions of existing modernization plans. Among other things, the integration aims at (i) assessing the economic feasibility and costs of particular strategies, (ii) integrating projections for future petrol demand (quantity and structure) into the modernization plans, and (iii) identifying key obstacles at refinery level which can be reduced by means of applying specific measures. Furthermore, the issue of benzene and other aromatics could be considered in a phase-out strategy in order to maximize its environmental benefits.

9. The recommended specific measures are described below. The implementation of these measures, where relevant, is a prerequisite for achieving the above-mentioned objectives. It should be noted that the different instruments are not **listed according to importance.**

1. Enabling conditions and policies

10. **Strengthening the ability of refineries to attract investors.** In some countries the lack of financing, in particular equity financing, is considered the major obstacle to a rapid lead phase-out. Facilitating refineries' access to commercial financing may, therefore, in these cases be a prerequisite for achieving the 2005 objective. The reasons for the apparent difficulties in attracting external financing are many and differ from country to country so the possible actions to ease this restraint are numerous. In some central and east European countries, and in the newly independent States, the refining industry is characterized by excess refining capacity, obsolete technology, poor level of repair and maintenance, and a product slate that no longer matches the demand for refinery products. This last problem is due to the decline in demand for heavy fuels, and the trend of increasing demand for high-octane petrol in the future. These factors call for substantial investments so that the refineries can become

and remain competitive in the long term, and for firm decisions concerning restructuring and privatization of the east European refinery sector. In some countries it may be necessary to undertake rationalizations in the refining industry, and to clarify issues related to ownership and control of refineries. These factors play a crucial role in providing the refining industry with the appropriate conditions to become competitive and economically viable in the long run, and, thereby, attract domestic and foreign investors. To facilitate the refineries' access to commercial financing, it is, therefore, important to thoroughly investigate the country-specific conditions which currently constitute important barriers, and to identify the appropriate national actions to overcome them.

11. **Economic incentives**. Petrol tax differentiation has proven a very effective means of increasing the demand for unleaded petrol in the countries where it has been used. A tax differentiation scheme would render the consumer price of unleaded petrol lower than that of leaded petrol. In the absence of such measures, unleaded petrol will be more expensive than leaded petrol. If leaded petrol is to be phased out gradually, a tax differentiation scheme will be a very effective way to accelerate the phase-out. Furthermore, a tax differentiation scheme will stimulate the marketing and use of other lubricating additives than lead and it may also make requirements for catalytic converters more effective. Tax differentiation schemes can be designed to encourage refineries and petrol distributors to minimize the content of lead in leaded petrol.

12. **Efficient implementation of petrol quality standards.** Effective petrol standards are a prerequisite for achieving a lead phase-out. Without efficiently enforced standards, the effects of information campaigns and economic incentive measures are greatly reduced if not eliminated. Poorly enforced petrol quality standards constitute an important restraint in some countries. This is particularly a problem in countries where the refineries do not control the quality of petrol in the distribution chain, and where there is a large number of small independent petrol distributors. These are dominant features of some central and east European countries and newly independent States. There is a need to strengthen control, monitoring and enforcement of petrol standards. This requires an operational system of government-enforced standards, compliance monitoring procedures (sampling, testing, record-keeping, etc.), and statutory penalties for violations.

13. **Information campaigns**. Unleaded petrol may, without any modifications, be used by all cars which do not have soft valve seats (with a few possible exceptions). Cars with soft valve seats and other cars believed to need leaded petrol present a particular problem in central and eastern Europe (excluding newly independent States). It is estimated that approximately 40% of the vehicle fleet consist of these cars. All vehicles produced in the newly independent States can use unleaded petrol. Information campaigns are an important means to support the demand for unleaded petrol, and they may strongly support the efficiency of the above economic incentives. Campaigns aimed at car owners can, inter alia, inform on the applicability of unleaded petrol, and on the environmental and health benefits of using unleaded petrol.

2. International cooperation and support

14. **External technical assistance.** External technical assistance is crucial to achieving a phase-out of lead in petrol. External technical assistance can prove highly beneficial in the framing of strategies, action plans and possibly also in relation to refinery modernization plans. External technical assistance can also facilitate experience sharing and provide the countries in question with the necessary supply of human resources to accelerate the process. Training and institution building to improve the ability to enforce petrol standards could also prove an important component of the technical assistance provided. Thus, bilateral and multilateral (e.g. Tacis and Phare) western assistance has an

important role to play in the process of phasing out lead from petrol in Europe. As part of the external technical assistance, the following two areas are particularly important:

- **Testing the capability of the car fleet to use unleaded petrol**. Some car manufacturers, e.g. the Dacia manufacturer, still recommend that their cars use leaded petrol. In these cases, it is necessary to investigate (by means of testing) the extent to which leaded petrol is actually required by these cars, and if so, the amount of lead necessary. This is mainly an area of concern in the central and eastern Europe where a substantial share of the vehicle fleet has soft valve seats. Furthermore, it may be necessary to investigate specific car models to ascertain whether it is necessary to replace lead by other additives to provide the lubricating effect for the valves, and to incite the marketing and use of these non-lead additives.

- **Facilitation of experience sharing**. A number of countries have phased out lead in petrol or are in the process of doing so. Other countries still have low market shares of unleaded petrol. A continuation of the experience sharing between these countries is important in the identification of the appropriate phase-out path. The newly independent States have a number of common features which are different from those observed in other countries, and which may make the phase-out of lead from petrol a fairly complicated task in these countries. The facilitation of experience sharing between these countries is, therefore, of the utmost importance to ensure a rapid phase-out of lead. This may, for instance, relate to ways of strengthening enforcement of petrol quality standards, ways of controlling the distribution of petrol, ways of projecting future petrol demands, and the identification and implementation of government measures to support the phase-out of lead from petrol.

15. **Access to concessional financing and other financing of investments from international sources.** Concessional financing can play an important role in accelerating a lead phase-out in specific countries where the lack of financing is considered a major restraint on an accelerated lead phase-out. Economies in transition that are in a state of economic recession and where the financial markets are not fully developed are, inter alia, characterized by a scarcity of financing, high inflation rates and high interest rates. In these cases investment schemes partially financed by international financing institutions on favourable conditions can prove important in facilitating a lead phase-out at the refineries. Thus, international financing institutions have an important role to play in achieving the objective in terms of providing assistance in project preparation and documentation, and in providing (partial) financing for the investments. In this regard, the Project Preparation Committee, which has been established under the Environmental Action Plan for Central and Eastern Europe, is encouraged to support potential World Bank and EBRD investments related to the phase-out of leaded petrol.

Introduction

16. At the third “Environment for Europe” Ministerial Conference, held in October 1995 in Sofia, Bulgaria, the "Sofia Initiatives" presented by six central and east European countries (Bulgaria, Hungary, Poland, Romania, Slovakia and Slovenia) were adopted. One of these initiatives, the Sofia Initiative on Local Air Quality (SILAQ), was to improve local air quality in central and eastern Europe. The promotion of unleaded petrol is one of its main objectives.

17. Another major achievement of the Sofia conference was the endorsement of the Environmental Programme for Europe (EPE). Several of its key recommendations were annexed to the Ministerial Declaration of the Conference. One recommendation was to reduce the lead content in petrol with the ultimate aim of completely phasing out lead from petrol in Europe.

18. Consequently, the Committee on Environmental Policy set up an open-ended Task Force at its third session on 20-22 May 1996 to consider a strategy for the phase-out of leaded petrol in Europe. The Task Force was open to participation by all UN/ECE members. Furthermore, the World Bank, the European Bank for Reconstruction and Development and other organizations were invited to participate. The Task Force held four meetings and took several initiatives to evaluate the possibilities for phasing out leaded petrol in Europe. Based on this, the Task Force has prepared the proposal for a pan-European strategy to phase out lead in petrol presented in this document.

19. In line with its mandate, the Task Force focused on providing the necessary background analyses to work out a technically well-founded proposal for a pan-European strategy. In fulfilling its mandate the Task Force did, however, become increasingly aware of the fact that the phase-out cannot be separated from other environmental and health concerns.

20. Road traffic is a major contributor to the emission of lead as well as to several other severe environmental problems. The phase-out of lead is an important measure to improve the environment and health conditions all over Europe, but it must be underlined that there are still many other environmental problems caused by mobile sources which must also be solved to finally achieve an environmentally sustainable transport system. This is clearly reflected, for instance, in the Declaration of the UN/ECE Regional Conference on Transport and the Environment held in Vienna on 12-14 November 1997 as well as in the Declaration of the central European Initiative (CEI) Ministers: Towards Sustainable Transport in the CEI countries, adopted in New York on 25 June 1997.

