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TNO-report

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Incremental cost and remaining emission in 2010 of Heavy Metals (HM) resulting from the implementation of the draft HM Protocol under the UN/ECE Convention on Long Range Transboundary Air Pollution

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Summary

Within the framework of the UN/ECE Convention on Long-Range Transboundary Air Pollution a protocol is under preparation to reduce air amissions of heavy metals. This project aims at determining the effect of emission reduction and the potential costs of the implementation of the protocol, per country and per emission source category. Furthermore, attention will be converged on the benefits in relation to future emissions after the implementation of the Protocol.

Emission projections, prepared for the year 2010, are based on 'The European Emission Inventory of Heavy Metals and Persistent Organic Pollutants for 1990' [UBA-TNO '97] and the Official Energy Pathway scenario (OEP) of RAINS 7.2 [IIASA '97].

The species involved are cadmium, lead and mercury, the three heavy metals covered by the Protocol. Also, the effect of measures to reduce emission from cadmium, lead and mercury on the future emissions of copper, zinc, chromium, arsenic and nickel has been calculated as well.

Three types of emission projections have been prepared:

1. Applying the OEP Scenario, without any emission reduction activity;
2. Applying the OEP Scenario, assuming a range of autonomous emission reducing activities (i.e. non-protocol related measures, both country and region specific);
3. Applying the OEP Scenario, assuming both the autonomous emission reducing developments (2) and the implementation of the Protocol measures.

The results of the emission projections are presented per region in the figures below:

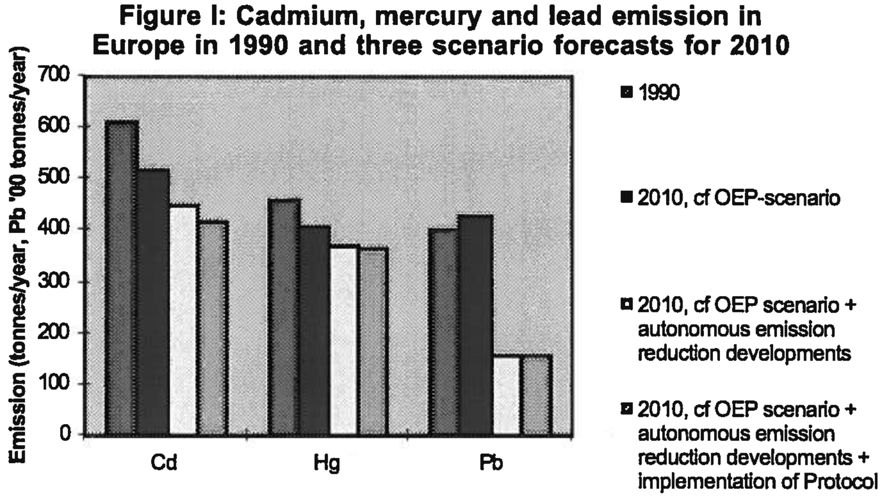


Figure I: Cadmium, mercury and lead emission in Europe in 1990 and three scenario forecasts for 2010
Emission (tonnes/year, Pb '00 tonnes/year)
700
600
500
400
300
200
100
0
Cd
Hg
Pb
1990
2010, cf OEP-scenario
2010, cf OEP scenario + autonomous emission reduction developments
2010, cf OEP scenario + autonomous emission reduction developments + implementation of Protocol

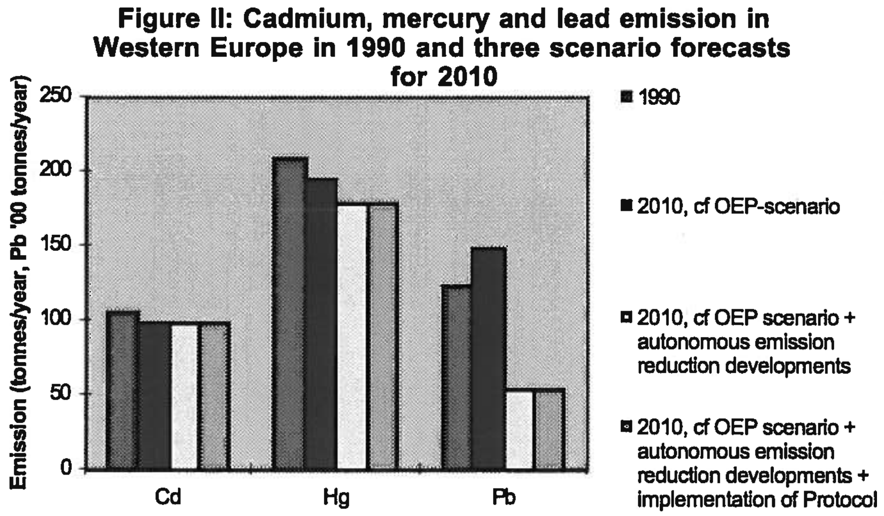


Figure II: Cadmium, mercury and lead emission in Western Europe in 1990 and three scenario forecasts for 2010
Emission (tonnes/year, Pb '00 tonnes/year)
250
200
150
100
50
0
Cd
Hg
Pb
1990
2010, cf OEP-scenario
2010, cf OEP scenario + autonomous emission reduction developments
2010, cf OEP scenario + autonomous emission reduction developments + implementation of Protocol

Figure III: Cadmium, mercury and lead emission in Southern Europe and three scenario forecasts for 2010

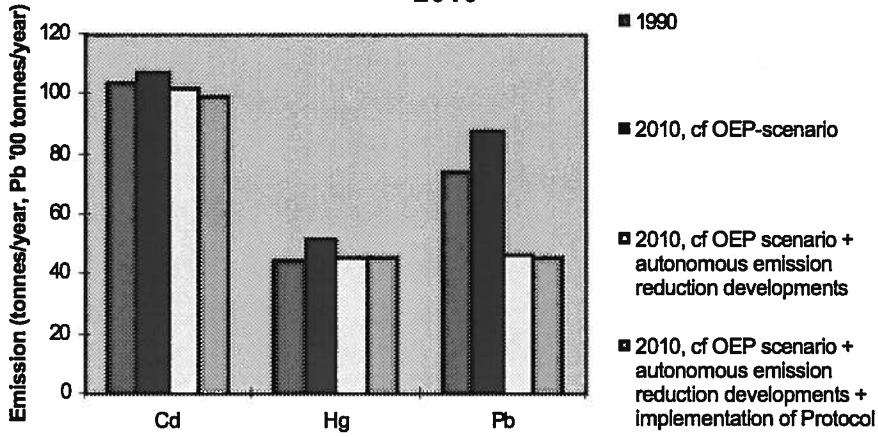


Figure IV: Cadmium, mercury and lead emission in Central and Eastern Europe in 1990 and three scenario forecasts for 2010

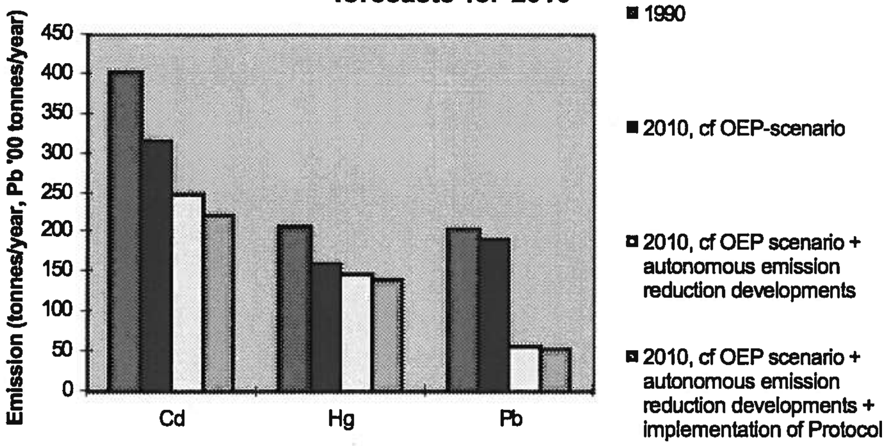
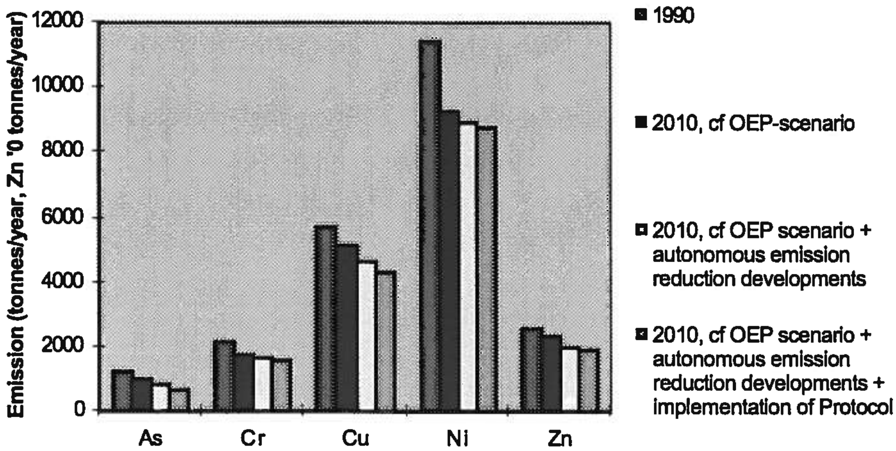


Figure V: Arsenic, chromium, copper, nickel and zinc emission in Europe in 1990 and three scenario forecasts for 2010



As a result of autonomous developments and the HM Protocol besides cadmium, mercury and lead also for 5 other HM emissions will be reduced (see figure 5). The following emission reductions are estimated for Europe:

Table I *Emission reduction after the implementation of the HM Protocol in Europe compared to 1990, for cadmium, lead and mercury and 5 other HM.*

Substance	Emission level in 1990 (tonnes)	Emission level in 2010 after Protocol (tonnes)	Reduction (%)
Cadmium	610	420	32
Mercury	460	360	21
Lead	40000	15000	62
Arsenic	1200	700	42
Chromium	2200	1600	27
Copper	5700	4300	25
Nickel	11000	9000	23
Zinc	26000	19000	25

For stationary sources the main abatement measures comprised dedusting. Also for PM_{10} emission is expected to decrease as a result of the protocol. Achieved reduction is expected to lie in the order of 30%. More detailed information will follow this report.

The incremental costs of the implementation of the HM Protocol have been estimated both with and without taking into account autonomous emission reduction measures.

For the following source categories Protocol-related emission control for dust/HM has been capitalised:

Public power stations (hard coal, lignite, oil shale and residual oil fired)
Industrial combustion (hard coal, lignite, and residual oil fired)
Basic oxygen furnaces in the iron and steel industry
Electric arc furnaces in the iron and steel industry
Sinter agglomeration plants in the iron and steel industry
Copper works
Lead works
Zinc works
Cement production plants
Glass production plants
Chloro-alkali industry
Waste incinerators

The total annual costs of implementation of measures listed in the UN/ECE draft HM Protocol are estimated to amount to 440 MECU/year when also the foreseen autonomous emission reducing developments would take place (the contribution would amount to 1300 MECU/year without any autonomous developments). By far the largest contribution comes from emission control at stationary sources, more than 90%. The total investment costs are estimated to be 3,5 billion ECU (11 without any autonomous developments). Protocol-related emission reduction measures concerning restrictions on or elimination of the use of heavy metal containing products are estimated not to significantly influence the total costs of the HM Protocol when expected autonomous developments are counted for. Figure VI indicates the distribution of the annual costs of the HM Protocol implementation over the different source sectors after expected autonomous emission reduction measures have taken place. Costs of the Protocol without any additional autonomous emission reduction activity are presented in figure VII.

Figure VI: Annual cost of HM Protocol (440 MECU/year) after autonomous developments, for Europe, by sector

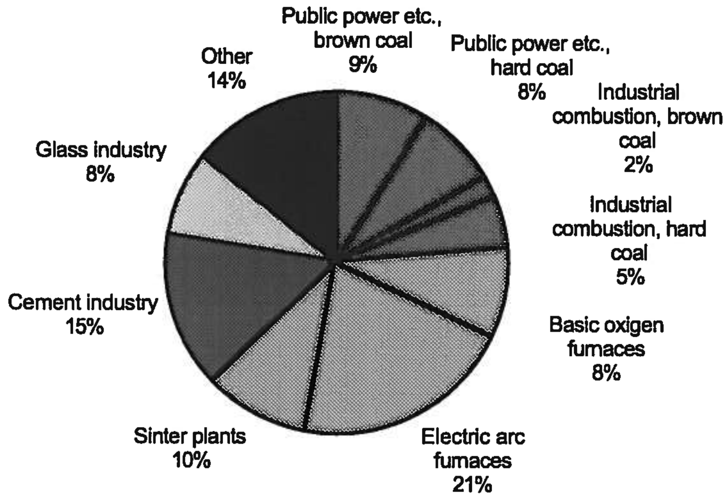
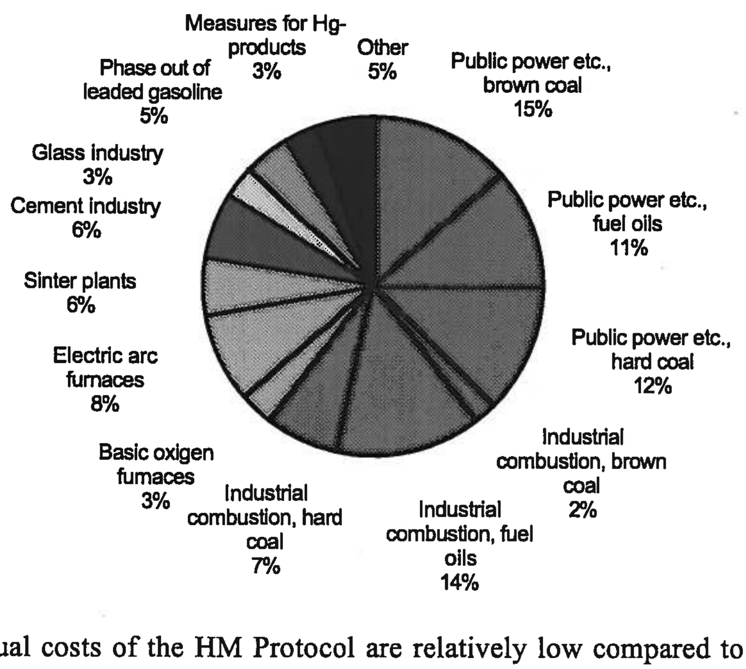


Figure VII: Annual cost of HM Protocol (1,300 MECU/year) without autonomous emission reduction, for Europe, by sector



Annual costs of the HM Protocol are relatively low compared to the costs of emission control of sulphur and nitrogen oxides within the UN/ECE framework [IIASA '97].

Content

Annex:

1 Results of emission projections per substance, per source category and per country
2 Detailed overview of the link between sectors from RAINS 7.2 and [UBA-TNO '97]

1. Introduction

1.1 Framework of this study

At the Third International North Sea Conference it has been decided by Ministerial Declaration that emissions of Priority Hazardous Substances were to be reduced by 1995 (or 1999 at the latest) by 50% or 70% (depending on substance) of the emission level of 1985. The Oslo and Paris Commissions (OSPARCOM) have been requested to co-operate with other relevant international organizations to realise an inventory of atmospheric emissions. These organizations are the Helsinki Commission (HELCOM) and the Executive Body (EB) for the United Nations Economic Commission for Europe (UN-ECE) Convention on Long-range Transboundary Air Pollution (LRTAP). Within the framework of OSPARCOM, HELCOM and the UN-ECE a European emission inventory on heavy metals (HM) and persistent organic pollutants (POP) has been carried out [UBA-TNO '97]. This inventory with base year 1990 includes all European countries, except the three Caucasian countries and Turkey and has been based on official country submissions and supplementary default emission estimates by TNO.

The ECE Task Forces on HM and POP have prepared substantiation reports (EB.AIR/WG.6/R21/Add.1 and EB.AIR/WG6/R20/Add.1) and have concluded that protocols should be developed. This started by Ad Hoc Preparatory Working Groups and is being continued by the Working Group on Strategies. The Working Group on strategy has prepared draft protocols for a number of HM and POPs and is in the process of finalising both Protocols. For this process, additional information on the effects of implementation of the protocols in terms of reduced emissions and incremental costs could be beneficial. Therefore, a study has been carried out, which has been based on the emission inventory results and on RAINS 7.2 scenario assumptions for activity data of which the results are presented in this report.
The Dutch Ministry of Housing, Spatial Planning and the Environment, EC-DG XI and TNO act as sponsor to this study

1.2 Aim of this study

The project of which results are presented here aims at determining the potential costs of the implementation of the UN/ECE Heavy Metals Emission Protocol, per country and per emission source category. Furthermore, attention will be converged on the benefits in relation to future emissions of cadmium, mercury and lead and to a range of other heavy metal emissions and PM_{10}, after the described emission reduction measures have been implemented. The results will refer to the year 2010, starting from the 'The European Emission Inventory of Heavy Metals and Persistent Organic Pollutants for 1990' [UBA-TNO '97] using the RAINS 7.2 scenario model [IIASA '97].

1.3 Description emission reduction measures to reduce air emission as listed in the HM Protocol

For 3 heavy metals being cadmium, lead and mercury, a draft Protocol is under development. The HM Protocol as has been used in this study can be divided into 2 sections, based on the types of described abatement measures.

1.3.1 Emission limit values expressed as maximum admissible concentration in stack gases or maximum admissible specific emission from stationary sources:

General (independent of source type):
- Cd: 0.2 mg/Nm^3 (mass flow threshold 1 g Cd/h)
- Hg: 0.2 mg/Nm^3 (mass flow threshold 1 g Hg/h)
- Pb: 5 mg/Nm^3 (mass flow threshold 25 g Pb/h)
- Dust: 150 mg/Nm^3 (for mass flows < 0.5 kg dust/h)
- Dust: 50 mg/Nm^3 (for mass flows > 0.5 kg dust/h)

Combustion plants in power generation and industry:
- Dust: 50 mg/Nm^3 (thermal output threshold 50 MWth)

Industrial process emissions:
- Dust, Basic oxygen furnaces in the iron and steel industry: 50 mg/Nm^3
- Dust, Electric arc furnaces in the iron and steel industry: 20 mg/Nm^3
- Dust, Sinter agglomeration plants in the iron and steel industry: 100 mg/Nm^3
- Dust, Cupola furnaces in the iron and steel industry: 20 mg/Nm^3
- Dust, non-Ferrous metals production plants (excl. Lead works): 20 mg/Nm^3
- Dust, Lead works: 10 mg/Nm^3
- Dust, Clinker coolers in cement production: 100 mg/Nm^3
- Dust, Cement grinding in cement production: 75 mg/Nm^3
- Dust, Glass production plants: 50 mg/Nm^3
- Hg, Chloro-alkali industry: 1.5 g/Mg Cl2 production capacity

Waste incinerators:
- Dust, 10 mg/Nm^3
- Cd, 0.05 mg/Nm^3
- Hg, 0.05 mg/Nm^3
- Pb, 0.5 mg/Nm^3

1.3.2 Emission reduction measures by setting the following conditions to the use of heavy metal containing products:

- Lead content of marketed petrol intended for on-road vehicles shall not exceed 0.005 g/l (small quantities of leaded petrol permitted)
- Phase out of sale and production of mercury containing electrical components and measuring and control devices (vital uses excepted)
- Limitation of maximum mercury content to 0.025% for batteries and 1% for button cells
- Limitation of the maximum mercury content in linear fluorescent lamps and in compact fluorescent lamps for external ballast to 10 mg/per lamp and in self ballasted compact fluorescent lamps to 6 mg per lamp
- Non-Mandatory limitation of the use of various other products containing Cadmium, Lead and Mercury.

1.4 Scenario's for emission projections

The projections in this report are based on the economic projections as used in the RAINS model [IIASA '97]. The box below describes scenarios available in RIANS 7.2. This project uses the Official Energy Pathway and the Agricultural Pathway scenario as described in the text box. RAINS provides 5 year advancing data on the consumption of various fuels and commodities and on output for certain industrial activities, per country.

> **The RAINS 7.2 Model of Air Pollution**
>
> **General Overview (from the RAINS 7.2 manual)**
>
> The 'Regional Air Pollution Information and Simulation' (RAINS)-model has been developed by IIASA as a tool for the integrated assessment of alternative strategies to reduce acid deposition in Europe and Asia (Alcamo J., Shaw R., and Hordijk L. (eds), (1990): The RAINS Model of Acidification. Science and Strategies in Europe. Dordrecht, Netherlands: Kluwer Academic Publishers.).
>
> RAINS 7.2 is distributed with the following sets of projections of energy consumption and agricultural activities for all European countries up to the year 2010:
>
> - The 'Official Energy Pathway', i.e., projections of energy consumption as reported by governments to UN/ECE and published in the UN/ECE Energy Data
> - Base (UN/ECE, 1995a). Where necessary, missing forecast data have been constructed by IIASA based on a simple energy projection model.
> - The 'Conventional Wisdom' energy scenario of DG-XVII of the European Commission (only for the Member States of the European Union).
> - The 'Agricultural Pathway' as compiled from national and international sources.
>
> The 'Conventional Wisdom' energy scenario is one of the recent energy scenarios used by DG-XVII of the European Commission. Data are extracted from the 'Energy 2020' Study (DG-XVII, 1996). For Denmark the DG-XVII projections have been replaced by the forecast of the national energy plan recently adopted by the Danish Parliament.
>
> Agricultural forecasts up to the year 2010 have been collected by IIASA, using national information (Marttila, 1995; Nemi, 1995; Pippatti, 1996; Henriksson, 1996; Riseth, 1990; Menzi, 1995), and studies performed for the Commission of the European Communities, DG-VI (EC DG-VI, 1995a-k - including countries of Central and Eastern Europe, Former Yugoslavia and Baltic Republics), and Egmond, 1995; Stolwijk, 1996; Folmer et.al, 1995 for EC-9 countries. Forecasts for Republics of Former Soviet Union were derived on the basis of the OECD study (OECD, 1995). Additional IIASA reports were used for both livestock and fertilizer forecasts Klaassen, 1991; Klaassen, 1995).
>
> The forecast of fertilizer consumption is based on estimates of the International Fertilizer Industry Association (Ginet, 1995). This forecast extends till 1999, the values for 2005 and 2010 are based on trend extrapolation assuming the same quantitative increase (Isherwood, 1995). The forecasts of fertilizer production and use till the year 2000 in Western Europe are in good agreement with results of an overview of world nitrogen supply and demand by B.L. Bump (Bump, 1995).

1.4.1 Projected air emission of HM disregarding autonomous developments

In order to estimate the HM emission for 2010 assuming 'Business as in 1990' the emission estimates from [UBA-TNO '97] have been projected assuming standard economic growth and without any autonomous environmental measure.

The projected emission of HM for the year 2010 assuming standard economic growth has been estimated by applying the OEP scenario to the activity rates, while applying the 1990 emission factors as used for the [UBA-TNO '97] study. In case no scenario data is available in a specific source category, a default scenario, for instance the forecasted evolvement of energy consumption, has been used. Data have been projected per country and per source category. The projection of the activity data will be discussed in more detail in paragraph 2.2.1.

1.4.2 Projected air emission of HM taking into account autonomous developments

The information available to us on future non-Protocol related HM reduction strategies in Europe of which implementation before the year 2010 is expected has been applied here. These so-called autonomous developments, in contrast with the Protocol guidelines, will result in emission reduction and can either comprise abatement of HM emission from stationary sources or restriction of the use of certain products. In this project the following developments have been defined as autonomous and have been taken into account in the emission projections:

- Closure before 2010 of certain plants, eliminating possible need for environmental upgrading.
- Elimination of the marketing of leaded petrol.
- Mercury emission reduction resulting from the EURO-CHLOR program for the chloro-alkali-industry.
- Phase out of mercury containing products.
- Phase out of open hearth furnaces in the iron and steel industry.
- National air emission regulations for heavy metals.
- European Union Directives for air emission reduction for countries in the EU
- Implementation of the UN/ECE Second Sulphur Protocol.

1.4.3 Projected air emission of HM taking into account autonomous developments and the implementation of the HM Protocol

The projected emission of HM for the year 2010 after implementation of the UN/ECE HM Protocol has been based on standard economical growth according to the OEP-scenario (1.4.1) and environmental results of foreseen autonomous developments. Furthermore, emission factors for stationary sources, when included in the Protocol, have been updated, reflecting the influence of the Protocol. The emissions due to the use of certain products which are scheduled for restrictions have been either set to 0 or adjusted downwards, depending on the Protocol related measures for the specific source category. The effect of the Protocol on activity rates and emission factors will be discussed in more detail in the paragraphs 2.2.1 respectively 2.2.2.

1.4.4 Emission projections for other HM and PM_{10}

Apart from cadmium, mercury lead and mercury, emission projections have also been prepared for 5 other heavy metals, being arsenic, chromium, copper, nickel and zinc. Following this report a short note on fine particulate matter (PM_{10}) will be prepared by TNO in which results of emission projections for this compound will be presented.

1.5 Cost of Protocol related measures

On the basis of [UBA-TNO '97], various other literature sources and national expert communications, the technological effort needed to comply with the protocols has been inventoried per country and per source category, on an installation level when possible. The required measures have subsequently been capitalised using available cost engineering methods.

The cost estimates have been made using two different starting points:

- The cost that have to be made in order to come to the emission levels resulting from the Protocol, without any additional emission reducing activity in Europe.

- The cost to implement the HM Protocol after foreseen autonomous developments and non-protocol-related other environmental legislation have been implemented (2.3.2 and 2.3.3).

2. Methodology

2.1 General

A full emission inventory for Europe for Heavy Metals is available [UBA-TNO '97]. The emissions per country and per activity can be related to economic activities in each country. Projected emissions can then be derived by applying the following formula:

$$E_{pollutant} = \sum_{activities} A_{activity} \times (\sum_{technology} EF_{technology,pollutant} \times (P_{technology}))$$

with	$E_{pollutant}$	Emission of the pollutant under study
	$A_{activity}$	Activity rate for each source category/sector
	$Ef_{technology,\ polllutant}$	Emission factor for the activity and the pollutant
	$P_{technology}$	Penetration of the technology, with $\sum_{technologies} P_{technology} = 1$

2.1.1 *Projections for energy related emissions*

In the approach for energy related emissions, the activity can be interpreted as the per sector and per fuel energy for the years considered:

To use this method in a first step thus a combination of:

1. the sectors discerned in the projection table and the technology split available in the inventory and of
2. the fuels as used in the projection and in the inventory should be made.

From the definitions of both activity and fuel splits in the energy balance and in the inventory this can relatively easily be derived.

To compile the projection all activity rates *A* (fuel uses) should be replaced by the expected values in the projected year.

2.1.2 *Projections for non-energy related emissions*

In order to be able to project non-energy related emissions basically the same approach can be used as for energy use. Instead of fuel consumption the output levels of for instance certain industrial activities, like for instance cement production, should be used.

2.1.3 Technological development: emission factors

It might be expected that in most projections some assumptions on technological development and the introduction of new technologies must be assessed. In the formula mentioned above this means that the emission factors should be modified according to the technological assumptions in the projection. Some general examples might be:

- Decrease of HM content in all or certain fuels: multiply the emission factors by the expected decrease;
- The introduction of un-leaded gasolines: replace all Pb emission factors for road traffic by low Pb content emission factors;
- Introduction of abatement technologies at certain activities and fuels: BAT: assume $P_{technology} = 1$ for the technology where the emission factor is lowest for each of the activities and $P_{technology} = 0$ for all others;

2.1.4 Policy development: penetration

The third aspect in the above formula is the policy induced or autonomous penetration of new technologies into the economic system. This is mainly relevant when a projected time series of emissions is to be produced. Such projections can be made on the basis of assumptions on the replacement of existing technologies and plants by newer ones, by deriving time series of expected penetrations $P_{technology}$. Such time series need to be dependent on economic model outputs like investments.

2.1.5 The projection

Projections for energy related emissions in this report have been prepared on the basis of the Official Energy Pathway scenario as defined in RAINS 7.2. Figures 1 and 2 show aggregated results of this scenario. The scenario shows a decrease of energy used between 1990 and 1995 and a steady increase from 1995 onwards. This is caused by the transitions in the Central and Eastern European countries (Figure 3).

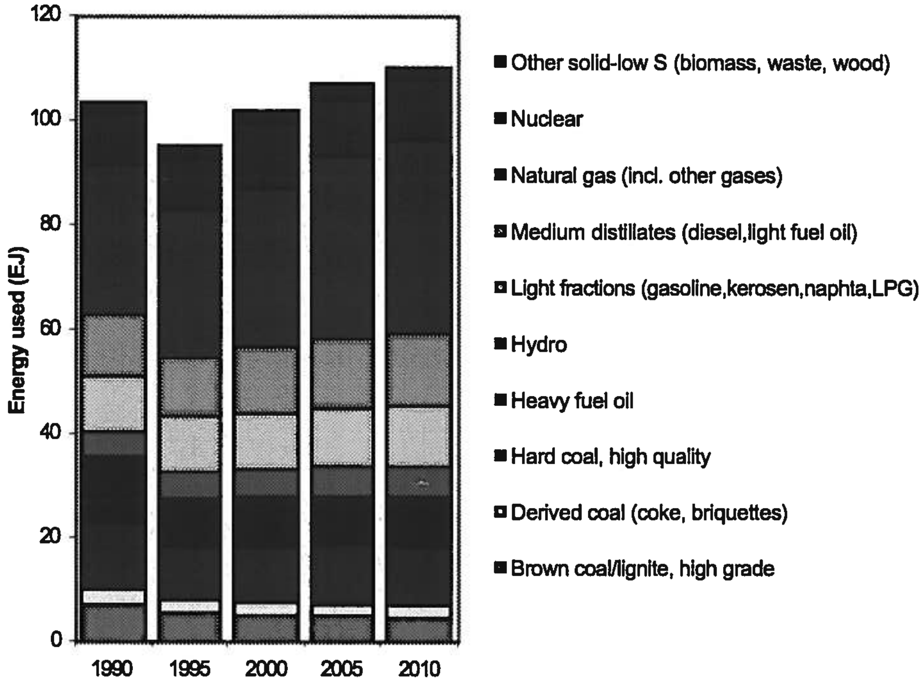


Figure 1 *Projected energy use per fuel in Europe (from RAINS 7.2).*

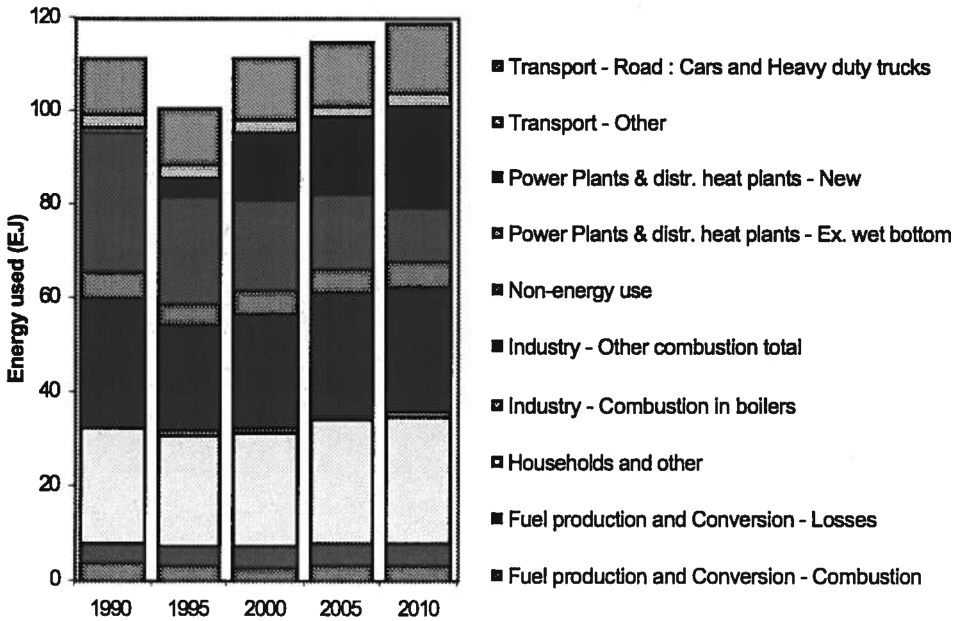


Figure 2 *Energy use by sector in Europe according to the OEP scenario of RAINS 7.2.*

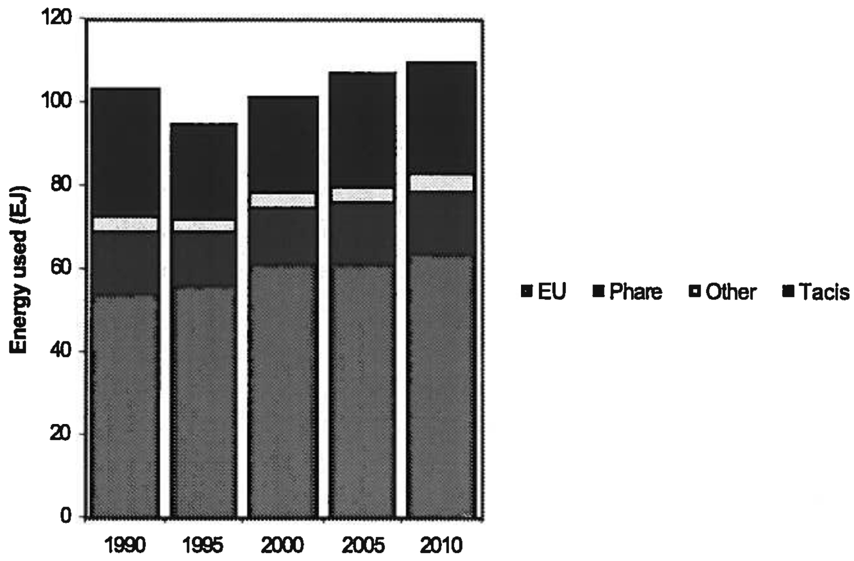


Figure 3 *Energy use in different parts of Europe.*

2.2 Emission projections for 2010

2.2.1 Projections of activity levels

In order to project activity levels for the year 2010, for most source categories, levels have been projected according to the OEP scenario. For some specific source categories other types of data are more suitable. Use has then been made of either other scenario data like Agricultural Pathway from RAINS 7.2, a default scenario (like total of energy consumption), or the 1990 level has been assumed applicable for 2010. In RAINS 7.2 data are presented per country, per fuel type and per economic sector, the latter more or less harmonizing with the CORINAIR 94 SNAP-codes. In table 2 below, all HM emission source categories as discerned in [UBA-TNO '97] have been listed. Per source category, it is indicated which parameters from RAINS 7.2 have been used to forecast the activity level in 2010. A more detailed table is given in Annex 2, in which all RAINS categories are listed and links with the [UBA-TNO '97] categories have been indicated.

Table 2 Parameters from RAINS 7.2 used for the activity level projection.

Description of source category	Parameter used for activity rate projection
Publ. power, cogen. & district heating	
Brown coal	Brown coal in 'Publ. power etc.' according to OEP
Fuel oils	Fuel oil in 'Publ. power etc.' according to OEP
Hard coal	Hard coal in 'Publ. power etc.' according to OEP
Other fuels	1990 value
Comm. instit. & resid. Combustion	
Brown coal	Brown coal in 'Comm. etc.' according to OEP
Fuel oils	Fuel oil in 'Comm. etc.' according to OEP
Hard coal	Hard coal in 'Comm. etc.' according to OEP
Other fuels	1990 value
Industrial combustion	
Brown coal	Brown coal in 'Ind. etc.' according to OEP
Fuel oils	Brown coal in 'Ind. etc.' according to OEP
Hard coal	Brown coal in 'Ind. etc.' according to OEP
Other fuels	1990 value
Iron and steel industry	
Coke production	Coke production according to OEP
Blast furnace	Pig iron production according to OEP
Pig iron	Pig iron production according to OEP
Open hearth furnace	Assumed 0 in 2010
Basic oxygen furnace	Sinter production according to OEP
Electric arc furnace	Pig iron production according to OEP
Rolling	Sinter production according to OEP
Sinter plants	Sinter production according to OEP
Foundries	Pig iron production according to OEP
Iron and steel, non-specified	Pig iron production according to OEP
Non-ferrous metals production	
Al industry	Non-ferrous metals production according to OEP
Cu industry	Non-ferrous metals production according to OEP
Non-specified non ferrous	Non-ferrous metals production according to OEP
Other non-ferrous metals	Non-ferrous metals production according to OEP
Pb industry	Non-ferrous metals production according to OEP
Zn industry	Non-ferrous metals production according to OEP
Other production processes	
Chloro-alkali industry	Total energy consumption according to OEP
Halogenated HC production	Total energy consumption according to OEP
Paper pulp (Kraft process)	Paper and pulp production according to OEP
Paper and pulp industry	Paper and pulp production according to OEP
Road paving with asphalt	Total energy consumption according to OEP
Cement industry	Cement & lime production according to OEP
Glass industry	Total energy consumption according to OEP
Non-spec. production processes	1990 value
Solvent use	
Paint use	Tot. Energy cons. acc. to OEP for C. & E. Eur., 1990 value for W. Eur.
Wood preservation	Tot. Energy cons. acc. to OEP for C. & E. Eur., 1990 value for W. Eur.
Solvent use, non specified	1990 value
Road transport	
combustion	Total energy cons. in sector road transport acc. To OEP
non-combustion	Total energy cons. in sector road transport acc. To OEP
Road transport, non-specified	Total energy cons. in sector road transport acc. To OEP
Other mobile sources and machinery	
combustion	Total energy cons. in sector other transport acc. To OEP
non-combustion	Total energy cons. in sector other transport acc. To OEP
Waste treatment and disposal	
Waste incineration	Total energy consumption according to OEP
Landfill	Total energy consumption according to OEP
Cremation	1990 value
Agriculture	
Pesticide use	Cons. of fertilizer according to Agricultural Pathway Scenario of RAINS
Nature	1990 value
Electrical equipment	Electricity production according to OEP
Not specified	1990 value

2.2.2 Projections of emission factors

Emission factor projections for the heavy metal emission source categories in [UBA-TNO '97] have been made for the three scenario types:

1. assuming *'Business as in 1990'* (without any emission reduction activity).
2. assuming a range of *autonomous emission reducing activities* (i.e. non-protocol related measures, both country and region specific) that are not related to the Protocol;
3. assuming both autonomous emission reducing developments and implementation of the *Protocol measures.*

In the following sections of the report the effect of autonomous developments on emission factors will be discussed, followed by the further influence of Protocol-related measures. Emission control at stationary sources (A) and conditions to the use of HM containing products (B) are discussed separately.

1. *Business as in 1990.*
   Emission factors for 1990 have been used in this case.

2. *Autonomous emission reducing activities.*

There are a number of autonomous developments and other non-Protocol related measures foreseen in Europe that will reduce heavy metals emissions. These measures are, according to our information, planned for the period until the year 2010 and will influence the emission factors:

- **Elimination of leaded gasoline**

It is assumed that for all countries in Europe by the year 2010 the use of leaded gasoline will be phased out. Marketed amounts have declined significantly in most Western European countries during recent years and leaded gasoline is no longer used in for instance Austria, Denmark, Finland, Germany, Netherlands, Norway, Slovak Republic, Sweden. Other countries in Europe are expected to follow, all the more since modern automotive engines no longer require leaded fuel for operation.

The elimination of the use of leaded gasoline reduce lead emission in Europe drastically.