21. **Initiatives** taken under the mandate of the Task Force or in parallel include:

- General considerations for a strategy to phase out leaded petrol in Europe;
- Country assessments on, inter alia, the current status of the use of leaded petrol in 37 European countries;
- A country programme for the phase-out of lead from petrol in Ukraine;
- The Sofia Initiative on Local Air Quality (SILAQ) organized a workshop in Burgas, Bulgaria, to facilitate the exchange of experience and information on the phase-out of lead in petrol. All six countries that participate in this Initiative are in the process of working out national plans for the phase-out of lead, or they have already completed their plans. The Task Force and the Initiative have sought to coordinate their efforts so as to improve complementarity and avoid duplications;
- A regional car fleet study;
- A National Commitment Building Programme covering Azerbaijan, Kazakhstan and Uzbekistan; and
- An implementors' guide on the process of phasing out lead in petrol.

22. The conclusions of the Task Force are based on the findings from the above initiatives, supplemented with existing relevant material compiled and processed by the Task Force.

23. In preparing the present proposal, the Task Force has focused on (i) providing in-depth technical analyses and documentation of the issue, and (ii) reaching consensus among Task Force members on the conclusions to be drawn from these analyses. Consequently, this document presents a summary of the technical results and a proposal for a pan-European strategy to phase out lead from petrol in Europe.

24. Within the framework of the Convention on Long-range Transboundary Air Pollution a protocol on heavy metals is being negotiated. This will, among many other objectives, address the question of the phase-out of lead in petrol, including a recommendation for a phase-out date. The negotiations, being highly political and technically complicated, may or may not be completed before the upcoming Ministerial Conference “Environment for Europe” to be held in Århus, Denmark, in June 1998.

25. The Task Force considers a protocol on heavy metals, a natural legal instrument for implementing the common objective of phasing out lead in petrol. Thus, the Task Force views the future protocol on heavy metals and the present, technically focused, strategy for the phase-out of lead in petrol as highly complementary initiatives.

I. ENVIRONMENTAL AND HEALTH IMPACTS OF LEADED PETROL

D. Environmental impact

26. **Seriousness of the problem.** Lead is a hazardous heavy metal and a known neurotoxin that affects the neurological development of young children and causes cardiovascular problems in adults even at low levels of exposure which were previously thought to be safe. Evidence from many countries suggests that human exposure to lead is one of the most serious environmental problems facing the populations, especially the children. (Lovei; 1996 and 1997)

27. **Sources of lead emissions.** In many urban areas, transport is the single most important source of lead emissions. Lead in the form of tetraethyl lead (TEL) or tetramethyl lead (TML) is added to petrol to increase the octane content. The exposure is primarily caused by airborne lead and lead in dust and soil. Lead emissions and exposure in central city areas are typically 3-4 times higher than in the suburbs and 10 times higher than in rural areas. Exhaust from vehicles using leaded petrol typically accounts for more than 90% of the lead emissions into the atmosphere in congested urban areas, when few or no measures to reduce these emissions have been taken. (see for example Lovei; 1996 and 1997 and Walsh and Shah; 1997)

28. Vehicular lead emissions consist of organic and inorganic lead and are highly toxic. Due to the small size of the lead particles, inorganic lead is easily absorbed by the body. Other sources of lead emissions include industrial processes such as metal smelting and production and destruction of lead batteries as well as coal combustion sources such as power plants, incinerators and certain sources of domestic heating.

Box 1 Examples of lead concentrations and effects of lead phase-out

- In Budapest, Hungary, average concentrations of airborne lead in busy parts of the city and those in the suburbs were 3.0 μg/m^3 and 0.4-0.5 μg/m^3 respectively, 1985. *(Lovei and Levy, cited in Lovei; 1996)*
- The percentage of children having blood levels above 10 μg/dl declined from 11.5% to 8.2% in the Hungarian city of Sopron after traffic was re-directed. (*cited in Lovei; 1997*)
- Rapidly decreasing levels of ambient lead concentrations in European countries phasing out lead in petrol clearly demonstrate the benefits to be achieved through lead phase-out. *(DEPA, MEE; 1997)*
- In Jakarta, Indonesia 3.6 μg/m^3 lead concentrations were measured in a central location and 0.3 μg/m^3 in a less congested district, 1987. *(Tri-Tugaswati cited in Lovei; 1996)*

29. **Lead absorption and accumulation.** While vehicular lead emissions primarily pose an immediate health hazard through inhalation, emissions also accumulate in the soil, contaminate drinking water and enter the food chain, thus contributing to ingestion for long periods of time. As lead accumulates in the bones of the human body and is gradually released into the bloodstream there is a very strong argument for arresting this development through an early phase-out of lead in petrol.

30. **Local problem.** The environmental effects of lead emissions are primarily local.

E. Health impact

31. **Children**. Lead emissions are particularly harmful to children, whose developing nervous systems are very susceptible to disruptions caused by lead. This and the fact that children tend to eat dust (hands become contaminated), soil and paint renders this group very vulnerable to the health hazards associated with lead emissions. Children of low-income families may be at special risk because malnourishment and physical stress exacerbate the impact of lead.

32. Exposure to lead retards the mental and physical development of children, causing reading and learning disabilities, changes in behaviour such as hyperactivity, reduced attention span, and hearing loss. The effects on the intellectual performance and behaviour of children have been discovered by intelligence quotient (IQ) tests.

33. Increases in blood lead levels are the best indicators of exposure to lead. Blood lead levels even below 10 micrograms per decilitre (10 μg/dl) can cause serious and persistent damage to the nervous system. Studies in western countries of the relationship between blood lead levels of children and their IQs conclude that an increase in their blood lead levels of 10 μg/dl can be related to a decrease in IQ of about 2.5. This combined with statistical relations between ambient lead concentrations and blood lead levels suggests that a 1 μg/m3 increase in ambient airborne lead concentrations causes an approximate mean decrement of 1 IQ point in children exposed to the emissions. (Studies cited in Lovei; 1996, Walsh and Shah; 1997 and Lovei; 1997)

Box 2 Examples of health impacts of lead exposure and phase-out results

- In Budapest, Hungary, 57% of tested children in downtown areas but only about 2% in the suburbs had blood lead levels over 20 µg/dl. This may cause up to four IQ decrement points in the children in the downtown areas particularly exposed to lead emissions. (Rudnay, Lovei and Levy cited in Lovei; 1996)
- In Manila, the Philippines, 33% of street vendors 6-14 years of age who are exposed to high levels of traffic-related lead emissions had blood lead levels over 20 µg/dl. Only 10% of other sampled schoolchildren of the same age group exceeded the level of 20 µg/dl. Mean IQ decrements due to lead exposure have been estimated at 2.2% in school children and 3.1% in child street vendors, while maximum IQ decrements in these population groups ranged from 4.5 to 6.4 gradients, respectively. (Hertzman, Subida and Torres et al cited in Lovei; 1996)
- In Katowice, Poland, an IQ gradient difference of 13 points existed between children with the highest and the lowest blood lead levels. In Romhany, Hungary, children with blood lead levels above 25 µg/dl exhibited a reduction of 10 IQ points compared to children with blood lead levels below 10 µg/dl. (Hertzman, cited in Lovei; 1997)
- In Bangkok, Thailand, it is estimated that excessive exposure to lead has caused 200,000 to 500,000 cases of hypertension, resulting in some 400 deaths per year in the late 1980s. Similarly, Jakarta, Indonesia, has an estimated 130,000 cases of hypertension each year due to lead exposure. In Cairo, Egypt, more than 800 infants are estimated to die annually in consequence of their mothers' exposure to lead. (*Study results cited by World Bank/Lovei; 1996*)
- In the United States, petrol contributed to about half the blood lead burdens measured in the 1970s. Studies suggest that a decrease of 100 metric tons per day of lead used in petrol is associated with a decrease in mean blood lead levels of 2.14 µg/dl in the American population. In 1976, when leaded petrol was still used extensively in the United States the average blood lead levels of the population was 16 µg/dl. As a result of a gradual phase-out of lead in petrol it dropped to 10 µg/dl in 1980 and 3 µg/dl in 1996. (United States EPA cited in Lovei; 1996)

34. **Foetals**. Foetal exposure to lead may cause adverse reproductive outcomes including reduced gestational age, reduced birth weight, foetal death, and increases in infant mortality. Reduced gestational age and birth weight may, in turn, be associated with other negative effects, such as reduced IQs or other developmental problems.

35. **Adults**. For adults, exposure to even low levels of lead concentrations has been shown to cause high blood pressure with the increased risk of contracting cardiovascular diseases. This may result in heart attacks, strokes and premature death. Exposure to lead may also cause kidney injuries and increase the risk of cancer.