- **EURO-CHLOR program for the chloro-alkali-industry**

The organisation of chlorine producers EURO CHLOR has developed a concept of voluntary measures that imply that by the year 2010 the specific emission of mercury will be 1.5 g Hg/t Chlorine producing capacity. Conformation to this emission limit value is foreseen Western Europe and will result in a decrease of mercury release for this source compared to the emission estimates from [UBA-TNO '97].

- **National emission regulations**

For several countries in Europe information on target values for heavy metal emission and future mandatory emission legislation is available on a national basis. The estimated effect of national regulations before 2010 on emission factors is indicated per country and per source category in table 3. The percentages in the third column represent the fraction of the total emission reduction due to implementation of the HM Protocol, that will be achieved by currently foreseen national policies. These percentages are estimated based on a comparison of currently reported flue gas dust concentrations and particulate removal efficiencies, dust concentrations or removal efficiencies prescribed by national legislation and the emission limit values of the HM Protocol. In case national legislation leads to full compliance with the Protocol this has also been indicated. Emission factors after implementation of the Protocol are discussed in the section 'Protocol measures; HM emitting stationary sources'.

Table 3 Influence of foreseen autonomous developments by national initiative on emission factors.

Country	Source category	% of reduction due to Protocol as a result of national legislation
Poland	Power gen. & large industrial comb. plants, coal-fired	50 for Cd and Pb, 0 for Hg
Czech Republic	Power gen. & large industrial comb. plants, coal-fired	80 for Cd and Pb, 0 for Hg
Slovak Republic	Power gen. & large ind. Comb. plants, coal and oil-fired	50 for Cd and Pb, 0 for Hg
Slovenia	Power gen. & large industrial comb. plants, coal-fired	Complies (= 100%)
Southern Europe	Large industrial combustion plants	Complies (= 100%)
Slovak Republic	Sinter production	Complies (= 100%)
Italy	Non-ferrous metals production	Complies (= 100%)
Slovak republic	Non-ferrous metals production	50 for Cd and Pb, 0 for Hg
Italy	Cement production	Complies (= 100%)
Slovak Republic	Cement production	Complies (= 100%)
Italy	Glass production	Complies (= 100%)
Slovak Republic	Chloro alkali industry	Complies (= 100%)

Note that this table does not intend represent an overview of future European emission regulations, instead only in case a significant effect on the 1990 emission factors from [UBA-TNO '97] in this respect is expected, the estimated effect is given.

- **European Union Directives for countries in the EU**

The European Union has set target emission limit values for several emission source categories. The limit values included in this study are:

1 10 mg dust/Nm^3 for the incineration of hazardous waste, which brings about that waste incineration plants in all countries within the EU will already, or at least in due course, obey the Protocol;

2 50 mg/Nm^3 for combustion plants > 500 MWth and 100 mg/Nm^3 for combustion plants between 50 and 500 MWth; this will imply that the majority of the utility plants and the large industrial combustion plants in the EU will comply to the emission limit values of the Protocol before the year 2010.

Implementation of the Second Sulphur Protocol

In case the Second Sulphur Protocol will be implemented in Europe the flue gas desulphurisation (FGD) equipment that will be installed as a result will also affect heavy metal emission [e.g. Karl et al. '96]. The magnitude of this effect will be dependant on the FGD technology (dry, semi dry or wet) that will be used:

For wet FGD processes to operate well, removal of particulates to about 100 mg/Nm^3 before FGD is required for technical reasons [Middelkamp '97] and a further reduction by FGD equipment itself to about 50 mg/Nm^3 is expected [Karl et al.]. Besides, in case the produced gypsium is intended to be marketed as for instance a building product, there usually are limits to the heavy metal content, also necessitating thorough dedustment. For dry and semi-dry FGD processes extensive dust removal to 50-100 mg/Nm^3 is not demanded in order for the FGD to operate without problems [Middelkamp '97]. Also stringent limits to heavy metal contents might not always apply since smaller quantities of waste gypsium can for instance be dumped in a nearby mining site instead of being marketed, moreover because the future supply of gypsium is expected to overcome demand. In case dry or semi-dry FGD is used, the installation will not automatically also comply to the HM Protocol. As an engineering judgement, depending on the dust content of the raw gas, an emission reduction of particle bound HM of about 50% is estimated as a result of the application of dry or semi-dry FGD. This estimate is based on the characteristics of dry and semi-dry FGD and [Berdowski et al. '95, Rijpkema '93]. This percentage represents the fraction of the total emission reduction due to implementation of the HM Protocol that will be achieved by dry or semi-dry FGD.

For large installations wet FGD technology is generally preferred. Based on literature [e.q. Rentz et al. '96] as an average for Europe, it has been assumed that 85% of the coal-fired power generating capacity will be equipped with wet desulphurisation processes by 2010 as a result of the Second Sulphur Protocol. This will lead to compliance with the Protocol for 85% of the coal-fired capacity due to the necessary dedustment before the wet FGD process and the effect of the FGD process itself. For the remaining 15% of the utility plants dry and semi-dry FGD processes have been assumed expecting to lead to approximately 50% emission reduction (percentage represents the fraction of the total emission reduction due to implementation of the HM Protocol that will be achieved by FGD) for particle bound HM.

Industrial combustion plants are usually somewhat lower in capacity compared to utility plants. For smaller plants the application of wet FGD is economically less attractive. Therefore only 70% of the large industrial combustion plants is assumed to be equipped with wet FGD [Rentz et al. '96]. The remaining 30% is assumed to be equipped with dry or semi dry FGD processes. Plants that will be equipped with wet FGD are assumed to comply with the heavy metals Protocol whereas for plants equipped with dry or semi dry processes only some emission reduction is expected.

3A. Protocol measures; HM emitting stationary sources

In this section the choice of emission factors used to project the emission after implementation of the Protocol is discussed. First, it will be explained, in general terms for which countries and source categories a Protocol-related emission reduction is expected, followed by emission factors after the Protocol.

Based on [UBA-TNO '97], [Berdowski et al. '95], national expert communications, currently applied national emission standards [UNECE '96, Rentz et al '96] and various other literature sources [e.g. Klimont '93, TNO-KEMA '94] it has been estimated per country which stationary sources did, in general, not yet comply with the draft HM Protocol for the base year of [UBA-TNO '97], being mostly 1990.

It has been necessary to restrict the outcome of this analysis to a sector and country level or, to be more exact, to the format for which HM emission factors are available, namely the sector definitions used in [UBA-TNO '97]. There is for certain sectors more detailed information available for the large HM emitting installations in the form of reported flue gas dust concentrations per plant. Based on these flue gas data a detailed estimate could be made of the achieved particulate matter emission reduction in case a sector does not comply to the Protocol. However, in order to estimate HM emission reduction from particulate matter emission data, further information on specific HM contents of the used fuels and on particle-bound HM enrichment would be required. There is no easily quantifiable relation between dust and HM emission. Therefore detailed data on an installation level have only been used in the cost estimates to determine which plants need Protocol-related upgrading. This will be discussed in more detail in paragraph 2.3.2.

In table 4 the country-source combinations for which it is estimated that the Protocol emission limit values where generally exceeded in 1990 have been listed. For the country-source combinations listed in table 4, Protocol-related reduction of 1990 emission factors is expected. Presenting an overview like in table 4 will inevitably result in rather rough and approximate statements which might be incorrect in specific cases and for specific installations. However, exact and detailed information on HM emission factors and on whether or not a sector complies is, although strictly speaking essential in this respect, unfortunately not always sufficiently available on a sector and country basis.

Table 4 Source-country combinations that are estimated, in general, not to comply with the HM Protocol for the base year 1990[4]

Region	CORINAIR sectors that do not yet comply with the Protocol
Central and Eastern Europe[1]	'01-power generation'[3], '03-industrial combustion'[3], all processes in '04 industrial processes' mentioned in the Protocols, '0902 waste incineration plants'
Southern Europe[2]	'03-industrial combustion'[3], all processes in '04 industrial processes' mentioned in the Protocols

[1] includes the following countries (ISO3-a codes): ALB, BGR, BIH, BLR, CZE, EST, HRV, HUN, LTU, LVA, MDA, MKD, POL, ROM, RUS, SVK, SVN, UKR and YUG

[2] includes the following countries: ESP, GRC, ITA and PRT

[3] includes hard coal-firing, brown coal firing, shale oil-firing and residual oil firing

[4] the following countries do, in general, comply (ISO3-a): AUT, BEL, CHE, DEU, DNK, FIN, FRA, GBR, IRL, NLD, NOR and SWE

Within the framework of [UBA-TNO '97] specific emission factors for heavy metals have been developed for three regions in Europe, based on among others the PARCOM-ATMOS emission factor manual '93 [v.d. Most et al '93] and the Atmospheric Emission Inventory Guidebook [McInnes '95], yielding an emission factor database used for [UBA-TNO '97]. In order to be able to evaluate the emission decrease after implementation of the protocol, an additional emission estimate has been made for the source categories-region combinations mentioned in table 4, based on emission factors currently applying for Western Europe since prescribed emission standards in this region are, in general, in the same order as in the Protocol [UNECE '96]. The emission factors for Western Europe are the lowest factors in the emission factor database and are considered a reasonable approximation of heavy metal emission factors applicable after implementation of the protocol.

3B. Protocol measures; HM containing products scheduled for elimination or restrictions on use

The HM protocol also reserves a section for the use of heavy metal containing products:

- Lead content of marketed petrol intended for on-road vehicles shall not exceed 0.005 g/l (small quantities of leaded petrol permitted);In this study we assumed this to be an autonomous measure

- Phase out of sale and production of mercury containing electrical components and measuring and control devices (vital uses excepted)
- Limitation of maximum mercury content to 0.025% for batteries and 1% for button cells
- Limitation of the maximum mercury content in linear fluorescent lamps and in compact fluorescent lamps for external ballast to 10 mg/per lamp and in self ballasted compact fluorescent lamps to 6 mg per lamp
- The collection and recycling or disposal in an environmentally sound manner of the above mentioned products must be promoted.
- non-Mandatory limitation of the use of various other products containing Cadmium, Lead and Mercury.

The use of batteries, mercury containing electrical components and measuring and control devices, fluorescent lamps and other HM containing products can lead to air emission of HM, mainly during disposal of waste. Elimination will reduce the HM load on the gas cleaning section of waste incinerators (also comprising carbon filters in order to remove mercury). In this study no further influence on emission factors for this source is presumed since sufficient particle-bound and gaseous HM removal is assumed in the study to result from the emission limit values of the Protocol.

Air emission due to breakage of fluorescent lamps and mercury thermometers during use leads also to some minor air emission according to [UBA-TNO '97]. In the emission projections emission from these sources have been assumed 0 after implementation of the Protocol, assuming the Protocol-related measures to be effective for disposal of products and neglecting the remaining emissions due to breakage of fluorescent lamps.

2.3 Type of measures and their cost for stationary HM emission sources and the use of HM containing products

2.3.1 General

In this paragraph the emission reduction measures resulting from implementation of the Protocol are discussed, per source category, in terms of type and cost. A distinction is made between emission control at stationary sources (subdivided in power generation, industrial combustion and process emissions) and the use of certain HM containing products. The influence of autonomous developments is discussed separately at the end of each section.

For stationary sources Protocol related measures bring about a modification to an existing installation in order to meet the new emission limit value. A non-recurring investment has to be made in that case.

In this study both investment costs and resulting annual costs have been estimated. Firstly, the total capital investment (TCI) of the measure has been estimated based on literature data which will be further discussed in the paragraphs 2.3.2 and 2.3.3. The annuity (annual capital costs) is subsequently calculated by using [Kok '97]:

$$Annuity = \frac{i(i+1)^n}{(1+i)^n - 1}$$

with i = Interest rate (-)
n = Amortisation period (years)

Based on the technical life expectancy of the emission control units, an amortisation period of 20 years is chosen. The calculations are furthermore based on an interest rate of 4%. This results in an annuity of 7.4%.

The annuity of the TCI is increased by the operational costs in order to come to the total annual costs. The operational costs, comprising fixed operational costs (maintenance, labour, other overhead costs, insurance etc.) and variable operational costs (energy, raw materials) are estimated by taking a percentage of the TCI. Strictly speaking running costs are dependant on the emission control technique that is used, for instance fabric filters have a somewhat higher operational cost due to frequent replacement of the filter cloth. These differences are however neglected due to the overall uncertainty of the cost estimates and a fixed percentage, being 5%, (4% for the fixed operational costs and 1% for the variable operational costs [TNO-MPT '97]), has been used in order to estimate the total operational costs.

For product use, when significant, costs are calculated as investment costs or non-recurring 'disposal'-costs depending to the type of the measures.

The cost estimates have been made according to two different starting points:

- The cost that have to be made to come to the emission levels resulting from implementation of the HM Protocol, based on without any additional emission reducing activity in Europe (see table 4).

- The cost to implement the HM Protocol after foreseen autonomous developments and non-Protocol-related other environmental legislation has been implemented (2.3.2 and 2.3.3)

Total annual costs have been calculated based on the estimated investment costs and presented in chapter 3 and not further discussed in chapter 2.

2.3.2 Protocol related emission control at stationary sources

The technological measures that will, according to our data, be necessary to up-grade a plant to comply with the Protocol are mentioned below per source category. The general procedure has been to estimate the specific waste gas production for a certain process or process step and subsequently sizing and capitalising the needed deduster based on point source information, after the most suitable abatement technology has been inventoried. Further motivation of the proposed measures will be given per source category below.

Power generation - control measures

In order to assess te consequences of the Protocol for Power generation in Europe, some closer attention will be given to the emission limit values. The sector Power generation is in the first place be covered by the emission limit of 50 mg dust/Nm^3 for combustion plants larger than 50 MWth. However, strictly speaking a general emission limit might also apply, depending on which (dust or heavy metal limit value) is the most stringent:

- mass flows > 1 g Cd/h 0.2 mg Cd/m^3 STP
- mass flows > 1 g Hg/h 0.2 mg Hg/m^3 STP
- mass flows > 25 g Pb/h 5 mg Pb/m^3 STP

For coal-fired plants the heavy metal contents in the emitted fly ash is usually in the order of 0 to 50 ppm for lead and 0 to 5 ppm for cadmium [v.d. Most '93]. These values agree with trace element analysis's from several national expert communications. Moreover, according to [Smith '97] there are no coal types in use in Europe known to have exceptionally high cadmium, lead or mercury contents (mercury contents are usually in the range of 0 to 1 ppm. This would imply that in general the maximum admissible cadmium and lead concentrations in off-gasses will probably not be exceeded and that the dust concentration limit of 50 mg/m^3 STP is the most stringent value for coal-firing. Special attention must be given to mercury since this compound would require separate equipment in addition to dust collectors and desulphurisation units in order to be removed from an flue gas stream. Separate mercury removal is however not commonly practised in electricity generation in Europe [KEMA '97]. Trace element analysis of raw coals suggest a concentration an order of magnitude lower than cadmium [e.g. v.d. Most '93] but reliable emission data are still somewhat scarce. In this stage it is assumed that the mercury concentrations in off-gasses are such that additional removal is not necessary to comply with the protocol. When regarding dust concentrations, combustion plants firing residual oil usually attain values of around 150 mg/m^3 [e.g. CONCAWE '80, '84, Dutch Emission Registration '97] and lower values in more optimised boilers. The concentration is dependant on the fuel specifications and burner characteristics and the emission limit value of 50 dust mg/m^3 is usually exceeded for heavy fuel oil-fired plants. Metal contents in the emitted solid particles can sometimes be higher than is the case for coal fly ash [e.g. v.d. Most '93], especially for cadmium. Therefore, in extreme cases when a cadmium-rich oil is used combined with a high soot emission (e.g. above 500 mg/m^3 STP), the cadmium concentration in the flue gas can amount to about 0.5 mg/m^3, hereby exceeding the general emission limit value for Cadmium. This is however not considered a representative situation in Europe and it is assumed that the dust concentration limit of 50 mg/m^3 STP is the only value to be taken into consideration for oil-firing.

Coal-fired and heavy fuel oil-fired plants comprise the bulk of the SNAP 01-installations that will have to be upgraded to meet the emission criteria for stationary combustion.

In order to estimate the costs of the Protocol for Power generation in Europe, input data on which installations need upgrading are essential. It has been inventoried which power stations in Europe do not yet comply to the Protocol. In this analysis the reference year is not 1990, instead it has been attempted to gain the most recent information. There are several overviews available in order to determine the number of present installations and their specifications like capacity and emission. Data have been inventoried predominantly based on information available from [Veldt '92], CORINAIR90, [Klimont '93], [UBA-TNO '97] and [Clarke '96]. It has also been attempted to inventory the already present dust collectors. Data indicate that nearly all large coal fired combustion plants are fitted with ESP. Flue gas particulate matter concentrations are for the larger part relatively well known per installation for years around 1990 and often around 1995. This information has been collected from various sources, the most important sources being TNO, [Klimont '92], [TNO-KEMA '94], [UBA-TNO '97], [Jones '96] and several national reportings and expert communications. Below, in table 5 a short summary of the findings per country is presented. The information listed in table 5 serves as the basis for the national inventories of the required emission reduction measures for Power generation, disregarding future autonomous developments.

Table 5 *Power stations that are currently not yet complying to the HM Protocol in Europe and some of their characteristics.*

Country	Number of HC-fired plants	Range of dust load (mg/Nm³)	Number of BC-fired plants	Range of dust load (mg/Nm³)	Number of RO-fired plants	Range of dust load (mg/Nm³)	Total number of plants to be upgraded
Belarus	1	500			19	150	20
Bosnia-Herzegovina			3	500-1000			3
Bulgaria	2	400	8	200-3000 (500)	2	150	12
Croatia					5	150	5
Czech Republic	8	300-7000 (500)	27	300-7000 (500)	4	30-200	39
Estonia	5, shale oil-fired	1000-20000 (1500)			2	150	7
Hungary			13	160-5600 (300)	5	160	18
Latvia					1	150	1
Lithuania					5	150	5
Macedonia			2	500	1	150	3
Moldova	1	500			2	150	3
Poland	58	300-8000 (1000)	4	100-1600	1	150	63
Romania			13	150-2500 (400)	5	150	18
Russian Federation	50	1000	5	1000	98	150	153
Serbia-Montenegro			11	500	3	150	14
Slovak Republic	3	300-4000 (400)	5	600-3500	3	70-200	11
Slovenia			3	500-1000	2	150	5
Ukraine	22	1000			12	150	35

Power stations located in countries that are not listed in table 5, like the countries in Southern Europe and Western Europe, are estimated to already comply with Protocol. From table 5 it is concluded that the majority of the coal- and residual oil-fired plants in Central and Eastern Europe and the Russian Federation need upgrading although almost all plants are fitted with ESP. Reported particulate collection efficiencies are relatively low (90-98 %, limit values of protocol require >99.5%) which can be caused by lower design efficiencies, the use of a lower grade coal than foreseen in the design, a higher gas flow rate than foreseen or frequent system upsets. It might otherwise be interesting to mention that the high particulate matter emissions often reported for these regions usually contain on average only 10-30% PM_{10} [e.g. KEMA-TNO '94, Taithy '96].

In Estonia shale oil is used in several combustion plants. The use of this fuel leads to a significant particulate matter emission [UBA-TNO '97] and these plants will be included in the cost calculations. Especially in some states of former Soviet Union and also in other countries natural gas fired plants make up for a large part of the electricity generating capacity. Cadmium and lead emission from natural gas-firing is not significant according [UBA-TNO '97]. Limited information is available on mercury emissions but in this stage no definitive conclusions can be drawn, although data indicate some emission. Mercury in raw natural gas is usually removed at gas processing plants before combustion.

For emission control at large combustion plants several abatement technologies like electrostatic techniques, fabric filters and scrubbers are at disposal. In general, the most cost-effective emission reduction measure for the Eastern European power and heat generation is in general the electrostatic precipitator. This conclusion is confirmed by detailed reportings [Jones '96, '94] on upgrade programs for power plants in Eastern Europe. In many cases high sulphur coal is used, resulting in a favourable ash resistivity, thus making electrostatic techniques economically attractive. Moreover, properly operated precipitators are effective in removing smaller size particulate and there is ample experience with the application of electrostatic precipitators for coal fired plants. Electrostatic techniques are also applicable for oil-firing, contrary to fabric filters, although collection efficiencies are in that case not as high. However the emission limit value of 50 mg/m^3 STP can in most cases be easily met.

Power generation - costs

The Starting point of the cost calculation will be retrofitting new ESP on all plants that do not comply with the Protocol. In practice this comprises the majority of the coal-fired, shale oil-fired and residual oil-fired plants >50 MWth in Central and Eastern Europe and the Russian Federation and only industrial combustion plants in Southern Europe.

The costs for upgrading combustion plants with environmental controls are primarily determined by the produced waste gas flow, the number of installations and the required collection efficiency. The actual dust emission as a cost parameter is only important in order to determine whether a plants needs upgrading. Investment costs of ESP are dependant on the waste gas flow rate because this determines the dimensions of the equipment. Costs mainly comprise the costs of:

- the required plate area which are approximately linear to the waste gas flow given the required collection efficiency;
- the containment which is approximately linear to the square root of the waste gas flow;
- control equipment, carriage, erection and commissioning which is only to some extent dependant on waste gas flow.

As a result costs show a complex investment progression, because depending on the gas flow rate, different of the above mentioned cost accounts are cost determining. For gas flow rates from 10,000 to about 200,000 - 300,000 Nm^3/h specific investment costs (ECU/Nm^3 waste gas flow) decrease to the power of 0.60-0.65 with increasing flow rate [e.g. Kok '97, Rijpkema '93, Rentz '96] since cost of containment, structure (carriage, piping) and control equipment are dominating. For the average power station waste gas flow rates are far higher, up to 2,000,000 Nm^3/h is no exception. In the range from about 200,000 to 3,000,000 Nm^3/h costs are determined by the plate area resulting in a rather low investment progression (costs are almost linear to waste gas flow) [e.g. UN/ECE '97].

Investment costs are for several reasons highly site specific, for instance:
- space conditions are highly variable;
- choice of material which is dependant on waste gas characteristics, is variable;
- fuel characteristics vary;
- there might be different requirements to the availability of the filter;
- required collection efficiency is dependant on the raw gas dust load and the emission limits.

In order to determine a reliable relation between investment costs and gas flow rate, results from various literature, preferably referring to a standard configuration (comprising a 3 field cross linked ESP with 99.7% collection efficiency for a coal fired plant), have been compared:
- [Rijpkema '93] presents flow rate dependant investment costs for the range 50,000 - 300,000 Nm^3/h which have been supplied by a large process engineering firm. When corrected for slightly different material costs specific investments for waste gas flows around 300,000 m^3/h range from 7 - 15 ECU/Nm^3.
- [Van den Vlierd '97] presents investment costs for a standard coal fired power station (99.5% collection efficiency) based on offers from three manufacturers. After data processing 5 - 10 ECU/Nm^3 is found for large flow rates.
- [Rentz et al '95] presents a relation between waste gas flow rate and specific investments for flows up to 200,000 Nm^3/h. For higher flow rates a constant value of about 6 ECU/Nm^3 is suggested.
- [UN/ECE '97] presents non-referenced specific investment costs of ESP, being about 5 - 10 ECU/Nm^3.
- [Turner '91] gives a methodology for estimating investment costs. For high flow rates results seem rather high, about 15 - 20 ECU/Nm^3 although [Schaerer '93] presumably reports in the same range for a German coal-fired plant.

[Turner '91] also mentions a 20-40% cost increase for retrofit and 30% cost increase has been used in this study.
Based on an evaluation of the mentioned literature followed by expert judgement from [Van den Vlierd '97] the following cost relation has been con-

structed (figure 4). Presented costs comprise total investment costs for the complete unit from flange to flange including an estimated additional cost increase of 30% as a result of retro-fit.

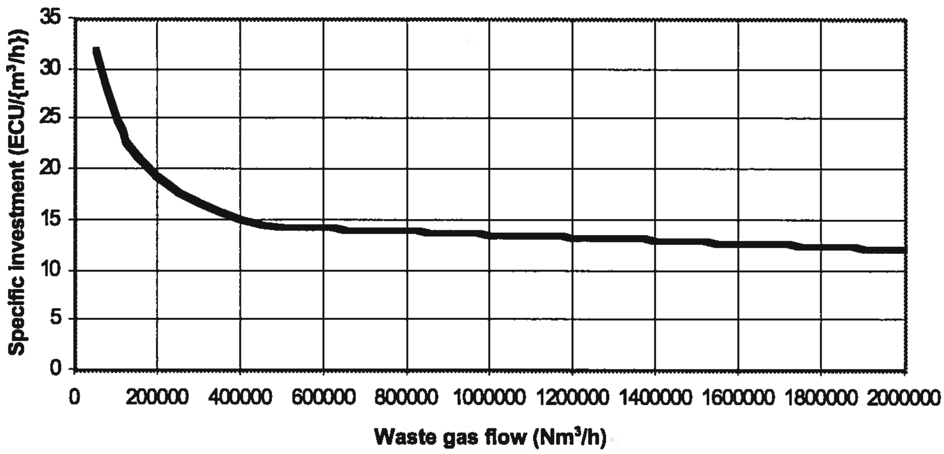


Figure 4 *Flow rate dependency of specific investment costs for ESP retro-fit as used in this study.*

We realise that these results have their limitations. In case a power station needs upgrading as a result of obligatory emission limits that have to be met, it is often economically more attractive to incorporate replacement or retro-fit of an ESP in a complete upgrade program, involving for instance also flue gas desulphurisation (see under autonomous developments), modernisation or replacement of the boilers and burners or the installation of DENOX units, or even complete reconstruction. There are other aspects which increase the uncertainty of the cost calculation such as the possibilities that the old installations offer for upgrading. Strictly speaking there is no single solution for all Eastern European power plants. However, all relevant aspects are impossible to inventory in this scope. It is assumed that fuel-characteristics like ash-content will remain the same in the future despite the improvements that can be achieved when for instance using a fuel with a lower ash content. Besides, many older installations will be decommissioned by national initiative instead of upgraded and new and more environmentally friendly installations can be build as replacement.

Industrial combustion - control measures

This sector covers many large combustion plants, generally somewhat lower in capacity than power stations, although many plants above 500 MWth are in use. Information on large industrial combustion plants is available on a less comprehensive level than for power stations. It is estimated that all coal-, residual oil- and shale oil-fired industrial combustion plants > 50 MWth in Southern [UN/ECE '96], Central and Eastern Europe [e.g. Klimont '93, CSOP '91] and in the Russian Federation [USSR-SC, '90] will be touched by the Protocol. Information (number of plants and capacities) is only for eight countries available in the form of point source data submitted within the framework of CORINAIR 90. For these countries a more detailed cost analysis is possible using the same approach as for power generation. The output of this analysis is among others a general and fairly consistent relation between abatement costs for industrial combustion and fuel consumptions in various industrial sectors. This relation has been determined by comparing investment costs with fuel consumptions, assuming all plants > 50 MWth need upgrading. For the countries for which no point source information was available, costs have thus been estimated based on the fuel consumptions in the industrial sectors in which mainly plants above 50 MWth are used, according to [IEA '95].

Industrial combustion - costs

For industrial combustion roughly the same cost relations as valid for the sector Power generation etc. are applied. Although furnace capacities are usually lower, ESP is generally considered the most cost efficient abatement technology for this source.

Process emissions - control measures

In this section Protocol-related emission reduction measures are discussed. The emission limit values listed in the Protocol generally refer to maximum admissable dust concentrations in the stack gasses, for various processes. Again, emission abatement costs are primarily determined by the produced waste gas flow rate. However, the emission limit values are highly process specific, as are the type of the most suitable control technologies and waste gas characteristics. This leads to higly variable specific investment costs for the different processes. The general procedure for estimating investment costs for production processes has been to:

1. assess, per country, the total number of present installations of a certain production process; Plant information comprising process type and capacity is available for all processes covered by the protocols on an installation level, except for cupola furnaces, glass production plants and municipal waste incinerators (latter for countries outside the EU). Plant information is also partly lacking for the chloro-alkali industry. Most point source data have been collected within the framework of [UBA-TNO '97].

2. estimate which plants do not yet comply with the Protocol; In this stage emission data, serving as basis for the selection of plants that will need upgrading, have been estimated mainly with the aid of generalised emission factors. The emission data are based primarely information from TNO, [UBA-TNO '97], [Rentz et al. '96], [Klimont '93], [TFHME '94], the Dutch emission registration and various national expert communications.

3. estimate the production-dependant waste gas release of the waste gas flow to be cleaned; Most data are taken from the Dutch emission Registration, [Rentz et al. '96] and [TFHME '94].

4. inventory the most suitable emission control technology given a certain process and emission requirements; Most data are taken from the Dutch emission Registration, [Rentz et al. '96] and [TFHME '94]. When possible, fabric filters are applied but for various processes other control technologies are more suitable.

5. capitalising the required emission measure depending on the flow to be cleaned and the technology; This can be difficult since process-specific cost information is not always available to the same level of detail. Most information is taken from [Rentz et al. '96].

For the following categories emission limit values are mentioned:

- Iron ore sinter production plants
- Iron ore pellet production plants
- Electric arc furnaces in the secondary iron and steel industry
- Basic oxygen furnaces in steel making
- Cupola furnaces at iron foundries
- non-Ferrous metal production including primary aluminium, primary and secondary copper, primary and secondary lead, primary zinc and primary nickel
- Waste incineration plants
- Clinker coolers in cement production industries
- Cement grinding in the cement production industries
- Glass production
- Chloro-alkali industry

Process emissions - costs

Per production process, the findings referring to investment costs will be briefly discussed in the following:

Iron ore sinter production plants
It is estimated that plants located in Southern, Central and Eastern Europe do not yet comply with the Protocol. Point source information comprising production capacities is available for these regions. The emission limit value for this category is expected to be met by retrofit of a 3-field ESP to the sinter oven. The costs have been calculated with the aid the cost relation similar to the relation as used for ESP at power plants.

Iron ore pellet production plants
It is estimated that plants located in Southern, Central and Eastern Europe do not yet comply with the Protocol for this source category. Needed emission reduction measures comprise a high efficiency scrubber for which investment costs applicable to this sector per unit of production capacity are given in [Rentz et al]. No point source information is available and the abatement costs have been estimated based on production figures.

Basic oxygen furnaces in the primary iron an steel industries
Plants located in Southern, Central and Eastern Europe are estimated not yet to comply to the Protocol for this source category. Point source information is available for these regions and has been used in the cost estimates. Needed emission reduction measures comprise the addition of new ESP to the furnace outlet. The same cost formula as has been used for ESP at large combustion plants is used to estimate the costs.

Electric arc furnaces in the secondary iron and steel industry
Our estimation is that plants located in Southern, Central and Eastern Europe do not yet comply with the Protocol for this source category. Point source information is available for these regions and has been used in the cost estimates. Needed emission reduction measures in order to comply with the Protocol include process encapsulation by a dog house construction and a fabric filter. Cost estimates are based on [Rentz et al.] and non-referenced information in the Technical Annexes to the Protocol [UN/ECE '97].

Cupola furnaces at iron foundries
There is hardly any information available for this source category. Point source data are not available for cold blast cupola furnaces. Production figures are available from [CAEF '92]. Although no quantitative data can be given at this stage the potential emission abatement cost are not expected to dominate the total investment costs in the iron and steel sector.

non-Ferrous metal production, primary copper production
It is estimated that plants within the region Southern, Central and Eastern Europe do not yet comply with the protocol. Measures are needed for sintering/roasting of the copper concentrates, the smelters and the converters. Point source information is available for this category and has been used in the cost estimates. For sintering/roasting a non-referenced abatement cost relation from [UNECE '97] has been used. The measures comprise the application of ESP and scrubbers and a fabric filter. For the smelting process (conventional blast furnace operation is assumed) and the converting step fabric filters have been capitalised according to [Rentz et al.].

non-Ferrous metal production, secondary copper production
It is estimated that plants within the region Southern, Central and Eastern Europe do not yet comply with the protocol. Capitalised measures comprise a fabric filter. The cost relation is according to [Rentz et al.]. Cost estimates are based on point source information.

non-Ferrous metal production, primary lead production
Plants within the regions Southern, Central and Eastern Europe are estimated not to comply with the Protocol yet. The cost determining measure for all process types is, according to our information, a fabric filter for the rotary furnace. Costs of this measure are given in [Rentz et al.]. Cost estimates are based on point source information.

non-Ferrous metal production, secondary lead production
It is estimated that plants within the region Southern, Central and Eastern Europe do not yet comply with the protocol. Capitalised measures comprise a fabric filter for the smelting furnace. The cost of this measure is calculated is according to [Rentz et al.]. Cost estimates are based on point source information.

non-Ferrous metal production, primary zinc production
It is estimated that plants within the region Southern, Central and Eastern Europe do not yet comply with the protocol. Measures needed for all process types include an ESP for the roasting and sintering step. In addition for process types other than electrical a second ESP for the smelter and a fabric filter for the refining step has been capitalised. Point source information (including process types) is available for this category and has been used in the cost estimates. The cost of ESP has been capitalised analogous to large combustion plants. Fabric filters have been capitalised according to [Rentz et al.].

Clinker coolers and cement grinding in cement production industry
According to our information plants in the region Central and Eastern Europe do not yet comply with the Protocol. ESP appears to be the most suitable abatement measure for the rotary kiln and the clinker cooler. Investment costs are estimated analogous to large combustion plants. Apart from the rotary kiln and clinker cooler measures are also needed for the crusher, mill and dryer for cement production plants. For these emission sources a fabric filter is considered most suitable. The costs are estimated according [Rentz et al.].

Glass manufacture
According to presently available information glass production plants in Southern, Central and Eastern Europe do not yet comply to the emission Protocol. Point source information is scarce and abatement costs have been calculated based on production statistics. Cost information for heavy metal emission reduction from glass production plants is given in [Rentz et al.]. After further

processing this information can be expressed per unit of production. The primary abatement measure that is assumed most suitable for large plants comprises ESP for tank and pot furnaces.

Chloro-alkali industry
Information is somewhat scarce for this category. It is not fully known which plants in which regions already comply with the Protocol for this sector. It is also unclear which autonomous developments have already been implemented. In this stage it is estimated that at least all mercury based plants in Central and Eastern Europe need further mercury emission abatement. The only cost information available (from the German VCI [VCI '97]) concerns the complete conversion to a membrane-based process. Cost may be overestimated here since a complete conversion might not be necessary in order to meet the Protocol. No further point source information is available for this industry and it is therefore assumed that 2/3 of the total chlorine producing capacity is mercury based. Costs have been estimated based on production statistics.

Waste incineration plants

It is not fully clear which autonomous developments have already been implemented in Western Europe for this sector, therefore it is difficult to estimate which plants do not comply with the Protocol. Data indicate that most plants are fitted with ESP. For Central and Eastern European plants it is estimated that most plants need new ESP. Point source information is however not available for this region and costs of ESP have been calculated based on estimated amounts of burned waste and the characteristics of an assumed 'standard' incinerator based on [Rijpkema '93]. The presented cost estimates are therefore uncertain. Waste incinerators in Europe will possibly also be upgraded with other types of emission abatement technologies as a result of emission limit values for other compounds. These measures will further reduce the emission of heavy metals.

Influence of autonomous developments of investment costs for stationary sources

In paragraph 2.2.2 of this report, the autonomous developments and non-Protocol related other environmental legislation that has been reckoned in this project has been listed and briefly discussed. Most of these autonomous developments result in decreased costs of the Protocol:

- **Closure of certain plants before the year 2010 in several countries**

It is expected that in the period until 2010 throughout Europe some older heavy metal emitting installations will be closed and will subsequently not be under consideration for Protocol related measures. This will naturally also influence the outcome of the cost estimates. However information on which plants will be shut down is for a large part lacking on a country basis. In order to estimate the number of installations of a certain type that will be shut down before 2010 the scenario data have been used. In case there is a decrease in output forecasted for a certain activity, the percentage of the plants that will be closed for that activity has been estimated by taking the percentage decline of the output. Newly constructed installations are assumed to comply with the UN/ECE emission limit values.

- **Compliance with the Protocol as a result of the EURO CHLOR program in Western. and Southern European countries**

It is assumed as autonomous development for Western and Southern Europe that the chloro-alkali industry will comply with the Protocol by the year 2010 as a result of voluntarily emission reduction to 1.5 gHg/ton Cl2 production capacity. The chloro alkali industry will in that case conform to the Protocol in these regions and no further investments need to be made.

- **Compliance as a result of European Union emission regulations for countries in the EU**

It is expected that all countries in Southern Europe will comply with the emission limit value that are set for waste incineration plants and large combustion plants, hence no further Protocol-related investments need to be made in these sectors.

- **-(Partial) compliance as a result of future national emission regulations for some countries**

As has been indicated in paragraph 2.2.2 some source categories in certain countries are estimated to comply with the Protocol by the year 2010 as a result of autonomous developments. These have been listed in the referring section. For other categories and countries an emission reduction is forecasted while a further reduction of the emissions will be necessary to comply with the Protocol. It has been attempted to quantify this further reduction in terms of cost, thus quantifying the incremental costs of the HM Protocol. In [AWMA '93] specific investment costs are given for ESP and fabric filters as a function of the collection efficiency. In case an emission reduction is foreseen it is estimated which further increase in particulate collection efficiency of the dust collector is needed to comply with the Protocol. This increase in collection efficiency is capitalised according to the relative increase in investment costs starting from the lower collection efficiency (foreseen by autonomous development) to the higher required collection efficiency (required by the Protocol) according to [AWMA '93]. This cost increase has been taken as implementation cost of the Protocol after autonomous developments.

- **(Partial) compliance as a result of the implementation of the second Sulphur Protocol for countries in Europe**

Besides the above mentioned autonomous developments a further reduction in costs is expected as a result of the second Sulphur Protocol. As has been mentioned in paragraph 2.2.2 the Sulphur Protocol will bring about a decrease of dust emissions for certain source categories and hence a reduction of abatement costs (see referring section). It is estimated that the application of wet FGD processes will lead to reduction in particulate matter emission to such extent that no further measures are needed to comply to the Protocol. In case wet or semi dry FGD is used no cost reduction is foreseen.

2.3.3 Costs of the Protocol-related measures referring to the use of certain products

The HM protocol reserves a section devoted the use of heavy metal containing products. Several measures are mentioned which will subsequently be discussed in terms of cost in the following:

Phase out of leaded gasoline

Throughout recent years, in most European countries, a decrease of the use of leaded in favour of unleaded gasoline is observed. In several countries (Austria, Denmark, Finland, Germany, Netherlands, Norway, Slovak Republic, Sweden) lead in automotive fuels has been completely banned. In order to determine the amount of leaded gasoline used in Europe data referring for 1995 are available for EU-members while for other countries no more recent data as for 1990 are available from [UBA-TNO '97]. According to information from a large petrochemical company, the replacement of lead in gasoline leads to an additional investment in refining equipment of ECU 0.01/liter gasoline. The cost estimate for replacement of leaded gasoline is derived from ECU 0.01/l and the most recent data on national consumptions of leaded gasoline in Europe.

Phase out of sale and production of mercury containing electrical components and measuring and control devices

Mercury containing electrical components comprise mainly relays, thermostats and various switches. Mercury has also been used in measuring and control devices such as thermometers, manometers, barometers, pressure gauges, pressure switches and pressure transmitters. According to [DHV '94] for almost all mercury containing components, mercury-free alternatives have been demonstrated to be equally effective and have been used for many years now. The application of mercury in electrical components and control devices is generally considered to be obsolete although significant amounts of mercury containing components are still in use in Europe. In many countries (future) legislation will prohibit the production and sale of mercury containing components [OECD '96]. Switching to mercury-free alternatives is estimated to be cost neutral. Environmentally friendly collection and recycling or disposal can, however, not be considered cost neutral (see referring section).