F. Other health and environmental issues of lead phase-out

36. **Benzene** naturally occurs in small amounts in crude oil, and is also one of the many aromatic compounds formed during oil refining, particularly reforming processes. Aromatics increase the octane rating of the petrol. Omitting lead from petrol production may cause refiners to increase the content of aromatics,

including benzene. Thus, phasing out lead in petrol might in some circumstances, if no measures are taken to counteract it, imply increased emissions of benzene and other aromatics. But there are other options for increasing the octane rating, e.g. the use of oxygenates, which, as a side effect, will lower CO and HC emissions. An increased content of benzene may also be avoided by changing the refinery processes. Finally, catalytic converters can help reduce emissions of benzene significantly (by as much as 80%).

37. **Scavengers**. Halogenated lead scavengers are added to leaded petrol to prevent significant deposits of lead in the combustion chamber and on the spark plugs. These scavengers are ultimately exhausted from the vehicle and they create dioxins. There are strong indications that scavengers may be carcinogenic in animals and humans. Removing the lead from petrol will eliminate the need for scavengers and thereby reduce this cancer risk. As a side effect, the lifetime of exhaust pipes and spark plugs will increase.

38. **Hydrocarbons (HC), carbon monoxide (CO) and nitrogen oxide (NO_x) emissions** can be substantially reduced by the use of catalytic converters. The health benefits from a reduction in these emissions are manifold, and a substantial number of countries have implemented catalytic converter programmes.

39. Indeed, emissions of HC, NO_x and CO may be reduced by more than 90%. Catalytic converters, however, require unleaded petrol, as leaded petrol will poison (deactivate) the converter. Evidence suggests that catalyst systems may be very sensitive to the use of leaded petrol and that even an occasional tank of leaded petrol will have a small but permanent effect on the level of emitted pollutants (Walsh and Shah; 1997). Thus, the availability of unleaded petrol is a clear prerequisite for the effectiveness of catalytic converters.

II. STATE OF THE PHASE-OUT OF LEAD FROM PETROL IN EUROPE

A. Market shares

40. Market shares of unleaded petrol have continued to rise in most European countries in recent years. A rough estimate suggests that unleaded petrol held a market share of about 65% in Europe in 1996, and the share is expected to be even higher today.

41. Table 1 provides an overview of the status of phase-out of leaded petrol in a number of European countries. The table is largely based on data provided by the countries themselves, supplemented by information from other sources in a few cases. The table does not include European countries for which no information was available. It should be noted that petrol use estimates are largely based on information on production, imports and exports. Thus, no account is taken either of stock fluctuations or cross-frontier trade. The latter is a major reason for the high per capita petrol consumption in Slovenia.

42. The table clearly shows the trend of increasing market shares for unleaded petrol in European countries. Thus, 16 of the 37 countries listed had market shares above 75% in 1996. Among them, 11 countries had market shares in excess of 90%, and 7 of those had phased out lead in petrol completely by 1996: Slovakia, Sweden, Norway, Finland, Denmark, Austria and Albania. Another 10 had market shares between 50% and 75%. The table also shows a great discrepancy between countries. Thus, 4 of the 37 countries had market shares of unleaded petrol below 20% in 1996, and 7 countries had market shares in the range of 25%-50%.

Table 1. Status of unleaded petrol in Europe[1/]

Country figures apply to latest year available	Maximum lead content inleaded petrol	Emissions of lead from vehicles	Production of leaded and unleaded petrol	Refineries	Market share of unleaded petrol Year, %							Petrol use	
Categorized acc. to 1996 market share	g/l	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
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		10	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*
Azerbaijan	0.12-0.17	15.8	723	2							57		
Russian Federation	0.17-0.37	27.0	36,591	26		30			38	47		33,254	224
50%-74%													
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						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
Republic of 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
United Kingdom	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	0						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: DEPA, MEE; 1997; In the case of Spain, the source is Concawe; 1996.

[1/] The countries have been categorized 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 petrol use is low-octane petrol (i.e. lower than RON90).

43. In view of the proposed EU directive aiming to phase out leaded petrol by 2000/2005 it is remarkable that four EU countries are found in this group; Spain, Italy, Greece and Portugal. These four countries still use significant amounts of leaded petrol. At the same time it should be noted that central and east European countries such as Slovakia, Estonia, Lithuania, Latvia, the Czech Republic, Slovenia and Hungary have comparatively high market shares for unleaded petrol.

44. Many newly independent States appear to have fairly high market shares of unleaded petrol. However, information on petrol distribution in these countries is very limited and subject to a high degree of uncertainty. In Ukraine, for instance, more detailed investigations indicate that lead is likely to be added to the petrol somewhere in the distribution channel to provide the average octane demanded by the vehicle fleet. Thus, the market share of unleaded petrol is likely to be smaller than indicated in the table.

B. Strategies, plans and instruments

45. **Strategies and plans** for the phase-out of lead in petrol have already been worked out in a number of countries (figure in brackets indicate the final phase-out date aimed at): Croatia (2005: 85% market share), Lithuania (1997), Poland (2000), Romania (2003), Turkey (2003) and Slovenia (2000). Hungary and Bulgaria intend to reduce the production of leaded petrol substantially by the year 2000, and Bulgaria also expects to ban the production and import of leaded petrol by the year 2003. The Russian Federation has adopted an action plan to increase the production share for unleaded petrol by 65% by the year 2000. The Republic of Moldova and Belarus intend 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 the year 2000. It appears, however, that some countries have difficulties in achieving these objectives. Thus, the Russian Federation indicates that lack of financing is the main reason why the country is one or two years delayed in achieving the 65% objective. Similar problems are foreseen in other newly independent States and in certain other central and east European countries such as Bulgaria and Romania.

46. The EU Council of Ministers has adopted a proposal for a directive stipulating a ban on the sale of leaded petrol by 1 January 2000. Individual countries may, however, obtain an exemption until 1 January 2005 on the grounds of excessive socio-economic problems or by documenting that a ban would not lead to environmental or health benefits because of the climatic conditions in the country concerned for instance. The proposed directive further includes the possibility of sales of up to 0.5% leaded petrol for use in vintage cars. The proposed directive is subject to further discussions between the Council and the European Parliament, and the adoption of the final directive is expected to take place in mid-1998.

47. **Measures applied.** Past and current experience shows that the following measures are commonly applied in Europe and have proven successful in supporting the phase-out of leaded petrol:

- Reduced limits for lead content in leaded petrol;
- Tax differentiation to the benefit of unleaded petrol; and
- Information campaigns on the environmental benefits and the technical feasibility of using unleaded petrol in different car models.

48. Furthermore, bans on the sale of leaded petrol are in force in Austria, Slovakia and Sweden. The bans were, however, not implemented until a complete phase-out had been achieved.

49. In addition, a number of countries enforce car exhaust emission limits which can be met only by means of catalytic converters. The effective implementation of these limits naturally supports the demand for unleaded petrol.

Box 3 Issues of importance to the phase-out of lead in petrol in newly independent States

Petrol demand. Low-octane petrol holds a high market share in the newly independent States today. The petrol demand structure is, however, likely to change in the future towards higher octane petrol. Vehicles manufactured in these countries have no problems using unleaded petrol. Unleaded petrol appears to have very high market shares in the newly independent States, although information on market shares is uncertain. In the newly independent States, the number of grades sold at the petrol stations can be much higher than in other parts of Europe; 10-15 grades as opposed to about 3 grades.

Petrol supply. Refineries need substantial investments to change their product slate to satisfy with future demand, inter alia, due to a significant decline in the demand for heavy fuels caused by the significant shift to the use of natural gas in energy production. The changes called for include a higher fraction of light products and a higher fraction of high-octane petrol. There appears to be a substantial excess distillation capacity in many newly independent States. Lead is added in very limited amounts at the refineries.

Petrol distribution. There are indications that lead is added somewhere in the distribution channel to bring the average octane pool up to the market requirements. There is no dual distribution of leaded and unleaded petrol. The control of the distribution system appears insufficient, and illegal and/or uncontrolled distribution of petrol takes place. Enforcement and control of petrol standards and other requirements also appear insufficient, particularly at the distribution level. This problem is further complicated by the lack of vertical integration (i.e. lack of involvement of refineries in distribution) and by the substantial number of small independent petrol distributors.

Policies. Refinery modernization plans (often involving lead phase-out among other things) have been worked out in many countries, and they are often accompanied by governmental aims to phase out lead in petrol. However, the implementation of these policies and plans is considerably delayed in many countries. Many countries have implemented, or are in the process of preparing, stricter exhaust emission standards requiring catalytic converters on cars, but the lack of a dual distribution system would render these schemes highly ineffective. Petrol quality standards must be more efficiently enforced and controlled. The lack of a dual distribution system considerably limits the scope of applying market-based instruments to increase the demand for unleaded petrol.

Market conditions. Privatization is well under way in a number of newly independent States. However, in many there still seems to be a need for stable and competitive conditions to undertake the refining activities.

Implications. The current high market shares for unleaded petrol may be difficult to maintain in the future unless there is a substantial upgrading of the refining capacity. There is a need for a dual distribution system to support a gradual phase-out of lead in petrol, and to support the effects of possible requirements for catalytic converters. There is a great need for strengthening enforcement and control of petrol quality standards. There is a need to establish attractive market conditions in order to provide the conditions for establishing a viable and profitable refining industry in the long run and thereby increase the ability of the refineries to attract external investors. There is a high degree of uncertainty as to the actual average lead content in the petrol consumed. This is because most data have been collected at the refinery level (and through the customs authorities). There is a need to collect more information at the retail level to investigate whether, and to what extent, lead is added to the petrol after it has left the refinery or entered the country.

50. **Lead content in petrol.** The majority of the countries in table 1 apply a limit of 0.15 g/l for the lead content in leaded petrol. However, in the newly independent States limits are higher (in the range of 0.17-0.37 g/l). Romania has recently reduced the limit from 0.6 g/l to 0.32 g/l and plans a further reduction by the year 2001. Croatia has a limit of 0.5 g/l for domestically produced petrol, and of 0.15 g/l for imported petrol. Croatia will have a general limit of 0.15 g/l by the year 2002. Greece applies a limit of 0.40 g/l for the RON90 petrol.

51. **Benzene content in petrol.** Increasing concerns over other environmental and health effects from petrol use can be observed in Europe. For example, EU has proposed reduced limits for the content of benzene in petrol from the current level of 5% v/v to 1% v/v. It appears that few, if any, newly independent States have set limits for the content of benzene. However, most other European countries including central and east European countries have a limit for the content of benzene of 5% v/v, and in some countries the limit is only 3% v/v.

III. TECHNICAL OPTIONS FOR PHASING OUT LEAD

52. **Refineries: The key sector.** Most European countries are largely self-sufficient in dominant oil refinery products such as petrol. A few smaller countries (e.g. Estonia, Latvia, Armenia, Republic of Moldova, Luxembourg and to some extent Slovenia) rely on petrol imports. Furthermore, a country like Ukraine, which used to be a major petrol exporter, now imports approximately 50% of its petrol. Phasing out lead from petrol in a country necessitates changes in the product mix of its domestic refinery sector. In Romania, however, the export of unleaded RON90 petrol amounts to about twice as much as its total domestic petrol consumption. One of the reasons for the fairly low Romanian market share for unleaded petrol is the believed inability of domestic car models to use unleaded petrol.

53. **Technical feasibility**. For years oil refiners have added lead to petrol because it is the least expensive way to increase the octane level to meet the requirements of the vehicle fleet. However, there are no technical reasons for not using unleaded petrol in most vehicles. Most importantly, it is technically possible to convert nearly all types of refineries to the production of unleaded petrol, although the costs to do so differ significantly. Conversion of production to unleaded petrol is simpler and less costly in a country with a modern and sophisticated refinery sector than in one with refineries characterized by older and simpler refining technologies.

54. **Octane demand.** In phasing out lead from petrol it must be ensured that refineries are capable of producing sufficient amounts of unleaded petrol with the average octane demanded by the country's vehicle fleet. If the average octane produced is lower than the average octane demanded, it may result in the addition of lead to the petrol somewhere in the distribution system (after the petrol has left the refinery).

A. Vehicles

55. **Petrol quality**. A petrol's octane number is a measure of its propensity to knock in a standard test engine. The higher the octane number, the better the anti-knock performance.

56. **Vehicle fleet structure.** The potential demand for unleaded petrol depends on the share of the vehicle fleet that can operate on unleaded petrol. The consumption of unleaded petrol can further be stimulated by introducing price incentives in favour of unleaded petrol and providing information on the vehicles' ability to use unleaded petrol.

57. Vehicles may be grouped into those (i) equipped with catalytic converters which must use unleaded petrol; (ii) with hardened exhaust valve seats but without catalytic converters, which may use leaded as well as unleaded fuel; (iii) with soft exhaust valve seats, which may not be able to use unleaded petrol; and (iv) with two-stroke engines, which can always use unleaded petrol. Only a small fraction of the existing vehicles in Europe are still presumed to need leaded petrol. They are predominantly found in central and eastern Europe (excluding the newly independent States) where it is estimated that approximately 40% of the vehicle fleet need the lubricating effect for the valves which can be provided by lead. Vehicles produced in the newly independent States can, however, all use unleaded petrol.

58. For example, manufacturers indicate that Dacia and ARO must be fuelled by leaded RON98, Skoda's model 120 (produced before 1993/1994) and FSO (produced before 1990) are also said to need leaded petrol. However, it is obvious that additional testing is necessary to establish the correct fuelling requirements for these engine types. In EU, a directive from 1989 stipulates that all cars sold in EU, with certain exceptions, must be made for unleaded petrol. Since 1991, all cars made in EU have been made for unleaded petrol.

59. **Octane requirement**. Most existing western European passenger cars have engines with high compression ratios that make them very economical in terms of fuel consumption. These engines require fuel with octane ratings up to RON98. Cars made in western Europe normally require RON95. Vehicles with engines with low compression ratios may use petrol with low octane ratings, especially under low to moderate load conditions. These vehicles are widespread in some central and east European countries, notably in the Russian Federation and the former Soviet republics. For example, in the Russian Federation all cars with two-stroke engines use low-octane petrol (MON76). The same goes for a number of Russian-made cars produced as late as the mid-1990s.

60. **Petrol-driven heavy-duty vehicles.** In contrast to the rest of Europe, most heavy-duty vehicles in the newly independent States are petrol-fuelled and use low-octane petrol.

61. **Catalytic converters**. Vehicles with catalytic converters must use unleaded petrol. While compulsory use of catalytic converters will eventually lead to the phase-out of leaded petrol, use of this option as the means to phase out lead from petrol may prolong the process unnecessarily. This is particularly true in central and eastern Europe, where turnover rates for the vehicle fleet are low. Furthermore, it should be underlined that the availability of unleaded petrol in sufficient amounts is a prerequisite for the effective implementation of requirements to equip cars with catalytic converters.

62. **Lubrication of the valves.** Beside its octane-boosting abilities, lead also lubricates the exhaust valves in engine cylinders. Cars with soft valve seats of cast iron or soft steel may suffer under severe engine conditions if the lead content in petrol goes below a certain limit. For all practical purposes the limit is estimated to be substantially lower than the common limit of 0.15 g/l.

During the phase-out process in Denmark, the lead content was reduced to 0.05 g/l, and apparently this did not cause any problems for the vehicle fleet. European car manufacturers guarantee that a level of 0.07 g/l is sufficient. The older part of the car fleet typically consists of cars with soft valve seats, but also brands produced in central and eastern Europe in the early nineties may need the lubricating effect.

63. The refining industry in a number of countries has developed and used a (sodium or potassium-based) additive to replace lead to lubricate the valves in cars with soft valve seats. For example, in Slovakia, where a large part of the car fleet consists of vehicles with soft valve seats, the development and use of a specific alternative lubricating additive is considered of the utmost importance for the successful and rapid phase-out of leaded petrol. This development is an important breakthrough in the efforts to accelerate the phase-out of lead in petrol. The no-lead lubricating additives may be added to the petrol at the refinery, by the distributor, or as is the case in Germany, they may be purchased separately at the petrol stations and added during filling by the car users themselves.

64. In Sweden, an estimated 500,000 cars need the lubricating effect previously provided by lead, and other additives are now used instead. The additives are added to the RON96 and RON98 petrol. Car manufacturers cannot guarantee that catalysts will not be damaged by the additive in the long term.

B. The refinery sector

65. **Oil refining**. An oil refinery transforms crude oils into numerous co-products, one of which is petrol. Petrol production is a complex operation involving the production of a number of petrol components and mixing these blend stocks to a given specification.

66. In a lead phase-out context, the fundamental issue is how to compensate, most cost-effectively, for the loss of octane, resulting from the removal of lead from petrol.

67. The formulation of the end product varies from refinery to refinery. Each refinery is unique and has its own process capacity to produce a unique set of blend stocks. Each refinery has its individual cost structure and faces a unique set of technical requirements when product quality is to be changed or improved, including the removal of lead.