Limitation of maximum mercury content to 0.025% for batteries, 1% for button cells, 10 mg per lamp for linear fluorescent lamps with external ballast and 6 mg per lamp for self ballasted fluorescent lamps

In the Netherlands currently marketed batteries and fluorescent lamps already comply with these limit values (button cells excluded) and (future) legislation leading to adaptation of the limit values is foreseen for almost all other countries in Europe [OECD '96]. In Europe, lamps and batteries complying to these mercury limit values are extensively marketed. It is expected that the implementation of the limits to mercury contents for these products will be cost neutral.

Promotion of collection and recycling or disposal in an environmentally sound manner of mercury containing products

In the Netherlands it is estimated that about 50 tonnes of mercury is present in the form of products that are in use (dental amalgams excluded) [DHV '96]. For mercury containing products which carry on average 1% mercury, a potential collection efficiency of 10-20% is foreseen in the Netherlands. Notably electrical components are expected to be difficult to collect. The costs of promotional activities, handling and disposal or recycling are estimated to be in the range of 100-1000 ECU/kg Hg [DHV '96], leading to ECU 5,000,000-50,000,000,- for the Netherlands, having 15,000,000 inhabitants. When neglecting socio-economic differences between countries, a rough estimate of the costs for countries in Europe is made, based on population. According to [DHV

'96] costs might decrease significantly as a result of an increasing volume of mercury containing products to be collected and disposed of. Based on [OECD '96] it is assumed that environmentally safe collection and recycling or disposal will be future autonomous policy in Europe and is assumed to be autonomous policy.
For other (non-mandatory) limitation of the use of various other products containing Cadmium, Lead and Mercury costs are not expected to significantly influence the costs of the HM Protocol are not further capitalised. Some costs may arise from the collection and disposal or recycling of batteries.

3. Results

3.1 Emission projections per source group

Emission projections have been prepared for the following substances: cadmium, lead, mercury, arsenic, chromium, copper, nickel and zinc. The emission projections are processed per source category according to [UBA-TNO '97]. As has been discussed in chapter 2, three emission projections have been made, being:

1. Projected emission of HM in 2010, disregarding autonomous developments
2. Projected emission of HM in 2010 taking into account autonomous emission reduction measures
3. Projected emission of HM in 2010 taking into account autonomous emission reduction measures and the implementation of the HM Protocol

Results of emission projection are listed per heavy metal and per source category for three regions in Europe in the tables 6 to 8. The emission in 1990 according to [UBA-TNO '97] has also been given. A graphic representation of the emission totals is per region and per heavy metal presented in the figures 5 to 9. It should be noted that the emission estimates for HM are relatively uncertain and hence conclusions should be drawn with care. The emission projections in this study are based on [UBA-TNO '97]. The uncertainty that the emission estimates from [UBA-TNO '97] might have, will inevitably return in our results. In case emissions for 1990 are underestimated in [UBA-TNO '97] the emission reduction due to the Protocol might seem lower than expected. Results for cadmium, mercury and lead are presented per country in Annex 1.

Table 6: Projected emission of eight heavy metals for the year 1190 (A), 2010 assuming respectively 'Business as in 1990' (B) and 2010 taking into account autonomous emission reduction measures (C), for Western Europe[1)]

Description	SNAP	Cd, A	Cd, B	Cd, C	Hg, A	Hg, B	Hg, C	Pb, A	Pb, B	Pb, C
Total		**110**	**98**	**98**	**210**	**200**	**180**	**12000**	**15000**	**5400**
Not specified		**1,9**	**1,9**	**1,9**	**2,6**	**2,6**	**2,6**	**110**	**110**	**110**
Total Public power etc.	**010000**	**8,8**	**7,8**	**7,8**	**33**	**33**	**33**	**140**	**130**	**130**
Public power etc. brown coal	01bc	2,8	2	2	4,4	2,5	2,5	21	15	15
Public power etc. fuel oils	01fo	1,3	1,9	1,9	1,3	1,7	1,7	14	24	24
Public power etc. hard coal	01hc	3,6	2,8	2,8	16	16	16	77	66	66
Public power etc. other fuels	01of	1,1	1,1	1,1	12	12	12	29	29	29
Total Commercial etc.	**020000**	**7,9**	**6,5**	**6,5**	**12**	**6**	**6**	**110**	**57**	**57**
Commercial etc. brown coal	02bc	0,48	0,037	0,037	4,2	0,22	0,22	22	1,1	1,1
Commercial etc. fuel oils	02fo	1,2	1	1	0,14	0,14	0,14	6	5,3	5,3
Commercial etc. hard coal	02hc	1,1	0,33	0,33	2,9	0,64	0,64	39	8,3	8,3
Commercial etc. other fuels	02of	5,1	5,1	5,1	5	5	5	42	42	42
Total Industrial combustion	**030000**	**19**	**12**	**12**	**24**	**13**	**13**	**420**	**360**	**360**
Industrial combustion brown coal	03bc	8,9	1,6	1,6	14	2,5	2,5	81	15	15
Industrial combustion fuel oils	03fo	8,3	9,1	9,1	0,93	1,7	1,7	190	220	220
Industrial combustion hard coal	03hc	1,1	1,1	1,1	7,4	6,2	6,2	140	120	120
Industrial combustion other fuels	03of	0,42	0,42	0,42	2,1	2,1	2,1	5,7	5,7	5,7
Total Production processes	**040000**	**40**	**36**	**36**	**98**	**95**	**79**	**1400**	**1300**	**1300**
Petroleum industries	040100									
Coke production	040201	2,3	2,2	2,2	1,3	1,3	1,3	12	11	11
Blast furnace	040202	0,67	0,65	0,65	1,2	1,1	1,1	110	100	100
Pig iron	040203	0,51	0,49	0,49				4,1	3,9	3,9
Open hearth furnace	040205	2						35		
Basic oxigen furnace	040206	1,7	1,6	1,6	0,1	0,1	0,1	72	70	70
Electric arc furnace	040207	12	10	10	2,3	1,1	1,1	420	340	340
Sinter plants	040209	3	3	3	0,7	0,69	0,69	150	150	150
Foundries	0402xx	0,19	0,17	0,17				7,8	7,1	7,1
Al industry	040301	0,45	0,42	0,42	0,001	0,00095	0,00095	0,55	0,52	0,52
Cu industry	0403cu	1,6	1,7	1,7	0,035	0,039	0,039	27	26	26
Non-specified non ferrous		5,3	5	5	36	34	34	260	260	260
Other non-ferrous metals	0403ot	0,007								
Pb industry	0403pb	7,1	6,7	6,7	2,6	2,5	2,5	190	170	170
Zn industry	0403zn	2	2,1	2,1	0,047	0,045	0,045	11	10	10
NPK fertilisers	040407	0,17	0,14	0,14						
Chloro-alkali industry	040413				23	25	8,8			
Halogenated HC production	040524				0,76	0,88	0,88			
Cement industry	040612	1,1	1,1	1,1	29	28	28	31	29	29
Glass industry	040613	0,55	0,63	0,63	0,28	0,32	0,32	99	100	100
Battery manufacturing	040615							0,63	0,77	0,77
Non-spec. production processes					0,04	0,04	0,04			
Extraction and distr. of fossil fuels	**050000**	**0,012**	**0,015**	**0,015**	**0,029**	**0,036**	**0,036**	**0,77**	**0,95**	**0,95**
Solvent use	**060000**	**0,3**	**0,3**	**0,3**						
Other solvent use	0603&4	0,3	0,3	0,3						
Solvent use, non specified	06oth									
Road transport	**070000**	**9,8**	**12**	**12**	**0,001**	**0,0014**	**0,0014**	**9800**	**12000**	**3000**
Road transport combustion	0701-5	9,1	11	11	0,001	0,0014	0,0014	9700	12000	2800
Road transport non-combustion	0706/7	0,54	0,67	0,67				7,5	9,3	9,3
Road transport non-specified		0,23	0,23	0,23				160	160	160
non-Road transport	**080000**	**0,33**	**0,33**	**0,33**	**0,011**	**0,0087**	**0,0087**	**87**	**83**	**83**
Other transport combustion	0801co	0,33	0,33	0,33	0,011	0,0087	0,0087	87	83	83
Other transport non-combustion	0801nc									
Waste treatment and disposal	**090000**	**18**	**21**	**21**	**40**	**46**	**46**	**430**	**500**	**500**
Waste incineration	090200	17	21	21	37	43	43	330	400	400
Landfill	090400	0,2	0,21	0,21	0,27	0,28	0,28	99	110	110
Cremation	090900	0,025	0,025	0,025	2,3	2,3	2,3	0,06	0,06	0,06
Hg therm. and vapour lamps					1,4					

Description	SNAP	As, A	As, B	As, C	Cr, A	Cr, B	Cr, C	Cu, A	Cu, B	Cu, C	Ni, A	Ni, B	Ni, C	Zn, A	Zn, B	Zn, C
Total		**340**	**240**	**240**	**840**	**750**	**750**	**930**	**800**	**800**	**1700**	**2200**	**2200**	**7000**	**6700**	**6700**
Not specified		**1,5**	**1,5**	**1,5**	**9,5**	**9,5**	**9,5**	**9,2**	**9,2**	**9,2**	**95**	**95**	**95**	**230**	**230**	**230**
Total Public power etc.	**010000**	**140**	**110**	**110**	**63**	**58**	**58**	**81**	**70**	**70**	**730**	**1200**	**1200**	**300**	**260**	**260**
Public power etc. brown coal	01bc	17	12	12	17	12	12	35	24	24	21	15	15	57	40	40
Public power etc. fuel oils	01fo	3,6	5,5	5,5	11	18	18	9,1	16	16	620	1100	1100	17	28	28
Public power etc. hard coal	01hc	110	83	83	33	26	26	35	28	28	82	65	65	160	140	140
Public power etc. other fuels	01of	9,6	9,6	9,6	1,4	1,4	1,4	1,7	1,7	1,7	3,1	3,1	3,1	59	59	59
Total Commercial etc.	**020000**	**30**	**8,7**	**8,7**	**17**	**7,7**	**7,7**	**26**	**14**	**14**	**110**	**59**	**59**	**160**	**130**	**130**
Commercial etc. brown coal	02bc	2	0,11	0,11	0,87	0,1	0,1	0,3	0,1	0,1	15	0,8	0,8	0,23	0,029	0,03
Commercial etc. fuel oils	02fo	2	1,8	1,8	3	2,6	2,6	2,2	1,9	1,9	50	49	49	5,2	4,6	4,6
Commercial etc. hard coal	02hc	23	4,2	4,2	11	2,5	2,5	16	4,3	4,3	38	8,2	8,2	32	5,7	5,7
Commercial etc. other fuels	02of	2,6	2,6	2,6	2,5	2,5	2,5	7,4	7,4	7,4	1,4	1,4	1,4	120	120	120
Total Industrial combustion	**030000**	**130**	**77**	**77**	**120**	**69**	**69**	**210**	**94**	**94**	**530**	**580**	**580**	**770**	**580**	**580**
Industrial combustion brown coal	03bc	66	12	12	63	11	11	140	25	25	81	15	15	220	40	40
Industrial combustion fuel oils	03fo	14	15	15	27	30	30	38	42	42	390	490	490	140	160	160
Industrial combustion hard coal	03hc	46	49	49	28	26	26	26	26	26	62	69	69	310	290	290
Industrial combustion other fuels	03of	0,54	0,54	0,54	1,6	1,6	1,6	1,3	1,3	1,3	2	2	2	93	93	93
Total Production processes	**040000**	**46**	**44**	**44**	**580**	**550**	**550**	**270**	**260**	**260**	**150**	**140**	**140**	**3800**	**3400**	**3400**
Petroleum industries	040100										1	1,1	1,1			
Coke production	040201	0,91	0,88	0,88	8,2	7,9	7,9	4,1	4	4	3	2,9	2,9	12	12	12
Blast furnace	040202	5,6	5,4	5,4	9,5	9,3	9,3	34	33	33	12	12	12	360	350	350
Pig iron	040203	0,17	0,16	0,16	0,62	0,59	0,59				0,28	0,27	0,27	2,8	2,7	2,7
Open hearth furnace	040205															
Basic oxigen furnace	040206	0,64	0,62	0,62	17	16	16	6,9	6,6	6,6	4	3,9	3,9	210	210	210
Electric arc furnace	040207	2,5	2,3	2,3	490	470	470	37	35	35	70	66	66	2100	1800	1800
Sinter plants	040209	1,2	1,2	1,2	11	11	11	22	22	22	16	16	16	40	39	39
Foundries	0402xx	0,28	0,27	0,27	2,2	2,1	2,1				0,51	0,48	0,48	10	9,9	9,9
Al industry	040301	0,3	0,29	0,29	0,66	0,63	0,63	0,31	0,3	0,3	14	13	13	15	14	14
Cu industry	0403cu	6	5,9	5,9				39	40	40	0,12	0,12	0,12	79	81	81
Non-specified non ferrous		15	14	14				120	110	110				450	430	430
Other non-ferrous metals	0403ot				7	6,7	6,7							9,6		
Pb industry	0403pb	4,8	4,4	4,4				2,4	2,3	2,3				250	230	230
Zn industry	0403zn				3,2						0,59			70	72	72
NPK fertilisers	040407				0,15	0,13	0,13				0,066	0,061	0,061	8,4	5,9	5,9
Chloro-alkali industry	040413															
Halogenated HC production	040524															
Cement industry	040612	1,5	1,5	1,5	13	12	12				14	13	13	36	34	34
Glass industry	040613	7	7,1	7,1	13	15	15	3,3	3,8	3,8	10	12	12	36	40	40
Battery manufacturing	040615															
Non-spec. production processes					2	2	2				1	1	1	82	82	82
Extraction and distr. of fossil fuels	**050000**	**0,54**	**0,67**	**0,67**	**0,19**	**0,23**	**0,23**	**0,24**	**0,3**	**0,3**	**0,73**	**0,9**	**0,9**	**2,2**	**2,7**	**2,7**
Solvent use	**060000**													**4,3**	**4,3**	**4,3**
Other solvent use	0603&4															
Solvent use, non specified	06oth													4,3	4,3	4,3
Road transport	**070000**				**8,9**	**10**	**10**	**150**	**170**	**170**	**72**	**82**	**82**	**1100**	**1300**	**1300**
Road transport combustion	0701-5				7	8,1	8,1	89	100	100	65	75	75	530	600	600
Road transport non-combustion	0706/7				1,1	1,4	1,4	11	13	13	1,1	1,4	1,4	410	540	540
Road transport non-specified					0,77	0,75	0,75	51	50	50	6	5,9	5,9	160	150	150
non-Road transport	**080000**	**0,9**	**0,87**	**0,87**	**0,55**	**0,49**	**0,49**	**210**	**200**	**200**	**18**	**18**	**18**	**26**	**24**	**24**
Other transport combustion	0801co	0,9	0,87	0,87	0,55	0,49	0,49	32	30	30	18	18	18	26	24	24
Other transport non-combustion	0801nc							180	170	170						
Waste treatment and disposal	**090000**	**1,9**	**2,3**	**2,3**	**43**	**51**	**51**	**36**	**43**	**43**	**27**	**32**	**32**	**870**	**1000**	**1000**
Waste incineration	090200	1,9	2,3	2,3	43	51	51	36	43	43	27	32	32	620	740	740
Landfill	090400													260	280	280
Cremation	090900															
Hg therm. and vapour lamps																

[1)] The emission projections for 2010 taking into account autonomous emission reduction developments (C) are identical to the projection for 2010 after taking into account autonomous emission reduction developments and the implementation of the Protocol, therefore these emissions do not appear in the table.

Table 7a: Projected emission of Cd, Hg and Pb for the year 1990 (A), 2010 assuming respectively 'Business as in 1990' (B), 2010 taking into account autonomous emission reduction measures (C) and 2010 after autonomous developments and implementation of the Protocol (D), for Southern Europe

Description	SNAP	Cd, A	Cd, B	Cd, C	Cd, D	Hg, A	Hg, B	Hg, C	Hg, D	Pb, A	Pb, B	Pb, C	Pb, D
Total		100	110	100	99	45	52	46	45	7500	8700	4700	4600
Total Public power etc.	**010000**	**10**	**8.5**	**8.5**	**8.5**	**10**	**14**	**14**	**14**	**51**	**65**	**65**	**65**
Public power etc. brown coal	01bc	0.6	0.8	0.8	0.8	4.3	5.3	5.3	5.3	5.9	7.9	7.9	7.9
Public power etc. fuel oils	01fo	9	6.4	6.4	6.4	0.11	0.17	0.17	0.17	16	11	11	11
Public power etc. hard coal	01hc	0.86	1.4	1.4	1.4	5.6	8.2	8.2	8.2	28	45	45	45
Public power etc. other fuels	01of	0.0049	0.0049	0.0049	0.0049	0.018	0.018	0.018	0.018	0.0047	0.0047	0.0047	0.0047
Total Commercial etc.	**020000**	**2.6**	**2.9**	**2.9**	**2.9**	**1.5**	**1.5**	**1.5**	**1.5**	**9.6**	**10**	**10**	**10**
Commercial etc. brown coal	02bc	0.005	0.01	0.01	0.01	0.007	0.014	0.014	0.014	0.029	0.056	0.056	0.056
Commercial etc. fuel oils	02fo	1.5	1.8	1.8	1.8	0.11	0.13	0.13	0.13	3.2	4.3	4.3	4.3
Commercial etc. hard coal	02hc	0.26	0.22	0.22	0.22	0.44	0.4	0.4	0.4	4.1	3.7	3.7	3.7
Commercial etc. other fuels	02of	0.85	0.85	0.85	0.85	0.93	0.93	0.93	0.93	2.2	2.2	2.2	2.2
Total Industrial combustion	**030000**	**11**	**12**	**9.6**	**9.6**	**9.4**	**9.6**	**9.6**	**9.6**	**170**	**170**	**170**	**170**
Industrial combustion brown coal	03bc	0.0052	0.0053	0.0029	0.0029	0.022	0.035	0.035	0.035	0.041	0.059	0.022	0.022
Industrial combustion fuel oils	03fo	5.1	5.3	3.8	3.8	0.6	0.77	0.77	0.77	11	12	9.2	9.2
Industrial combustion hard coal	03hc	0.54	0.57	0.021	0.021	1.6	1.6	1.6	1.6	12	13	11	11
Industrial combustion other fuels	03of	5.7	5.7	5.7	5.7	7.2	7.2	7.2	7.2	150	150	150	150
Total Production processes	**040000**	**38**	**35**	**32**	**29**	**18**	**20**	**14**	**14**	**530**	**490**	**490**	**380**
Coke production	040201	0.61	0.58	0.58	0.58	0.2	0.19	0.19	0.19	1.8	1.7	1.7	1.7
Blast furnace	040202	0.46	0.44	0.44	0.44	0.26	0.25	0.25	0.25	77	74	74	74
Pig iron	040203												
Open hearth furnace	040205												
Basic oxigen furnace	040206	0.52	0.5	0.5	0.41	0.034	0.032	0.032	0.029	21	20	20	18
Electric arc furnace	040207	15	14	14	11	2.4	2.1	2.1	1.9	210	190	190	180
Sinter plants	040209	1.7	1.5	1.5	1.2	0.11	0.094	0.094	0.094	49	44	44	44
Foundries	0402xx												
Al industry	040301	0.1	0.075	0.075	0.075								
Cu industry	0403cu	0.21	0.2	0.16	0.16					2.5	2.3	2.3	2.3
Pb industry	0403pb	0.48	0.44	0.36	0.36	0.078	0.075	0.075	0.075	150	140	140	38
Zn Industry	0403zn	17	16	13	13	0.52	0.5	0.5	0.5	20	19	19	19
NPK fertilisers	040407	0.57	0.45	0.45	0.45								
Chloro-alkali industry	040413					5.9	8.5	2.4	2.4				
Cement industry	040612	0.7	0.67	0.58	0.58	9	8.6	8.6	8.6	4.5	4.2	4.2	4.2
Battery manufacturing	040615	0.001	0.0014	0.0014	0.0014					0.29	0.41	0.41	0.41
Solvent use	**060000**	**0.032**	**0.032**	**0.032**	**0.032**					**0.78**	**0.78**	**0.78**	**0.78**
Paint use	060100												
Other solvent use	0603&4	0.032	0.032	0.032	0.032					0.78	0.78	0.78	0.78
Road transport	**070000**	**28**	**35**	**35**	**35**					**3700**	**5000**	**990**	**990**
Road transport combustion	0701-5	26	33	33	33					3700	5000	990	990
Road transport non-combustion	0706/7	2.2	2.9	2.9	2.9								
non-Road transport	**080000**	**7.7**	**7.7**	**7.7**	**7.7**					**2900**	**2900**	**2900**	**2900**
Other transport combustion	0801co	7.7	7.7	7.7	7.7					2900	2900	2900	2900
Other transport non-combustion	0801nc												
Waste treatment and disposal	**090000**	**0.81**	**1**	**0.84**	**0.84**	**5.1**	**6.5**	**6.5**	**6.5**	**23**	**28**	**27**	**27**
Waste incineration	090200	0.81	1	0.84	0.84	5	6.4	6.4	6.4	23	28	27	27
Cremation	090900					0.13	0.13	0.13	0.13				
Agriculture	**100000**	**5.2**	**5.2**	**5.2**	**5.2**								
Pesticide use	100600	5.2	5.2	5.2	5.2								

Table 7b: Projected emission of As, Cr, Cu, Ni and Zn for the year 1990 (A), 2010 assuming respectively 'Business as in 1990' (B), 2010 taking into account autonomous emission reduction measures (C) and 2010 after autonomous developments and implementation of the Protocol (D), for Southern Europe

Description	SNAP	As, A	As, B	As, C	As, D	Cr, A	Cr, B	Cr, C	Cr, D	Cu, A	Cu, B	Cu, C	Cu, D	Ni, A	Ni, B	Ni, C	Ni, D	Zn, A	Zn, B	Zn, C	Zn, D
Total		**230**	**200**	**170**	**160**	**340**	**300**	**280**	**230**	**2100**	**2200**	**2200**	**2200**	**3200**	**3000**	**3000**	**2900**	**4800**	**5100**	**5100**	**5000**
Total Public power etc.	**010000**	**140**	**110**	**110**	**110**	**130**	**95**	**95**	**95**	**24**	**27**	**27**	**27**	**960**	**670**	**670**	**670**	**98**	**140**	**140**	**140**
Public power etc. brown coal	01bc	3.1	3.7	3.7	3.7	2.2	2.7	2.7	2.7	5.5	7.7	7.7	7.7	2.9	3.6	3.6	3.6	27	38	38	38
Public power etc. fuel oils	01fo	110	79	79	79	120	83	83	83	11	7.5	7.5	7.5	940	650	650	650	15	10	10	10
Public power etc. hard coal	01hc	23	28	28	28	7	9.2	9.2	9.2	7.3	12	12	12	12	17	17	17	55	90	90	90
Public power etc. other fuels	01of	0.17	0.17	0.17	0.17	0.052	0.052	0.052	0.052	0.006	0.006	0.006	0.006	0.036	0.036	0.036	0.036	0.22	0.22	0.22	0.22
Total Commercial etc.	**020000**	**8.2**	**9**	**9**	**9**	**7.8**	**8.5**	**8.5**	**8.5**	**3.3**	**3.4**	**3.4**	**3.4**	**24**	**27**	**27**	**27**	**22**	**22**	**22**	**22**
Commercial etc. brown coal	02bc	0.005	0.01	0.01	0.01	0.02	0.04	0.04	0.04	0.028	0.056	0.056	0.056	0.02	0.04	0.04	0.04	0.059	0.12	0.12	0.12
Commercial etc. fuel oils	02fo	7.8	8.7	8.7	8.7	6.2	7.1	7.1	7.1	1.3	1.7	1.7	1.7	23	27	27	27	1.9	2.5	2.5	2.5
Commercial etc. hard coal	02hc	0.2				0.29				0.28				0.3				1.7	1.6	1.6	1.6
Commercial etc. other fuels	02of	0.29	0.29	0.29	0.29	1.3	1.3	1.3	1.3	1.7	1.7	1.7	1.7	0.64	0.64	0.64	0.64	18	18	18	18
Total Industrial combustion	**030000**	**53**	**45**	**21**	**21**	**65**	**59**	**42**	**42**	**53**	**53**	**52**	**52**	**470**	**470**	**450**	**450**	**270**	**270**	**260**	**260**
Industrial combustion brown coal	03bc	0.016	0.024	0.023	0.023	0.0082	0.016	0.016	0.016	0.022	0.059	0.0058	0.0058	0.0071	0.016	0.016	0.016	0.12	0.29	0.029	0.029
Industrial combustion fuel oils	03fo	38	32	11	11	45	41	27	27	5.9	6.3	6.3	6.3	450	450	430	430	8.4	8.9	8.9	8.9
Industrial combustion hard coal	03hc	6.9	5.1	1.5	1.5	8.8	6.9	4.2	4.2	1.3	1.5	0.26	0.26	9.5	8	7.5	7.5	15	18	4.5	4.5
Industrial combustion other fuels	03of	8.2	8.2	8.2	8.2	11	11	11	11	46	46	46	46	13	13	13	13	250	250	250	250
Total Production processes	**040000**	**32**	**30**	**24**	**15**	**100**	**98**	**96**	**39**	**48**	**45**	**45**	**43**	**51**	**47**	**46**	**33**	**1600**	**1500**	**1500**	**1400**
Coke production	040201	0.77	0.73	0.73	0.73	3.1	2.9	2.9	2.9	0.82	0.78	0.78	0.78	0.74	0.71	0.71	0.71	1.7	1.7	1.7	1.7
Blast furnace	040202	11	10	10	10	6.9	6.5	6.5	6.5	17	17	17	17	6.5	6.2	6.2	6.2	230	220	220	220
Pig iron	040203																				
Open hearth furnace	040205																				
Basic oxigen furnace	040206	1	0.96	0.96	0.24	5.8	5.5	5.5	1.6	1.9	1.8	1.8	1.4	1.3	1.2	1.2	0.81	53	51	51	47
Electric arc furnace	040207	8.5	8	8	2.1	75	70	70	21	14	13	13	11	18	17	17	5.2	820	730	730	730
Sinter plants	040209	2.8	2.7	2.7	0.5	8.6	8.1	8.1	3.7	6.2	5.6	5.6	5.6	11	9.7	9.7	8.7	7.7	7	7	7
Foundries	0402xx																				
Al industry	040301													7.6	5.8	5.8	5.8	6.4	4.6	4.6	4.6
Cu industry	0403cu	0.89	0.85	0.16	0.16					7.1	6.8	6.8	6.8					12	11	11	11
Pb industry	0403pb	4.6	4.4	0.81	0.81					0.21	0.2	0.2	0.2					20	18	18	18
Zn industry	0403zn																	480	460	460	390
NPK fertilisers	040407																				
Chloro-alkali industry	040413																				
Cement industry	040612	2.4	2.2	0.58	0.58	5.4	5.1	2.9	2.9					6.6	6.2	5.8	5.8	8.7	8.2	8.2	8.2
Battery manufacturing	040615																				
Solvent use	**060000**									**150**	**150**	**150**	**150**					**0.48**	**0.48**	**0.48**	**0.48**
Paint use	060100									150	150	150	150								
Other solvent use	0603&4																	0.48	0.48	0.48	0.48
Road transport	**070000**					**30**	**37**	**37**	**37**	**290**	**370**	**370**	**370**	**230**	**290**	**290**	**290**	**1300**	**1600**	**1600**	**1600**
Road transport combustion	0701-5					22	26	26	26	230	290	290	290	220	280	280	280	290	380	380	380
Road transport non-combustion	0706/7					8.7	11	11	11	59	76	76	76	8	10	10	10	960	1200	1200	1200
non-Road transport	**080000**	**0.99**	**0.99**	**0.99**	**0.99**	**0.5**	**0.5**	**0.5**	**0.5**	**1600**	**1600**	**1600**	**1600**	**1500**	**1500**	**1500**	**1500**	**1500**	**1500**	**1500**	**1500**
Other transport combustion	0801co	0.99	0.99	0.99	0.99	0.5	0.5	0.5	0.5	1500	1500	1500	1500	1500	1500	1500	1500	1500	1500	1500	1500
Other transport non-combustion	0801nc									77	77	77	77								
Waste treatment and disposal	**090000**	**0.78**	**0.94**	**0.21**	**0.21**	**5**	**6.1**	**3.1**	**3.1**	**2.7**	**3.4**	**3.4**	**3.4**	**0.75**	**0.92**	**0.84**	**0.84**	**37**	**46**	**46**	**46**
Waste incineration	090200	0.78	0.94	0.21	0.21	5	6.1	3.1	3.1	2.7	3.4	3.4	3.4	0.75	0.92	0.84	0.84	37	46	46	46
Cremation	090900																				
Agriculture	**100000**																				
Pesticide use	100600																				

Table 8a: Projected emission of Cd, Hg and Pb for the year 1990 (A), 2010 assuming respectively 'Business as in 1990' (B), 2010 taking into account autonomous emission reduction measures (C) and 2010 after autonomous developments and implementation of the Protocol (D), for Central and Eastern Europe

Description	Cd, A	Cd, B	Cd, C	Cd, D	Hg, A	Hg, B	Hg, C	Hg, D	Pb, A	Pb, B	Pb, C	Pb, D
Total	**400**	**310**	**250**	**220**	**210**	**160**	**150**	**140**	**20000**	**19000**	**5600**	**5500**
Total Public power etc.	**80**	**51**	**17**	**14**	**72**	**55**	**53**	**53**	**1100**	**730**	**720**	**700**
Public power etc. brown coal	31	21	2.6	1.4	24	19	18	17	64	43	43	43
Public power etc. fuel oils	30	15	12	12	0.057	0.0046	0.0046	0.0046	100	49	49	49
Public power etc. hard coal	19	14	1.3	0.33	47	36	35	35	870	610	600	600
Public power etc. other fuels	0.63	0.63	0.63	0.19	0.25	0.25	0.25	0.25	31	31	31	4.7
Total Commercial etc.	**87**	**86**	**86**	**86**	**32**	**21**	**21**	**21**	**650**	**560**	**560**	**560**
Commercial etc. brown coal	1.8	0.57	0.57	0.57	3.2	1.3	1.3	1.3	13	5	5	5
Commercial etc. fuel oils	11	19	19	19	0.003	0.0063	0.0063	0.0063	31	43	43	43
Commercial etc. hard coal	73	64	64	64	28	19	19	19	600	500	500	500
Commercial etc. other fuels	1.8	1.8	1.8	1.8	0.86	0.86	0.86	0.86	5.3	5.3	5.3	5.3
Total Industrial combustion	**55**	**44**	**11**	**8.9**	**34**	**23**	**17**	**16**	**510**	**360**	**160**	**150**
Industrial combustion brown coal	1.6	0.9	0.17	0.077	1.1	0.82	0.78	0.78	5.5	14	2.2	1.2
Industrial combustion fuel oils	20	20	8.5	8.5	0.17	0.11	0.11	0.11	55	42	29	29
Industrial combustion hard coal	33	23	2.3	0.15	32	22	16	15	450	310	130	120
Industrial combustion other fuels	0.16	0.16	0.16	0.16	0.097	0.097	0.097	0.097	0.33	0.33	0.33	0.33
Total Production processes	**130**	**84**	**83**	**63**	**60**	**50**	**46**	**41**	**3300**	**1900**	**1800**	**1700**
Coke production	5	4.3	4.3	4.3	3	2.6	2.6	2.6	22	19	19	19
Blast furnace	2.1	1.7	1.7	1.7	2.1	1.7	1.7	1.7	570	460	460	460
Pig iron	0.2	0.2	0.2	0.2	0.47	0.47	0.47	0.47	38	38	38	38
Open hearth furnace	23								690			
Basic oxigen furnace	1.7	1.4	1.4	1.4	0.22	0.19	0.19	0.18	89	74	74	74
Electric arc furnace	15	12	12	12	3.6	3	3	3	270	220	220	210
Rolling	0.006	0.006	0.006	0.006					0.23	0.23	0.23	0.23
Sinter plants	15	6.5	6.5	6.4	6.4	4.7	1.4	1.4	950	430	420	420
Foundries	0.9	0.89	0.89	0.89					46	46	46	46
Iron and steel, non-specified	0.16	0.16	0.16	0.16					8	8	8	8
Al industry	0.35	0.32	0.32	0.32	0.14	0.14	0.14	0.14				
Cu industry	24	22	22	2.3	4.4	4.4	4.4	0.058	160	150	140	74
Ni industry												
Other non-ferrous metals					0.002	0.002	0.002	0.002	0.13	0.13	0.13	0.13
Pb industry	1.2	0.95	0.95	0.3	1.3	1.1	1.1	1.1	100	83	83	65
Zn industry	34	23	23	23	3.3	2.3	2.3	2.3	83	57	57	57
NPK fertilisers	0.46	0.52	0.52	0.52								
Chloro-alkali industry					1.5	1.7	1.5	0.83				
Pesticide production	0.002	0.0033	0.0033	0.0033								
Cement industry	1.3	1.1	1.1	1.1	32	27	26	26	19	17	11	11
Glass industry	7.4	7.3	7.3	7.3	0.16	0.16	0.16	0.16	270	240	240	240
Battery manufacturing									0.2	0.24	0.24	0.24
Synthetic grid blasting					0.001	0.0011	0.0011	0.0011	0.052	0.056	0.056	0.056
Non-spec. production processes	1.4	1.4	1.4	1.4	1.3	1.3	1.3	1.3	15	15	15	15
Extraction and distr. of fossil fuels					**0.69**	**0.75**	**0.75**	**0.75**				
Road transport	**37**	**40**	**40**	**40**					**14000**	**15000**	**1900**	**1900**
Road transport combustion	37	40	40	40					14000	15000	1900	1900
Road transport non-combustion	0.55	0.6	0.6	0.6								
non-Road transport	**9.3**	**8.6**	**8.6**	**8.6**	**0.13**	**0.11**	**0.11**	**0.11**	**520**	**470**	**470**	**470**
Other transport combustion	9.3	8.6	8.6	8.6	0.13	0.11	0.11	0.11	520	470	470	470
Other transport non-combustion												
Waste treatment and disposal	**1.6**	**1.6**	**1.6**	**1.2**	**9.5**	**9.4**	**9.4**	**7.4**	**35**	**35**	**35**	**29**
Waste incineration	1.6	1.6	1.6	1.2	8.2	8.2	8.2	6.1	35	35	35	29
Cremation					1.3	1.3	1.3	1.3				

Table 8b: Projected emission of As, Cr, Cu, Ni and Zn for the year 1990 (A), 2010 assuming respectively 'Business as in 1990' (B), 2010 taking into account autonomous emission reduction measures (C) and 2010 after autonomous developments and implementation of the Protocol (D), for Central and Eastern Europe

Description	As, A	As, B	As, C	As, D	Cr, A	Cr, B	Cr, C	Cr, D	Cu, A	Cu, B	Cu, C	Cu, D	Ni, A	Ni, B	Ni, C	Ni, D	Zn, A	Zn, B	Zn, C	Zn, D
Total	**640**	**560**	**410**	**300**	**1000**	**700**	**640**	**610**	**2700**	**2100**	**1600**	**1300**	**6500**	**4100**	**3700**	**3700**	**14000**	**11000**	**8100**	**7600**
Total Public power etc.	**190**	**120**	**99**	**92**	**280**	**160**	**140**	**130**	**350**	**250**	**62**	**37**	**3500**	**1700**	**1600**	**1600**	**2300**	**1600**	**280**	**150**
Public power etc. brown coal	38	19	11	11	20	13	8.7	8.5	73	52	5.6	2.8	21	14	11	11	310	220	27	15
Public power etc. fuel oils	90	45	40	40	220	110	100	100	52	25	24	24	3400	1700	1500	1500	100	49	43	43
Public power etc. hard coal	60	47	41	41	34	29	17	16	210	160	17	8.1	63	53	38	37	1800	1300	160	81
Public power etc. other fuels	6.9	6.9	6.9	0.82	8.4	8.4	8.4	0.86	15	15	15	1.6	3.3	3.3	3.3	0.36	53	53	53	7.5
Total Commercial etc.	**110**	**90**	**90**	**90**	**200**	**160**	**160**	**160**	**500**	**390**	**390**	**390**	**410**	**330**	**330**	**330**	**2500**	**2100**	**2100**	**2100**
Commercial etc. brown coal	28	13	13	13	14	6.1	6.1	6.1	16	6.3	6.3	6.3	18	5.2	5.2	5.2	47	16	16	16
Commercial etc. fuel oils	19	23	23	23	41	45	45	45	13	16	16	16	22	26	26	26	24	31	31	31
Commercial etc. hard coal	66	53	53	53	150	110	110	110	460	360	360	360	370	300	300	300	2400	2000	2000	2000
Commercial etc. other fuels	0.22	0.22	0.22	0.22	2.4	2.4	2.4	2.4	3.9	3.9	3.9	3.9	1.7	1.7	1.7	1.7	33	33	33	33
Total Industrial combustion	**110**	**140**	**51**	**45**	**210**	**160**	**120**	**120**	**420**	**310**	**44**	**19**	**1800**	**1200**	**1000**	**1000**	**1800**	**1300**	**200**	**66**
Industrial combustion brown coal	16	72	5.9	0.62	5	21	2	0.46	7.3	21	1.8	0.15	4.1	17	1.7	0.46	20	37	3.8	0.77
Industrial combustion fuel oils	50	40	26	26	110	77	65	65	37	39	15	15	1600	1100	920	920	52	40	27	27
Industrial combustion hard coal	47	32	19	18	86	59	52	51	380	250	27	3.7	160	110	90	89	1700	1200	170	37
Industrial combustion other fuels	0.067	0.067	0.067	0.067	0.049	0.049	0.049	0.049	0.32	0.32	0.32	0.32	0.051	0.051	0.051	0.051	0.085	0.085	0.085	0.085
Total Production processes	**220**	**200**	**160**	**68**	**300**	**190**	**190**	**180**	**740**	**500**	**460**	**200**	**330**	**250**	**250**	**250**	**6300**	**4400**	**4400**	**4100**
Coke production	2.1	1.7	1.7	1.7	17	15	15	15	9.1	7.7	7.7	7.7	6.5	5.5	5.5	5.5	22	19	19	19
Blast furnace	17	14	14	14	21	17	17	17	100	83	83	83	31	25	25	25	1700	1300	1300	1300
Pig iron	0.022	0.022	0.022	0.022	0.34	0.34	0.34	0.34	2.7	2.7	2.7	2.7	3.1	3.1	3.1	3.1	90	90	90	90
Open hearth furnace	4.8				62				150								690			
Basic oxigen furnace	1.2	1	1	0.89	6.4	5.4	5.4	5.3	8.8	7.8	7.8	5.5	6.2	5.7	5.7	2.9	240	200	200	200
Electric arc furnace	2.5	2.1	2.1	2	41	37	37	20	22	19	19	13	6	5	5	5	1100	940	940	930
Rolling	0.021	0.021	0.021	0.021	1.3	1.3	1.3	1.3	0.016	0.016	0.016	0.016	0.031	0.031	0.031	0.031	0.86	0.86	0.86	0.86
Sinter plants	7.6	4.2	3.1	2.8	46	20	20	19	100	52	42	41	110	46	46	45	170	84	64	68
Foundries	1.9	1.9	1.9	1.9	7.1	7	7	7					3.2	3.2	3.2	3.2	32	32	32	32
Iron and steel, non-specified	0.33	0.33	0.33	0.08	1.2	1.2	1.2	0.8					0.56	0.56	0.56	0.2	5.6	5.6	5.6	5.6
Al industry					0.016	0.016	0.016	0.016					24	21	21	21	26	23	23	23
Cu industry	140	130	95	3.6	0.028	0.027	0.027	0.027	330	310	280	36	55	53	53	53	430	390	390	120
Ni industry					50	50	50	50					21	21	21	21				
Other non-ferrous metals	0.074	0.074	0.074	0.074	8.3	8.3	8.3	8.3	0.67	0.67	0.67	0.67	1.6	1.6	1.6	1.6	12	12	12	12
Pb industry	3.5	3.3	3.3	3					3.1	2.7	2.7	2.1					27	23	23	12
Zn industry																	1700	1200	1200	1200
NPK fertilisers																				
Chloro-alkali industry																				
Pesticide production																				
Cement industry	1.7	1.5	1.2	1.1	7.7	6.6	6	5.4	0.31	0.28	0.28	0.28	14	11	11	10	27	22	21	21
Glass industry	16	15	15	15	5.9	6	6	6	1.5	1.5	1.5	1.5	4.5	4.5	4.5	4.5	29	29	29	29
Battery manufacturing																				
Synthetic grid blasting	0.011	0.012	0.012	0.012	0.057	0.062	0.062	0.062	0.11	0.12	0.12	0.12	0.045	0.049	0.049	0.049	0.18	0.19	0.19	0.19
Non-spec. production processes	22	22	22	22	20	20	20	20	6.9	6.9	6.9	6.9	48	48	48	48	7.8	7.8	7.8	7.8
Extraction and distr. of fossil fuels																				
Road transport	**0.012**	**0.016**	**0.016**	**0.016**	**25**	**28**	**28**	**28**	**470**	**500**	**500**	**500**	**400**	**420**	**420**	**420**	**960**	**1000**	**1000**	**1000**
Road transport combustion	0.012	0.016	0.016	0.016	23	25	25	25	460	490	490	490	400	420	420	420	720	750	750	750
Road transport non-combustion					2.1	2.4	2.4	2.4	12	13	13	13	2	2.2	2.2	2.2	240	260	260	260
non-Road transport	**4.5**	**3.9**	**3.9**	**3.9**	**5.8**	**5.3**	**5.3**	**5.3**	**170**	**150**	**150**	**150**	**110**	**100**	**100**	**100**	**170**	**150**	**150**	**150**
Other transport combustion	4.5	3.9	3.9	3.9	5.8	5.3	5.3	5.3	150	130	130	130	110	100	100	100	170	150	150	150
Other transport non-combustion									18	17	17	17								
Waste treatment and disposal	**0.19**	**0.2**	**0.2**	**0.094**	**2.7**	**2.7**	**2.7**	**2.1**	**4**	**3.9**	**3.9**	**3.2**	**0.96**	**0.95**	**0.95**	**0.72**	**41**	**40**	**40**	**30**
Waste incineration	0.19	0.2	0.2	0.094	2.7	2.7	2.7	2.1	4	3.9	3.9	3.2	0.96	0.95	0.95	0.72	41	40	40	30
Cremation																				