68. **Refinery types**. Refineries may be grouped into three main types based on the complexity of their operations. Topping refineries are the simplest of all. The processes include crude distillation, treating and blending. Hydro skimming refineries are relatively simple, using the processes of crude distillation, treating, upgrading (generally, only catalytic reforming), and blending. Conversion refineries are relatively complex, including crude distillation, treating, upgrading, conversion (e.g. catalytic cracking), and blending. For topping and skimming refineries the mix of refined products is, to a large extent, determined by the quality of the crude oil processed, while the more advanced conversion refineries can yield larger fractions of higher valued light products, e.g. high-octane petrol and high-grade diesel fuel, and less heavy products.

69. **Ability to produce unleaded petrol.** Under normal circumstances, topping refineries cannot produce as much finished petrol with the needed octane number

without adding lead. Most hydro skimmers and conversion refineries can maintain petrol production in a lead phase-out, utilizing either existing refinery plant capacity or through plant or process modification. Most of the approximately 200 refineries in Europe are conversion refineries with facilities to upgrade petrol, e.g. by reforming. Still, the relative capacity differs substantially, and central and east European countries (in particular newly independent States) need significant conversion and upgrading capacity to be able to produce sufficient amounts of unleaded petrol with the demanded average octane number.

70. **Replacing lead**. When no lead is added to the petrol, the octane increment formerly provided by lead (e.g. in the order of 3 RON for 0.15 g/l in the case of high-octane petrol) must be replaced to satisfy the octane requirement of the existing vehicle fleet. Following a decision in EU, all new cars in EU must be able to run on RON95 unleaded petrol. There are several options for replacing lead. In general, the more advanced the refinery, the more technological options exist. In general, capital investments are needed to modernize the refinery operations.

71. The needed increase in octane number can be obtained by (i) increasing the relative volume of high-octane blendstocks (e.g. alkylate and reformate), (ii) increasing the octane of the reformate, and (iii) by adding oxygenates with high octane numbers (e.g. methyltertiarybutylether (MTBE)). Each refinery must find its own individual solutions. Increasing the reformer severity as a single measure can in certain circumstances lead to an increase in the content of aromatics in the unleaded petrol and in the emissions of benzene.

72. Experience from some countries, e.g. the United States and Germany, shows, however, that there need not be an increase in the average level of aromatics, benzene or sulphur after a phase-out of lead. As a result of the increase in oxygenates in petrol, carbon monoxide and hydrocarbon emissions after combustion are significantly reduced.

Box 4 Refinery alternatives for lead phase-out and the implications for benzene emissions

Skimming refineries. The most cost-effective method to avoid adding lead to the petrol will in most cases be to increase reformer severity and/or expand reforming capacity. This option will, however, lead to a larger content of aromatics, including benzene. Alternatively, refineries may add purchased oxygenates or other octane-enhancing additives. These options are not presently thought to have negative environmental and health implications. Adding butane, on the other hand, will increase the volatility of the petrol produced.

Conversion refineries have more ways to avoid adding lead to the petrol pool and avoid increasing other known environmental and health dangers. These additional options include the installation of isomerization, polymerization and alkylation units and the installation of technology to establish their own production of MTBE. Still, increasing reformer severity and/or expanding reforming capacity will in most cases be the cheapest solution for conversion refineries as well.

Implications. There are fewer options available for phasing out lead in skimming refineries compared to conversion refineries. If an increase in the content of benzene is to be avoided in skimming refineries, there are two options: (i) to add purchased octane-boosting additives and/or (ii) to upgrade refineries to include conversion. The former may not be the most cost-effective, but it does not involve substantial up-front investments. The second option normally requires substantial upfront investments. Undertaking these investments will, however, typically allow the refinery to reduce its operational costs for petrol production, and provide it with more cost-effective options to replace lead.

C. Distribution system

73. **Requirements.** The introduction of unleaded petrol may be supported by a distribution system that allows for separate storage, transport and sale of leaded and unleaded petrol. Furthermore, the distribution system must ensure that no contamination of unleaded petrol occurs, which may harm cars equipped with catalytic converters designed to use unleaded petrol only. Sale of unleaded petrol may require new pumps in addition to those used for leaded petrol with different size of pump nozzles to avoid misfuelling.

74. **Distribution of petrol in the newly independent States.** The distribution system presents a specific area of concern in much of central and eastern Europe, notably in the newly independent States. For example, in Ukraine this sector in its present state may prove to be a major obstacle to an effective implementation of a phase-out strategy. The distribution of petrol in Ukraine is largely undertaken by many small distributors, and their number is steadily increasing. There is little exact knowledge on the distribution system, but it remains a fact that control and enforcement of existing legislation on fuel standards and safety regulations are insufficient, and that it is considered a very difficult task to enforce petrol quality standards beyond the refinery level.

IV. ECONOMIC BENEFITS AND COSTS OF PHASING OUT LEAD

A. Economic benefits of improved health

75. The economic benefits of the phase-out of lead equal the avoided economic costs of impacts on health resulting from vehicular lead emissions.

76. **Children**. These social costs primarily relate to reduced productive and earning powers over the lifetime of those suffering cognitive damage. The social costs may be divided into:

- Direct effects of lowered IQ on earnings, e.g. in terms of reduced productivity;
- Indirect effects influencing the length of education and participation in the workforce.

Furthermore, quality of life and general welfare may be affected.

77. The economic benefits of avoided health impacts are country-specific. They depend on cost of labour and capital, labour productivity, life expectancy, cost of health care and the way people value their health and life. The figures given below should be seen in this light. A review of studies on health impacts concludes that a one-point reduction in IQ is associated with a 0.9% reduction in lifetime earnings in the countries studied. Furthermore, learning disabilities among children caused by exposure to lead may result in a need for special education or similar assistance.

78. **Adults**. For adults, the direct costs that may be avoided through a phase-out of lead include medical expenditures owing to hypertension and strokes, missed workdays, other discomforts, restriction in leisure activities, pain, and the risk of premature death.

79. **Factors affecting the health benefits.** The total benefits for a particular country of phasing out lead in petrol depend on a number of country-specific features, such as traffic intensity and population density. As a general observation, central and eastern Europe is characterized by less intense traffic than western Europe and lower population density. Both these factors suggest that the benefits per unit of leaded petrol phased out are likely to be smaller in central and eastern Europe than in western Europe.

80. On the other hand, there is a clear tendency of an increasing number of cars per capita in many central and east European countries, which is likely to increase vehicular lead emissions if no measures are taken to counteract this effect.

Box 5 Examples of valuations of health benefits from phase-out of lead

- The estimated net present value of benefits associated with a 1 µg/dl permanent reduction in mean blood lead levels amounted to US$ 1,300 per child turning 6 years each year in the United States (Schwartz cited in Lovei; 1996)
- The number of children receiving daily assistance beside their regular school education is 17% higher among those with high lead exposure than those with low exposure. *(Bellinger et al).* These costs have been estimated at US$ 3,320 per child with blood levels above 25 µg/dl in the United States in 1989. (Schwartz cited in Lovei; 1996)
- Annual health benefits in the United States of reducing the population's blood lead levels by 1 µg/dl were estimated at US$ 6.9 billion for benefits relating to children and US$ 9.9 billion for benefits to adults. (Schwartz cited in Lovei; 1996)
- In the Russian Federation, it is estimated that the annual environmental benefit (avoided environmental loss) from the complete removal of leaded petrol would amount to US $1.44 billion. The gradual equipping of all cars with catalytic converters would add another US$ 0.8 billion to that amount in terms of additional avoided environmental loss. (SCEP; 1997)

81. Finally, benefits are not distributed evenly across a particular country. Particular urban areas in central and eastern Europe may be exposed to much higher traffic intensity than the country average. These areas would, of course, benefit substantially from lead phase-out. For example, the populations of St. Petersburg and Moscow in the Russian Federation have benefited from the phase-out of lead from petrol in these two cities.

B. Other economic benefits

82. In addition to the health benefits, car owners will also experience savings from reduced maintenance costs as a result of the shift from leaded to unleaded petrol. These savings can be attributed to inter alia: (Studies from United States EPA cited in Walsh and Shah; 1997):

- Longer intervals between spark plug changes;
- Reduced need for muffler replacement; and
- Reduced need for exhaust pipe replacement.

Furthermore, experience from the United States has indicated longer intervals between oil and filter changes. However, this need not necessarily apply to Europe.