Figure 5: Cadmium, mercury and lead emission in Europe in 1990 and three scenario forecasts for 2010

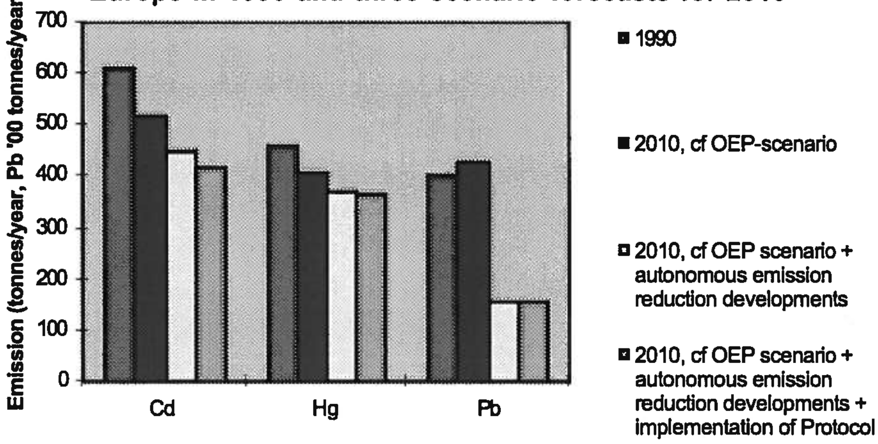


Figure 6: Cadmium, mercury and lead emission in Western Europe in 1990 and three scenario forecasts for 2010

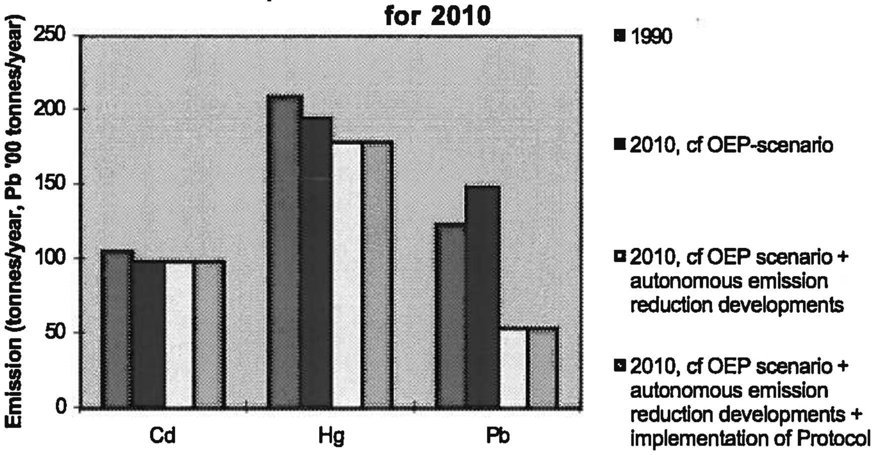


Figure 7: Cadmium, mercury and lead emission in Southern Europe and three scenario forecasts for 2010

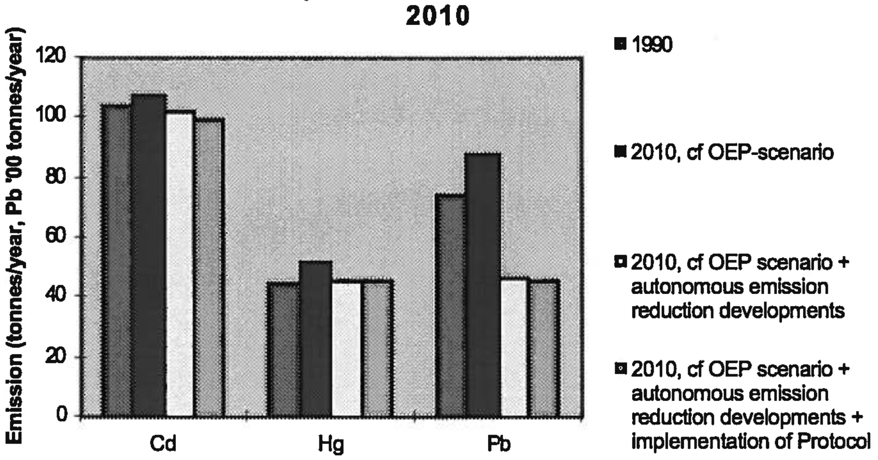


Figure 8: Cadmium, mercury and lead emission in Central and Eastern Europe in 1990 and three scenario forecasts for 2010

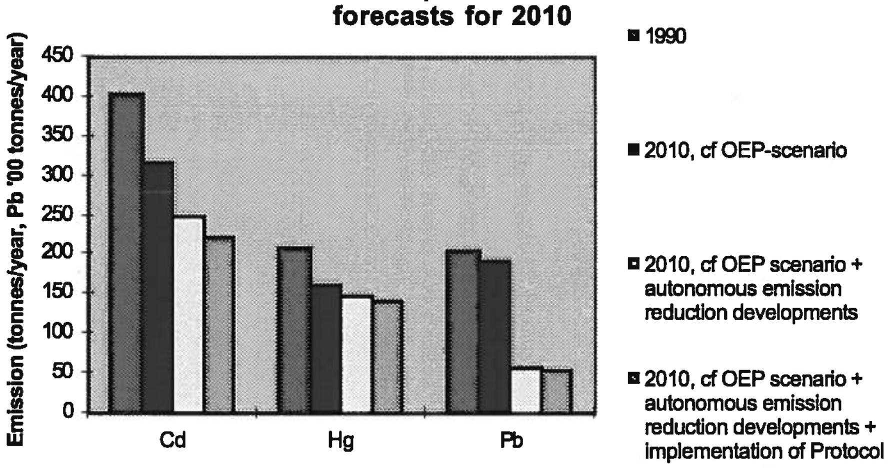
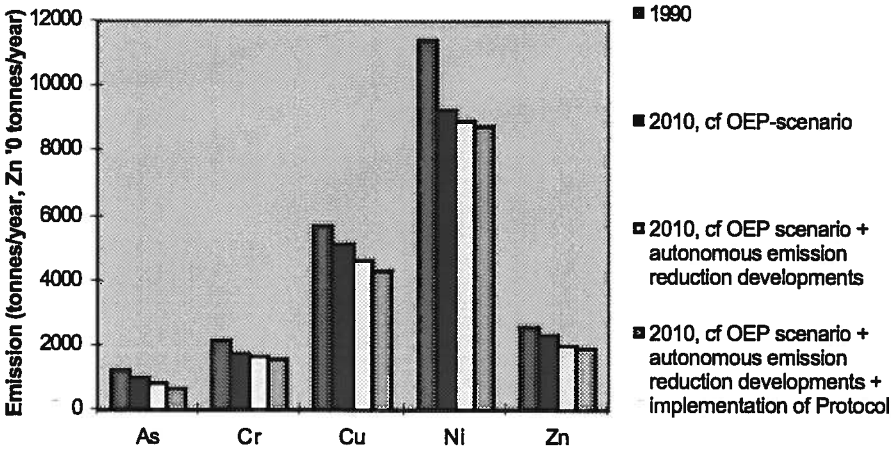


Figure 9: Arsenic, chromium, copper, nickel and zinc emission in Europe in 1990 and three scenario forecasts for 2010



3.2 Emission reduction to be expected

The HM emission decrease after implementation of foreseen autonomous emission reduction and the HM Protocol, compared to the 1990 levels as inventoried in [UBA-TNO '97] has been listed per substance in table 9a and 9b:

Table 9a *Emission reduction due to implementation of HM Protocol in Europe compared to 1990, for cadmium, lead and mercury*

Substance	Emission level in 1990 (tonnes)	Emission level in 2010 after Protocol (tonnes)	Reduction (%)
Cadmium	610	420	32
Mercury	460	360	21
Lead	40000	15000	62

Remaining large sources after implementation of the Protocol are according to this study:

- for cadmium: residential combustion in Central and Eastern Europe, road transport and the zinc production industry (although the contribution of the zinc industry is rather uncertain)
- for mercury: coal firing in general and the cement production industry (mercury removal from large waste gas flows from these sources is difficult)
- for lead: remaining emission from the use of gasoline (still containing some lead)

Table 9b Emission reduction due to implementation of HM Protocol in Europe compared to 1990, for arsenic, chromium, copper, nickel and zinc

Substance	Emission level in 1990 (tonnes)	Emission level in 2010 after Protocol (tonnes)	Reduction (%)
Arsenic	1200	700	42
Chromium	2200	1600	27
Copper	5700	4300	25
Nickel	11000	9000	23
Zinc	26000	19000	25

In relation to the 1990 levels achieved emission reduction is approximately 40% for arsenic (among others due to a large emission reduction at copper smelters), 60% for lead (mainly due to the elimination of leaded gasoline) and 20-30% for the other metals. For PM_{10} an emission reduction is also expected. A first order estimate will be around 30%, more attention will be given to PM_{10} in a coming short note on this matter.

3.3 Cost estimates of implementation of HM Protocol

The estimated investment costs and other non-recurring costs of the draft HM Protocol (total 3,500 MECU) taking into account foreseen autonomous emission reduction developments are presented in table 10a, per source category and per country. Non-recurring costs (including running costs) have subsequently been processed to annual costs as explained in paragraph 2.3.1. The annual costs of the draft HM Protocol are given in table 10b, again per country and source category. In figure 10 the total annual costs of the Protocol (total 440 MECU/year) are graphically represented per source category for Europe as a whole. The distribution of the investment costs yields a similar picture, since for most source categories the cost estimates are based on the same annuity.

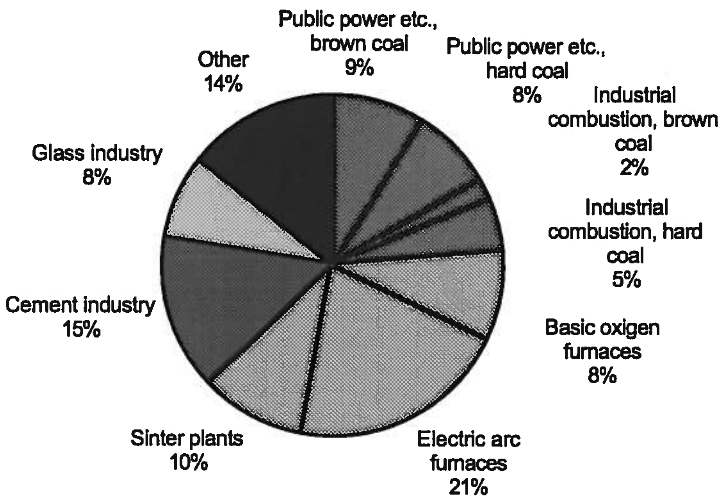
Table 9a: Total capital investments and other non-recurring costs, per country and source category, resulting from the implementation of the HM Protocol, in case no autonomous emission reduction would take place

Country	National total	Public power etc., brown coal	Public power etc., fuel oils	Public power etc., hard coal	Public power etc., other fuels	Industrial combustion, brown coal	Industrial combustion, fuel oils	Industrial combustion, hard coal	Basic oxigen furnaces	Electric arc furnaces	Sinter plants	Cu industry	Pb industry	Zn industry	Chloro-alkali industry	Cement industry	Glass industry	Waste incineration	Phase out of leaded gasoline	Measures for Hg-products
Albania	21					3.2	4.2	3.2				0.43				6.4		0.82	0.6	2
Austria	5																			5
Belarus	310		220	3.4			31			17						8.7	1.9	1	20	7
Belgium	15																		8	7
Bosnia Herzegovina	93	68							2.5	1.4	5.5					4.3		1	7	3
Bulgaria	310	120	10	34		4.9	24	18	5.4	20	7.1	4.2	4.2	1.2	18	22	4.1	2	10	6
Croatia	87	5.8	39			1.2	6.4	1.9		2.1	1.7		0.31			15	2.5	1	7	3
Czech Republic	680	280	4.7	33	3.2	100	43	57	15	40	31		0.86			32	24	2.2	8	7
Denmark	3																			3
Estonia	220		8.8		170	14	7.5	1.7								4.9	0.21	0.32	3	1
Finland	3																			3
France	120																		80	40
Germany	70																		20	50
Greece	110					5.2	27	28		20							1.1		20	7
Hungary	260	97	30			13	42	1.8	6.8	5.7	9	0.75				20	4	5.3	20	7
Ireland	6																		4	2
Italy	1000					5.5	380	54	47	270	53	2	20	4			37		100	40
Latvia	21		7.5	0.68			1.9	0.44								4.4	0.79	0.45	3	2
Lithuania	150		74				55	0.56								12		0.54	4	2
Luxembourg	1.3																		1	0.3
Macedonia	63	22	7.4			1.4	8.2	2					3.8	3.3		3.9		0.62	7	3
Moldova	53		8.2	29			0.72	0.56								5		0.62	5	3
Netherlands	10																			10
Norway	13																		10	3
Poland	1800	420	2.7	570		2.2	69	340	31	50	41	13	6.1	3.1	130	70	8.6	5.8	30	30
Portugal	210					5.9	130	33	2	8.8	2.5		0.29				8.5		10	7
Romania	590	160	40		24	1.5	40	2.6	23	45	32	1.8	4.3	2.3		49	110	3.7	20	20
Russian Federation	2200	5.7	640	270		13	220	25	89	140	200	26	4.5	5.3		260	15	11	200	100
Serbia Montenegro	320	230	4.2			3.9	17		8.4	7.7	5.5	4.7	8.3	1.3		17		2.2	7	3
Slovak Republic	270	30	7	24		59	25	25	17		14	0.82			39	20	2.7	1.1	4	3
Slovenia	90	43	7.1			7.2	11			13	1.3		1.4			2	0.1	0.62	3	1
Spain	620					5	240	55	24	140	27	7	8.4	2.6			14		60	30
Sweden	6																			6
Switzerland	25																		20	5
Ukraine	1100		61	320		1.4	85	78	75	79	180		1.6	0.8		78	93	3.8	60	30
United Kingdom	120																		80	40
Total Europe	**11000**	**1500**	**1200**	**1300**	**200**	**250**	**1500**	**720**	**350**	**860**	**610**	**61**	**64**	**24**	**180**	**630**	**330**	**44**	**800**	**500**

Table 9b: Total annual costs, per country and source category, resulting from the implementation of the HM Protocol, in case no autonomous emission reduction would take place

Country	National total	Public power etc., brown coal	Public power etc., fuel oils	Public power etc., hard coal	Public power etc., other fuels	Industrial combustion, brown coal	Industrial combustion, fuel oils	Industrial combustion, hard coal	Basic oxigen furnaces	Electric arc furnaces	Sinter plants	Cu Industry	Pb Industry	Zn Industry	Chloro-alkali Industry	Cement Industry	Glass Industry	Waste Incineration	Phase out of leaded gasoline	Measures for Hg-products
Albania	8.7					0.48		0.54				0.43				6.4		0.82		
Austria																				
Belarus	10			0.51												6.9	1.7	0.91		
Belgium																				
Bosnia Herzegovina	14	9.3														3.8		0.99		
Bulgaria	120	17		4.4		1.5		5.3	5.4	20	7.1	4.2	4.2	1.2	17	22	4	1.9		
Croatia	18	0.35						0.44					0.27			14	2.5	1		
Czech Republic	280	69		8.4	3.2	36		20	15	40	31		0.86			32	22	2.1		
Denmark																				
Estonia	180				170	3.2		0.33								4.9	0.18	0.28		
Finland																				
France																				
Germany																				
Greece	1.1																1.1			
Hungary	66	14						0.44	6.8	5.7	9	0.75				20	4	5.3		
Ireland																				
Italy	350								44	260	50									
Latvia	5.7			0.1				0.13								4.4	0.71	0.4		
Lithuania	12							0.17								12		0.45		
Luxembourg																				
Macedonia	7.1	2.7				0.16		0.19								3.5		0.57		
Moldova	4.2			3.5				0.13										0.51		
Netherlands																				
Norway																				
Poland	820	150		200		0.76		120	31	50	41	13	6.1	3.1	130	70	8.6	5.8		
Portugal	19								1.9	8.4							8.5			
Romania	320	22			24	0.049		0.79	23	45	32	1.7	4.1	2.2		49	110	3.7		
Russian Federation	480	0.43		27		2		5.5	72	110		23	4	4.8		210	14	9.9		
Serbia Montenegro	61	29				0.62						4.3	7.5	1.2		16		2.2		
Slovak Republic	63	7.5		6		21		8.8	17			0.29					2.7	0.39		
Slovenia	4												1.3			2	0.1	0.62		
Spain	210								23	130	27	6.6	7.9	2.5			14			
Sweden																				
Switzerland																				
Ukraine	460			28		0.41		15	60	63	140					63	80	3.2		
United Kingdom																				
Total Europe	**3500**	**320**		**280**	**200**	**66**		**180**	**300**	**730**	**340**	**55**	**36**	**15**	**150**	**540**	**280**	**41**		

Figure 10: Annual cost of HM Protocol (440 MECU/year) after autonomous developments, for Europe, by sector



Costs of implementation of the HM Protocol have also been estimated in reference to the current situation in Europe, in other words, in case no autonomous emission reduction would take place in Europe before the year 2010. The results are presented in the tables 11a and 11b. Table 11a represents the investment costs and other non-recurring costs (total 11,000 MECU) and table 11b the costs processed to annual costs (including running costs, total 1,300 MECU/year). A graphic representation of the annual costs is given in figure 11.

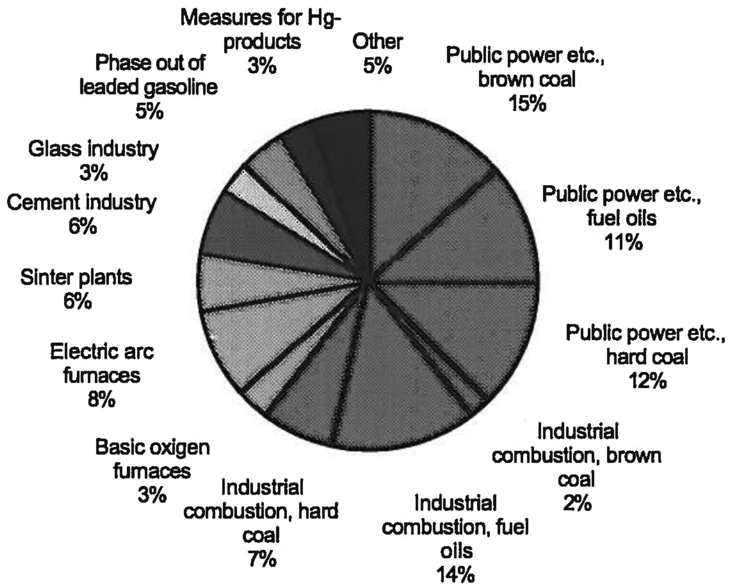
Table 10a: Total capital investments and other non-recurring costs, per country and source category, resulting from the implementation of the HM Protocol, when all foreseen autonomous emission reduction is counted for

Country	National total	Public power etc., brown coal	Public power etc., fuel oils	Public power etc., hard coal	Public power etc., other fuels	Industrial combustion, brown coal	Industrial combustion, fuel oils	Industrial combustion, hard coal	Basic oxigen furnaces	Electric arc furnaces	Sinter plants	Cu industry	Pb industry	Zn industry	Chloro-alkali industry	Cement industry	Glass industry	Waste incineration	Phase out of leaded gasoline	Measures for Hg-products
Albania	2.3					0.4	0.52	0.4				0.054				0.8		0.1	0.05	0.2
Austria																				0.4
Belarus	35		27	0.42			3.6			2.1						1.1	0.24	0.13	1	0.6
Belgium																			0.6	0.6
Bosnia Herzegovina	10	8.5							0.31	0.17	0.69					0.53		0.13	0.5	0.3
Bulgaria	37	15	1.3	4.3		0.6	3	2.2	0.67	2.4	0.88	0.53	0.52	0.15	2.2	2.8	0.51	0.25	0.9	0.5
Croatia	9.5	0.71	4.8			0.15	0.79	0.24		0.26	0.21		0.038			1.9	0.31	0.13	0.5	0.3
Czech Republic	83	34	0.59	4.2	0.4	13	5.4	7	1.9	5	3.8		0.11			4	3	0.27	0.6	0.6
Denmark																				0.3
Estonia	26		1.1		22	1.7	0.93	0.21								0.61	0.026	0.039	0.2	0.09
Finland																				0.3
France																			6	3
Germany																			1	4
Greece	10					0.64	3.4	3.4		2.5							0.14		1	0.6
Hungary	29	12	3.7			1.6	5.3	0.22	0.85	0.71	1.1	0.093				2.5	0.5	0.65	1	0.6
Ireland																			0.3	0.2
Italy	110					0.68	47	6.7	5.8	34	6.6	0.24	2.4	0.5			4.6		7	3
Latvia	2		0.94	0.084			0.24	0.055								0.54	0.098	0.055	0.2	0.1
Lithuania	18		9.2				6.9	0.069								1.4		0.067	0.3	0.2
Luxembourg																			0.07	0.02
Macedonia	6.5	2.7	0.92			0.17	1	0.24					0.47	0.41		0.48		0.077	0.5	0.3
Moldova	5.5		1	3.6			0.089	0.069								0.62		0.077	0.4	0.2
Netherlands																				0.8
Norway																			0.9	0.2
Poland	220	52	0.34	70		0.27	8.5	42	3.8	6.2	5	1.6	0.75	0.38	16	8.7	1.1	0.72	2	2
Portugal	24					0.73	16	4.1	0.25	1.1	0.31		0.036				1		0.9	0.5
Romania	68	20	4.9		3	0.18	4.9	0.32	2.8	5.6	3.9	0.22	0.53	0.29		6.1	14	0.45	1	1
Russian Federation	240	0.7	80	34		1.6	27	3.1	11	17	25	3.2	0.56	0.66		32	1.9	1.3	10	8
Serbia Montenegro	39	29	0.52			0.48	2.1		1	0.95	0.68	0.59	1	0.17		2.2		0.27	0.5	0.3
Slovak Republic	33	3.7	0.86	3		7.3	3.1	3.1	2.1		1.7	0.1			4.8	2.5	0.34	0.14	0.3	0.3
Slovenia	11	5.3	0.88			0.89	1.3			1.6	0.17		0.18			0.25	0.012	0.077	0.2	0.1
Spain	65					0.62	30	6.8	3	17	3.3	0.86	1	0.32			1.7		4	2
Sweden																				0.5
Switzerland																			1	0.4
Ukraine	130		7.6	39		0.17	11	9.7	9.3	9.8	22		0.19	0.099		9.7	12	0.47	5	3
United Kingdom																			6	3
Total Europe	1300	180	150	160	25	31	180	90	43	110	75	7.5	7.9	3	23	79	41	5.4	60	40

Table 10b: Total annual costs, per country and source category, resulting from the implementation of the HM Protocol, when all foreseen autonomous emission reduction is counted for

Country	National total	Public power etc., brown coal	Public power etc., fuel oils	Public power etc., hard coal	Public power etc., other fuels	Industrial combustion, brown coal	Industrial combustion, fuel oils	Industrial combustion, hard coal	Basic oxigen furnaces	Electric arc furnaces	Sinter plants	Cu industry	Pb industry	Zn industry	Chloro-alkali industry	Cement industry	Glass industry	Waste incineration	Phase out of leaded gasoline	Measures for Hg-products
Albania	1.1					0.08		0.067				0.054				0.8		0.1		
Austria																				
Belarus	1.2			0.063												0.86	0.21	0.11		
Belgium																				
Bosnia Herzegovina	1.8	1.2														0.48		0.12		
Bulgaria	14	2.2		0.55		0.18		0.66	0.67	2.4	0.88	0.53	0.52	0.15	2.2	2.8	0.5	0.24		
Croatia	2.2	0.043						0.054					0.034			1.7	0.31	0.13		
Czech Republic	35	8.6		1	0.4	4.4		2.5	1.9	5	3.8		0.11			4	2.8	0.26		
Denmark																				
Estonia	23				22	0.4		0.041								0.61	0.023	0.034		
Finland																				
France																				
Germany																				
Greece	0.14																0.14			
Hungary	8.2	1.7						0.054	0.85	0.71	1.1	0.093				2.5	0.5	0.65		
Ireland																				
Italy	44								5.5	32	6.2									
Latvia	0.71			0.013				0.016								0.54	0.088	0.05		
Lithuania	1.5							0.021								1.4		0.056		
Luxembourg																				
Macedonia	0.87	0.33				0.02		0.024								0.43		0.07		
Moldova	0.52			0.44				0.017										0.063		
Netherlands																				
Norway																				
Poland	100	18		25		0.094		15	3.8	6.2	5	1.6	0.75	0.38	16	8.7	1.1	0.72		
Portugal	2.3								0.24	1							1			
Romania	40	2.8			3	0.0061		0.097	2.8	5.6	3.9	0.21	0.5	0.27		6.1	14	0.45		
Russian Federation	59	0.053		3.4		0.25		0.68	8.9	13		2.9	0.5	0.59		26	1.7	1.2		
Serbia Montenegro	7.5	3.6				0.077						0.53	0.93	0.15		1.9		0.27		
Slovak Republic	7.8	0.92		0.75		2.6		1.1	2.1			0.035					0.34	0.048		
Slovenia	0.5												0.16			0.25	0.012	0.077		
Spain	27								2.8	17	3.3	0.82	0.99	0.31			1.7			
Sweden																				
Switzerland																				
Ukraine	57			3.5		0.051		1.9	7.5	7.9	18					7.8	9.9	0.4		
United Kingdom																				
Total Europe	440	39		34	25	8.1		22	37	91	42	6.8	4.5	1.8	18	66	35	5.1		

Figure 11: Annual cost of HM Protocol (1,300 MECU/year) without autonomous emission reduction, for Europe, by sector



3.4 Investment cost for emission control at stationary sources

The costs of implementation of the draft HM Protocol are dominated by the investment costs for emission control at stationary sources. In case all foreseen non-Protocol-related emission reduction measures have been implemented in Europe the highest costs have to be made in the iron and steel industry according to figure 10, notably the secondary iron and steel sector. Also the costs of emission control for stationary combustion still make a relevant contribution in spite of the implementation of the second Sulphur Protocol. The cost of Protocol-related emission control for the cement industry adds considerably to the total costs as well.

In case foreseen non-Protocol-related emission reduction measures would not take place in Europe before the year 2010 the picture is different. The share of the costs for environmental upgrade of stationary combustion would in that case by far make the largest contribution to the total costs of the Protocol. The implementation of the second Sulphur Protocol will eliminate these costs for the highest part.

3.5 Annual costs resulting from the elimination of certain products

In addition to the investment costs for emission control for stationary sources there are potential costs resulting from the emission reduction measures referring to HM containing products. In this study, as explained in paragraph 2.3.3, the prescribed elimination and collection, recycling or disposal of mercury containing products and the phase out of leaded gasoline is assumed to be an autonomous measure in Europe. However costs of the HM Protocol are also estimated in case no autonomous emission reduction measures take place. In that case the elimination of leaded gasoline would make the largest contribution, followed by the collection and disposal of mercury containing products (see figure 11).

4. Conclusions

The total annual costs of the implementation of the draft HM Protocol is estimated to amount to 440 MECU/year for Europe as a whole, when autonomous developments as foreseen are counted for (1,300 with no autonomous emission reduction).

Annual costs of the HM Protocol are low compared to the costs of emission control of sulphur and nitrogen oxides within the UN/ECE framework.

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6. Authentication

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Names and establishments to which part of the research was put out to contract:
-

Date upon which, or period in which, the research took place:
December 1997

Signature:	Approved by:
i.a	i.a.
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Annex 1 Results of emission projections per substance, per source category and per country

Projected emission of Cd, Hg and Pb per country (ISO-a3) in 1990, in 2010 without autonomous emission reduction, in 2010 after autonomous developments (no additional influence of Protocol assumed)

iso3	SNAP	description	Cd 1990	Cd 2010	Cd + autonom. dev.	Hg 1990	Hg 2010	Hg + autonom. dev.	Pb 1990	Pb 2010	Pb + autonom. dev.
		Total	4.3	4.2	4.2	7	6.3	6.3	510	480	190
CHE	01bc	Public power etc. brown coal									
CHE	01fo	Public power etc. fuel oils	0.089	0.14	0.14				0.38	0.6	0.6
CHE	01hc	Public power etc. hard coal							0.001		
CHE	01of	Public power etc. other fuels	0.04	0.04	0.04	0.02	0.02	0.02	0.1	0.1	0.1
CHE	02bc	Commercial etc. brown coal	0.001			0.002			0.003		
CHE	02fo	Commercial etc. fuel oils	0.27	0.25	0.25				1.1	1	1
CHE	02hc	Commercial etc. hard coal	0.002			0.006			0.033		
CHE	02of	Commercial etc. other fuels	0.026	0.026	0.026	0.15	0.15	0.15	0.16	0.16	0.16
CHE	03bc	Industrial combustion brown coal									
CHE	03fo	Industrial combustion fuel oils	1.1	1.2	1.2				5.6	6.7	6.7
CHE	03hc	Industrial combustion hard coal	0.008	0.0099	0.0099	0.21	0.25	0.25	1.2	1.5	1.5
CHE	03of	Industrial combustion other fuels	0.037	0.037	0.037	0.12	0.12	0.12	0.12	0.12	0.12
CHE	040100	Petroleum industries									
CHE	040201	Coke production									
CHE	040202	Blast furnace									
CHE	040203	Pig iron									
CHE	040205	Open hearth furnace									
CHE	040206	Basic oxigen furnace									
CHE	040207	Electric arc furnace	0.45			1.1			60		
CHE	040208	Rolling									
CHE	040209	Sinter plants									
CHE	0402xx	Foundries	0.005						0.27		
CHE	040301	Al industry	0.007								
CHE	0403cu	Cu industry									
CHE	0403ni	Ni industry									
CHE	0403ot	Other non-ferrous metals	0.007								
CHE	0403pb	Pb industry									
CHE	0403zn	Zn Industry									
CHE	040407	NPK fertilisers									
CHE	040413	Chloro-alkali industry				0.39	0.41	0.41			
CHE	040524	Halogenated HC production									
CHE	040525	Pesticide production									
CHE	040602	Paper pulp (Kraft process)									
CHE	04060x	Paper and pulp industry									
CHE	040611	Road paving with asphalt									
CHE	040612	Cement industry	0.021	0.02	0.02	0.16	0.15	0.15	0.47	0.44	0.44
CHE	040613	Glass industry									
CHE	040615	Battery manufacturing									
CHE	0406xx	Synthetic grid blasting									
CHE	050000	Extraction and distr. of fossil fuels									
CHE	060100	Paint use									
CHE	060201	Industrial degreasing									
CHE	060202	Dry cleaning									
CHE	0603&4	Other solvent use									
CHE	060406	Wood preservation									
CHE	0701-5	Road transport combustion	0.069	0.073	0.073				290	310	21
CHE	0706/7	Road transport non-combustion									
CHE	0801co	Other transport combustion	0.003	0.0026	0.0026				19	16	16
CHE	0801nc	Other transport non-combustion									
CHE	090200	Waste incineration	2	2.1	2.1	4.5	4.8	4.8	36	39	39
CHE	090400	Landfill	0.2	0.21	0.21	0.27	0.28	0.28	99	110	110
CHE	090900	Cremation	0.015	0.015	0.015	0.064	0.064	0.064			
CHE	100600	Pesticide use									
CHE	110000	Nature									
CHE	eel	Electrical equipment									

Projected emission of Cd, Hg and Pb per country (ISO-a3) in 1990, in 2010 without autonomous emission reduction, in 2010 after autonomous developments (no additional influence of Protocol assumed)

iso3	SNAP	description	Cd 1990	Cd 2010	Cd + autonom. dev.	Hg 1990	Hg 2010	Hg + autonom. dev.	Pb 1990	Pb 2010	Pb + autonom. dev.
		Total	31	20	20	110	94	88	2300	2500	1700
DEU	01bc	Public power etc. brown coal	2.8	2	2	3.4	2.4	2.4	21	14	14
DEU	01fo	Public power etc. fuel oils				0.4	0.35	0.35	2.2	2	2
DEU	01hc	Public power etc. hard coal	0.51	0.57	0.57	4.5	5	5	15	17	17
DEU	01of	Public power etc. other fuels	0.92	0.92	0.92	12	12	12	28	28	28
DEU	02bc	Commercial etc. brown coal	0.46	0.022	0.022	4.2	0.2	0.2	21	1	1
DEU	02fo	Commercial etc. fuel oils	0.01	0.011	0.011	0.1	0.11	0.11	0.1	0.11	0.11
DEU	02hc	Commercial etc. hard coal	0.3	0.052	0.052	0.6	0.1	0.1	5.2	0.9	0.9
DEU	02of	Commercial etc. other fuels									
DEU	03bc	Industrial combustion brown coal	8.9	1.6	1.6	14	2.4	2.4	81	15	15
DEU	03fo	Industrial combustion fuel oils	0.1	0.2	0.2	0.8	1.6	1.6	4.3	8.5	8.5
DEU	03hc	Industrial combustion hard coal	0.1	0.051	0.051	1.2	0.62	0.62	4.4	2.3	2.3
DEU	03of	Industrial combustion other fuels	0.13	0.13	0.13	0.62	0.62	0.62	3.3	3.3	3.3
DEU	040201	Coke production	0.8	0.76	0.76	0.45	0.43	0.43	3.4	3.3	3.3
DEU	040202	Blast furnace	0.22	0.21	0.21	0.79	0.75	0.75	53	51	51
DEU	040203	Pig iron									
DEU	040205	Open hearth furnace	2						35		
DEU	040206	Basic oxigen furnace	0.7	0.67	0.67				26	24	24
DEU	040207	Electric arc furnace	4.9	4.7	4.7				98	93	93
DEU	040208	Rolling									
DEU	040209	Sinter plants	1.7	1.6	1.6	0.35	0.33	0.33	87	83	83
DEU	0402xx	Foundries	0.18	0.17	0.17				7.5	7.1	7.1
DEU	040301	Al industry									
DEU	0403cu	Cu industry									
DEU	0403nf	Non-specified non ferrous	5.3	5	5	36	34	34	260	260	260
DEU	0403ni	Ni industry									
DEU	0403ot	Other non-ferrous metals									
DEU	0403pb	Pb industry									
DEU	0403zn	Zn industry									
DEU	040407	NPK fertilisers									
DEU	040413	Chloro-alkali industry				10	10	3.7			
DEU	040524	Halogenated HC production									
DEU	040525	Pesticide production									
DEU	040602	Paper pulp (Kraft process)									
DEU	04060x	Paper and pulp industry									
DEU	040611	Road paving with asphalt									
DEU	040612	Cement industry	0.69	0.66	0.66	24	23	23	20	19	19
DEU	040613	Glass industry	0.18	0.18	0.18	0.07	0.068	0.068	62	61	61
DEU	040615	Battery manufacturing									
DEU	0406xx	Synthetic grid blasting									
DEU	050000	Extraction and distr. of fossil fuels									
DEU	060100	Paint use									
DEU	060201	Industrial degreasing									
DEU	060202	Dry cleaning									
DEU	0603&4	Other solvent use									
DEU	060406	Wood preservation									
DEU	0701-5	Road transport combustion							1500	1800	1000
DEU	0706/7	Road transport non-combustion	0.4	0.49	0.49						
DEU	0801co	Other transport combustion	0.14	0.11	0.11	0.011	0.0087	0.0087	31	25	25
DEU	0801nc	Other transport non-combustion									
DEU	090200	Waste incineration									
DEU	090400	Landfill									
DEU	090900	Cremation	0.01	0.01	0.01	0.2	0.2	0.2	0.06	0.06	0.06
DEU	100600	Pesticide use									
DEU	110000	Nature									
DEU	eel	Electrical equipment									

Projected emission of Cd, Hg and Pb per country (ISO-a3) in 1990, in 2010 without autonomous emission reduction, in 2010 after autonomous developments (no additional influence of Protocol assumed)

iso3	SNAP	description	Cd 1990	Cd 2010	Cd + autonom. dev.	Hg 1990	Hg 2010	Hg + autonom. dev.	Pb 1990	Pb 2010	Pb + autonom. dev.
		Total	2.1	2.1	2.1	6.9	8.5	8.5	180	170	74
DNK	01bc	Public power etc. brown coal									
DNK	01fo	Public power etc. fuel oils	0.062	0.13	0.13				0.21	0.45	0.45
DNK	01hc	Public power etc. hard coal	0.019	0.029	0.029	2.1	3.1	3.1	1.9	2.8	2.8
DNK	01of	Public power etc. other fuels	0.013	0.013	0.013	0.16	0.16	0.16	0.026	0.026	0.026
DNK	02bc	Commercial etc. brown coal							0.001		
DNK	02fo	Commercial etc. fuel oils	0.11	0.059	0.059				0.43	0.23	0.23
DNK	02hc	Commercial etc. hard coal	0.028	0.04	0.04	0.041	0.059	0.059	0.46	0.67	0.67
DNK	02of	Commercial etc. other fuels	0.049	0.049	0.049	0.073	0.073	0.073	0.29	0.29	0.29
DNK	03bc	Industrial combustion brown coal									
DNK	03fo	Industrial combustion fuel oils	0.17	0.17	0.17				0.59	0.59	0.59
DNK	03hc	Industrial combustion hard coal	0.001	0.0012	0.0012	0.13	0.15	0.15	0.11	0.14	0.14
DNK	03of	Industrial combustion other fuels	0.002	0.002	0.002	0.027	0.027	0.027	0.005	0.005	0.005
DNK	040100	Petroleum industries									
DNK	040201	Coke production									
DNK	040202	Blast furnace									
DNK	040203	Pig iron									
DNK	040205	Open hearth furnace									
DNK	040206	Basic oxigen furnace									
DNK	040207	Electric arc furnace									
DNK	040208	Rolling									
DNK	040209	Sinter plants									
DNK	0402xx	Foundries									
DNK	040301	Al industry									
DNK	0403cu	Cu industry									
DNK	0403ni	Ni industry									
DNK	0403ot	Other non-ferrous metals									
DNK	0403pb	Pb industry									
DNK	0403zn	Zn Industry									
DNK	040407	NPK fertilisers									
DNK	040413	Chloro-alkali industry				0.025	0.029				
DNK	040524	Halogenated HC production									
DNK	040525	Pesticide production									
DNK	040602	Paper pulp (Kraft process)									
DNK	04060x	Paper and pulp industry									
DNK	040611	Road paving with asphalt									
DNK	040612	Cement industry	0.017	0.017	0.017	0.41	0.41	0.41	0.17	0.17	0.17
DNK	040613	Glass industry									
DNK	040615	Battery manufacturing									
DNK	0406xx	Synthetic grid blasting									
DNK	050000	Extraction and distr. of fossil fuels									
DNK	060100	Paint use									
DNK	060201	Industrial degreasing									
DNK	060202	Dry cleaning									
DNK	0603&4	Other solvent use									
DNK	060406	Wood preservation									
DNK	0701-5	Road transport combustion	1.3	1.2	1.2				150	140	42
DNK	0706/7	Road transport non-combustion	0.017	0.016	0.016						
DNK	0801co	Other transport combustion	0.06	0.068	0.068				11	12	12
DNK	0801nc	Other transport non-combustion									
DNK	090200	Waste incineration	0.25	0.29	0.29	3.8	4.3	4.3	13	14	14
DNK	090400	Landfill									
DNK	090900	Cremation				0.25	0.25	0.25			
DNK	100600	Pesticide use									
DNK	110000	Nature									
DNK	eel	Electrical equipment									

Projected emission of Cd, Hg and Pb per country (ISO-a3) in 1990, in 2010 without autonomous emission reduction, in 2010 after autonomous developments (no additional influence of Protocol assumed)

iso3	SNAP	description	Cd 1990	Cd 2010	Cd + autonom. dev.	Hg 1990	Hg 2010	Hg + autonom. dev.	Pb 1990	Pb 2010	Pb + autonom. dev.
		Total	3.7	4.6	4.6	3	4.2	4.2	210	270	110
FIN	01bc	Public power etc. brown coal									
FIN	01fo	Public power etc. fuel oils	0.12	0.12	0.12				0.42	0.4	0.4
FIN	01hc	Public power etc. hard coal	0.005	0.013	0.013	0.56	1.4	1.4	0.51	1.3	1.3
FIN	01of	Public power etc. other fuels	0.014	0.014	0.014	0.19	0.19	0.19	0.027	0.027	0.027
FIN	02bc	Commercial etc. brown coal									
FIN	02fo	Commercial etc. fuel oils	0.26	0.19	0.19				0.93	0.69	0.69
FIN	02hc	Commercial etc. hard coal	0.001	0.001	0.001	0.002	0.002	0.002	0.023	0.023	0.023
FIN	02of	Commercial etc. other fuels	0.096	0.096	0.096	0.19	0.19	0.19	0.58	0.58	0.58
FIN	03bc	Industrial combustion brown coal									
FIN	03fo	Industrial combustion fuel oils	0.33	0.45	0.45				1.1	1.5	1.5
FIN	03hc	Industrial combustion hard coal	0.003	0.0043	0.0043	0.35	0.51	0.51	0.32	0.46	0.46
FIN	03of	Industrial combustion other fuels	0.062	0.062	0.062	0.87	0.87	0.87	0.13	0.13	0.13
FIN	040100	Petroleum industries									
FIN	040201	Coke production	0.024	0.059	0.059	0.015	0.037	0.037	0.11	0.26	0.26
FIN	040202	Blast furnace	0.046	0.061	0.061	0.046	0.061	0.061	11	15	15
FIN	040203	Pig iron									
FIN	040205	Open hearth furnace									
FIN	040206	Basic oxigen furnace	0.061	0.081	0.081	0.007	0.0093	0.0093	3.7	4.9	4.9
FIN	040207	Electric arc furnace	0.33	0.44	0.44	0.071	0.094	0.094	5.5	7.3	7.3
FIN	040208	Rolling									
FIN	040209	Sinter plants	0.25	0.33	0.33	0.05	0.066	0.066	15	20	20
FIN	0402xx	Foundries									
FIN	040301	Al industry									
FIN	0403cu	Cu industry	0.22	0.37	0.37	0.007	0.012	0.012	0.72	1.2	1.2
FIN	0403ni	Ni industry									
FIN	0403ot	Other non-ferrous metals									
FIN	0403pb	Pb industry									
FIN	0403zn	Zn industry	0.18	0.3	0.3				0.18	0.3	0.3
FIN	040407	NPK fertilisers									
FIN	040413	Chloro-alkali industry				0.1	0.13	0.13			
FIN	040524	Halogenated HC production									
FIN	040525	Pesticide production									
FIN	040602	Paper pulp (Kraft process)									
FIN	04060x	Paper and pulp industry									
FIN	040611	Road paving with asphalt									
FIN	040612	Cement industry	0.017	0.017	0.017	0.42	0.42	0.42	0.17	0.17	0.17
FIN	040613	Glass industry									
FIN	040615	Battery manufacturing									
FIN	0406xx	Synthetic grid blasting									
FIN	050000	Extraction and distr. of fossil fuels									
FIN	060100	Paint use									
FIN	060201	Industrial degreasing									
FIN	060202	Dry cleaning									
FIN	0603&4	Other solvent use									
FIN	060406	Wood preservation									
FIN	0701-5	Road transport combustion	1.6	2	2				170	210	55
FIN	0706/7	Road transport non-combustion	0.02	0.025	0.025						
FIN	0801co	Other transport combustion	0.022	0.021	0.021				1.9	1.8	1.8
FIN	0801nc	Other transport non-combustion									
FIN	090200	Waste incineration	0.01	0.013	0.013	0.15	0.2	0.2	0.5	0.66	0.66
FIN	090400	Landfill									
FIN	090900	Cremation				0.002	0.002	0.002			
FIN	100600	Pesticide use									
FIN	110000	Nature									
FIN	eel	Electrical equipment									

Projected emission of Cd, Hg and Pb per country (ISO-a3) in 1990, in 2010 without autonomous emission reduction, in 2010 after autonomous developments (no additional influence of Protocol assumed)

iso3	SNAP	description	Cd 1990	Cd 2010	Cd + autonom. dev.	Hg 1990	Hg 2010	Hg + autonom. dev.	Pb 1990	Pb 2010	Pb + autonom. dev.
		Total	15	16	16	32	32	31	4400	5400	890
FRA	01bc	Public power etc. brown coal	0.012			0.9			0.21		
FRA	01fo	Public power etc. fuel oils	0.43	0.58	0.58	0.68	0.92	0.92	3.2	4.3	4.3
FRA	01hc	Public power etc. hard coal	0.05	0.028	0.028	3.8	2.1	2.1	0.88	0.49	0.49
FRA	01of	Public power etc. other fuels	0.055	0.055	0.055	0.055	0.055	0.055	0.028	0.028	0.028
FRA	02bc	Commercial etc. brown coal									
FRA	02fo	Commercial etc. fuel oils	0.014	0.0088	0.0088	0.023	0.014	0.014	0.11	0.066	0.066
FRA	02hc	Commercial etc. hard coal	0.006			0.45			0.11		
FRA	02of	Commercial etc. other fuels	3.2	3.2	3.2	3.2	3.2	3.2	1.6	1.6	1.6
FRA	03bc	Industrial combustion brown coal	0.02	0.02	0.02	0.087	0.087	0.087	0.3	0.3	0.3
FRA	03fo	Industrial combustion fuel oils	3.5	3.6	3.6				88	90	90
FRA	03hc	Industrial combustion hard coal	0.065	0.039	0.039	2.6	1.6	1.6	49	30	30
FRA	03of	Industrial combustion other fuels	0.047	0.047	0.047	0.21	0.21	0.21	0.7	0.7	0.7
FRA	040100	Petroleum industries									
FRA	040201	Coke production	0.02	0.019	0.019				1.7	1.6	1.6
FRA	040202	Blast furnace	0.027	0.026	0.026				0.27	0.26	0.26
FRA	040203	Pig iron									
FRA	040205	Open hearth furnace									
FRA	040206	Basic oxigen furnace	0.014	0.013	0.013				7.2	6.9	6.9
FRA	040207	Electric arc furnace	3.7	3.5	3.5				160	160	160
FRA	040208	Rolling									
FRA	040209	Sinter plants									
FRA	0402xx	Foundries									
FRA	040301	Al industry	0.23	0.22	0.22	0.001	0.00095	0.00095	0.55	0.52	0.52
FRA	0403cu	Cu industry									
FRA	0403ni	Ni industry									
FRA	0403ot	Other non-ferrous metals									
FRA	0403pb	Pb industry									
FRA	0403zn	Zn industry									
FRA	040407	NPK fertilisers	0.029	0.021	0.021						
FRA	040413	Chloro-alkali industry				2.6	3.2	2			
FRA	040524	Halogenated HC production									
FRA	040525	Pesticide production									
FRA	040602	Paper pulp (Kraft process)									
FRA	04060x	Paper and pulp industry									
FRA	040611	Road paving with asphalt									
FRA	040612	Cement industry									
FRA	040613	Glass industry									
FRA	040615	Battery manufacturing							0.63	0.77	0.77
FRA	0406xx	Synthetic grid blasting									
FRA	050000	Extraction and distr. of fossil fuels									
FRA	060100	Paint use									
FRA	060201	Industrial degreasing									
FRA	060202	Dry cleaning									
FRA	0603&4	Other solvent use									
FRA	060406	Wood preservation									
FRA	0701-5	Road transport combustion							4000	5000	500
FRA	0706/7	Road transport non-combustion							7.5	9.3	9.3
FRA	0801co	Other transport combustion							6.7	6.7	6.7
FRA	0801nc	Other transport non-combustion									
FRA	090200	Waste incineration	3.5	4.3	4.3	17	20	20	64	79	79
FRA	090400	Landfill									
FRA	090900	Cremation									
FRA	09vapl	Hg therm. and vapour lamps				1.4					
FRA	100600	Pesticide use									
FRA	110000	Nature									
FRA	eel	Electrical equipment									

Projected emission of Cd, Hg and Pb per country (ISO-a3) in 1990, in 2010 without autonomous emission reduction, in 2010 after autonomous developments (no additional influence of Protocol assumed)

iso3	SNAP	description	Cd 1990	Cd 2010	Cd + autonom. dev.	Hg 1990	Hg 2010	Hg + autonom. dev.	Pb 1990	Pb 2010	Pb + autonom. dev.
		Total	25	26	26	26	28	19	2700	3600	1400
GBR	01bc	Public power etc. brown coal									
GBR	01fo	Public power etc. fuel oils	0.085	0.18	0.18	0.13	0.28	0.28	6.8	14	14
GBR	01hc	Public power etc. hard coal	2.9	2.1	2.1	2.9	2.1	2.1	56	40	40
GBR	01of	Public power etc. other fuels									
GBR	02bc	Commercial etc. brown coal									
GBR	02fo	Commercial etc. fuel oils	0.059	0.061	0.061	0.017	0.018	0.018	1.6	1.6	1.6
GBR	02hc	Commercial etc. hard coal	0.43	0.066	0.066	1.1	0.16	0.16	27	4.2	4.2
GBR	02of	Commercial etc. other fuels	0.09	0.09	0.09	0.09	0.09	0.09	0.045	0.045	0.045
GBR	03bc	Industrial combustion brown coal									
GBR	03fo	Industrial combustion fuel oils	0.073	0.084	0.084	0.063	0.073	0.073	3.8	4.4	4.4
GBR	03hc	Industrial combustion hard coal	0.81	0.96	0.96	2	2.3	2.3	51	60	60
GBR	03of	Industrial combustion other fuels	0.02	0.02	0.02	0.02	0.02	0.02	0.01	0.01	0.01
GBR	040100	Petroleum industries									
GBR	040201	Coke production	0.39	0.37	0.37	0.23	0.22	0.22	1.7	1.6	1.6
GBR	040202	Blast furnace	0.21	0.2	0.2	0.087	0.083	0.083	1	0.99	0.99
GBR	040203	Pig iron	0.51	0.49	0.49				4.1	3.9	3.9
GBR	040205	Open hearth furnace									
GBR	040206	Basic oxigen furnace	0.41	0.39	0.39	0.04	0.038	0.038	12	12	12
GBR	040207	Electric arc furnace	1.1	1	1	0.68	0.65	0.65	43	40	40
GBR	040208	Rolling									
GBR	040209	Sinter plants	0.31	0.3	0.3	0.1	0.1	0.1	10	10	10
GBR	0402xx	Foundries									
GBR	040301	Al industry	0.029	0.028	0.028						
GBR	0403cu	Cu industry	0.24	0.23	0.23				6.1	5.8	5.8
GBR	0403ni	Ni industry									
GBR	0403ot	Other non-ferrous metals									
GBR	0403pb	Pb industry	6.4	6.1	6.1	2.4	2.3	2.3	120	110	110
GBR	0403zn	Zn industry									
GBR	040407	NPK fertilisers	0.033	0.023	0.023						
GBR	040413	Chloro-alkali industry				7.9	9.7	1.3			
GBR	040524	Halogenated HC production									
GBR	040525	Pesticide production									
GBR	040602	Paper pulp (Kraft process)									
GBR	04060x	Paper and pulp industry									
GBR	040611	Road paving with asphalt									
GBR	040612	Cement industry	0.26	0.25	0.25	0.16	0.15	0.15	7.6	7.2	7.2
GBR	040613	Glass industry	0.34	0.42	0.42	0.13	0.16	0.16	14	17	17
GBR	040615	Battery manufacturing									
GBR	0406xx	Synthetic grid blasting									
GBR	050000	Extraction and distr. of fossil fuels	0.012	0.015	0.015	0.029	0.036	0.036	0.77	0.95	0.95
GBR	060100	Paint use									
GBR	060201	Industrial degreasing									
GBR	060202	Dry cleaning									
GBR	0603&4	Other solvent use	0.3	0.3	0.3						
GBR	060406	Wood preservation									
GBR	0701-5	Road transport combustion	0.35	0.49	0.49	0.001	0.0014	0.0014	2200	3100	830
GBR	0706/7	Road transport non-combustion	0.088	0.12	0.12						
GBR	0801co	Other transport combustion	0.006	0.006	0.006				0.12	0.12	0.12
GBR	0801nc	Other transport non-combustion									
GBR	090200	Waste incineration	9.5	12	12	6.3	7.8	7.8	150	180	180
GBR	090400	Landfill									
GBR	090900	Cremation				1.3	1.3	1.3			
GBR	100600	Pesticide use									
GBR	110000	Nature									
GBR	eel	Electrical equipment									

Projected emission of Cd, Hg and Pb per country (ISO-a3) in 1990, in 2010 without autonomous emission reduction, in 2010 after autonomous developments (no additional influence of Protocol assumed)

iso3	SNAP	description	Cd 1990	Cd 2010	Cd + autonom. dev.	Hg 1990	Hg 2010	Hg + autonom. dev.	Pb 1990	Pb 2010	Pb + autonom. dev.
		Total	1.6	1.7	1.7	1.6	2.3	2.3	130	160	37
IRL	01bc	Public power etc. brown coal									
IRL	01fo	Public power etc. fuel oils	0.1	0.36	0.36				0.34	1.2	1.2
IRL	01hc	Public power etc. hard coal	0.004	0.012	0.012	0.43	1.3	1.3	0.39	1.2	1.2
IRL	01of	Public power etc. other fuels	0.017	0.017	0.017	0.21	0.21	0.21	0.035	0.035	0.035
IRL	02bc	Commercial etc. brown coal	0.015	0.015	0.015	0.023	0.023	0.023	0.09	0.09	0.09
IRL	02fo	Commercial etc. fuel oils	0.064	0.08	0.08				0.24	0.29	0.29
IRL	02hc	Commercial etc. hard coal	0.13	0.064	0.064	0.19	0.094	0.094	2.1	1.1	1.1
IRL	02of	Commercial etc. other fuels	0.11	0.11	0.11	0.16	0.16	0.16	0.65	0.65	0.65
IRL	03bc	Industrial combustion brown coal				0.004	0.001	0.001	0.001	0.00025	0.00025
IRL	03fo	Industrial combustion fuel oils	0.17	0.16	0.16				0.56	0.55	0.55
IRL	03hc	Industrial combustion hard coal	0.001	0.00046	0.00046	0.12	0.053	0.053	0.11	0.048	0.048
IRL	03of	Industrial combustion other fuels	0.001	0.001	0.001	0.011	0.011	0.011	0.002	0.002	0.002
IRL	040100	Petroleum industries									
IRL	040201	Coke production									
IRL	040202	Blast furnace									
IRL	040203	Pig iron									
IRL	040205	Open hearth furnace									
IRL	040206	Basic oxigen furnace									
IRL	040207	Electric arc furnace	0.23			0.049			3.7		
IRL	040208	Rolling									
IRL	040209	Sinter plants									
IRL	0402xx	Foundries									
IRL	040301	Al industry									
IRL	0403cu	Cu industry									
IRL	0403ni	Ni industry									
IRL	0403ot	Other non-ferrous metals									
IRL	0403pb	Pb industry	0.051			0.019			3.5		
IRL	0403zn	Zn industry									
IRL	040407	NPK fertilisers									
IRL	040413	Chloro-alkali industry									
IRL	040524	Halogenated HC production									
IRL	040525	Pesticide production									
IRL	040602	Paper pulp (Kraft process)									
IRL	04060x	Paper and pulp industry									
IRL	040611	Road paving with asphalt									
IRL	040612	Cement industry	0.016	0.015	0.015	0.41	0.39	0.39	0.16	0.15	0.15
IRL	040613	Glass industry									
IRL	040615	Battery manufacturing									
IRL	0406xx	Synthetic grid blasting									
IRL	050000	Extraction and distr. of fossil fuels									
IRL	060100	Paint use									
IRL	060201	Industrial degreasing									
IRL	060202	Dry cleaning									
IRL	0603&4	Other solvent use									
IRL	060406	Wood preservation									
IRL	0701-5	Road transport combustion	0.67	0.82	0.82				120	150	30
IRL	0706/7	Road transport non-combustion	0.008	0.0099	0.0099						
IRL	0801co	Other transport combustion	0.012	0.012	0.012				1.1	1.1	1.1
IRL	0801nc	Other transport non-combustion									
IRL	090200	Waste incineration									
IRL	090400	Landfill									
IRL	090900	Cremation				0.01	0.01	0.01			
IRL	100600	Pesticide use									
IRL	110000	Nature									
IRL	eel	Electrical equipment									

Projected emission of Cd, Hg and Pb per country (ISO-a3) in 1990, in 2010 without autonomous emission reduction, in 2010 after autonomous developments (no additional influence of Protocol assumed)

iso3	SNAP	description	Cd 1990	Cd 2010	Cd + autonom. dev.	Hg 1990	Hg 2010	Hg + autonom. dev.	Pb 1990	Pb 2010	Pb + autonom. dev.
		Total	1.1	1	1	0.77	0.77	0.77	74	75	60
LUX	01bc	Public power etc. brown coal									
LUX	01fo	Public power etc. fuel oils	0.02	0.011	0.011				0.17	0.094	0.094
LUX	01hc	Public power etc. hard coal							0.03		
LUX	01of	Public power etc. other fuels									
LUX	02bc	Commercial etc. brown coal	0.001			0.001			0.008		
LUX	02fo	Commercial etc. fuel oils	0.019	0.014	0.014				0.18	0.14	0.14
LUX	02hc	Commercial etc. hard coal							0.008		
LUX	02of	Commercial etc. other fuels									
LUX	03bc	Industrial combustion brown coal				0.001			0.001		
LUX	03fo	Industrial combustion fuel oils	0.2	0.16	0.16				2.6	2.1	2.1
LUX	03hc	Industrial combustion hard coal	0.001	0.00064	0.00064	0.043	0.027	0.027	0.47	0.3	0.3
LUX	03of	Industrial combustion other fuels									
LUX	040100	Petroleum industries									
LUX	040201	Coke production									
LUX	040202	Blast furnace	0.079	0.075	0.075	0.053	0.05	0.05	14	13	13
LUX	040203	Pig iron									
LUX	040205	Open hearth furnace									
LUX	040206	Basic oxigen furnace	0.13	0.13	0.13	0.011	0.01	0.01	5.6	5.4	5.4
LUX	040207	Electric arc furnace									
LUX	040208	Rolling									
LUX	040209	Sinter plants	0.69	0.65	0.65	0.093	0.088	0.088	29	28	28
LUX	0402xx	Foundries									
LUX	040301	Al industry									
LUX	0403cu	Cu industry									
LUX	0403ni	Ni industry									
LUX	0403ot	Other non-ferrous metals									
LUX	0403pb	Pb industry									
LUX	0403zn	Zn industry									
LUX	040407	NPK fertilisers									
LUX	040413	Chloro-alkali industry									
LUX	040524	Halogenated HC production									
LUX	040525	Pesticide production									
LUX	040602	Paper pulp (Kraft process)									
LUX	04060x	Paper and pulp industry									
LUX	040611	Road paving with asphalt									
LUX	040612	Cement industry				0.16	0.16	0.16			
LUX	040613	Glass industry									
LUX	040615	Battery manufacturing									
LUX	0406xx	Synthetic grid blasting									
LUX	050000	Extraction and distr. of fossil fuels									
LUX	060100	Paint use									
LUX	060201	Industrial degreasing									
LUX	060202	Dry cleaning									
LUX	0603&4	Other solvent use									
LUX	060406	Wood preservation									
LUX	0701-5	Road transport combustion							21	26	11
LUX	0706/7	Road transport non-combustion									
LUX	0801co	Other transport combustion									
LUX	0801nc	Other transport non-combustion									
LUX	090200	Waste incineration				0.41	0.43	0.43	0.002	0.0021	0.0021
LUX	090400	Landfill									
LUX	090900	Cremation				0.002	0.002	0.002			
LUX	100600	Pesticide use									
LUX	110000	Nature									
LUX	eel	Electrical equipment									

Projected emission of Cd, Hg and Pb per country (ISO-a3) in 1990, in 2010 without autonomous emission reduction, in 2010 after autonomous developments (no additional influence of Protocol assumed)

iso3	SNAP	description	Cd 1990	Cd 2010	Cd + autonom. dev.	Hg 1990	Hg 2010	Hg + autonom. dev.	Pb 1990	Pb 2010	Pb + autonom. dev.
		Total	2.4	2.3	2.3	3	2.3	2.3	270	260	100
NLD	010000	Public power etc., non-specified	0.18	0.12	0.12	0.3	0.19	0.19	5.6	3.6	3.6
NLD	020000	Commercial etc., non-specified	0.0068	0.0045	0.0045	0.0034	0.0023	0.0023	0.16	0.11	0.11
NLD	030000	Industrial combustion, non-specified	0.12	0.12	0.12	0.19	0.19	0.19	11	11	11
NLD	040100	Petroleum industries							0.011	0.013	0.013
NLD	040200	Iron and steel, non-specified	0.69	0.65	0.65	0.38	0.36	0.36	54	52	52
NLD	040300	Non-ferrous metals industries, non-specified	0.15	0.15	0.15				0.042	0.04	0.04
NLD	04060x	Paper and pulp industry	0.14	0.14	0.14	0.39	0.39	0.39	2.7	2.7	2.7
NLD	050000	Extraction and distr. of fossil fuels							0.01	0.011	0.011
NLD	060100	Paint use	0.000026	0.000026	0.000026	0.000015	0.000015	0.000015	0.0046	0.0046	0.0046
NLD	0603&4	Other solvent use	0.029	0.029	0.029	0.058	0.058	0.058	1.8	1.8	1.8
NLD	0701-5	Road transport combustion	0.051	0.05	0.05				180	180	20
NLD	0706/7	Road transport non-combustion	0.45	0.44	0.44				1.2	1.2	1.2
NLD	080100	Other transport combustion	0.019	0.021	0.021	0.011	0.012	0.012	0.79	0.86	0.86
NLD	090200	Waste incineration	0.53	0.58	0.58	0.97	1.1	1.1	10	11	11
NLD	090900	Cremation				0.057	0.057	0.057			

Projected emission of Cd, Hg and Pb per country (ISO-a3) in 1990, in 2010 without autonomous emission reduction, in 2010 after autonomous developments (no additional influence of Protocol assumed)

iso3	SNAP	description	Cd 1990	Cd 2010	Cd + autonom. dev.	Hg 1990	Hg 2010	Hg + autonom. dev.	Pb 1990	Pb 2010	Pb + autonom. dev.
		Total	2.4								
NOR	01bc	Public power etc. brown coal									
NOR	01fo	Public power etc. fuel oils									
NOR	01hc	Public power etc. hard coal									
NOR	01of	Public power etc. other fuels	0.002	0.002	0.002	0.028	0.028	0.028	0.005	0.005	0.005
NOR	02bc	Commercial etc. brown coal									
NOR	02fo	Commercial etc. fuel oils	0.043	0.043	0.043				0.17	0.17	0.17
NOR	02hc	Commercial etc. hard coal	0.002			0.003			0.035		
NOR	02of	Commercial etc. other fuels	0.069	0.069	0.069	0.13	0.13	0.13	0.41	0.41	0.41
NOR	03bc	Industrial combustion brown coal									
NOR	03fo	Industrial combustion fuel oils	0.14	0.13	0.13				0.5	0.46	0.46
NOR	03hc	Industrial combustion hard coal	0.002	0.0017	0.0017	0.18	0.15	0.15	0.17	0.14	0.14
NOR	03of	Industrial combustion other fuels	0.009	0.009	0.009	0.18	0.18	0.18	0.018	0.018	0.018
NOR	040100	Petroleum industries									
NOR	040201	Coke production									
NOR	040202	Blast furnace	0.001			0.001			0.27		
NOR	040203	Pig iron									
NOR	040205	Open hearth furnace									
NOR	040206	Basic oxigen furnace									
NOR	040207	Electric arc furnace	0.27			0.058			4.4		
NOR	040208	Rolling									
NOR	040209	Sinter plants	0.006	0.006	0.006	0.001	0.001	0.001	0.36	0.36	0.36
NOR	0402xx	Foundries									
NOR	040301	Al industry	0.13	0.12	0.12						
NOR	0403cu	Cu industry									
NOR	0403ni	Ni industry									
NOR	0403ot	Other non-ferrous metals									
NOR	0403pb	Pb industry									
NOR	0403zn	Zn industry	0.13	0.12	0.12				0.13	0.12	0.12
NOR	040407	NPK fertilisers									
NOR	040413	Chloro-alkali industry				0.05	0.054	0.054			
NOR	040524	Halogenated HC production									
NOR	040525	Pesticide production									
NOR	040602	Paper pulp (Kraft process)									
NOR	04060x	Paper and pulp industry									
NOR	040611	Road paving with asphalt									
NOR	040612	Cement industry	0.013	0.013	0.013	0.32	0.32	0.32	0.13	0.13	0.13
NOR	040613	Glass industry									
NOR	040615	Battery manufacturing									
NOR	0406xx	Synthetic grid blasting									
NOR	050000	Extraction and distr. of fossil fuels									
NOR	060100	Paint use									
NOR	060201	Industrial degreasing									
NOR	060202	Dry cleaning									
NOR	0603&4	Other solvent use									
NOR	060406	Wood preservation									
NOR	0701-5	Road transport combustion	1.4	1.7	1.7				200	230	67
NOR	0706/7	Road transport non-combustion	0.006	0.007	0.007						
NOR	0801co	Other transport combustion	0.084	0.1	0.1				17	21	21
NOR	0801nc	Other transport non-combustion									
NOR	090200	Waste incineration	0.086	0.092	0.092	1.3	1.4	1.4	4.3	4.6	4.6
NOR	090400	Landfill									
NOR	090900	Cremation				0.1	0.1	0.1			
NOR	100600	Pesticide use									
NOR	110000	Nature									
NOR	eel	Electrical equipment									

Projected emission of Cd, Hg and Pb per country (ISO-a3) in 1990, in 2010 without autonomous emission reduction, in 2010 after autonomous developments (no additional influence of Protocol assumed)

iso3	SNAP	description	Cd 1990	Cd 2010	Cd + autonom. dev.	Hg 1990	Hg 2010	Hg + autonom. dev.	Pb 1990	Pb 2010	Pb + autonom. dev.
		Total	2	2	2	1.4	1.6	1.6	540	650	210
SWE	01bc	Public power etc. brown coal									
SWE	01fo	Public power etc. fuel oils	0.009	0.038	0.038	0.001	0.0042	0.0042	0.09	0.38	0.38
SWE	01hc	Public power etc. hard coal				0.042	0.13	0.13	0.52	1.6	1.6
SWE	01of	Public power etc. other fuels	0.025	0.025	0.025	0.004	0.004	0.004	0.3	0.3	0.3
SWE	02bc	Commercial etc. brown coal									
SWE	02fo	Commercial etc. fuel oils	0.037	0.018	0.018	0.003	0.0015	0.0015	0.39	0.19	0.19
SWE	02hc	Commercial etc. hard coal				0.004			0.69		
SWE	02of	Commercial etc. other fuels	0.18	0.18	0.18	0.09	0.09	0.09	6.5	6.5	6.5
SWE	03bc	Industrial combustion brown coal									
SWE	03fo	Industrial combustion fuel oils	0.054	0.041	0.041	0.006	0.0046	0.0046	0.52	0.4	0.4
SWE	03hc	Industrial combustion hard coal				0.054	0.078	0.078	0.79	1.1	1.1
SWE	03of	Industrial combustion other fuels	0.097	0.097	0.097	0.016	0.016	0.016	1.2	1.2	1.2
SWE	040100	Petroleum industries									
SWE	040201	Coke production	0.006	0.0057	0.0057	0.021	0.02	0.02	0.089	0.085	0.085
SWE	040202	Blast furnace	0.006	0.006	0.006	0.035	0.035	0.035	5.1	5.1	5.1
SWE	040203	Pig iron									
SWE	040205	Open hearth furnace									
SWE	040206	Basic oxigen furnace	0.008	0.008	0.008	0.005	0.005	0.005	1.5	1.5	1.5
SWE	040207	Electric arc furnace	0.14	0.14	0.14	0.17	0.17	0.17	7.5	7.5	7.5
SWE	040208	Rolling									
SWE	040209	Sinter plants	0.036	0.036	0.036	0.039	0.039	0.039	6.8	6.8	6.8
SWE	0402xx	Foundries									
SWE	040301	Al industry	0.048	0.046	0.046						
SWE	0403cu	Cu industry	0.83	0.79	0.79	0.018	0.017	0.017	3.1	3	3
SWE	0403ni	Ni industry									
SWE	0403ot	Other non-ferrous metals									
SWE	0403pb	Pb industry	0.52	0.49	0.49	0.23	0.22	0.22	49	46	46
SWE	0403zn	Zn Industry									
SWE	040407	NPK fertilisers									
SWE	040413	Chloro-alkali industry				0.2	0.22	0.22			
SWE	040524	Halogenated HC production									
SWE	040525	Pesticide production									
SWE	040602	Paper pulp (Kraft process)									
SWE	04060x	Paper and pulp industry									
SWE	040611	Road paving with asphalt									
SWE	040612	Cement industry									
SWE	040613	Glass industry							2	2.2	2.2
SWE	040615	Battery manufacturing									
SWE	0406xx	Synthetic grid blasting									
SWE	04oth	Non-spec. production processes				0.04	0.04	0.04			
SWE	050000	Extraction and distr. of fossil fuels									
SWE	060100	Paint use									
SWE	060201	Industrial degreasing									
SWE	060202	Dry cleaning									
SWE	0603&4	Other solvent use									
SWE	060406	Wood preservation									
SWE	0701-5	Road transport combustion							450	560	130
SWE	0706/7	Road transport non-combustion									
SWE	0801co	Other transport combustion									
SWE	0801nc	Other transport non-combustion									
SWE	090200	Waste incineration	0.035	0.039	0.039	0.17	0.19	0.19	0.7	0.79	0.79
SWE	090400	Landfill									
SWE	090900	Cremation				0.3	0.3	0.3			
SWE	100600	Pesticide use									
SWE	110000	Nature									
SWE	eel	Electrical equipment									

Projected emission of Cd, Hg and Pb per country (ISO-a3) in 1990, in 2010 without autonomous emission reduction, in 2010 after autonomous developments and in 2010 after autonomous developments and implementation of Protocol

ISO3	SNAP	description	Cd 1990	Cd 2010	Cd + autonom. dev.	Cd + Prot.	Hg 1990	Hg 2010	Hg + autonom. dev.	Hg + Prot.	Pb 1990	Pb 2010	Pb + autonom. dev.	Pb + Prot.
ALB		Total	0.65	0.63	0.54	0.32	0.51	0.4	0.4	0.4	33	72	14	14
ALB	01bc	Public power etc. brown coal	0.045	0.027	0.0033	0.0013	0.027	0.016	0.016	0.016	0.09	0.054	0.054	0.054
ALB	01fo	Public power etc. fuel oils	0.055	0.062	0.062	0.062					0.18	0.21	0.18	0.18
ALB	01hc	Public power etc. hard coal												
ALB	01of	Public power etc. other fuels												
ALB	02bc	Commercial etc. brown coal	0.022				0.033				0.13			
ALB	02fo	Commercial etc. fuel oils	0.003	0.0033	0.0033	0.0033					0.011	0.012	0.012	0.012
ALB	02hc	Commercial etc. hard coal												
ALB	02of	Commercial etc. other fuels												
ALB	03bc	Industrial combustion brown coal	0.084	0.042	0.0081	0.0021	0.051	0.026	0.025	0.025	0.17	0.085	0.085	0.085
ALB	03fo	Industrial combustion fuel oils	0.072	0.068	0.068	0.068					0.24	0.23	0.23	0.23
ALB	03hc	Industrial combustion hard coal	0.054	0.03	0.0051	0.00061	0.12	0.067	0.067	0.067	1.2	0.69	0.69	0.69
ALB	03of	Industrial combustion other fuels												
ALB	040100	Petroleum industries												
ALB	040201	Coke production												
ALB	040202	Blast furnace												
ALB	040203	Pig iron												
ALB	040205	Open hearth furnace												
ALB	040206	Basic oxigen furnace												
ALB	040207	Electric arc furnace												
ALB	040208	Rolling												
ALB	040209	Sinter plants												
ALB	0402xx	Foundries												
ALB	040301	Al industry												
ALB	0403cu	Cu industry	0.24	0.24	0.24	0.036	0.001	0.001	0.001	0.001	1.2	1.2	1.2	1.2
ALB	0403ni	Ni industry												
ALB	0403ot	Other non-ferrous metals												
ALB	0403pb	Pb industry												
ALB	0403zn	Zn industry												
ALB	040407	NPK fertilisers												
ALB	040413	Chloro-alkali industry												
ALB	040524	Halogenated HC production												
ALB	040525	Pesticide production												
ALB	040602	Paper pulp (Kraft process)												
ALB	04060x	Paper and pulp industry												
ALB	040611	Road paving with asphalt												
ALB	040612	Cement industry	0.008	0.008	0.008	0.0075	0.19	0.19	0.19	0.19	0.075	0.075	0.075	0.075
ALB	040613	Glass industry												
ALB	040615	Battery manufacturing												
ALB	0406xx	Synthetic grid blasting												
ALB	050000	Extraction and distr. of fossil fuels												
ALB	060100	Paint use												
ALB	060201	Industrial degreasing												
ALB	060202	Dry cleaning												
ALB	0603&4	Other solvent use												
ALB	060406	Wood preservation												
ALB	0701-5	Road transport combustion	0.057	0.13	0.13	0.13					30	69	12	12
ALB	0706/7	Road transport non-combustion	0.002	0.0047	0.0047	0.0047								
ALB	0801co	Other transport combustion												
ALB	0801nc	Other transport non-combustion												
ALB	090200	Waste incineration	0.006	0.0067	0.0067	0.0067	0.093	0.1	0.1	0.1	0.31	0.35	0.35	0.31
ALB	090400	Landfill												
ALB	090900	Cremation												
ALB	100600	Pesticide use												
ALB	110000	Nature												
ALB	eel	Electrical equipment												

Projected emission of Cd, Hg and Pb per country (ISO-a3) in 1990, in 2010 without autonomous emission reduction, in 2010 after autonomous developments and in 2010 after autonomous developments and implementation of Protocol