Box 6 Components of cost savings from the use of unleaded versus leaded petrol

- Canadian estimates (1980 prices) indicate maintenance savings from the shift from leaded to unleaded petrol in the range of US$ 0.017 per litre of petrol, corresponding to about US$ 27/year. (Mowle, 1981 cited in Walsh and Shah; 1997)

- For the United States, maintenance savings from shifting from leaded to unleaded petrol has been estimated to be in the range of US$ 0.003 to US$ 0.024 per litre of petrol. *(Hirshfeld and Kolb; 1995 and Walsh; 1995)*

- United States estimates of the cost savings for light-duty vehicles lie in the range of US$ 0.00145/km when using unleaded petrol compared to a level of 0.29 g/l. Comparing a level shift from petrol with a lead content of 0.13 g/l to unleaded petrol, the cost savings are estimated to amount to about US$ 0.00037/km (United States EPA, 1985)

83. Although available estimates on the cost savings achieved show a fairly high degree of variation (box 6) and are relatively old, it is nevertheless important to note that significant maintenance cost savings can be achieved by shifting from leaded to unleaded petrol.

C. Economic costs of phasing out lead

84. **Refineries in Europe.** The number of refineries in eastern Europe and the newly independent States is comparable to the number in western Europe. The aggregate crude oil distillation capacity is also of a similar size. However, western Europe has a secondary processing capacity, measured as a per cent of the crude oil distillation capacity, much higher than eastern European refineries and refineries in the newly independent States. The difference is particularly pronounced with respect to the conversion capacity as shown in table 2.

85. Furthermore, the refineries in eastern Europe tend to be older, more energy-intensive, and generally in need of repair and maintenance.

Table 2. Refining capacity in Europe. Petrol production

Region	Number of refineries	Crude oil capacity 1000 b/cd	Catalytic cracking 1,000 b/cd (conversion)	Catalytic hydrocracking 1,000 b/cd	Reforming 1,000 b/cd
Western Europe	112	14,121	2,125	716	2,158
Central and eastern Europe including newly independent States	96	12,650	837	91	1,483

Source: Oil & Gas Journal, Dec. 1996.

86. **Investment requirements.** It is difficult to give an estimate of the investments required to phase out lead. Each refinery in the world is unique with its own profile of technical process capacity, crude oil and product slate. Specific investment strategies depend, inter alia, on the condition of the existing equipment and the potentials and costs of revamping existing units, local market conditions and refining inputs. Hence, the investments needed and the technical options for removing lead should be assessed case by case. However, the cost of phasing out lead from petrol will, in general, be less for the advanced refineries, which have more technological options available for adjusting.

87. Studies and actual country-specific experience in, for example, Slovakia and Bulgaria indicate that a reduction in the lead content of petrol can to some extent be accomplished by optimizing and modifying refinery operations, thereby substantially reducing net costs.

88. The opportunity to blend octane-boosting purchased organic components (e.g. MTBE) into the petrol pool is an alternative to undertaking the upfront capital investments, which to some extent have been used in a number of countries. However, extensive use of this option is usually more expensive in the long run because of the excessive recurrent costs related to this option. Hence, it should be seen mainly as a temporary measure to gain marginal octane in a transition phase, and as a means of fine-tuning the octane pool to satisfy demands.

89. **Cost estimates.** Cost estimates of phasing out lead at refinery level may be made either in terms of estimated investment costs required to change production technology and capacity, or the additional cost per unit of future unleaded petrol production.

90. Cost estimates from a number of studies at individual refineries, including investment cost amortized over the life of the investment and incremental operating costs, indicate that the cost of phasing out leaded petrol is US$ 0.01-0.02 per litre of petrol. The incremental cost of a total lead phase-out has been estimated at approximately US$ 0.03 per litre for less advanced skimming refineries, but may be higher in some cases. These estimates were made for specific refineries and should therefore be interpreted with care. However, the figures seem to be a relatively good indication of the order of magnitude of the phase-out costs. It should be noted that investment requirements at refineries as such may, and often do, largely exceed the above numbers. However, this is because the investments made, which are necessary for a cost-efficient lead phase-out, typically involve a number of additional efficiency gains, which would in any case be needed in a competitive market perspective. The above costs, therefore, relate to the share of investment costs which can be attributed only to the removal of lead.

91. Sweden has estimated that the costs of the additive which has replaced lead to lubricate the valves are about US$ 0.003 per litre of petrol.

92. Hypothetical studies of the refining sector in Latin America and Asia (Abt, 1995) show that the minimum cost solutions of lead phase-out at a hydro skimming refinery and at an advanced conversion refinery exhibit substantial variations. The total costs of a lead phase-out (including capital charges) amount to US$ 0.01 per litre of petrol for the average conversion refinery, compared to US$ 0.02 per litre for the average hydro skimming refinery. However, investment requirements are larger for the conversion refinery (US$ 59 million (per 100,000 barrels/day capacity) compared to US$ 50 million). The hydro skimming refinery will, thus, be

faced with fewer upfront investment requirements, but the total costs per litre of petrol will be higher, because the hydro skimming refinery has to add expensive purchased organic components (such as MTBE) to the petrol pool in order to reach the required octane quality.

93. **Hypothetical cost estimate.** Based on the above study, a very rough estimate of the order of magnitude of investment requirements in central and eastern Europe may be calculated. The estimate assumes that the technological status of the refineries there equals that of Latin American and Asian refineries and that they are similar with regard to other relevant features. This is, of course, a very rough assumption. The cost estimate takes as a staring point the investment cost per 100,000 barrels/day refinery capacity. These investments costs are then scaled by the actual capacity of an average central or east European refinery (approximately 130,000 barrels/day).

94. Under these assumptions, the upfront investment cost of phasing out leaded petrol in the central and eastern Europe (including the newly independent States) can be estimated at US$ 6-8 billion. This figure, however, probably underestimates the real costs of a cost-effective lead phase-out, although the estimate does not take into account that the refining industry in some central and east European countries is fairly advanced, in a good condition and producing substantial amounts of unleaded petrol. Costs could be higher because revamps are not included, and because many refineries are in need of repair in order to operate efficiently with current technology. Secondly, the estimate does not consider the need in some central and east European countries, in particular the newly independent States, to technologically restructure the industry in terms of increasing the conversion capacity and other more advanced processes. (See table 2). The investment costs in this case may range from US$ 200-300 million or more per refinery. Some refineries in central and eastern Europe are likely to need more critical revamps leading to investment costs even in excess of this estimate.

95. For example, a Russian investment programme with a total cost of US$ 12-15 billion aims to switch the product slate towards lighter products including an increase of 65% in the production of high-quality unleaded petrol. The programme thus aims to make the Russian refining industry more efficient, and thereby increase its competitiveness. The figure may, therefore, give a more realistic estimate of the investment costs involved in improving the efficiency of the Russian refinery industry, enabling it also to produce more high-quality unleaded petrol in a cost-effective manner.

96. In conclusion, the investment costs that can be attributed to lead phase-out alone may be estimated very roughly at US$ 6-8 billion. Furthermore, a cost-effective lead phase-out (with the least social costs) will require additional investments to improve the efficiency of refineries in general. These investments can be fairly large, and far in excess of the costs that can be attributed to the lead phase-out alone.

97. **Financial and institutional constraints**. The ease with which the shift to production of unleaded petrol can take place depends on the ability of the sector to respond to changes in product demands. This is particularly an issue in countries where the refinery sector is in transition from State ownership and protection to partial or full private ownership and market liberalization. Many refineries in these countries experience immediate difficulties in attracting investors to provide the often very large capital investments needed for their reconstruction and possible addition of new process units. This is an area of

concern in many newly independent States and in some other central and east European countries such as Bulgaria, Romania and Croatia.

98. **Technical restructuring**. It is generally accepted that the refineries in a number of newly independent States have to reduce their production surplus of heavy fuel oils and shift the production towards lighter products to meet current and future demand profiles. To this end, the refinery sector must undergo technological restructuring to remain profitable. This restructuring can to some extent facilitate the lead phase-out in petrol production as it will increase the octane pool of the petrol production, and because lead phase-out objectives may be included as an explicit component in the restructuring.

Box 7 Examples of modernization programmes in the refinery sector

A number of central and east European countries are in the process of preparing modernization plans and programmes for their refineries. The estimated upfront investments are substantial.

- A major programme for modernization and reconstruction of the refinery industry in the Russian Federation was approved in 1996 at an estimated cost of US$ 12-15 billion. The programme is intended to increase the output of light products at a number of Russian refineries including an increase in the production of unleaded petrol of 65%. However, the fulfilment in the year 2000 of the programme has been delayed 2-3 years due to limited financial resources.
- Without further investments the Bulgarian refineries may at the most attain a production share for unleaded petrol production of 80%. Investments of US$ 110 million, primarily at a medium-sized refinery, are needed to reach a point where the total production is unleaded and has a satisfactory octane rating of RON95. In 1995, about 7.5 million tons of crude oil were processed, and processing capacity is estimated in the range of 12.5 million tons. The major obstacle to modernization and a phase-out of lead at the Bulgarian refineries is the lack of finance. The substantial upfront capital investments should, however, be balanced against the increase in the efficiency of refinery operations and the opportunities for realizing a product slate of a higher value.
- In the final stages of the lead phase-out programme in Slovakia it was necessary to add upgrading capacity at the refinery combined with a unit for the production of a lubricating alternative to lead. The total investment costs in the final stage amounted to US$ 25 million, which translates into a total cost increase of US$ 0.02 per litre of petrol (including operational costs and use of the no-lead lubricating additive). In the earlier stages, reformer severity increase and optimization of refinery operations reduced the lead content in petrol from 0.7 g/l to 0.4 g/l. Further optimization and the addition of organic components brought the lead content down to 0.25 g/l. To bring the lead content down to 0.15 g/l a conversion unit was brought on stream.