ISO3	SNAP	description	Cd 1990	Cd 2010	Cd + autonom. dev.	Cd + Prot.	Hg 1990	Hg 2010	Hg + autonom. dev.	Hg + Prot.	Pb 1990	Pb 2010	Pb + autonom. dev.	Pb + Prot.
		Total	8.4	8.3	4.8	3.5	6.9	6.8	6.6	4.6	320	330	150	140
BGR	01bc	Public power etc. brown coal	2.9	2.8	0.33	0.13	1.7	1.7	1.5	1.5	5.7	5.6	5.2	5.2
BGR	01fo	Public power etc. fuel oils	0.2	0.11	0.067	0.067					0.68	0.36	0.36	0.36
BGR	01hc	Public power etc. hard coal	0.3	0.26	0.024	0.0049	0.66	0.56	0.54	0.54	15	13	13	13
BGR	01of	Public power etc. other fuels												
BGR	02bc	Commercial etc. brown coal	0.075	0.049	0.049	0.049	0.11	0.074	0.074	0.074	0.45	0.29	0.29	0.29
BGR	02fo	Commercial etc. fuel oils	0.23	0.33	0.33	0.33					0.78	1.1	1.1	1.1
BGR	02hc	Commercial etc. hard coal												
BGR	02of	Commercial etc. other fuels	0.032	0.032	0.032	0.032	0.08	0.08	0.08	0.08	0.19	0.19	0.19	0.19
BGR	03bc	Industrial combustion brown coal	0.21	0.22	0.04	0.0094	0.12	0.13	0.12	0.11	0.41	0.43	0.37	0.36
BGR	03fo	Industrial combustion fuel oils	1.2	1	0.68	0.68					3.8	3.5	2.5	2.5
BGR	03hc	Industrial combustion hard coal	0.2	0.23	0.04	0.0068	0.44	0.5	0.5	0.5	10	11	11	11
BGR	03of	Industrial combustion other fuels												
BGR	040100	Petroleum industries												
BGR	040201	Coke production	0.065	0.065	0.065	0.065	0.039	0.039	0.039	0.039	0.29	0.29	0.29	0.29
BGR	040202	Blast furnace	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	5.1	5.1	5.1	5.1
BGR	040203	Pig iron									0.003	0.003	0.003	0.003
BGR	040205	Open hearth furnace												
BGR	040206	Basic oxigen furnace	0.027	0.027	0.027	0.027	0.003	0.003	0.003	0.003	1.6	1.6	1.6	1.6
BGR	040207	Electric arc furnace	0.59	0.59	0.59	0.59	0.13	0.13	0.13	0.13	9.7	9.7	9.7	9.7
BGR	040208	Rolling												
BGR	040209	Sinter plants	0.2	0.2	0.2	0.14	0.039	0.039	0.039	0.028	12	12	12	8.3
BGR	0402xx	Foundries												
BGR	040301	Al industry												
BGR	0403cu	Cu industry	0.66	0.66	0.66	0.091	0.003	0.003	0.003	0.003	3.3	3.3	3.3	3
BGR	0403ni	Ni industry												
BGR	0403ot	Other non-ferrous metals												
BGR	0403pb	Pb industry	0.36	0.36	0.36	0.093	0.16	0.16	0.16	0.16	29	29	29	29
BGR	0403zn	Zn industry	0.073	0.073	0.073	0.073					0.073	0.073	0.073	0.073
BGR	040407	NPK fertilisers												
BGR	040413	Chloro-alkali industry					0.25	0.24	0.24	0.086				
BGR	040524	Halogenated HC production												
BGR	040525	Pesticide production												
BGR	040602	Paper pulp (Kraft process)												
BGR	04060x	Paper and pulp industry												
BGR	040611	Road paving with asphalt												
BGR	040612	Cement industry	0.04	0.04	0.04	0.04	0.99	0.99	0.99	0.99	0.4	0.4	0.4	0.4
BGR	040613	Glass industry	0.1	0.099	0.099	0.099	0.034	0.033	0.033	0.033	8.1	7.9	7.9	7.9
BGR	040615	Battery manufacturing												
BGR	0406xx	Synthetic grid blasting												
BGR	050000	Extraction and distr. of fossil fuels												
BGR	060100	Paint use												
BGR	060201	Industrial degreasing												
BGR	060202	Dry cleaning												
BGR	0603&4	Other solvent use												
BGR	060406	Wood preservation												
BGR	0701-5	Road transport combustion	0.88	0.93	0.93	0.93					200	210	31	31
BGR	0706/7	Road transport non-combustion												
BGR	0801co	Other transport combustion	0.018	0.018	0.018	0.018					7.3	7.1	7.1	7.1
BGR	0801nc	Other transport non-combustion												
BGR	090200	Waste incineration	0.14	0.14	0.14	0.017	2.1	2.1	2.1	0.25	7.1	6.9	6.9	0.85
BGR	090400	Landfill												
BGR	090900	Cremation												
BGR	100600	Pesticide use												
BGR	110000	Nature												
BGR	eel	Electrical equipment												

Projected emission of Cd, Hg and Pb per country (ISO-a3) in 1990, in 2010 without autonomous emission reduction, in 2010 after autonomous developments and in 2010 after autonomous developments and implementation of Protocol

ISO3	SNAP	description	Cd 1990	Cd 2010	Cd + autonom. dev.	Cd + Prot.	Hg 1990	Hg 2010	Hg + autonom. dev.	Hg + Prot.	Pb 1990	Pb 2010	Pb + autonom. dev.	Pb + Prot.
		Total	0.4	0.13	0.13	0.13	0.22	0.19	0.19	0.19	8.6	0.93	0.93	0.93
BIH	01bc	Public power etc. brown coal												
BIH	01fo	Public power etc. fuel oils												
BIH	01hc	Public power etc. hard coal												
BIH	01of	Public power etc. other fuels												
BIH	02bc	Commercial etc. brown coal	0.009	0.0036	0.0036	0.0036	0.013	0.0052	0.0052	0.0052	0.053	0.021	0.021	0.021
BIH	02fo	Commercial etc. fuel oils	0.038	0.053	0.053	0.053					0.14	0.2	0.2	0.2
BIH	02hc	Commercial etc. hard coal												
BIH	02of	Commercial etc. other fuels												
BIH	03bc	Industrial combustion brown coal												
BIH	03fo	Industrial combustion fuel oils												
BIH	03hc	Industrial combustion hard coal												
BIH	03of	Industrial combustion other fuels												
BIH	040100	Petroleum industries												
BIH	040201	Coke production	0.075	0.068	0.068	0.068	0.045	0.041	0.041	0.041	0.33	0.3	0.3	0.3
BIH	040202	Blast furnace												
BIH	040203	Pig iron												
BIH	040205	Open hearth furnace	0.21								5.9			
BIH	040206	Basic oxigen furnace	0.019				0.002				1.1			
BIH	040207	Electric arc furnace	0.04				0.009				0.66			
BIH	040208	Rolling												
BIH	040209	Sinter plants												
BIH	0402xx	Foundries												
BIH	040301	Al industry												
BIH	0403cu	Cu industry												
BIH	0403ni	Ni industry												
BIH	0403ot	Other non-ferrous metals												
BIH	0403pb	Pb industry												
BIH	0403zn	Zn Industry												
BIH	040407	NPK fertilisers												
BIH	040413	Chloro-alkali industry												
BIH	040524	Halogenated HC production												
BIH	040525	Pesticide production												
BIH	040602	Paper pulp (Kraft process)												
BIH	04060x	Paper and pulp industry												
BIH	040611	Road paving with asphalt												
BIH	040612	Cement industry												
BIH	040613	Glass industry												
BIH	040615	Battery manufacturing												
BIH	0406xx	Synthetic grid blasting												
BIH	050000	Extraction and distr. of fossil fuels												
BIH	060100	Paint use												
BIH	060201	Industrial degreasing												
BIH	060202	Dry cleaning												
BIH	0603&4	Other solvent use												
BIH	060406	Wood preservation												
BIH	0701-5	Road transport combustion												
BIH	0706/7	Road transport non-combustion												
BIH	0801co	Other transport combustion												
BIH	0801nc	Other transport non-combustion												
BIH	090200	Waste incineration	0.009	0.0086	0.0086	0.0086	0.13	0.12	0.12	0.12	0.44	0.41	0.41	0.41
BIH	090400	Landfill												
BIH	090900	Cremation					0.022	0.022	0.022	0.022				
BIH	100600	Pesticide use												
BIH	110000	Nature												
BIH	eel	Electrical equipment												

Projected emission of Cd, Hg and Pb per country (ISO-a3) in 1990, in 2010 without autonomous emission reduction, in 2010 after autonomous developments and in 2010 after autonomous developments and implementation of Protocol

ISO3	SNAP	description	Cd 1990	Cd 2010	Cd + autonom. dev.	Cd + Prot.	Hg 1990	Hg 2010	Hg + autonom. dev.	Hg + Prot.	Pb 1990	Pb 2010	Pb + autonom. dev.	Pb + Prot.
		Total	6.6	3.5	1.8	1.7	0.091	0.077	0.077	0.077	740	730	100	100
BLR	01bc	Public power etc. brown coal												
BLR	01fo	Public power etc. fuel oils	0.21	0.12	0.12	0.12					15	8.4	8.4	8.4
BLR	01hc	Public power etc. hard coal	0.79	1.6	0.12	0.00081	0.019	0.039	0.039	0.039	0.82	1.7	1	0.98
BLR	01of	Public power etc. other fuels					0.014	0.014	0.014	0.014				
BLR	02bc	Commercial etc. brown coal												
BLR	02fo	Commercial etc. fuel oils	0.006	0.0035	0.0035	0.0035					0.26	0.15	0.15	0.15
BLR	02hc	Commercial etc. hard coal	4.9	1.1	1.1	1.1	0.043	0.0098	0.0098	0.0098	5	1.1	1.1	1.1
BLR	02of	Commercial etc. other fuels					0.001	0.001	0.001	0.001				
BLR	03bc	Industrial combustion brown coal												
BLR	03fo	Industrial combustion fuel oils	0.1	0.067	0.067	0.067					2.6	1.7	1.7	1.7
BLR	03hc	Industrial combustion hard coal	0.21	0.17	0.027	0.00058	0.005	0.0041	0.0041	0.0041	0.22	0.18	0.18	0.18
BLR	03of	Industrial combustion other fuels					0.002	0.002	0.002	0.002				
BLR	040100	Petroleum industries												
BLR	040201	Coke production												
BLR	040202	Blast furnace												
BLR	040203	Pig iron												
BLR	040205	Open hearth furnace												
BLR	040206	Basic oxigen furnace												
BLR	040207	Electric arc furnace												
BLR	040208	Rolling												
BLR	040209	Sinter plants												
BLR	0402xx	Foundries												
BLR	040301	Al industry												
BLR	0403cu	Cu industry												
BLR	0403ni	Ni industry												
BLR	0403ot	Other non-ferrous metals												
BLR	0403pb	Pb industry												
BLR	0403zn	Zn industry												
BLR	040407	NPK fertilisers	0.039	0.034	0.034	0.034								
BLR	040413	Chloro-alkali industry												
BLR	040524	Halogenated HC production												
BLR	040525	Pesticide production												
BLR	040602	Paper pulp (Kraft process)												
BLR	04060x	Paper and pulp industry												
BLR	040611	Road paving with asphalt												
BLR	040612	Cement industry												
BLR	040613	Glass industry	0.015	0.013	0.013	0.013	0.005	0.0044	0.0044	0.0044	1.2	1.1	1.1	1.1
BLR	040615	Battery manufacturing												
BLR	0406xx	Synthetic grid blasting												
BLR	04iro	Iron and steel, non-specified	0.16	0.16	0.16	0.16					8	8	8	8
BLR	04oth	Non-spec. production processes	0.11	0.11	0.11	0.11					14	14	14	14
BLR	050000	Extraction and distr. of fossil fuels												
BLR	060100	Paint use												
BLR	060201	Industrial degreasing												
BLR	060202	Dry cleaning												
BLR	0603&4	Other solvent use												
BLR	060406	Wood preservation												
BLR	0701-5	Road transport combustion	0.032	0.032	0.032	0.032					690	690	68	68
BLR	0706/7	Road transport non-combustion												
BLR	0801co	Other transport combustion	0.005	0.0049	0.0049	0.0049								
BLR	0801nc	Other transport non-combustion												
BLR	090200	Waste incineration					0.001	0.00088	0.00088	0.00088	0.002	0.0018	0.0018	0.0018
BLR	090400	Landfill												
BLR	090900	Cremation					0.001	0.001	0.001	0.001				
BLR	100600	Pesticide use												
BLR	110000	Nature												
BLR	eel	Electrical equipment												

Projected emission of Cd, Hg and Pb per country (ISO-a3) in 1990, in 2010 without autonomous emission reduction, in 2010 after autonomous developments and in 2010 after autonomous developments and implementation of Protocol

ISO3	SNAP	description	Cd 1990	Cd 2010	Cd + autonom. dev.	Cd + Prot.	Hg 1990	Hg 2010	Hg + autonom. dev.	Hg + Prot.	Pb 1990	Pb 2010	Pb + autonom. dev.	Pb + Prot.
		Total	12	8.2	4.5	4.4	9.3	6.3	6.3	6.3	340	300	170	170
CZE	01bc	Public power etc. brown coal	4.4	3.3	0.22	0.17	2.7	2	2	2	8.8	6.7	6.7	6.7
CZE	01fo	Public power etc. fuel oils	0.1	0.096	0.096	0.096					0.35	0.32	0.32	0.32
CZE	01hc	Public power etc. hard coal	0.43	0.48	0.017	0.0096	0.95	1.1	1.1	1.1	22	24	22	22
CZE	01of	Public power etc. other fuels												
CZE	02bc	Commercial etc. brown coal	0.49	0.054	0.054	0.054	0.73	0.081	0.081	0.081	2.9	0.32	0.32	0.32
CZE	02fo	Commercial etc. fuel oils	0.23	0.26	0.26	0.26					0.79	0.9	0.9	0.9
CZE	02hc	Commercial etc. hard coal	0.31	0.078	0.078	0.078	0.46	0.11	0.11	0.11	5.2	1.3	1.3	1.3
CZE	02of	Commercial etc. other fuels												
CZE	03bc	Industrial combustion brown coal	0.67				0.4				1.3			
CZE	03fo	Industrial combustion fuel oils	0.49	0.28	0.28	0.28					1.7	0.94	0.94	0.94
CZE	03hc	Industrial combustion hard coal	0.68	0.18	0.017	0.0037	1.5	0.41	0.41	0.41	15	4	4	4
CZE	03of	Industrial combustion other fuels												
CZE	040100	Petroleum industries												
CZE	040201	Coke production	0.36	0.36	0.36	0.36	0.22	0.22	0.22	0.22	1.6	1.6	1.6	1.6
CZE	040202	Blast furnace	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	27	27	27	27
CZE	040203	Pig iron												
CZE	040205	Open hearth furnace	0.76								21			
CZE	040206	Basic oxigen furnace	0.16	0.16	0.16	0.16	0.02	0.02	0.02	0.02	9.8	9.8	9.8	9.8
CZE	040207	Electric arc furnace	1.1	1.1	1.1	1.1	0.25	0.25	0.25	0.25	19	19	19	19
CZE	040208	Rolling												
CZE	040209	Sinter plants	0.8	0.8	0.8	0.8	0.16	0.16	0.16	0.16	48	48	48	48
CZE	0402xx	Foundries												
CZE	040301	Al industry												
CZE	0403cu	Cu industry												
CZE	0403ni	Ni industry												
CZE	0403ot	Other non-ferrous metals												
CZE	0403pb	Pb industry	0.071	0.071	0.071	0.071					3.6	3.6	3.6	3.6
CZE	0403zn	Zn industry												
CZE	040407	NPK fertilisers												
CZE	040413	Chloro-alkali industry												
CZE	040524	Halogenated HC production												
CZE	040525	Pesticide production												
CZE	040602	Paper pulp (Kraft process)												
CZE	04060x	Paper and pulp industry												
CZE	040611	Road paving with asphalt												
CZE	040612	Cement industry	0.061	0.061	0.061	0.061	1.5	1.5	1.5	1.5	0.61	0.61	0.61	0.61
CZE	040613	Glass industry												
CZE	040615	Battery manufacturing												
CZE	0406xx	Synthetic grid blasting												
CZE	050000	Extraction and distr. of fossil fuels												
CZE	060100	Paint use												
CZE	060201	Industrial degreasing												
CZE	060202	Dry cleaning												
CZE	0603&4	Other solvent use												
CZE	060406	Wood preservation												
CZE	0701-5	Road transport combustion	0.69	0.7	0.7	0.7					150	150	27	27
CZE	0706/7	Road transport non-combustion	0.022	0.022	0.022	0.022								
CZE	0801co	Other transport combustion	0.0026	0.0023	0.0023	0.0023								
CZE	0801nc	Other transport non-combustion												
CZE	090200	Waste incineration	0.02	0.018	0.018	0.018	0.29	0.28	0.28	0.28	0.98	0.92	0.92	0.92
CZE	090400	Landfill												
CZE	090900	Cremation					0.034	0.034	0.034	0.034				
CZE	100600	Pesticide use												
CZE	110000	Nature												
CZE	eel	Electrical equipment												

Projected emission of Cd, Hg and Pb per country (ISO-a3) in 1990, in 2010 without autonomous emission reduction, in 2010 after autonomous developments and in 2010 after autonomous developments and implementation of Protocol

ISO3	SNAP	description	Cd 1990	Cd 2010	Cd + autonom. dev.	Cd + Prot.	Hg 1990	Hg 2010	Hg + autonom. dev.	Hg + Prot.	Pb 1990	Pb 2010	Pb + autonom. dev.	Pb + Prot.
		Total	3.9	3.1	1.6	1.1	2	1.6	1.6	1.6	170	200	54	27
EST	01bc	Public power etc. brown coal	2.2	1.6	0.19	0.08	1.3	0.96	0.96	0.96	4.5	3.2	3.2	3.2
EST	01fo	Public power etc. fuel oils	0.14	0.044	0.044	0.044					0.48	0.15	0.15	0.15
EST	01hc	Public power etc. hard coal	0.017				0.038				0.86			
EST	01of	Public power etc. other fuels	0.48	0.48	0.48	0.048	0.18	0.18	0.18	0.18	29	29	29	2.9
EST	02bc	Commercial etc. brown coal												
EST	02fo	Commercial etc. fuel oils	0.41	0.39	0.39	0.39					1.4	1.3	1.3	1.3
EST	02hc	Commercial etc. hard coal	0.033	0.022	0.022	0.022	0.048	0.032	0.032	0.032	0.55	0.36	0.36	0.36
EST	02of	Commercial etc. other fuels	0.032	0.032	0.032	0.032	0.049	0.049	0.049	0.049	0.19	0.19	0.19	0.19
EST	03bc	Industrial combustion brown coal	0.14	0.11	0.02	0.0053	0.083	0.064	0.064	0.064	0.28	0.21	0.21	0.21
EST	03fo	Industrial combustion fuel oils												
EST	03hc	Industrial combustion hard coal	0.01	0.0067	0.0011	0.00013	0.022	0.015	0.015	0.015	0.43	0.29	0.29	0.29
EST	03of	Industrial combustion other fuels	0.002	0.002	0.002	0.002	0.0012	0.0012	0.0012	0.0012	0.004	0.004	0.004	0.004
EST	040100	Petroleum industries												
EST	040201	Coke production												
EST	040202	Blast furnace												
EST	040203	Pig iron												
EST	040205	Open hearth furnace												
EST	040206	Basic oxigen furnace												
EST	040207	Electric arc furnace												
EST	040208	Rolling												
EST	040209	Sinter plants												
EST	0402xx	Foundries												
EST	040301	Al industry												
EST	0403cu	Cu industry												
EST	0403ni	Ni industry												
EST	0403ot	Other non-ferrous metals												
EST	0403pb	Pb industry												
EST	0403zn	Zn industry												
EST	040407	NPK fertilisers												
EST	040413	Chloro-alkali industry												
EST	040524	Halogenated HC production												
EST	040525	Pesticide production												
EST	040602	Paper pulp (Kraft process)												
EST	04060x	Paper and pulp industry												
EST	040611	Road paving with asphalt												
EST	040612	Cement industry	0.0091	0.0091	0.0091	0.0091	0.23	0.23	0.23	0.23	0.091	0.091	0.091	0.091
EST	040613	Glass industry												
EST	040615	Battery manufacturing												
EST	0406xx	Synthetic grid blasting												
EST	050000	Extraction and distr. of fossil fuels												
EST	060100	Paint use												
EST	060201	Industrial degreasing												
EST	060202	Dry cleaning												
EST	0603&4	Other solvent use												
EST	060406	Wood preservation												
EST	0701-5	Road transport combustion	0.34	0.43	0.43	0.43					130	170	19	19
EST	0706/7	Road transport non-combustion	0.0045	0.0056	0.0056	0.0056								
EST	0801co	Other transport combustion	0.0017	0.0017	0.0017	0.0017	0.002	0.0019	0.0019	0.0019	0.023	0.022	0.022	0.022
EST	0801nc	Other transport non-combustion												
EST	090200	Waste incineration	0.0014	0.0012	0.0012	0.0012	0.021	0.018	0.018	0.018	0.07	0.06	0.06	0.06
EST	090400	Landfill												
EST	090900	Cremation					0.008	0.008	0.008	0.008				
EST	100600	Pesticide use												
EST	110000	Nature												
EST	eel	Electrical equipment												

Projected emission of Cd, Hg and Pb per country (ISO-a3) in 1990, in 2010 without autonomous emission reduction, in 2010 after autonomous developments and in 2010 after autonomous developments and implementation of Protocol

ISO3	SNAP	description	Cd 1990	Cd 2010	Cd + autonom. dev.	Cd + Prot.	Hg 1990	Hg 2010	Hg + autonom. dev.	Hg + Prot.	Pb 1990	Pb 2010	Pb + autonom. dev.	Pb + Prot.
		Total	3.2	3.2	2.1	2.1	1.1	0.87	0.84	0.83	470	620	24	24
HRV	01bc	Public power etc. brown coal												
HRV	01fo	Public power etc. fuel oils	0.62	0.47	0.11	0.11					0.33	0.25	0.25	0.25
HRV	01hc	Public power etc. hard coal	0.078	0.14	0.011	0.00066	0.06	0.11	0.075	0.072	0.62	1.1	0.92	0.91
HRV	01of	Public power etc. other fuels												
HRV	02bc	Commercial etc. brown coal	0.081				0.3				0.36			
HRV	02fo	Commercial etc. fuel oils	0.35	0.44	0.44	0.44					0.96	1.2	1.2	1.2
HRV	02hc	Commercial etc. hard coal												
HRV	02of	Commercial etc. other fuels												
HRV	03bc	Industrial combustion brown coal	0.15				0.0027				0.16			
HRV	03fo	Industrial combustion fuel oils	0.64	0.53	0.074	0.074					1.3	1	0.32	0.32
HRV	03hc	Industrial combustion hard coal	0.15	0.11	0.017	0.00032	0.01	0.0077	0.0077	0.0077	1.9	1.5	0.64	0.5
HRV	03of	Industrial combustion other fuels												
HRV	040100	Petroleum industries												
HRV	040201	Coke production												
HRV	040202	Blast furnace									0.002			
HRV	040203	Pig iron												
HRV	040205	Open hearth furnace	0.051								2.5			
HRV	040206	Basic oxigen furnace												
HRV	040207	Electric arc furnace	0.001								0.28			
HRV	040208	Rolling												
HRV	040209	Sinter plants	0.025				0.005				1.5			
HRV	0402xx	Foundries	0.012								0.59			
HRV	040301	Al industry	0.01	0.009	0.009	0.009								
HRV	0403cu	Cu industry												
HRV	0403ni	Ni industry												
HRV	0403ot	Other non-ferrous metals												
HRV	0403pb	Pb industry									0.78	0.7	0.7	0.7
HRV	0403zn	Zn industry												
HRV	040407	NPK fertilisers												
HRV	040413	Chloro-alkali industry												
HRV	040524	Halogenated HC production												
HRV	040525	Pesticide production	0.002	0.0033	0.0033	0.0033								
HRV	040602	Paper pulp (Kraft process)												
HRV	04060x	Paper and pulp industry												
HRV	040611	Road paving with asphalt												
HRV	040612	Cement industry	0.021	0.019	0.019	0.016					0.3	0.27	0.27	0.17
HRV	040613	Glass industry									0.012	0.013	0.013	0.013
HRV	040615	Battery manufacturing												
HRV	0406xx	Synthetic grid blasting					0.001	0.0011	0.0011	0.0011	0.052	0.056	0.056	0.056
HRV	050000	Extraction and distr. of fossil fuels					0.69	0.75	0.75	0.75				
HRV	060100	Paint use												
HRV	060201	Industrial degreasing												
HRV	060202	Dry cleaning												
HRV	0603&4	Other solvent use												
HRV	060406	Wood preservation												
HRV	0701-5	Road transport combustion	1	1.4	1.4	1.4					450	620	20	20
HRV	0706/7	Road transport non-combustion	0.017	0.023	0.023	0.023								
HRV	0801co	Other transport combustion												
HRV	0801nc	Other transport non-combustion												
HRV	090200	Waste incineration												
HRV	090400	Landfill												
HRV	090900	Cremation					0.001	0.001	0.001	0.001				
HRV	100600	Pesticide use												
HRV	110000	Nature												
HRV	eel	Electrical equipment												

Projected emission of Cd, Hg and Pb per country (ISO-a3) in 1990, in 2010 without autonomous emission reduction, in 2010 after autonomous developments and in 2010 after autonomous developments and implementation of Protocol

ISO3	SNAP	description	Cd 1990	Cd 2010	Cd + autonom. dev.	Cd + Prot.	Hg 1990	Hg 2010	Hg + autonom. dev.	Hg + Prot.	Pb 1990	Pb 2010	Pb + autonom. dev.	Pb + Prot.
		Total	4.6	5.1	4.1	4	4.2	4.5	4.3	3.8	640	1000	91	91
HUN	01bc	Public power etc. brown coal	1.2	1.1	0.13	0.053	0.84	0.78	0.65	0.64	1.9	1.8	1.8	1.8
HUN	01fo	Public power etc. fuel oils	0.38	0.31	0.3	0.3					1	0.85	0.85	0.85
HUN	01hc	Public power etc. hard coal	0.0071	0.036	0.0035	0.00093	0.019	0.094	0.079	0.077	0.3	1.5	0.44	0.35
HUN	01of	Public power etc. other fuels												
HUN	02bc	Commercial etc. brown coal	0.18	0.16	0.16	0.16	0.32	0.3	0.3	0.3	0.88	0.82	0.82	0.82
HUN	02fo	Commercial etc. fuel oils	0.094	0.11	0.11	0.11					0.31	0.36	0.36	0.36
HUN	02hc	Commercial etc. hard coal	0.074	0.1	0.1	0.1	0.13	0.18	0.18	0.18	1	1.4	1.4	1.4
HUN	02of	Commercial etc. other fuels	0.078	0.078	0.078	0.078	0.23	0.23	0.23	0.23	0.39	0.39	0.39	0.39
HUN	03bc	Industrial combustion brown coal	0.021				0.015				0.036			
HUN	03fo	Industrial combustion fuel oils	0.068	0.11	0.11	0.11					0.21	0.35	0.25	0.25
HUN	03hc	Industrial combustion hard coal	0.014	0.012	0.0019	0.00023	0.037	0.031	0.026	0.025	0.38	0.31	0.31	0.31
HUN	03of	Industrial combustion other fuels												
HUN	040100	Petroleum industries												
HUN	040201	Coke production	0.025	0.025	0.025	0.025	0.018	0.018	0.018	0.018	0.09	0.09	0.09	0.09
HUN	040202	Blast furnace	0.034	0.034	0.034	0.034	0.041	0.041	0.041	0.041	7.1	7.1	7.1	7.1
HUN	040203	Pig iron												
HUN	040205	Open hearth furnace	0.44								9.9			
HUN	040206	Basic oxigen furnace	0.036	0.036	0.036	0.036	0.0052	0.0052	0.0052	0.0043	1.8	1.8	1.8	1.8
HUN	040207	Electric arc furnace	0.18	0.18	0.18	0.18	0.048	0.048	0.048	0.039	2.5	2.5	2.5	2.5
HUN	040208	Rolling												
HUN	040209	Sinter plants	0.19	0.19	0.19	0.19	0.045	0.045	0.045	0.037	9.4	9.4	9.4	9.4
HUN	0402xx	Foundries												
HUN	040301	Al industry	0.011	0.011	0.011	0.011								
HUN	0403cu	Cu industry	0.012	0.012	0.012	0.012					0.25	0.25	0.25	0.25
HUN	0403ni	Ni industry												
HUN	0403ot	Other non-ferrous metals												
HUN	0403pb	Pb industry												
HUN	0403zn	Zn industry												
HUN	040407	NPK fertilisers												
HUN	040413	Chloro-alkali industry												
HUN	040524	Halogenated HC production												
HUN	040525	Pesticide production												
HUN	040602	Paper pulp (Kraft process)												
HUN	04060x	Paper and pulp industry												
HUN	040611	Road paving with asphalt												
HUN	040612	Cement industry	0.04	0.04	0.04	0.039	1.2	1.2	1.2	0.98	0.33	0.33	0.33	0.33
HUN	040613	Glass industry												
HUN	040615	Battery manufacturing												
HUN	0406xx	Synthetic grid blasting												
HUN	050000	Extraction and distr. of fossil fuels												
HUN	060100	Paint use												
HUN	060201	Industrial degreasing												
HUN	060202	Dry cleaning												
HUN	0603&4	Other solvent use												
HUN	060406	Wood preservation												
HUN	0701-5	Road transport combustion	1.5	2.4	2.4	2.4					600	980	57	57
HUN	0706/7	Road transport non-combustion	0.023	0.038	0.038	0.038								
HUN	0801co	Other transport combustion	0.011	0.011	0.011	0.011	0.0013	0.0013	0.0013	0.0013	2.9	2.9	2.9	2.9
HUN	0801nc	Other transport non-combustion												
HUN	090200	Waste incineration	0.063	0.077	0.077	0.075	1.1	1.4	1.4	1.1	2.6	3.2	3.2	3.1
HUN	090400	Landfill												
HUN	090900	Cremation					0.12	0.12	0.12	0.12				
HUN	100600	Pesticide use												
HUN	110000	Nature												
HUN	eel	Electrical equipment												

Projected emission of Cd, Hg and Pb per country (ISO-a3) in 1990, in 2010 without autonomous emission reduction, in 2010 after autonomous developments and in 2010 after autonomous developments and implementation of Protocol

ISO3	SNAP	description	Cd 1990	Cd 2010	Cd + autonom. dev.	Cd + Prot.	Hg 1990	Hg 2010	Hg + autonom. dev.	Hg + Prot.	Pb 1990	Pb 2010	Pb + autonom. dev.	Pb + Prot.
		Total	2.8	2.1	1.9	1.9	0.003	0.0025	0.0025	0.0025	250	220	220	220
LTU	01bc	Public power etc. brown coal												
LTU	01fo	Public power etc. fuel oils	1	0.25	0.18	0.18					0.68	0.17	0.17	0.17
LTU	01hc	Public power etc. hard coal	0.019	0.00092	0.000081	0.000013	1.3E-06	6.3E-08	0.000000063	6.3E-08	0.18	0.009	0.009	0.009
LTU	01of	Public power etc. other fuels												
LTU	02bc	Commercial etc. brown coal												
LTU	02fo	Commercial etc. fuel oils	0.12	0.11	0.11	0.11					0.09	0.084	0.084	0.084
LTU	02hc	Commercial etc. hard coal	0.3	0.29	0.29	0.29	0.000014	0.000013	0.000013	0.000013	0.99	0.95	0.95	0.95
LTU	02of	Commercial etc. other fuels	0.0062	0.0062	0.0062	0.0062	2.9E-07	2.9E-07	0.00000029	2.9E-07	0.0072	0.0072	0.0072	0.0072
LTU	03bc	Industrial combustion brown coal												
LTU	03fo	Industrial combustion fuel oils	0.27	0.19	0.13	0.13					0.17	0.12	0.12	0.12
LTU	03hc	Industrial combustion hard coal	0.013	0.027	0.0044	0.00038	9.2E-07	1.9E-06	0.0000019	1.9E-06	0.13	0.27	0.27	0.27
LTU	03of	Industrial combustion other fuels												
LTU	040100	Petroleum industries												
LTU	040201	Coke production												
LTU	040202	Blast furnace												
LTU	040203	Pig iron												
LTU	040205	Open hearth furnace												
LTU	040206	Basic oxigen furnace												
LTU	040207	Electric arc furnace												
LTU	040208	Rolling												
LTU	040209	Sinter plants												
LTU	0402xx	Foundries												
LTU	040301	Al industry												
LTU	0403cu	Cu industry												
LTU	0403ni	Ni industry												
LTU	0403ot	Other non-ferrous metals												
LTU	0403pb	Pb industry												
LTU	0403zn	Zn industry												
LTU	040407	NPK fertilisers												
LTU	040413	Chloro-alkali industry												
LTU	040524	Halogenated HC production												
LTU	040525	Pesticide production												
LTU	040602	Paper pulp (Kraft process)												
LTU	04060x	Paper and pulp industry												
LTU	040611	Road paving with asphalt												
LTU	040612	Cement industry									0.02	0.02	0.02	0.02
LTU	040613	Glass industry	0.008	0.0067	0.0067	0.0067	0.003	0.0025	0.0025	0.0025	200	160	160	160
LTU	040615	Battery manufacturing												
LTU	0406xx	Synthetic grid blasting												
LTU	050000	Extraction and distr. of fossil fuels												
LTU	060100	Paint use												
LTU	060201	Industrial degreasing												
LTU	060202	Dry cleaning												
LTU	0603&4	Other solvent use												
LTU	060406	Wood preservation												
LTU	0701-5	Road transport combustion	1.1	1.2	1.2	1.2					49	54	54	54
LTU	0706/7	Road transport non-combustion												
LTU	0801co	Other transport combustion												
LTU	0801nc	Other transport non-combustion												
LTU	090200	Waste incineration												
LTU	090400	Landfill												
LTU	090900	Cremation												
LTU	100600	Pesticide use												
LTU	110000	Nature												
LTU	eel	Electrical equipment												

Projected emission of Cd, Hg and Pb per country (ISO-a3) in 1990, in 2010 without autonomous emission reduction, in 2010 after autonomous developments and in 2010 after autonomous developments and implementation of Protocol

ISO3	SNAP	description	Cd 1990	Cd 2010	Cd + autonom. dev.	Cd + Prot.	Hg 1990	Hg 2010	Hg + autonom. dev.	Hg + Prot.	Pb 1990	Pb 2010	Pb + autonom. dev.	Pb + Prot.
		Total	3.2	3	2	2	0.34	0.4	0.38	0.38	220	270	7	7
LVA	01bc	Public power etc. brown coal												
LVA	01fo	Public power etc. fuel oils	1.2	0.75	0.17	0.17					0.49	0.3	0.3	0.3
LVA	01hc	Public power etc. hard coal	0.17	0.37	0.029	0.0016	0.092	0.2	0.18	0.18	1	2.2	1.9	1.9
LVA	01of	Public power etc. other fuels	0.011	0.011	0.011	0.011	0.0016	0.0016	0.0016	0.0016	0.0026	0.0026	0.0026	0.0026
LVA	02bc	Commercial etc. brown coal												
LVA	02fo	Commercial etc. fuel oils												
LVA	02hc	Commercial etc. hard coal	0.66	0.54	0.54	0.54	0.24	0.19	0.19	0.19	1.3	1.1	1.1	1.1
LVA	02of	Commercial etc. other fuels												
LVA	03bc	Industrial combustion brown coal												
LVA	03fo	Industrial combustion fuel oils	0.12	0.06	0.013	0.013					0.049	0.025	0.025	0.025
LVA	03hc	Industrial combustion hard coal	0.011	0.016	0.0024	0.00007	0.006	0.0084	0.0078	0.0077	0.059	0.082	0.082	0.082
LVA	03of	Industrial combustion other fuels	0.0032	0.0032	0.0032	0.0032	0.00046	0.00046	0.00046	0.00046	0.00075	0.00075	0.00075	0.00075
LVA	040100	Petroleum industries												
LVA	040201	Coke production												
LVA	040202	Blast furnace												
LVA	040203	Pig iron												
LVA	040205	Open hearth furnace												
LVA	040206	Basic oxigen furnace												
LVA	040207	Electric arc furnace												
LVA	040208	Rolling												
LVA	040209	Sinter plants												
LVA	0402xx	Foundries												
LVA	040301	Al industry												
LVA	0403cu	Cu industry												
LVA	0403ni	Ni industry												
LVA	0403ot	Other non-ferrous metals												
LVA	0403pb	Pb industry												
LVA	0403zn	Zn Industry												
LVA	040407	NPK fertilisers												
LVA	040413	Chloro-alkali industry												
LVA	040524	Halogenated HC production												
LVA	040525	Pesticide production												
LVA	040602	Paper pulp (Kraft process)												
LVA	04060x	Paper and pulp industry												
LVA	040611	Road paving with asphalt												
LVA	040612	Cement industry									0.004	0.004	0.004	0.004
LVA	040613	Glass industry												
LVA	040615	Battery manufacturing												
LVA	0406xx	Synthetic grid blasting												
LVA	04oth	Non-spec. production processes	0.003	0.003	0.003	0.003					0.57	0.57	0.57	0.57
LVA	050000	Extraction and distr. of fossil fuels												
LVA	060100	Paint use												
LVA	060201	Industrial degreasing												
LVA	060202	Dry cleaning												
LVA	0603&4	Other solvent use												
LVA	060406	Wood preservation												
LVA	0701-5	Road transport combustion	1	1.2	1.2	1.2					210	260	3.1	3.1
LVA	0706/7	Road transport non-combustion												
LVA	0801co	Other transport combustion												
LVA	0801nc	Other transport non-combustion												
LVA	090200	Waste incineration												
LVA	090400	Landfill												
LVA	090900	Cremation												
LVA	100600	Pesticide use												
LVA	110000	Nature												
LVA	eel	Electrical equipment												

Projected emission of Cd, Hg and Pb per country (ISO-a3) in 1990, in 2010 without autonomous emission reduction, in 2010 after autonomous developments and in 2010 after autonomous developments and implementation of Protocol

ISO3	SNAP	description	Cd 1990	Cd 2010	Cd + autonom. dev.	Cd + Prot.	Hg 1990	Hg 2010	Hg + autonom. dev.	Hg + Prot.	Pb 1990	Pb 2010	Pb + autonom. dev.	Pb + Prot.
		Total	1.8	1.2	1	1	1.5	0.78	0.78	0.78	170	170	21	21
MDA	01bc	Public power etc. brown coal												
MDA	01fo	Public power etc. fuel oils	0.37	0.17	0.17	0.17					1.2	0.55	0.55	0.55
MDA	01hc	Public power etc. hard coal	0.25	0.2	0.019	0.0041	0.56	0.45	0.45	0.45	13	10	10	10
MDA	01of	Public power etc. other fuels												
MDA	02bc	Commercial etc. brown coal												
MDA	02fo	Commercial etc. fuel oils	0.47	0.3	0.3	0.3					1.6	1	1	1
MDA	02hc	Commercial etc. hard coal	0.23	0.12	0.12	0.12	0.33	0.18	0.18	0.18	3.8	2.1	2.1	2.1
MDA	02of	Commercial etc. other fuels												
MDA	03bc	Industrial combustion brown coal												
MDA	03fo	Industrial combustion fuel oils												
MDA	03hc	Industrial combustion hard coal	0.046	0.037	0.0062	0.00074	0.1	0.081	0.081	0.081	2.3	1.8	1.8	1.8
MDA	03of	Industrial combustion other fuels												
MDA	040100	Petroleum industries												
MDA	040201	Coke production												
MDA	040202	Blast furnace												
MDA	040203	Pig iron												
MDA	040205	Open hearth furnace												
MDA	040206	Basic oxigen furnace												
MDA	040207	Electric arc furnace												
MDA	040208	Rolling												
MDA	040209	Sinter plants												
MDA	0402xx	Foundries												
MDA	040301	Al industry												
MDA	0403cu	Cu industry												
MDA	0403ni	Ni industry												
MDA	0403ot	Other non-ferrous metals												
MDA	0403pb	Pb industry												
MDA	0403zn	Zn industry												
MDA	040407	NPK fertilisers												
MDA	040413	Chloro-alkali industry												
MDA	040524	Halogenated HC production												
MDA	040525	Pesticide production												
MDA	040602	Paper pulp (Kraft process)												
MDA	04060x	Paper and pulp industry												
MDA	040611	Road paving with asphalt												
MDA	040612	Cement industry	0.018				0.45				0.18			
MDA	040613	Glass industry												
MDA	040615	Battery manufacturing												
MDA	0406xx	Synthetic grid blasting												
MDA	050000	Extraction and distr. of fossil fuels												
MDA	060100	Paint use												
MDA	060201	Industrial degreasing												
MDA	060202	Dry cleaning												
MDA	0603&4	Other solvent use												
MDA	060406	Wood preservation												
MDA	0701-5	Road transport combustion	0.38	0.4	0.4	0.4					150	150	5	5
MDA	0706/7	Road transport non-combustion	0.0057	0.006	0.006	0.006								
MDA	0801co	Other transport combustion	0.00072	0.00072	0.00072	0.00072								
MDA	0801nc	Other transport non-combustion												
MDA	090200	Waste incineration	0.0038	0.0032	0.0032	0.0032	0.058	0.048	0.048	0.048	0.19	0.16	0.16	0.16
MDA	090400	Landfill												
MDA	090900	Cremation					0.022	0.022	0.022	0.022				
MDA	100600	Pesticide use												
MDA	110000	Nature												
MDA	eel	Electrical equipment												