99. **Demand projections.** To ensure a long-term cost-effective phase-out of lead in petrol, refinery modernization plans which aim (among other things) at phasing out lead from petrol must be keyed to sound projections of the country's vehicle fleet and hence the likely required volume and average octane of the country's petrol demands.

100. **Distribution.** In most countries, the introduction of unleaded petrol may be carried out without significant changes in the distribution infrastructure. Many countries already have a dual distribution system which clearly distinguishes between leaded and unleaded petrol, and in many of these countries there is also a fairly widespread distribution of unleaded petrol. This is true of all eastern European countries and most central and east European countries, excluding the newly independent States. Still, it should be noted that market shares for unleaded petrol are fairly low in Bulgaria and Romania. Nevertheless, 22% of the petrol stations in Romania offered unleaded petrol in 1995.

101. In the countries which have a wide and separate distribution of unleaded petrol, the costs of gradually increasing the market share of unleaded petrol with the ultimate aim of phasing out lead in petrol completely are likely to be fairly small. They may relate primarily to the once-and-for-all cleaning of tank lorries, pipes and underground storage tanks to be converted to unleaded petrol only.

102. In many newly independent States, there appears to be a need for more substantial changes in the distribution system in order to carry out a gradual phase-out of lead in petrol, and the implementation of these changes may involve significant costs. A major issue in this regard relates to the establishment of appropriate procedures and methods for enforcing and controlling quality standards beyond refinery level. This issue is further complicated by the large number of independent distributors. Furthermore, a dual distribution system is a prerequisite for (i) the efficient implementation of instruments that aim at increasing the demand for unleaded petrol, and (ii) requirements for catalytic converters, which are under consideration in many newly independent States, to have an actual positive environmental effect.

103. The establishment of a dual distribution system in the newly independent States concerned need not, however, mean a need to establish additional pumps at the petrol stations. At present it appears that the number of grades sold in the newly independent States may be quite large (in the order of 10 different grades compared 3-4 grades which are common in many other countries). International experience actually suggests that the optimum is a three-grade structure (Chemsystems, 1996). Thus, the introduction of a dual distribution system might be accompanied by a reduction in the number of grades sold. This has proven a fairly common approach in most of the countries where a dual distribution system has been established. In this case, the costs would relate mainly to the once-and-for-all cleaning mentioned above and to the provision of different pump nozzle sizes for the leaded and the unleaded grades. It may, however, be carefully considered whether a full cleaning of the system is appropriate. Switzerland, for instance, undertook a drainage only of tanks, pumps and pipes when changing from 0.15 g/l to 0.013g/l (unleaded petrol).

V. FEASIBILITY AND PHASE-OUT MEASURES

104. Experience in Europe and elsewhere has proven the economic and technical feasibility of phasing out leaded petrol. However, the conditions for phasing out lead in petrol in Europe may vary a great deal from one country to the other. Important parameters for the feasibility of phasing out lead are presented in table 3. The table summarizes the major observations made by the Task Force with respect to the feasibility of the phase-out of lead from petrol in Europe.

A. Feasibility and constraints

105. **Phase-out is feasible.** The most important conclusion of the work of the Task Force is that it is technically and economically feasible to phase out lead from petrol in Europe in the not too distant future. Experience in Europe and elsewhere has shown the economic and technical feasibility of phasing out lead in petrol. Furthermore, experience has also shown that the phase-out of lead in petrol can be achieved without increases in benzene emissions. This may, however, mean that government action is needed to regulate benzene content as well.

106. **Technological restructuring.** Many newly independent States' refining industries experience great changes in the demand for their products. This calls for substantial technological changes at the refineries in order to be competitive and profitable in the longer run. In itself, this may prove to be an enabling factor in the process of phasing out lead. Lead phase-out objectives can be, and often are, incorporated in these modernization plans at fairly low additional costs since the modernizations called for in themselves are very costly and involve substantial technological upgrading.

Table 3. Parameters that affect the feasibility of a lead phase-out

Sector	Parameters	Impact on feasibility	Country-specific features
Car owners	Vehicles with soft valve seats	The use of other lubricating additives is an important means to overcome this obstacle.	Cars believed in need of leaded petrol dominate relatively more in the central and eastern Europe. It appears that almost all cars in the newly independent States can use unleaded petrol.
	Vehicles with catalytic converters	Catalytic converter requirements can assist in making unleaded petrol more widely available.	Requirements in force in EU and in many central and east European countries including newly independent States associated to EU.
	Awareness of consumers	Car owners may be sceptical about the applicability of unleaded petrol.	This constraint exists to some extent in the central and eastern European. Awareness-building measures have proven suitable in this context.
Refining industry	Amount of production in the country	The feasibility of a lead phase-out tends to be larger in countries with little or no petrol production.	No refineries in small countries such as Estonia, Latvia, Georgia, the Republic of Moldova, Armenia, Luxembourg and little production in Slovenia. Other countries such as Spain, Italy, the Russian Federation, France, United Kingdom, Bulgaria and Germany have a large refining industry.
	Technologies applied in production	The higher the level of technology applied initially, the higher the octane pool and the less costly it will be to omit lead from petrol.	A general need for repair and upgrading in the newly independent States and in some other countries such as Bulgaria and Romania. Most newly independent States need technological restructuring to facilitate the necessary changes in the product slate. Lead phase-out objectives could be integrated in the process.
	Ability to attract external finance	Upfront investment requirements may often be substantial. The ability of refineries to attract domestic or foreign investors is a crucial factor in achieving a lead phase-out. Difficulties in attracting external finance may stem from the current structure of the refining industry and the general conditions in the country considered for undertaking refining activities.	Large excess distillation capacity in many newly independent States coupled with the need for substantial technological restructuring may require rationalizations to be carried out to establish a competitive and profitable refining industry. The appropriate conditions to undertake rationalizations and the establishment of stable and competitive conditions for the activities in the refining sector are prerequisites to attract investors. These issues need to be considered in a strategy for the phase-out of lead in petrol (see below), if such a strategy is to be fully implemented.
Distribu-tion system	Dual distribu-tion and availabi-lity of unleaded petrol.	A dual distribution system can support a gradual phase-out of leaded petrol. If unleaded petrol is initially available at most petrol stations it will be rela-tively inexpensive to increase sales of unleaded petrol.	The lack of a dual distribution system is mainly an observation in some newly independent States such as Ukraine. In the newly independent States, there is a substantial number of grades sold. Limiting their number may reduce the costs of establishing a dual distribution system. The lack of a dual distribution system substantially weakens the environmental effect of catalytic converters.
Policy level	Political commitment	The development of a comprehensive and operational strategy to phase out leaded petrol which takes into account the overall specifics of and conditions in the country is important to the realization of an overall phase-out.	EU proposal for a ban on sales of leaded petrol by 2000/2005. Many central and east European countries have developed plans for the phase-out of lead from petrol. Their actual implementation may, however, in many cases be hindered or delayed by the lack of finance to undertake the necessary investments at the refinery level.
	Use of policy measures	Tax differentiation and awareness-building measures are important means to increase demand for unleaded petrol.	Tax differentiation is widely used in western Europe. It is also used in some central and east European countries, but the resulting consumer price differences tend to be smaller. Awareness building (information campaigns) have been used successfully in some countries, in particular in western Europe.
	Enforcement and control	Effective enforcement and control of petrol and emission standards are -necessary to ensure the de facto efficiency of such standards including standards for lead content in leaded and unleaded petrol.	Enforcement and control may be insufficient in some central and east European countries, among which are the newly independent States. For example, in Ukraine, enforcement and control are stated as a primary area of concern in regard to the feasibility of a de facto and sustainable phase-out of lead in petrol.

107. **Investment costs.** While investment costs related to the necessary refinery conversion may be high, the increase in operating costs that can be attributed to the removal of lead alone will result in only fairly small increases in consumer prices. Still, it is important to recognize the concerns in many central and east European countries and newly independent States about the substantial upfront investment requirements.

108. The difficulties which some countries experience in attracting external investors to finance the necessary repair and upgrading must, however, be considered in a broader context in order to assess the actual reasons for investors' reluctance. Fundamentally, the refining industry is considered a favourable investment opportunity on the international markets. However, this presupposes, among other things, that prevailing conditions allow the sector to act competitively and are stable and foreseeable. These conditions are a prerequisite for the ability of the sector to remain or become profitable and to plan long-term. The fact that these conditions are not fully provided in some of the economies in transition may actually place a stronger restraint on the implementation of a phase-out strategy than the investment requirements per se. By the same token the removal of this restraint is likely to be a very difficult and complicated task in many countries as it may, inter alia, involve large socio-economic costs. These costs will arise as a result of structural rationalizations and modernizations in the refining industry.

109. Finally, it should be mentioned that the magnitude of the up-front investment requirements may hamper a determined effort to phase out lead in petrol. It is therefore crucial to underline that (i) the refining industry is a very capital-intensive industry and the investment requirements should be seen in this light, (ii) the investment costs must often cover substantial upgrading and repairs which will also help to improve the general cost-efficiency substantially at the refinery concerned, (iii) the investment costs may be depreciated over many years. Consequently, the cost per litre of petrol can be estimated to be in the range of US$ 0.01-0.03 per litre of petrol.

110. **Enforcement and control.** Adequate enforcement and control of petrol quality standards (in terms of regulations, compliance monitoring procedures (sampling, testing, record-keeping, etc.) and statutory penalties for violations) together with an environment where the rule of law prevails, are prerequisites for a de facto phase-out of lead in petrol. In some countries the lack of appropriate resources, procedures and technology may be an obstacle to efficient enforcement and control. This may prove to be an important barrier to an effective implementation of a strategy to phase out lead in petrol, and it is, therefore, important to consider how to address this very complex issue.

111. **Dual distribution system.** A dual distribution system is a prerequisite for consumer ability to make a deliberate choice between unleaded and leaded petrol. This has implications for the efficiency of catalytic converters. Furthermore, a dual distribution system is also necessary in a process where unleaded petrol is gradually phased in at the expense of leaded petrol. A gradual phase-out of leaded petrol could be accompanied by measures to stimulate the demand for unleaded petrol. The absence of a dual distribution system renders it difficult, if not impossible, to apply these measures. The lack of a dual distribution system in (some) newly independent States need not, however, be considered a restraint in itself. Rather, it is the lack of efficient control and enforcement which counteracts the establishment of a dual distribution system. Once efficient control and enforcement are in place, economic incentives and awareness-building

measures can also be implemented. The introduction of these measures will incite the distribution system to establish a dual distribution of petrol as a response to the resulting changes in consumer demand. The lack of sufficient control and enforcement may, however, also be an obstacle to the establishment of a dual distribution system by applying regulatory measures (for example, a requirement that all petrol stations, or all new petrol stations, must have at least one pump for unleaded petrol).

112. Phasing out lead from petrol without a dual distribution system would still require efficient control and enforcement. The lack of a dual distribution system would in this case mean that the phase-out would be accomplished by gradually reducing the lead content in leaded petrol, and it would mean that requirements for catalytic converters cannot be implemented until the phase-out has been completed. Otherwise, the converters could be destroyed. Furthermore, the lack of a dual distribution system would make awareness building ineffective. Economic incentives could still be applied, but only vis-à-vis the refineries, and their efficiency would depend on the tax differentiation being fully reflected in consumer prices.

113. **Vehicle fleet**. The composition of the vehicle fleet has been put forward as a potential restraint for an accelerated phase-out of lead. Still, the car fleet study (covering selected central and east European countries) and experience from a number of countries seem to indicate that the seriousness of this restraint is limited in the present circumstances. A major breakthrough in this regard is the development and widespread use of other additives than lead to give the lubricating effect for the valves in cars with soft valve seats. Furthermore, awareness-building measures have proven suitable in a number of countries to overcome consumers' reluctance and scepticism with regard to the applicability of unleaded petrol.

B. Phase-out measures at the national level

114. **Plans and instruments applied.** During the last 5-10 years a trend can be observed in Europe where more and more countries work out plans for a phase-down or phase-out of leaded petrol. These plans often include, or are accompanied by, specific instruments to support this process, e.g. lower limits for the lead content in leaded petrol, (stricter) limits for the benzene content, economic incentives and awareness-building measures. These trends reflect increasing concerns about health effects attributable to vehicular (lead) emissions, and a recognition of the need to take action to reduce or eliminate these effects. As such they are important in relation to an acceleration of the phase-out of lead in Europe. However, there are indications that some countries may face difficulties in achieving these objectives. For these countries, and for countries which have not yet adopted a strategy or a plan to phase out lead in petrol, working out a strategy which considers the issue of lead phase-out in a broad and comprehensive context may prove highly beneficial. A strategy like this may facilitate a cost-effective phase-out of lead which takes into account, for example, the socio-economic costs involved and other environmental effects from petrol production and use.

115. A country strategy should also contain a time schedule for the lead phase-out, and it may, furthermore, identify the instruments to apply in the process. Tables 4 and 5 summarize the major interventions which may be applied to support the phase-out of lead.

Table 4 Possible measures and activities to stimulate production and distribution of unleaded petrol

Type of measure or activity	Specific measures or activities	European experience		Efficiency considerations
		+/-	Comments	
Regulatory measures	Ban on production and/or sales of leaded petrol	(+)	Bans have been implemented only after lead was phased out.	In the period of adjustment, the imposition of bans will substantially reduce the scope of action on the part of refineries, which can lead to excessively high costs. At the final stage of the lead phaseout, bans on sales can ensure that imports of leaded petrol do not take place. This is particularly relevant in countries bordering countries where leaded petrol is produced.
	Reduction of the limits for lead in leaded petrol	+	Reductions have been widely implemented. 0.15 g/l is the common limit in Europe.	A highly relevant first step in countries where the lead content is still high. Experience proves that refinery costs need not be very high, and that the soft valve seats do not need a lead content above 0.15 g/l to provide the lubricating effect.
	Ban on the use of scavengers in leaded petrol	+	Scavengers have been eliminated in many European countries.	Experience from Germany indicates that at a level of 0.15 g/l of lead in leaded petrol there appears to be no technical obstacles to removing the scavengers.
Economic measures	Tax on the production of leaded petrol	-		Assumes that import and production are efficiency controlled. Entails a risk that lead may be added later in the process.
	Lead credit trading	-	This scheme was applied in the United States.	The applicability in Europe is highly limited. European experience with such schemes is limited, and the scheme is dependent on well-functioning markets.
Financial incentives	Support for feasibility studies and other studies	+	International donor supported feasibility studies have been prepared in some central and east European countries, as well as country strategies and sector analyses.	Feasibility studies, sector studies and assistance to the preparation of country strategies are undoubtedly important components to facilitate an acceleration of the phase-out of lead from petrol in Europe and to ensure a cost-effective phase-out. Of particular relevance is the provision of international assistance to central and east European countries where government resources are limited, and where investment needs are perceived to be the highest. Such studies can help to identify areas of particular concern to ease the access to finance and facilitate the access to concessional finance for investments.
	Access to concessional finance	(+)		In countries where the refinery does not operate under full market conditions provision of concessional finance, e.g. from development banks, may be warranted.

Table 5 Possible measures and activities to stimulate the use of unleaded petrol

Type of measure or activity	Specific measures or activities	European experience		Efficiency considerations
		+/-	Comments	
Regulatory measures	Car exhaust emission limits	+	The limits can be met only by the use of catalytic converters.	Should not be considered an instrument for phasing out lead from petrol, but can have an important supportive role in this process.
	Separate distribution of unleaded petrol	(+)	Applies In Western Europe and in most central and east European countries.	In some countries, notably the newly independent States, the lack of a separate and controlled distribution of unleaded and leaded petrol is the critical restraint on a phase-out of lead in petrol, as it is a prerequisite for the efficiency of economic measures and awareness-building measures, and for the monitoring and control of petrol sales in general.
	Different sizes of filling pistols	(+)		
Economic measures	Tax differentiation	+	Applies widely in Europe, especially western Europe	In a number of central and east European countries, fiscal concerns may be a restraint on the use of tax differentiation schemes, unless these are designed to be fiscally neutral. Still, if the distribution system is properly organized, tax differentiation can be a highly effective measure to promote a lead phase-out in these countries too.
Awareness building	Information campaigns	+	Applied in western Europe	Campaigns may provide information on the health effects of lead, on the applicability of unleaded petrol for different car makes and models, on the possible availability of other lubricating additives than lead and on other measures or initiatives taken (to support the effects of these). The effect of awareness-building measures increases the more environmentally aware consumers are and the more concerned they are with the condition of their vehicles.

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