Projected emission of Cd, Hg and Pb per country (ISO-a3) in 1990, in 2010 without autonomous emission reduction, in 2010 after autonomous developments and in 2010 after autonomous developments and implementation of Protocol

ISO3	SNAP	description	Cd 1990	Cd 2010	Cd + autonom. dev.	Cd + Prot.	Hg 1990	Hg 2010	Hg + autonom. dev.	Hg + Prot.	Pb 1990	Pb 2010	Pb + autonom. dev.	Pb + Prot.
		Total	9.1	0.97	0.5	0.46	1.5	0.53	0.53	0.53	210	200	7.4	7.4
MKD	01bc	Public power etc. brown coal	0.65	0.53	0.064	0.026	0.39	0.32	0.32	0.32	1.3	1.1	1.1	1.1
MKD	01fo	Public power etc. fuel oils	0.017	0.0066	0.0066	0.0066					0.056	0.022	0.022	0.022
MKD	01hc	Public power etc. hard coal												
MKD	01of	Public power etc. other fuels												
MKD	02bc	Commercial etc. brown coal	0.0014	0.00026	0.00026	0.00026	0.0021	0.00039	0.00039	0.00039	0.0084	0.0016	0.0016	0.0016
MKD	02fo	Commercial etc. fuel oils	0.0094	0.0068	0.0068	0.0068					0.035	0.025	0.025	0.025
MKD	02hc	Commercial etc. hard coal												
MKD	02of	Commercial etc. other fuels												
MKD	03bc	Industrial combustion brown coal	0.014	0.0055	0.0011	0.00028	0.0085	0.0033	0.0033	0.0033	0.028	0.011	0.011	0.011
MKD	03fo	Industrial combustion fuel oils	0.089	0.085	0.085	0.085					0.3	0.29	0.29	0.29
MKD	03hc	Industrial combustion hard coal	0.0098	0.0032	0.00053	0.000064	0.022	0.007	0.007	0.007	0.49	0.16	0.16	0.16
MKD	03of	Industrial combustion other fuels												
MKD	040100	Petroleum industries												
MKD	040201	Coke production												
MKD	040202	Blast furnace												
MKD	040203	Pig iron												
MKD	040205	Open hearth furnace												
MKD	040206	Basic oxigen furnace												
MKD	040207	Electric arc furnace												
MKD	040208	Rolling												
MKD	040209	Sinter plants												
MKD	0402xx	Foundries												
MKD	040301	Al industry												
MKD	0403cu	Cu industry												
MKD	0403ni	Ni industry												
MKD	0403ot	Other non-ferrous metals												
MKD	0403pb	Pb industry	0.1				0.052				8.7			
MKD	0403zn	Zn industry	7.9				0.79				20			
MKD	040407	NPK fertilisers												
MKD	040413	Chloro-alkali industry												
MKD	040524	Halogenated HC production												
MKD	040525	Pesticide production												
MKD	040602	Paper pulp (Kraft process)												
MKD	04060x	Paper and pulp industry												
MKD	040611	Road paving with asphalt												
MKD	040612	Cement industry	0.0061	0.0055	0.0055	0.0055	0.15	0.14	0.14	0.14	0.061	0.055	0.055	0.055
MKD	040613	Glass industry												
MKD	040615	Battery manufacturing												
MKD	0406xx	Synthetic grid blasting												
MKD	050000	Extraction and distr. of fossil fuels												
MKD	060100	Paint use												
MKD	060201	Industrial degreasing												
MKD	060202	Dry cleaning												
MKD	0603&4	Other solvent use												
MKD	060406	Wood preservation												
MKD	0701-5	Road transport combustion	0.29	0.32	0.32	0.32					180	200	5.5	5.5
MKD	0706/7	Road transport non-combustion	0.005	0.0055	0.0055	0.0055								
MKD	0801co	Other transport combustion	0.0004	0.00042	0.00042	0.00042					0.14	0.15	0.15	0.15
MKD	0801nc	Other transport non-combustion												
MKD	090200	Waste incineration	0.0042	0.0038	0.0038	0.0038	0.062	0.057	0.057	0.057	0.21	0.19	0.19	0.19
MKD	090400	Landfill												
MKD	090900	Cremation					0.01	0.01	0.01	0.01				
MKD	100600	Pesticide use												
MKD	110000	Nature												
MKD	eel	Electrical equipment												

Projected emission of Cd, Hg and Pb per country (ISO-a3) in 1990, in 2010 without autonomous emission reduction, in 2010 after autonomous developments and in 2010 after autonomous developments and implementation of Protocol

ISO3	SNAP	description	Cd 1990	Cd 2010	Cd + autonom. dev.	Cd + Prot.	Hg 1990	Hg 2010	Hg + autonom. dev.	Hg + Prot.	Pb 1990	Pb 2010	Pb + autonom. dev.	Pb + Prot.
		Total	92	98	70	69	33	31	25	23	1400	1500	750	730
POL	01bc	Public power etc. brown coal	1.8	1.8	0.39	0.33	4.2	4.2	4	4	3.3	3.3	3.3	3.3
POL	01fo	Public power etc. fuel oils	0.019	0.028	0.028	0.028					0.056	0.084	0.084	0.084
POL	01hc	Public power etc. hard coal	1.3	1.4	0.16	0.11	11	12	12	12	59	65	65	65
POL	01of	Public power etc. other fuels												
POL	02bc	Commercial etc. brown coal	0.2				0.017				0.45			
POL	02fo	Commercial etc. fuel oils	1.6	8.6	8.6	8.6					2.4	13	13	13
POL	02hc	Commercial etc. hard coal	51	52	52	52	4.3	4.4	4.4	4.4	330	340	340	340
POL	02of	Commercial etc. other fuels	1.5	1.5	1.5	1.5	0.21	0.21	0.21	0.21	3.4	3.4	3.4	3.4
POL	03bc	Industrial combustion brown coal	0.11				0.014				0.07			
POL	03fo	Industrial combustion fuel oils	5.5	11	0.5	0.5					6.2	12	0.85	0.85
POL	03hc	Industrial combustion hard coal	24	16	1.2	0.015	12	8.1	2.6	1.6	350	230	62	48
POL	03of	Industrial combustion other fuels												
POL	040100	Petroleum industries												
POL	040201	Coke production	0.68	0.68	0.68	0.68	0.41	0.41	0.41	0.41	3	3	3	3
POL	040202	Blast furnace									48	48	48	48
POL	040203	Pig iron									38	38	38	38
POL	040205	Open hearth furnace	0.79								56			
POL	040206	Basic oxigen furnace	0.18	0.18	0.18	0.18	0.022	0.022	0.022	0.022	0.72	0.72	0.72	0.72
POL	040207	Electric arc furnace	0.61	0.61	0.61	0.61	0.37	0.37	0.37	0.37	14	14	14	14
POL	040208	Rolling												
POL	040209	Sinter plants												
POL	0402xx	Foundries												
POL	040301	Al industry												
POL	0403cu	Cu industry												
POL	0403ni	Ni industry												
POL	0403ot	Other non-ferrous metals									0.024	0.024	0.024	0.024
POL	0403pb	Pb industry												
POL	0403zn	Zn industry												
POL	040407	NPK fertilisers	0.43	0.49	0.49	0.49								
POL	040413	Chloro-alkali industry					1	1.2	1.2	0.61				
POL	040524	Halogenated HC production												
POL	040525	Pesticide production												
POL	040602	Paper pulp (Kraft process)												
POL	04060x	Paper and pulp industry												
POL	040611	Road paving with asphalt												
POL	040612	Cement industry												
POL	040613	Glass industry												
POL	040615	Battery manufacturing									0.2	0.24	0.24	0.24
POL	0406xx	Synthetic grid blasting												
POL	050000	Extraction and distr. of fossil fuels												
POL	060100	Paint use												
POL	060201	Industrial degreasing												
POL	060202	Dry cleaning												
POL	0603&4	Other solvent use												
POL	060406	Wood preservation												
POL	0701-5	Road transport combustion	1.9	3	3	3					450	720	150	150
POL	0706/7	Road transport non-combustion	0.038	0.061	0.061	0.061								
POL	0801co	Other transport combustion	0.13	0.11	0.11	0.11					14	12	12	12
POL	0801nc	Other transport non-combustion												
POL	090200	Waste incineration												
POL	090400	Landfill												
POL	090900	Cremation												
POL	100600	Pesticide use												
POL	110000	Nature												
POL	eel	Electrical equipment												

Projected emission of Cd, Hg and Pb per country (ISO-a3) in 1990, in 2010 without autonomous emission reduction, in 2010 after autonomous developments and in 2010 after autonomous developments and implementation of Protocol

ISO3	SNAP	description	Cd 1990	Cd 2010	Cd + autonom. dev.	Cd + Prot.	Hg 1990	Hg 2010	Hg + autonom. dev.	Hg + Prot.	Pb 1990	Pb 2010	Pb + autonom. dev.	Pb + Prot.
		Total	22	21	19	9.3	7.5	6.4	5.6	5.5	580	560	440	340
ROM	01bc	Public power etc. brown coal	0.067	0.06	0.06	0.06	2.8	2.5	2	1.9	0.7	0.63	0.63	0.63
ROM	01fo	Public power etc. fuel oils	2.9	1.5	0.33	0.33					3.7	2	2	2
ROM	01hc	Public power etc. hard coal	0.082	0.041	0.0032	0.00013	0.63	0.32	0.037	0.014	7.1	3.5	0.86	0.65
ROM	01of	Public power etc. other fuels					0.01	0.01	0.01	0.01				
ROM	02bc	Commercial etc. brown coal	0.016	0.0096	0.0096	0.0096	0.69	0.41	0.41	0.41	0.17	0.1	0.1	0.1
ROM	02fo	Commercial etc. fuel oils	1.7	3.1	3.1	3.1					2.2	4	4	4
ROM	02hc	Commercial etc. hard coal	0.003	0.0014	0.0014	0.0014	0.02	0.0096	0.0096	0.0096	0.23	0.11	0.11	0.11
ROM	02of	Commercial etc. other fuels					0.027	0.027	0.027	0.027				
ROM	03bc	Industrial combustion brown coal	0.006	0.00067	0.00019	0.0001	0.24	0.027	0.005	0.0012	0.06	0.0067	0.0067	0.0067
ROM	03fo	Industrial combustion fuel oils	0.33	0.3	0.22	0.22					0.43	0.38	0.38	0.38
ROM	03hc	Industrial combustion hard coal	0.003	0.0033	0.0018	0.0016	0.026	0.028	0.028	0.028	0.29	0.32	0.32	0.32
ROM	03of	Industrial combustion other fuels												
ROM	040100	Petroleum industries												
ROM	040201	Coke production												
ROM	040202	Blast furnace												
ROM	040203	Pig iron	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.095	0.095	0.095	0.095
ROM	040205	Open hearth furnace	0.42								31			
ROM	040206	Basic oxigen furnace	0.13	0.13	0.13	0.13	0.016	0.016	0.016	0.016	7.9	7.9	7.9	7.9
ROM	040207	Electric arc furnace	0.6	0.6	0.6	0.6	0.36	0.36	0.36	0.35	33	33	33	27
ROM	040208	Rolling												
ROM	040209	Sinter plants	0.12	0.12	0.12	0.12	0.04	0.04	0.04	0.04	15	15	15	15
ROM	0402xx	Foundries	0.89	0.89	0.89	0.89					46	46	46	46
ROM	040301	Al industry	0.027	0.026	0.026	0.026								
ROM	0403cu	Cu industry	10	9.5	9.5	0.07					73	69	69	2.5
ROM	0403ni	Ni industry												
ROM	0403ot	Other non-ferrous metals												
ROM	0403pb	Pb industry	0.24	0.23	0.23	0.025	0.038	0.036	0.036	0.036	29	28	28	10
ROM	0403zn	Zn industry	2.3	2.2	2.2	2.2	0.23	0.22	0.22	0.22	5.7	5.4	5.4	5.4
ROM	040407	NPK fertilisers												
ROM	040413	Chloro-alkali industry												
ROM	040524	Halogenated HC production												
ROM	040525	Pesticide production												
ROM	040602	Paper pulp (Kraft process)												
ROM	04060x	Paper and pulp industry												
ROM	040611	Road paving with asphalt												
ROM	040612	Cement industry	0.011	0.011	0.011	0.011	0.39	0.39	0.39	0.39	0.31	0.31	0.31	0.31
ROM	040613	Glass industry	0.2	0.2	0.2	0.2	0.1	0.11	0.11	0.11	57	59	59	59
ROM	040615	Battery manufacturing												
ROM	0406xx	Synthetic grid blasting												
ROM	04oth	Non-spec. production processes	1.2	1.2	1.2	1.2	1.3	1.3	1.3	1.3	1.2	1.2	1.2	1.2
ROM	050000	Extraction and distr. of fossil fuels												
ROM	060100	Paint use												
ROM	060201	Industrial degreasing												
ROM	060202	Dry cleaning												
ROM	0603&4	Other solvent use												
ROM	060406	Wood preservation												
ROM	0701-5	Road transport combustion	0.014	0.017	0.017	0.017					130	160	32	32
ROM	0706/7	Road transport non-combustion												
ROM	0801co	Other transport combustion	0.022	0.021	0.021	0.021					140	130	130	130
ROM	0801nc	Other transport non-combustion												
ROM	090200	Waste incineration	0.34	0.36	0.36	0.046	0.6	0.62	0.62	0.62	1.4	1.4	1.4	1.4
ROM	090400	Landfill												
ROM	090900	Cremation												
ROM	100600	Pesticide use												
ROM	110000	Nature												
ROM	eel	Electrical equipment												

Projected emission of Cd, Hg and Pb per country (ISO-a3) in 1990, in 2010 without autonomous emission reduction, in 2010 after autonomous developments and in 2010 after autonomous developments and implementation of Protocol

ISO3	SNAP	description	Cd 1990	Cd 2010	Cd + autonom. dev.	Cd + Prot.	Hg 1990	Hg 2010	Hg + autonom. dev.	Hg + Prot.	Pb 1990	Pb 2010	Pb + autonom. dev.	Pb + Prot.
		Total	160	110	90	81	86	60	60	60	10000	8700	2500	2500
RUS	01bc	Public power etc. brown coal	13	6.6	0.8	0.33	7.9	4	4	4	26	13	13	13
RUS	01fo	Public power etc. fuel oils	19	9.4	9.4	9.4					62	31	31	31
RUS	01hc	Public power etc. hard coal	11	7	0.66	0.14	23	15	15	15	530	350	350	350
RUS	01of	Public power etc. other fuels	0.046	0.046	0.046	0.046	0.028	0.028	0.028	0.028	0.092	0.092	0.092	0.092
RUS	02bc	Commercial etc. brown coal												
RUS	02fo	Commercial etc. fuel oils	3.5	3.9	3.9	3.9					13	15	15	15
RUS	02hc	Commercial etc. hard coal	10	6.5	6.5	6.5	15	9.5	9.5	9.5	170	110	110	110
RUS	02of	Commercial etc. other fuels	0.035	0.035	0.035	0.035	0.053	0.053	0.053	0.053	0.21	0.21	0.21	0.21
RUS	03bc	Industrial combustion brown coal												
RUS	03fo	Industrial combustion fuel oils	9.2	5.2	5.2	5.2					31	18	18	18
RUS	03hc	Industrial combustion hard coal	4.5	3.3	0.55	0.066	10	7.2	7.2	7.2	45	33	33	33
RUS	03of	Industrial combustion other fuels	0.013	0.013	0.013	0.013	0.0076	0.0076	0.0076	0.0076	0.025	0.025	0.025	0.025
RUS	040100	Petroleum industries												
RUS	040201	Coke production	1.9	1.5	1.5	1.5	1.2	0.92	0.92	0.92	8.4	6.8	6.8	6.8
RUS	040202	Blast furnace	1.2	0.95	0.95	0.95	1.2	0.95	0.95	0.95	300	240	240	240
RUS	040203	Pig iron												
RUS	040205	Open hearth furnace	13								350			
RUS	040206	Basic oxigen furnace	0.61	0.48	0.48	0.48	0.073	0.058	0.058	0.058	36	29	29	29
RUS	040207	Electric arc furnace	8.6	6.9	6.9	6.9	1.9	1.5	1.5	1.5	140	110	110	110
RUS	040208	Rolling												
RUS	040209	Sinter plants	7				1.4				420			
RUS	0402xx	Foundries												
RUS	040301	Al industry	0.26	0.24	0.24	0.24								
RUS	0403cu	Cu industry	10	9.3	9.3	1.8	0.049	0.044	0.044	0.044	63	56	56	56
RUS	0403ni	Ni industry												
RUS	0403ot	Other non-ferrous metals												
RUS	0403pb	Pb industry												
RUS	0403zn	Zn industry	23	21	21	21	2.3	2.1	2.1	2.1	58	52	52	52
RUS	040407	NPK fertilisers												
RUS	040413	Chloro-alkali industry												
RUS	040524	Halogenated HC production												
RUS	040525	Pesticide production												
RUS	040602	Paper pulp (Kraft process)												
RUS	04060x	Paper and pulp industry												
RUS	040611	Road paving with asphalt												
RUS	040612	Cement industry	0.77	0.62	0.62	0.62	19	15	15	15	7.7	6.2	6.2	6.2
RUS	040613	Glass industry												
RUS	040615	Battery manufacturing												
RUS	0406xx	Synthetic grid blasting												
RUS	050000	Extraction and distr. of fossil fuels												
RUS	060100	Paint use												
RUS	060201	Industrial degreasing												
RUS	060202	Dry cleaning												
RUS	0603&4	Other solvent use												
RUS	060406	Wood preservation												
RUS	0701-5	Road transport combustion	20	19	19	19					7700	7400	1200	1200
RUS	0706/7	Road transport non-combustion	0.3	0.29	0.29	0.29								
RUS	0801co	Other transport combustion	2.9	2.5	2.5	2.5	0.095	0.079	0.079	0.079	230	190	190	190
RUS	0801nc	Other transport non-combustion												
RUS	090200	Waste incineration	0.13	0.12	0.12	0.12	2	1.8	1.8	1.8	6.5	5.9	5.9	5.9
RUS	090400	Landfill												
RUS	090900	Cremation					0.73	0.73	0.73	0.73				
RUS	100600	Pesticide use												
RUS	110000	Nature												
RUS	eel	Electrical equipment												

Projected emission of Cd, Hg and Pb per country (ISO-a3) in 1990, in 2010 without autonomous emission reduction, in 2010 after autonomous developments and in 2010 after autonomous developments and Implementation of Protocol

ISO3	SNAP	description	Cd 1990	Cd 2010	Cd + autonom. dev.	Cd + Prot.	Hg 1990	Hg 2010	Hg + autonom. dev.	Hg + Prot.	Pb 1990	Pb 2010	Pb + autonom. dev.	Pb + Prot.
		Total	9.7	10	9.4	9.2	12	12	8.6	4.2	170	210	83	80
SVK	01bc	Public power etc. brown coal	0.11	0.03	0.0074	0.0065	0.16	0.045	0.045	0.045	2.9	0.81	0.81	0.81
SVK	01fo	Public power etc. fuel oils	0.014	0.0011	0.0011	0.0011	0.057	0.0046	0.0046	0.0046	0.17	0.014	0.014	0.014
SVK	01hc	Public power etc. hard coal	0.067	0.034	0.0037	0.0026	0.11	0.053	0.053	0.053	1.7	0.87	0.87	0.87
SVK	01of	Public power etc. other fuels	0.071	0.071	0.071	0.071	0.005	0.005	0.005	0.005	1.7	1.7	1.7	1.7
SVK	02bc	Commercial etc. brown coal	0.17	0.079	0.079	0.079	0.2	0.092	0.092	0.092	4.7	2.2	2.2	2.2
SVK	02fo	Commercial etc. fuel oils					0.003	0.0063	0.0063	0.0063	0.009	0.019	0.019	0.019
SVK	02hc	Commercial etc. hard coal	0.007	0.0067	0.0067	0.0067	0.011	0.01	0.01	0.01	0.18	0.17	0.17	0.17
SVK	02of	Commercial etc. other fuels	0.005	0.005	0.005	0.005					0.019	0.019	0.019	0.019
SVK	03bc	Industrial combustion brown coal	0.11	0.49	0.091	0.058	0.12	0.55	0.55	0.55	2.8	13	1.4	0.5
SVK	03fo	Industrial combustion fuel oils	0.041	0.027	0.027	0.027	0.17	0.11	0.11	0.11	0.5	0.33	0.27	0.27
SVK	03hc	Industrial combustion hard coal	0.044	0.043	0.0088	0.006	0.07	0.069	0.069	0.069	1.1	1.1	1.1	1.1
SVK	03of	Industrial combustion other fuels	0.003	0.003	0.003	0.003					0.012	0.012	0.012	0.012
SVK	040201	Coke production												
SVK	040202	Blast furnace												
SVK	040203	Pig iron	0.19	0.19	0.19	0.19	0.47	0.47	0.47	0.47	0.14	0.14	0.14	0.14
SVK	040205	Open hearth furnace												
SVK	040206	Basic oxigen furnace	0.014	0.014	0.014	0.014	0.021	0.021	0.021	0.013	1.4	1.4	1.4	1.4
SVK	040207	Electric arc furnace	0.007	0.007	0.007	0.007					0.35	0.35	0.35	0.35
SVK	040208	Rolling	0.006	0.006	0.006	0.006					0.23	0.23	0.23	0.23
SVK	040209	Sinter plants	0.021	0.021	0.021	0.021	3.3	3.3	0.093	0.093	39	39	28	28
SVK	0402xx	Foundries												
SVK	040301	Al industry	0.007	0.007	0.007	0.007	0.14	0.14	0.14	0.14				
SVK	0403cu	Cu industry	0.37	0.37	0.2	0.025	4.3	4.3	4.3	0.00082	5.2	5.2	3	0.82
SVK	0403ni	Ni industry												
SVK	0403ot	Other non-ferrous metals					0.002	0.002	0.002	0.002	0.11	0.11	0.11	0.11
SVK	0403pb	Pb industry					0.84	0.84	0.84	0.84				
SVK	0403zn	Zn industry												
SVK	040407	NPK fertilisers												
SVK	040413	Chloro-alkali industry					0.3	0.3	0.13	0.13				
SVK	040524	Halogenated HC production												
SVK	040525	Pesticide production												
SVK	040602	Paper pulp (Kraft process)												
SVK	04060x	Paper and pulp industry												
SVK	040611	Road paving with asphalt												
SVK	040612	Cement industry	0.033	0.033	0.033	0.033	1.4	1.4	0.84	0.84	6.6	6.6	0.34	0.34
SVK	040613	Glass industry	7	7	7	7	0.012	0.012	0.012	0.012	10	10	10	10
SVK	040615	Battery manufacturing												
SVK	0406xx	Synthetic grid blasting												
SVK	050000	Extraction and distr. of fossil fuels												
SVK	060100	Paint use												
SVK	060201	Industrial degreasing												
SVK	060202	Dry cleaning												
SVK	0603&4	Other solvent use												
SVK	060406	Wood preservation												
SVK	0701-5	Road transport combustion	0.48	0.71	0.71	0.71					75	110	18	18
SVK	0706/7	Road transport non-combustion	0.018	0.027	0.027	0.027								
SVK	0801co	Other transport combustion												
SVK	0801nc	Other transport non-combustion												
SVK	090200	Waste incineration	0.86	0.85	0.85	0.85	0.76	0.75	0.75	0.75	12	12	12	12
SVK	090400	Landfill												
SVK	090900	Cremation					0.003	0.003	0.003	0.003				
SVK	100600	Pesticide use												
SVK	110000	Nature												
SVK	eel	Electrical equipment												

Projected emission of Cd, Hg and Pb per country (ISO-a3) in 1990, in 2010 without autonomous emission reduction, in 2010 after autonomous developments and in 2010 after autonomous developments and implementation of Protocol

ISO3	SNAP	description	Cd 1990	Cd 2010	Cd + autonom. dev.	Cd + Prot.	Hg 1990	Hg 2010	Hg + autonom. dev.	Hg + Prot.	Pb 1990	Pb 2010	Pb + autonom. dev.	Pb + Prot.
		Total	1	0.81	0.41	0.4	0.87	0.74	0.74	0.74	120	140	13	13
SVN	01bc	Public power etc. brown coal	0.47	0.41	0.021	0.021	0.28	0.25	0.25	0.25	0.95	0.83	0.83	0.83
SVN	01fo	Public power etc. fuel oils												
SVN	01hc	Public power etc. hard coal												
SVN	01of	Public power etc. other fuels												
SVN	02bc	Commercial etc. brown coal	0.0061	0.00096	0.00096	0.00096	0.0091	0.0014	0.0014	0.0014	0.036	0.0058	0.0058	0.0058
SVN	02fo	Commercial etc. fuel oils												
SVN	02hc	Commercial etc. hard coal												
SVN	02of	Commercial etc. other fuels												
SVN	03bc	Industrial combustion brown coal	0.0046	0.00075	0.000038	0.000038	0.0028	0.00045	0.00045	0.00045	0.0092	0.0015	0.0015	0.0015
SVN	03fo	Industrial combustion fuel oils	0.069	0.074	0.074	0.074					0.23	0.25	0.23	0.23
SVN	03hc	Industrial combustion hard coal	0.0016	0.0011	0.000021	0.000021	0.0035	0.0023	0.0023	0.0023	0.0016	0.0011	0.0011	0.0011
SVN	03of	Industrial combustion other fuels												
SVN	040100	Petroleum industries												
SVN	040201	Coke production												
SVN	040202	Blast furnace												
SVN	040203	Pig iron												
SVN	040205	Open hearth furnace												
SVN	040206	Basic oxigen furnace												
SVN	040207	Electric arc furnace	0.19				0.041				3.1			
SVN	040208	Rolling												
SVN	040209	Sinter plants												
SVN	0402xx	Foundries												
SVN	040301	Al industry	0.011	0.01	0.01	0.01								
SVN	0403cu	Cu industry												
SVN	0403ni	Ni industry												
SVN	0403ot	Other non-ferrous metals												
SVN	0403pb	Pb industry	0.068	0.061	0.061	0.041	0.013	0.012	0.012	0.012	4.3	3.8	3.8	3.8
SVN	0403zn	Zn industry												
SVN	040407	NPK fertilisers												
SVN	040413	Chloro-alkali industry												
SVN	040524	Halogenated HC production												
SVN	040525	Pesticide production												
SVN	040602	Paper pulp (Kraft process)												
SVN	04060x	Paper and pulp industry												
SVN	040611	Road paving with asphalt												
SVN	040612	Cement industry	0.018	0.016	0.016	0.016	0.45	0.41	0.41	0.41	0.18	0.16	0.16	0.16
SVN	040613	Glass industry												
SVN	040615	Battery manufacturing												
SVN	0406xx	Synthetic grid blasting												
SVN	050000	Extraction and distr. of fossil fuels												
SVN	060100	Paint use												
SVN	060201	Industrial degreasing												
SVN	060202	Dry cleaning												
SVN	0603&4	Other solvent use												
SVN	060406	Wood preservation												
SVN	0701-5	Road transport combustion	0.19	0.22	0.22	0.22					110	140	8.2	8.2
SVN	0706/7	Road transport non-combustion	0.0043	0.0052	0.0052	0.0052								
SVN	0801co	Other transport combustion	0.00052	0.00039	0.00039	0.00039								
SVN	0801nc	Other transport non-combustion												
SVN	090200	Waste incineration	0.0038	0.0038	0.0038	0.0038	0.057	0.057	0.057	0.057	0.19	0.19	0.19	0.19
SVN	090400	Landfill												
SVN	090900	Cremation					0.009	0.009	0.009	0.009				
SVN	100600	Pesticide use												
SVN	110000	Nature												
SVN	eel	Electrical equipment												

Projected emission of Cd, Hg and Pb per country (ISO-a3) in 1990, in 2010 without autonomous emission reduction, in 2010 after autonomous developments and in 2010 after autonomous developments and implementation of Protocol

ISO3	SNAP	description	Cd 1990	Cd 2010	Cd + autonom. dev.	Cd + Prot.	Hg 1990	Hg 2010	Hg + autonom. dev.	Hg + Prot.	Pb 1990	Pb 2010	Pb + autonom. dev.	Pb + Prot.
		Total	54	34	30	29	36	24	24	24	3900	3400	930	930
UKR	01bc	Public power etc. brown coal	0.16	0.17	0.021	0.0085	0.094	0.1	0.1	0.1	0.31	0.34	0.32	0.31
UKR	01fo	Public power etc. fuel oils	4	1.1	1.1	1.1					13	3.7	3.7	3.7
UKR	01hc	Public power etc. hard coal	4.5	2.7	0.25	0.053	9.9	5.9	5.9	5.9	220	130	130	130
UKR	01of	Public power etc. other fuels	0.016	0.016	0.016	0.016	0.0098	0.0098	0.0098	0.0098	0.033	0.033	0.033	0.033
UKR	02bc	Commercial etc. brown coal	0.25	0.14	0.14	0.14	0.37	0.21	0.21	0.21	1.5	0.83	0.83	0.83
UKR	02fo	Commercial etc. fuel oils	1.9	1.4	1.4	1.4					6.8	4.8	4.8	4.8
UKR	02hc	Commercial etc. hard coal	4.8	2.9	2.9	2.9	7	4.3	4.3	4.3	80	49	49	49
UKR	02of	Commercial etc. other fuels	0.14	0.14	0.14	0.14	0.21	0.21	0.21	0.21	0.83	0.83	0.83	0.83
UKR	03bc	Industrial combustion brown coal	0.014	0.014	0.0026	0.00068	0.0082	0.0082	0.0082	0.0082	0.027	0.027	0.027	0.027
UKR	03fo	Industrial combustion fuel oils	1.6	0.87	0.87	0.87					5.6	3	3	3
UKR	03hc	Industrial combustion hard coal	3.7	2.4	0.4	0.047	8.1	5.2	5.2	5.2	28	18	18	18
UKR	03of	Industrial combustion other fuels	0.14	0.14	0.14	0.14	0.086	0.086	0.086	0.086	0.29	0.29	0.29	0.29
UKR	040100	Petroleum industries												
UKR	040201	Coke production	1.9	1.5	1.5	1.5	1.1	0.92	0.92	0.92	8.4	6.7	6.7	6.7
UKR	040202	Blast furnace	0.69	0.55	0.55	0.55	0.69	0.55	0.55	0.55	170	140	140	140
UKR	040203	Pig iron												
UKR	040205	Open hearth furnace	8								220			
UKR	040206	Basic oxigen furnace	0.45	0.36	0.36	0.36	0.054	0.043	0.043	0.043	27	22	22	22
UKR	040207	Electric arc furnace	2.3	1.8	1.8	1.8	0.5	0.4	0.4	0.4	38	30	30	30
UKR	040208	Rolling												
UKR	040209	Sinter plants	6.4	5.1	5.1	5.1	1.3	1	1	1	380	310	310	310
UKR	0402xx	Foundries												
UKR	040301	Al industry	0.0068											
UKR	0403cu	Cu industry												
UKR	0403ni	Ni industry												
UKR	0403ot	Other non-ferrous metals												
UKR	0403pb	Pb industry	0.1				0.051				8.5			
UKR	0403zn	Zn industry	0.062								0.062			
UKR	040407	NPK fertilisers												
UKR	040413	Chloro-alkali industry												
UKR	040524	Halogenated HC production												
UKR	040525	Pesticide production												
UKR	040602	Paper pulp (Kraft process)												
UKR	04060x	Paper and pulp industry												
UKR	040611	Road paving with asphalt												
UKR	040612	Cement industry	0.22	0.17	0.17	0.17	5.4	4.3	4.3	4.3	2.2	1.7	1.7	1.7
UKR	040613	Glass industry												
UKR	040615	Battery manufacturing												
UKR	0406xx	Synthetic grid blasting												
UKR	050000	Extraction and distr. of fossil fuels												
UKR	060100	Paint use												
UKR	060201	Industrial degreasing												
UKR	060202	Dry cleaning												
UKR	0603&4	Other solvent use												
UKR	060406	Wood preservation												
UKR	0701-5	Road transport combustion	6.5	6.5	6.5	6.5					2500	2500	82	82
UKR	0706/7	Road transport non-combustion	0.098	0.098	0.098	0.098								
UKR	0801co	Other transport combustion	6.2	6	6	6	0.031	0.03	0.03	0.03	130	130	130	130
UKR	0801nc	Other transport non-combustion												
UKR	090200	Waste incineration	0.046	0.039	0.039	0.039	0.68	0.59	0.59	0.59	2.3	2	2	2
UKR	090400	Landfill												
UKR	090900	Cremation					0.26	0.26	0.26	0.26				
UKR	100600	Pesticide use												
UKR	110000	Nature												
UKR	eel	Electrical equipment												

Projected emission of Cd, Hg and Pb per country (ISO-a3) in 1990, in 2010 without autonomous emission reduction, in 2010 after autonomous developments and in 2010 after autonomous developments and implementation of Protocol

ISO3	SNAP	description	Cd 1990	Cd 2010	Cd + autonom. dev.	Cd + Prot.	Hg 1990	Hg 2010	Hg + autonom. dev.	Hg + Prot.	Pb 1990	Pb 2010	Pb + autonom. dev.	Pb + Prot.
		Total	8.3	6.4	3.9	1.9	3.9	2.7	2.7	2.7	600	610	62	62
YUG	01bc	Public power etc. brown coal	3.4	2.9	0.35	0.14	2.1	1.7	1.7	1.7	6.8	5.7	5.7	5.7
YUG	01fo	Public power etc. fuel oils	0.12	0.058	0.058	0.058					0.41	0.19	0.19	0.19
YUG	01hc	Public power etc. hard coal	0.0032				0.007				0.16			
YUG	01of	Public power etc. other fuels												
YUG	02bc	Commercial etc. brown coal	0.26	0.071	0.071	0.071	0.39	0.11	0.11	0.11	1.6	0.43	0.43	0.43
YUG	02fo	Commercial etc. fuel oils	0.06	0.048	0.048	0.048					0.2	0.16	0.16	0.16
YUG	02hc	Commercial etc. hard coal	0.16				0.24				2.7			
YUG	02of	Commercial etc. other fuels												
YUG	03bc	Industrial combustion brown coal	0.039	0.021	0.004	0.001	0.023	0.012	0.012	0.012	0.077	0.041	0.041	0.041
YUG	03fo	Industrial combustion fuel oils	0.17	0.14	0.14	0.14					0.58	0.48	0.48	0.48
YUG	03hc	Industrial combustion hard coal												
YUG	03of	Industrial combustion other fuels												
YUG	040100	Petroleum industries												
YUG	040201	Coke production												
YUG	040202	Blast furnace	0.041				0.041				10			
YUG	040203	Pig iron												
YUG	040205	Open hearth furnace												
YUG	040206	Basic oxigen furnace	0.023				0.0027				1.4			
YUG	040207	Electric arc furnace	0.37				0.079				6			
YUG	040208	Rolling												
YUG	040209	Sinter plants	0.3				0.059				18			
YUG	0402xx	Foundries												
YUG	040301	Al industry	0.018	0.016	0.016	0.016								
YUG	0403cu	Cu industry	2.1	1.9	1.9	0.29	0.011	0.0095	0.0095	0.0095	11	9.5	9.5	9.5
YUG	0403ni	Ni industry												
YUG	0403ot	Other non-ferrous metals												
YUG	0403pb	Pb industry	0.26	0.23	0.23	0.07	0.11	0.098	0.098	0.098	20	18	18	18
YUG	0403zn	Zn industry	0.054	0.049	0.049	0.049					0.054	0.049	0.049	0.049
YUG	040407	NPK fertilisers												
YUG	040525	Pesticide production												
YUG	040602	Paper pulp (Kraft process)												
YUG	04060x	Paper and pulp industry												
YUG	040612	Cement industry	0.02	0.018	0.018	0.018	0.51	0.46	0.46	0.46	0.2	0.18	0.18	0.18
YUG	0701-5	Road transport combustion	0.83	0.93	0.93	0.93					520	580	26	26
YUG	0706/7	Road transport non-combustion	0.017	0.019	0.019	0.019								
YUG	0801co	Other transport combustion	0.001	0.001	0.001	0.001								
YUG	0801nc	Other transport non-combustion												
YUG	090200	Waste incineration	0.019	0.019	0.019	0.019	0.29	0.29	0.29	0.29	0.97	0.97	0.97	0.97
YUG	090900	Cremation					0.049	0.049	0.049	0.049				
YUG	100600	Pesticide use												

Projected emission of Cd, Hg and Pb per country (ISO-a3) in 1990, in 2010 without autonomous emission reduction, in 2010 after autonomous developments and in 2010 after autonomous developments and implementation of Protocol

iso3	SNAP	description	Cd 1990	Cd 2010	Cd + autonom. dev.	Cd + Prot.	Hg 1990	Hg 2010	Hg + autonom. dev.	Hg + Prot.	Pb 1990	Pb 2010	Pb + autonom. dev.	Pb + Prot.
		Total	37	41	39	39	20	23	22	21	4700	5000	3800	3700
ESP	01bc	Public power etc. brown coal	0.084	0.056	0.056	0.056	1.3	0.84	0.84	0.84	0.84	0.56	0.56	0.56
ESP	01fo	Public power etc. fuel oils	0.37	0.57	0.57	0.57	0.11	0.17	0.17	0.17	0.81	1.2	1.2	1.2
ESP	01hc	Public power etc. hard coal	0.67	0.97	0.97	0.97	4	5.8	5.8	5.8	20	30	30	30
ESP	01of	Public power etc. other fuels												
ESP	02bc	Commercial etc. brown coal									0.001			
ESP	02fo	Commercial etc. fuel oils	0.37	0.43	0.43	0.43	0.11	0.13	0.13	0.13	0.81	0.95	0.95	0.95
ESP	02hc	Commercial etc. hard coal	0.24	0.22	0.22	0.22	0.43	0.4	0.4	0.4	3.9	3.7	3.7	3.7
ESP	02of	Commercial etc. other fuels	0.63	0.63	0.63	0.63	0.58	0.58	0.58	0.58	1.2	1.2	1.2	1.2
ESP	03bc	Industrial combustion brown coal	0.003				0.008				0.019			
ESP	03fo	Industrial combustion fuel oils	2	2.6	1.4	1.4	0.6	0.77	0.77	0.77	4.4	5.7	3.7	3.7
ESP	03hc	Industrial combustion hard coal	0.42	0.43	0.0088	0.0088	0.75	0.77	0.77	0.77	6.9	7.1	7.1	7.1
ESP	03of	Industrial combustion other fuels	5.7	5.7	5.7	5.7	6.9	6.9	6.9	6.9	150	150	150	150
ESP	040100	Petroleum industries												
ESP	040201	Coke production	0.21	0.2	0.2	0.2	0.12	0.12	0.12	0.12	0.9	0.86	0.86	0.86
ESP	040202	Blast furnace	0.16	0.15	0.15	0.15	0.16	0.15	0.15	0.15	41	39	39	39
ESP	040203	Pig iron												
ESP	040205	Open hearth furnace												
ESP	040206	Basic oxigen furnace	0.17	0.16	0.16	0.13	0.02	0.019	0.019	0.016	10	9.6	9.6	8.4
ESP	040207	Electric arc furnace	1.8	1.7	1.7	1.7	1.3	1.3	1.3	1.1	98	93	93	85
ESP	040208	Rolling												
ESP	040209	Sinter plants												
ESP	0402xx	Foundries												
ESP	040301	Al industry	0.036	0.034	0.034	0.034								
ESP	0403cu	Cu industry												
ESP	0403ni	Ni industry												
ESP	0403ot	Other non-ferrous metals												
ESP	0403pb	Pb industry									130	120	120	21
ESP	0403zn	Zn Industry												
ESP	040407	NPK fertilisers	0.57	0.45	0.45	0.45								
ESP	040413	Chloro-alkali industry					2	2.8	1	1				
ESP	040524	Halogenated HC production												
ESP	040525	Pesticide production												
ESP	040602	Paper pulp (Kraft process)												
ESP	04060x	Paper and pulp industry												
ESP	040611	Road paving with asphalt												
ESP	040612	Cement industry												
ESP	040613	Glass industry												
ESP	040615	Battery manufacturing	0.001	0.0014	0.0014	0.0014					0.29	0.41	0.41	0.41
ESP	0406xx	Synthetic grid blasting												
ESP	050000	Extraction and distr. of fossil fuels												
ESP	060100	Paint use												
ESP	060201	Industrial degreasing												
ESP	060202	Dry cleaning												
ESP	0603&4	Other solvent use	0.032	0.032	0.032	0.032					0.78	0.78	0.78	0.78
ESP	060406	Wood preservation												
ESP	0701-5	Road transport combustion	8.6	11	11	11					1300	1700	440	440
ESP	0706/7	Road transport non-combustion	2.1	2.7	2.7	2.7								
ESP	0801co	Other transport combustion	7.3	7.3	7.3	7.3					2900	2900	2900	2900
ESP	0801nc	Other transport non-combustion												
ESP	090200	Waste incineration	0.12	0.17	0.17	0.17	1.8	2.6	2.6	2.6	6.1	8.5	7.5	7.5
ESP	090400	Landfill												
ESP	090900	Cremation					0.001	0.001	0.001	0.001				
ESP	100600	Pesticide use	5.2	5.2	5.2	5.2								
ESP	110000	Nature												
ESP	eel	Electrical equipment												

Projected emission of Cd, Hg and Pb per country (ISO-a3) in 1990, in 2010 without autonomous emission reduction, in 2010 after autonomous developments and in 2010 after autonomous developments and implementation of Protocol

iso3	SNAP	description	Cd 1990	Cd 2010	Cd + autonom. dev.	Cd + Prot.	Hg 1990	Hg 2010	Hg + autonom. dev.	Hg + Prot.	Pb 1990	Pb 2010	Pb + autonom. dev.	Pb + Prot.
		Total	4.5	5.3	5.2	5.2	7.1	8.2	8.2	8.2	510	800	160	160
GRC	01bc	Public power etc. brown coal	0.51	0.74	0.74	0.74	3	4.4	4.4	4.4	5.1	7.4	7.4	7.4
GRC	01fo	Public power etc. fuel oils	0.44	0.21	0.21	0.21					1.5	0.71	0.71	0.71
GRC	01hc	Public power etc. hard coal												
GRC	01of	Public power etc. other fuels												
GRC	02bc	Commercial etc. brown coal	0.005	0.01	0.01	0.01	0.007	0.014	0.014	0.014	0.028	0.056	0.056	0.056
GRC	02fo	Commercial etc. fuel oils	0.14	0.32	0.32	0.32					0.53	1.3	1.3	1.3
GRC	02hc	Commercial etc. hard coal									0.005			
GRC	02of	Commercial etc. other fuels	0.065	0.065	0.065	0.065	0.16	0.16	0.16	0.16	0.39	0.39	0.39	0.39
GRC	03bc	Industrial combustion brown coal	0.002	0.0053	0.0029	0.0029	0.013	0.035	0.035	0.035	0.022	0.059	0.022	0.022
GRC	03fo	Industrial combustion fuel oils	0.32	0.4	0.4	0.4					1.1	1.3	1.1	1.1
GRC	03hc	Industrial combustion hard coal	0.071	0.06	0.0024	0.0024	0.31	0.27	0.26	0.26	2.8	2.4	2.4	2.4
GRC	03of	Industrial combustion other fuels												
GRC	040100	Petroleum industries												
GRC	040201	Coke production												
GRC	040202	Blast furnace												
GRC	040203	Pig iron												
GRC	040205	Open hearth furnace												
GRC	040206	Basic oxigen furnace												
GRC	040207	Electric arc furnace	0.7				0.15				11			
GRC	040208	Rolling												
GRC	040209	Sinter plants												
GRC	0402xx	Foundries												
GRC	040301	Al industry	0.022											
GRC	0403cu	Cu industry												
GRC	0403ni	Ni industry												
GRC	0403ot	Other non-ferrous metals												
GRC	0403pb	Pb industry												
GRC	0403zn	Zn Industry												
GRC	040407	NPK fertilisers												
GRC	040413	Chloro-alkali industry												
GRC	040524	Halogenated HC production												
GRC	040525	Pesticide production												
GRC	040602	Paper pulp (Kraft process)												
GRC	04060x	Paper and pulp industry												
GRC	040611	Road paving with asphalt												
GRC	040612	Cement industry	0.14	0.13	0.13	0.13	3.4	3.2	3.2	3.2	1.4	1.3	1.3	1.3
GRC	040613	Glass industry												
GRC	040615	Battery manufacturing												
GRC	0406xx	Synthetic grid blasting												
GRC	050000	Extraction and distr. of fossil fuels												
GRC	060100	Paint use												
GRC	060201	Industrial degreasing												
GRC	060202	Dry cleaning												
GRC	0603&4	Other solvent use												
GRC	060406	Wood preservation												
GRC	0701-5	Road transport combustion	2	3.2	3.2	3.2					470	770	140	140
GRC	0706/7	Road transport non-combustion	0.014	0.023	0.023	0.023								
GRC	0801co	Other transport combustion	0.1	0.1	0.1	0.1					8.2	8.2	8.2	8.2
GRC	0801nc	Other transport non-combustion												
GRC	090200	Waste incineration												
GRC	090400	Landfill												
GRC	090900	Cremation					0.05	0.05	0.05	0.05				
GRC	100600	Pesticide use												
GRC	110000	Nature												
GRC	eel	Electrical equipment												

Projected emission of Cd, Hg and Pb per country (ISO-a3) in 1990, in 2010 without autonomous emission reduction, in 2010 after autonomous developments and in 2010 after autonomous developments and implementation of Protocol

iso3	SNAP	description	Cd 1990	Cd 2010	Cd + autonom. dev.	Cd + Prot.	Hg 1990	Hg 2010	Hg + autonom. dev.	Hg + Prot.	Pb 1990	Pb 2010	Pb + autonom. dev.	Pb + Prot.
		Total	60	57	54	51	12	12	12	12	1600	1800	600	600
ITA	01bc	Public power etc. brown coal	0.0065	0.0065	0.0065	0.0065	0.024	0.024	0.024	0.024	0.0063	0.0063	0.0063	0.0063
ITA	01fo	Public power etc. fuel oils	7.6	5.3	5.3	5.3					12	8.4	8.4	8.4
ITA	01hc	Public power etc. hard coal	0.027	0.026	0.026	0.026	0.92	0.89	0.89	0.89	1.3	1.3	1.3	1.3
ITA	01of	Public power etc. other fuels	0.0049	0.0049	0.0049	0.0049	0.018	0.018	0.018	0.018	0.0047	0.0047	0.0047	0.0047
ITA	02bc	Commercial etc. brown coal												
ITA	02fo	Commercial etc. fuel oils	0.93	1	1	1					1.7	1.8	1.8	1.8
ITA	02hc	Commercial etc. hard coal	0.027				0.012				0.21			
ITA	02of	Commercial etc. other fuels	0.11	0.11	0.11	0.11	0.068	0.068	0.068	0.068	0.31	0.31	0.31	0.31
ITA	03bc	Industrial combustion brown coal	0.0002				0.00075				0.0002			
ITA	03fo	Industrial combustion fuel oils	2.3	1.8	1.5	1.5					3.7	2.9	2.9	2.9
ITA	03hc	Industrial combustion hard coal	0.012	0.0081	0.0065	0.0065	0.4	0.27	0.27	0.27	0.56	0.39	0.39	0.39
ITA	03of	Industrial combustion other fuels	0.0067	0.0067	0.0067	0.0067	0.025	0.025	0.025	0.025	0.0064	0.0064	0.0064	0.0064
ITA	040100	Petroleum industries												
ITA	040201	Coke production	0.39	0.37	0.37	0.37	0.072	0.069	0.069	0.069	0.83	0.79	0.79	0.79
ITA	040202	Blast furnace	0.29	0.28	0.28	0.28	0.09	0.086	0.086	0.086	35	33	33	33
ITA	040203	Pig iron												
ITA	040205	Open hearth furnace												
ITA	040206	Basic oxigen furnace	0.35	0.33	0.33	0.27	0.013	0.012	0.012	0.012	9.9	9.4	9.4	9.4
ITA	040207	Electric arc furnace	12	12	12	9.4	0.81	0.77	0.77	0.77	97	92	92	92
ITA	040208	Rolling												
ITA	040209	Sinter plants	1.6	1.5	1.5	1.2	0.099	0.094	0.094	0.094	46	44	44	44
ITA	0402xx	Foundries												
ITA	040301	Al industry	0.043	0.041	0.041	0.041								
ITA	0403cu	Cu industry	0.21	0.2	0.16	0.16					2.5	2.3	2.3	2.3
ITA	0403ni	Ni industry												
ITA	0403ot	Other non-ferrous metals												
ITA	0403pb	Pb industry	0.46	0.44	0.36	0.36	0.078	0.075	0.075	0.075	17	16	16	16
ITA	0403zn	Zn industry	17	16	13	13	0.52	0.5	0.5	0.5	20	19	19	19
ITA	040407	NPK fertilisers												
ITA	040413	Chloro-alkali industry					1.6	1.9	1.3	1.3				
ITA	040524	Halogenated HC production												
ITA	040525	Pesticide production												
ITA	040602	Paper pulp (Kraft process)												
ITA	04060x	Paper and pulp industry												
ITA	040611	Road paving with asphalt												
ITA	040612	Cement industry	0.49	0.47	0.38	0.38	3.8	3.6	3.6	3.6	2.4	2.2	2.2	2.2
ITA	040613	Glass industry												
ITA	040615	Battery manufacturing												
ITA	0406xx	Synthetic grid blasting												
ITA	050000	Extraction and distr. of fossil fuels												
ITA	060100	Paint use												
ITA	060201	Industrial degreasing												
ITA	060202	Dry cleaning												
ITA	0603&4	Other solvent use												
ITA	060406	Wood preservation												
ITA	0701-5	Road transport combustion	14	16	16	16					1400	1500	340	340
ITA	0706/7	Road transport non-combustion	0.14	0.16	0.16	0.16								
ITA	0801co	Other transport combustion	0.22	0.22	0.22	0.22					4.6	4.6	4.6	4.6
ITA	0801nc	Other transport non-combustion												
ITA	090200	Waste incineration	0.69	0.83	0.67	0.67	3.2	3.8	3.8	3.8	17	20	20	20
ITA	090400	Landfill												
ITA	090900	Cremation					0.03	0.03	0.03	0.03				
ITA	100600	Pesticide use												
ITA	110000	Nature												
ITA	eel	Electrical equipment												

Projected emission of Cd, Hg and Pb per country (ISO-a3) in 1990, in 2010 without autonomous emission reduction, in 2010 after autonomous developments and in 2010 after autonomous developments and implementation of Protocol

iso3	SNAP	description	Cd 1990	Cd 2010	Cd + autonom. dev.	Cd + Prot.	Hg 1990	Hg 2010	Hg + autonom. dev.	Hg + Prot.	Pb 1990	Pb 2010	Pb + autonom. dev.	Pb + Prot.
		Total	3	3.8	3.8	3.8	5.5	7.8	4.2	4.2	630	1100	100	100
PRT	01bc	Public power etc. brown coal												
PRT	01fo	Public power etc. fuel oils	0.62	0.34	0.34	0.34					2.1	1.1	1.1	1.1
PRT	01hc	Public power etc. hard coal	0.16	0.35	0.35	0.35	0.72	1.5	1.5	1.5	6.5	14	14	14
PRT	01of	Public power etc. other fuels												
PRT	02bc	Commercial etc. brown coal												
PRT	02fo	Commercial etc. fuel oils	0.045	0.077	0.077	0.077					0.17	0.28	0.28	0.28
PRT	02hc	Commercial etc. hard coal									0.005			
PRT	02of	Commercial etc. other fuels	0.049	0.049	0.049	0.049	0.12	0.12	0.12	0.12	0.29	0.29	0.29	0.29
PRT	03bc	Industrial combustion brown coal												
PRT	03fo	Industrial combustion fuel oils	0.45	0.53	0.53	0.53					1.5	1.8	1.5	1.5
PRT	03hc	Industrial combustion hard coal	0.041	0.076	0.0031	0.0031	0.18	0.34	0.34	0.34	1.7	3.1	1.7	1.7
PRT	03of	Industrial combustion other fuels	0.024	0.024	0.024	0.024	0.21	0.21	0.21	0.21	0.24	0.24	0.24	0.24
PRT	040100	Petroleum industries												
PRT	040201	Coke production	0.012	0.011	0.011	0.011	0.007	0.0067	0.0067	0.0067	0.051	0.049	0.049	0.049
PRT	040202	Blast furnace	0.007	0.0067	0.0067	0.0067	0.007	0.0067	0.0067	0.0067	1.7	1.6	1.6	1.6
PRT	040203	Pig iron												
PRT	040205	Open hearth furnace												
PRT	040206	Basic oxigen furnace	0.008	0.0076	0.0076	0.0076	0.001	0.00095	0.00095	0.00095	0.51	0.48	0.48	0.48
PRT	040207	Electric arc furnace	0.28	0.27	0.27	0.27	0.061	0.058	0.058	0.058	4.7	4.4	4.4	4.4
PRT	040208	Rolling												
PRT	040209	Sinter plants	0.037				0.007				2.2			
PRT	0402xx	Foundries												
PRT	040301	Al industry												
PRT	0403cu	Cu industry												
PRT	0403ni	Ni industry												
PRT	0403ot	Other non-ferrous metals												
PRT	0403pb	Pb industry	0.015								0.75			
PRT	0403zn	Zn industry												
PRT	040407	NPK fertilisers												
PRT	040413	Chloro-alkali industry					2.3	3.7	0.14	0.14				
PRT	040524	Halogenated HC production												
PRT	040525	Pesticide production												
PRT	040602	Paper pulp (Kraft process)												
PRT	04060x	Paper and pulp industry												
PRT	040611	Road paving with asphalt												
PRT	040612	Cement industry	0.073	0.069	0.069	0.069	1.8	1.7	1.7	1.7	0.73	0.69	0.69	0.69
PRT	040613	Glass industry												
PRT	040615	Battery manufacturing												
PRT	0406xx	Synthetic grid blasting												
PRT	050000	Extraction and distr. of fossil fuels												
PRT	060100	Paint use												
PRT	060201	Industrial degreasing												
PRT	060202	Dry cleaning												
PRT	0603&4	Other solvent use												
PRT	060406	Wood preservation												
PRT	0701-5	Road transport combustion	1.1	2	2	2					610	1100	73	73
PRT	0706/7	Road transport non-combustion	0.016	0.028	0.028	0.028								
PRT	0801co	Other transport combustion	0.011	0.011	0.011	0.011					2	2	2	2
PRT	0801nc	Other transport non-combustion												
PRT	090200	Waste incineration												
PRT	090400	Landfill												
PRT	090900	Cremation					0.05	0.05	0.05	0.05				
PRT	100600	Pesticide use												
PRT	110000	Nature												
PRT	eel	Electrical equipment												

Projected emission of Cd, Hg and Pb per country (ISO-a3) in 1990, in 2010 without autonomous emission reduction, in 2010 after autonomous developments (no additional influence of Protocol assumed)

iso3	SNAP	description	Cd 1990	Cd 2010	Cd + autonom. dev.	Hg 1990	Hg 2010	Hg + autonom. dev.	Pb 1990	Pb 2010	Pb + autonom. dev.
		Total	5.1	5.8	5.8	4.3	4.4	4.4	210	260	110
AUT	01bc	Public power etc. brown coal				0.07	0.082	0.082	0.03	0.035	0.035
AUT	01fo	Public power etc. fuel oils	0.17	0.26	0.26	0.07	0.11	0.11	0.21	0.32	0.32
AUT	01hc	Public power etc. hard coal	0.01	0.014	0.014	0.25	0.36	0.36	0.37	0.53	0.53
AUT	01of	Public power etc. other fuels									
AUT	02bc	Commercial etc. brown coal									
AUT	02fo	Commercial etc. fuel oils	0.07	0.064	0.064				0.29	0.27	0.27
AUT	02hc	Commercial etc. hard coal	0.14	0.073	0.073	0.28	0.15	0.15	2.3	1.2	1.2
AUT	02of	Commercial etc. other fuels	1.4	1.4	1.4	0.9	0.9	0.9	32	32	32
AUT	03bc	Industrial combustion brown coal	0.01	0.0033	0.0033	0.03	0.01	0.01	0.14	0.047	0.047
AUT	03fo	Industrial combustion fuel oils	0.15	0.11	0.11	0.06	0.042	0.042	0.18	0.13	0.13
AUT	03hc	Industrial combustion hard coal	0.03	0.027	0.027	0.09	0.081	0.081	0.58	0.52	0.52
AUT	03of	Industrial combustion other fuels									
AUT	040100	Petroleum industries									
AUT	040201	Coke production	0.01	0.0095	0.0095	0.06	0.057	0.057	0.04	0.038	0.038
AUT	040202	Blast furnace	0.01	0.0095	0.0095	0.07	0.067	0.067	2.9	2.7	2.7
AUT	040203	Pig iron									
AUT	040205	Open hearth furnace									
AUT	040206	Basic oxigen furnace	0.06	0.057	0.057	0.01	0.0095	0.0095	0.17	0.16	0.16
AUT	040207	Electric arc furnace	0.01	0.0095	0.0095				0.44	0.42	0.42
AUT	040208	Rolling									
AUT	040209	Sinter plants	0.04	0.038	0.038	0.06	0.057	0.057	3	2.9	2.9
AUT	0402xx	Foundries									
AUT	040301	Al industry									
AUT	0403cu	Cu industry	0.01	0.0096	0.0096	0.01	0.0096	0.0096	0.36	0.35	0.35
AUT	0403ni	Ni industry									
AUT	0403ot	Other non-ferrous metals									
AUT	0403pb	Pb industry	0.08	0.077	0.077				9	8.6	8.6
AUT	0403zn	Zn industry									
AUT	040407	NPK fertilisers									
AUT	040413	Chloro-alkali industry				0.27	0.34	0.34			
AUT	040524	Halogenated HC production									
AUT	040525	Pesticide production									
AUT	040602	Paper pulp (Kraft process)									
AUT	04060x	Paper and pulp industry									
AUT	040611	Road paving with asphalt									
AUT	040612	Cement industry	0.04	0.038	0.038	1.4	1.3	1.3	1.1	1	1
AUT	040613	Glass industry	0.03	0.037	0.037	0.01	0.012	0.012	2.6	3.3	3.3
AUT	040615	Battery manufacturing									
AUT	0406xx	Synthetic grid blasting									
AUT	050000	Extraction and distr. of fossil fuels									
AUT	060100	Paint use									
AUT	060201	Industrial degreasing									
AUT	060202	Dry cleaning									
AUT	0603&4	Other solvent use									
AUT	060406	Wood preservation									
AUT	0701-5	Road transport combustion	2.8	3.6	3.6				160	200	53
AUT	0706/7	Road transport non-combustion									
AUT	0801co	Other transport combustion									
AUT	0801nc	Other transport non-combustion									
AUT	090200	Waste incineration	0.02	0.025	0.025	0.62	0.77	0.77	0.27	0.34	0.34
AUT	090400	Landfill									
AUT	090900	Cremation				0.01	0.01	0.01			
AUT	100600	Pesticide use									
AUT	110000	Nature									
AUT	eel	Electrical equipment									

Projected emission of Cd, Hg and Pb per country (ISO-a3) in 1990, in 2010 without autonomous emission reduction, in 2010 after autonomous developments (no additional influence of Protocol assumed)

Iso3	SNAP	description	Cd 1990	Cd 2010	Cd + autonom. dev.	Hg 1990	Hg 2010	Hg + autonom. dev.	Pb 1990	Pb 2010	Pb + autonom. dev.
		Total	9.9	10	10	8.9	9.2	8.6	720	820	420
BEL	01bc	Public power etc. brown coal									
BEL	01fo	Public power etc. fuel oils	0.24	0.11	0.11				0.23	0.11	0.11
BEL	01hc	Public power etc. hard coal	0.056	0.053	0.053	1	0.95	0.95	1.6	1.5	1.5
BEL	01of	Public power etc. other fuels	0.014	0.014	0.014	0.029	0.029	0.029	0.008	0.008	0.008
BEL	02bc	Commercial etc. brown coal	0.002			0.004			0.005		
BEL	02fo	Commercial etc. fuel oils	0.23	0.24	0.24				0.46	0.47	0.47
BEL	02hc	Commercial etc. hard coal	0.098	0.032	0.032	0.22	0.074	0.074	0.83	0.27	0.27
BEL	02of	Commercial etc. other fuels									
BEL	03bc	Industrial combustion brown coal	0.008			0.016			0.17		
BEL	03fo	Industrial combustion fuel oils	2.4	2.8	2.8				87	100	100
BEL	03hc	Industrial combustion hard coal	0.026	0.022	0.022	0.49	0.41	0.41	29	24	24
BEL	03of	Industrial combustion other fuels	0.01	0.01	0.01	0.021	0.021	0.021	0.23	0.23	0.23
BEL	040100	Petroleum industries									
BEL	040201	Coke production	1	0.98	0.98	0.56	0.53	0.53	4.6	4.3	4.3
BEL	040202	Blast furnace	0.069	0.066	0.066	0.069	0.066	0.066	17	16	16
BEL	040203	Pig iron									
BEL	040205	Open hearth furnace									
BEL	040206	Basic oxigen furnace	0.27	0.26	0.26	0.031	0.029	0.029	16	15	15
BEL	040207	Electric arc furnace	0.53	0.5	0.5	0.15	0.14	0.14	33	32	32
BEL	040208	Rolling									
BEL	040209	Sinter plants									
BEL	0402xx	Foundries									
BEL	040301	Al industry									
BEL	0403cu	Cu industry	0.27	0.25	0.25				17	16	16
BEL	0403ni	Ni industry									
BEL	0403ot	Other non-ferrous metals									
BEL	0403pb	Pb industry	0.023	0.022	0.022				2.9	2.8	2.8
BEL	0403zn	Zn industry	1.7	1.7	1.7	0.047	0.045	0.045	11	10	10
BEL	040407	NPK fertilisers	0.11	0.098	0.098						
BEL	040413	Chloro-alkali industry				1	1.2	0.65			
BEL	040524	Halogenated HC production				0.76	0.88	0.88			
BEL	040525	Pesticide production									
BEL	040602	Paper pulp (Kraft process)									
BEL	04060x	Paper and pulp industry									
BEL	040611	Road paving with asphalt									
BEL	040612	Cement industry	0.047	0.045	0.045	1.6	1.5	1.5	1.3	1.2	1.2
BEL	040613	Glass industry				0.072	0.083	0.083	18	21	21
BEL	040615	Battery manufacturing									
BEL	0406xx	Synthetic grid blasting									
BEL	050000	Extraction and distr. of fossil fuels									
BEL	060100	Paint use									
BEL	060201	Industrial degreasing									
BEL	060202	Dry cleaning									
BEL	0603&4	Other solvent use									
BEL	060406	Wood preservation									
BEL	06oth	Solvent use, non specified									
BEL	0701-5	Road transport combustion	0.79	0.94	0.94				410	490	96
BEL	0706/7	Road transport non-combustion									
BEL	0801co	Other transport combustion	0.005	0.005	0.005				0.005	0.005	0.005
BEL	0801nc	Other transport non-combustion									
BEL	090200	Waste incineration	2	2.3	2.3	2.8	3.2	3.2	66	77	77
BEL	090400	Landfill									
BEL	090900	Cremation				0.009	0.009	0.009			
BEL	100600	Pesticide use									
BEL	110000	Nature									
BEL	eel	Electrical equipment									

Annex 2 Detailed overview of the link between sectors from RAINS 7.2 and [UBA-TNO '97]

Link_ID	RIANS Activity_ID	RAINS Fuel_ID	[UBA-TNO '97] Activity_ID
1	Cement and lime	No Fuel use	Cement production
2	Coke plants	No Fuel use	Coke production
3	Dairy cows	No Fuel use	
4	Fertilizer consumption	No Fuel use	Agriculture
5	Fertilizer production	No Fuel use	NPK fertilizer production
6	Fur animals	No Fuel use	
7	Horses	No Fuel use	
8	Laying hens	No Fuel use	
9	Non ferrous metals smelters	No Fuel use	Non-ferrous metal industry
10	Nitric acid plants	No Fuel use	
11	Other cattle	No Fuel use	
12	Other industry	No Fuel use	
13	Other poultry	No Fuel use	
14	Other anthropogenic sources	No Fuel use	
15	Pigs	No Fuel use	
16	Pig iron, blast furnaces	No Fuel use	Blast furnaces
17	Pulp and paper	No Fuel use	Paper and pulp industry
18	Oil refineries	No Fuel use	Petroleum refining
19	Sheep	No Fuel use	
20	Sinter - agglomerate	No Fuel use	Sinter plants, basic oxygen furn.
21	Sulphuric acid plants	No Fuel use	Sulphuric acid production
22	Waste	No Fuel use	
23	Fuel production and Conversion - Combustion	Brown coal/lignite, high grade	Industry brown coal
24	Fuel production and Conversion - Losses	Brown coal/lignite, high grade	Industry brown coal
25	Households and other	Brown coal/lignite, high grade	Small comb. sources brown coal
26	Industry - Combustion in boilers	Brown coal/lignite, high grade	Industry brown coal
27	Industry - Other combustion total	Brown coal/lignite, high grade	Industry brown coal
28	Non-energy use	Brown coal/lignite, high grade	
29	Power Plants & distr. heat plants - Ex. other	Brown coal/lignite, high grade	Transformation brown coal
30	Power Plants & distr. heat plants - Ex. wet bottom	Brown coal/lignite, high grade	Transformation brown coal
31	Power Plants & distr. heat plants - New	Brown coal/lignite, high grade	Transformation brown coal
32	Power Plants & distr. heat plants - total (calc)	Brown coal/lignite, high grade	
33	Transport - Other	Brown coal/lignite, high grade	Other transport combustion
34	Transport - Road : Cars and Heavy duty trucks	Brown coal/lignite, high grade	Road transport combustion
35	Fuel production and Conversion - Combustion	Brown coal/lignite, low grade	Industry brown coal
36	Fuel production and Conversion - Losses	Brown coal/lignite, low grade	Industry brown coal
37	Households and other	Brown coal/lignite, low grade	Small comb. sources brown coal
38	Industry - Combustion in boilers	Brown coal/lignite, low grade	Industry brown coal
39	Industry - Other combustion total	Brown coal/lignite, low grade	Industry brown coal
40	Non-energy use	Brown coal/lignite, low grade	
41	Power Plants & distr. heat plants - Ex. other	Brown coal/lignite, low grade	Transformation brown coal
42	Power Plants & distr. heat plants - Ex. wet bottom	Brown coal/lignite, low grade	Transformation brown coal
43	Power Plants & distr. heat plants - New	Brown coal/lignite, low grade	Transformation brown coal
44	Power Plants & distr. heat plants - total (calc)	Brown coal/lignite, low grade	

45	Transport - Other	Brown coal/lignite, low grade	Other transport combustion
46	Transport - Road : Cars and Heavy duty trucks	Brown coal/lignite, low grade	Road transport combustion
47	Fuel production and Conversion - Combustion	Derived coal (coke, briquettes)	Industry hard coal
48	Fuel production and Conversion - Losses	Derived coal (coke, briquettes)	Industry hard coal
49	Households and other	Derived coal (coke, briquettes)	Small comb. sources hard coal
50	Industry - Combustion in boilers	Derived coal (coke, briquettes)	Industry hard coal
51	Industry - Other combustion total	Derived coal (coke, briquettes)	Industry hard coal
52	Non-energy use	Derived coal (coke, briquettes)	
53	Power Plants & distr. heat plants - Ex. other	Derived coal (coke, briquettes)	Transformation hard coal
54	Power Plants & distr. heat plants - Ex. wet bottom	Derived coal (coke, briquettes)	Transformation hard coal
55	Power Plants & distr. heat plants - New	Derived coal (coke, briquettes)	Transformation hard coal
56	Power Plants & distr. heat plants - total (calc)	Derived coal (coke, briquettes)	
57	Transport - Other	Derived coal (coke, briquettes)	Other transport combustion
58	Transport - Road : Cars and Heavy duty trucks	Derived coal (coke, briquettes)	Road transport combustion
59	Fuel production and Conversion - Combustion	Electricity	
60	Fuel production and Conversion - Losses	Electricity	
61	Households and other	Electricity	
62	Industry - Combustion in boilers	Electricity	
63	Industry - Other combustion total	Electricity	
64	Non-energy use	Electricity	
65	Power Plants & distr. heat plants - Ex. other	Electricity	
66	Power Plants & distr. heat plants - Ex. wet bottom	Electricity	
67	Power Plants & distr. heat plants - New	Electricity	
68	Power Plants & distr. heat plants - total (calc)	Electricity	
69	Transport - Other	Electricity	
70	Transport - Road : Cars and Heavy duty trucks	Electricity	
71	Fuel production and Conversion - Combustion	Natural gas (incl. other gases)	
72	Fuel production and Conversion - Losses	Natural gas (incl. other gases)	
73	Households and other	Natural gas (incl. other gases)	
74	Industry - Combustion in boilers	Natural gas (incl. other gases)	
75	Industry - Other combustion total	Natural gas (incl. other gases)	
76	Non-energy use	Natural gas (incl. other gases)	
77	Power Plants & distr. heat plants - Ex. other	Natural gas (incl. other gases)	
78	Power Plants & distr. heat plants - Ex. wet bottom	Natural gas (incl. other gases)	
79	Power Plants & distr. heat plants - New	Natural gas (incl. other gases)	
80	Power Plants & distr. heat plants - total (calc)	Natural gas (incl. other gases)	
81	Transport - Other	Natural gas (incl. other gases)	Other transport combustion
82	Transport - Road : Cars and Heavy duty trucks	Natural gas (incl. other gases)	Road transport combustion
83	Fuel production and Conversion - Combustion	Hard coal, high quality	Industry hard coal
84	Fuel production and Conversion - Losses	Hard coal, high quality	Industry hard coal
85	Households and other	Hard coal, high quality	Small comb. sources hard coal
86	Industry - Combustion in boilers	Hard coal, high quality	Industry hard coal
87	Industry - Other combustion total	Hard coal, high quality	Industry hard coal
88	Non-energy use	Hard coal, high quality	
89	Power Plants & distr. heat plants - Ex. other	Hard coal, high quality	Transformation hard coal
90	Power Plants & distr. heat plants - Ex. wet bottom	Hard coal, high quality	Transformation hard coal
91	Power Plants & distr. heat plants - New	Hard coal, high quality	Transformation hard coal
92	Power Plants & distr. heat plants - total (calc)	Hard coal, high quality	
93	Transport - Other	Hard coal, high quality	Other transport combustion

94	Transport - Road : Cars and Heavy duty trucks	Hard coal, high quality	Road transport combustion
95	Fuel production and Conversion - Combustion	Hard coal, medium quality	Industry hard coal
96	Fuel production and Conversion - Losses	Hard coal, medium quality	Industry hard coal
97	Households and other	Hard coal, medium quality	Small comb. sources hard coal
98	Industry - Combustion in boilers	Hard coal, medium quality	Industry hard coal
99	Industry - Other combustion total	Hard coal, medium quality	Industry hard coal
100	Non-energy use	Hard coal, medium quality	
101	Power Plants & distr. heat plants - Ex. other	Hard coal, medium quality	Transformation hard coal
102	Power Plants & distr. heat plants - Ex. wet bottom	Hard coal, medium quality	Transformation hard coal
103	Power Plants & distr. heat plants - New	Hard coal, medium quality	Transformation hard coal
104	Power Plants & distr. heat plants - total (calc)	Hard coal, medium quality	
105	Transport - Other	Hard coal, medium quality	Other transport combustion
106	Transport - Road : Cars and Heavy duty trucks	Hard coal, medium quality	Road transport combustion
107	Fuel production and Conversion - Combustion	Hard coal, low quality	Industry hard coal
108	Fuel production and Conversion - Losses	Hard coal, low quality	Industry hard coal
109	Households and other	Hard coal, low quality	Small comb. sources hard coal
110	Industry - Combustion in boilers	Hard coal, low quality	Industry hard coal
111	Industry - Other combustion total	Hard coal, low quality	Industry hard coal
112	Non-energy use	Hard coal, low quality	
113	Power Plants & distr. heat plants - Ex. other	Hard coal, low quality	Transformation hard coal
114	Power Plants & distr. heat plants - Ex. wet bottom	Hard coal, low quality	Transformation hard coal
115	Power Plants & distr. heat plants - New	Hard coal, low quality	Transformation hard coal
116	Power Plants & distr. heat plants - total (calc)	Hard coal, low quality	
117	Transport - Other	Hard coal, low quality	Other transport combustion
118	Transport - Road : Cars and Heavy duty trucks	Hard coal, low quality	Road transport combustion
119	Fuel production and Conversion - Combustion	Heavy fuel oil	Industry fuel oils
120	Fuel production and Conversion - Losses	Heavy fuel oil	Industry fuel oils
121	Households and other	Heavy fuel oil	Small comb. sources fuel oils
122	Industry - Combustion in boilers	Heavy fuel oil	Industry fuel oils
123	Industry - Other combustion total	Heavy fuel oil	Industry fuel oils
124	Non-energy use	Heavy fuel oil	
125	Power Plants & distr. heat plants - Ex. other	Heavy fuel oil	Transformation fuel oils
126	Power Plants & distr. heat plants - Ex. wet bottom	Heavy fuel oil	Transformation fuel oils
127	Power Plants & distr. heat plants - New	Heavy fuel oil	Transformation fuel oils
128	Power Plants & distr. heat plants - total (calc)	Heavy fuel oil	
129	Transport - Other	Heavy fuel oil	Other transport combustion
130	Transport - Road : Cars and Heavy duty trucks	Heavy fuel oil	Road transport combustion
131	Fuel production and Conversion - Combustion	Heat (steam, hot water)	
132	Fuel production and Conversion - Losses	Heat (steam, hot water)	
133	Households and other	Heat (steam, hot water)	
134	Industry - Combustion in boilers	Heat (steam, hot water)	
135	Industry - Other combustion total	Heat (steam, hot water)	
136	Non-energy use	Heat (steam, hot water)	
137	Power Plants & distr. heat plants - Ex. other	Heat (steam, hot water)	
138	Power Plants & distr. heat plants - Ex. wet bottom	Heat (steam, hot water)	
139	Power Plants & distr. heat plants - New	Heat (steam, hot water)	
140	Power Plants & distr. heat plants - total (calc)	Heat (steam, hot water)	
141	Transport - Other	Heat (steam, hot water)	
142	Transport - Road : Cars and Heavy duty trucks	Heat (steam, hot water)	

143	Fuel production and Conversion - Combustion	Hydro	
144	Fuel production and Conversion - Losses	Hydro	
145	Households and other	Hydro	
146	Industry - Combustion in boilers	Hydro	
147	Industry - Other combustion total	Hydro	
148	Non-energy use	Hydro	
149	Power Plants & distr. heat plants - Ex. other	Hydro	
150	Power Plants & distr. heat plants - Ex. wet bottom	Hydro	
151	Power Plants & distr. heat plants - New	Hydro	
152	Power Plants & distr. heat plants - total (calc)	Hydro	
153	Transport - Other	Hydro	
154	Transport - Road : Cars and Heavy duty trucks	Hydro	
155	Fuel production and Conversion - Combustion	Light fractions (gasoline,kerosen,naphta,LPG)	Industry fuel oils
156	Fuel production and Conversion - Losses	Light fractions (gasoline,kerosen,naphta,LPG)	Industry fuel oils
157	Households and other	Light fractions (gasoline,kerosen,naphta,LPG)	Small comb. sources fuel oils
158	Industry - Combustion in boilers	Light fractions (gasoline,kerosen,naphta,LPG)	Industry fuel oils
159	Industry - Other combustion total	Light fractions (gasoline,kerosen,naphta,LPG)	Industry fuel oils
160	Non-energy use	Light fractions (gasoline,kerosen,naphta,LPG)	
161	Power Plants & distr. heat plants - Ex. other	Light fractions (gasoline,kerosen,naphta,LPG)	Transformation fuel oils
162	Power Plants & distr. heat plants - Ex. wet bottom	Light fractions (gasoline,kerosen,naphta,LPG)	Transformation fuel oils
163	Power Plants & distr. heat plants - New	Light fractions (gasoline,kerosen,naphta,LPG)	Transformation fuel oils
164	Power Plants & distr. heat plants - total (calc)	Light fractions (gasoline,kerosen,naphta,LPG)	
165	Transport - Other	Light fractions (gasoline,kerosen,naphta,LPG)	Other transport combustion
166	Transport - Road : Cars and Heavy duty trucks	Light fractions (gasoline,kerosen,naphta,LPG)	Road transport combustion
167	Fuel production and Conversion - Combustion	Medium distillates (diesel,light fuel oil)	Industry fuel oils
168	Fuel production and Conversion - Losses	Medium distillates (diesel,light fuel oil)	Industry fuel oils
169	Households and other	Medium distillates (diesel,light fuel oil)	Small comb. sources fuel oils
170	Industry - Combustion in boilers	Medium distillates (diesel,light fuel oil)	Industry fuel oils
171	Industry - Other combustion total	Medium distillates (diesel,light fuel oil)	Industry fuel oils
172	Non-energy use	Medium distillates (diesel,light fuel oil)	
173	Power Plants & distr. heat plants - Ex. other	Medium distillates (diesel,light fuel oil)	Transformation fuel oils
174	Power Plants & distr. heat plants - Ex. wet bottom	Medium distillates (diesel,light fuel oil)	Transformation fuel oils
175	Power Plants & distr. heat plants - New	Medium distillates (diesel,light fuel oil)	Transformation fuel oils
176	Power Plants & distr. heat plants - total (calc)	Medium distillates (diesel,light fuel oil)	
177	Transport - Other	Medium distillates (diesel,light fuel oil)	Other transport combustion
178	Transport - Road : Cars and Heavy duty trucks	Medium distillates (diesel,light fuel oil)	Road transport combustion
179	Power Plants & distr. heat plants - New	Nuclear	
180	Power Plants & distr. heat plants - total (calc)	Nuclear	
181	Fuel production and Conversion - Combustion	Other solid-low S (biomass, waste, wood)	

182	Fuel production and Conversion - Losses	Other solid-low S (biomass, waste, wood)	
183	Households and other	Other solid-low S (biomass, waste, wood)	
184	Industry - Combustion in boilers	Other solid-low S (biomass, waste, wood)	
185	Industry - Other combustion total	Other solid-low S (biomass, waste, wood)	
186	Non-energy use	Other solid-low S (biomass, waste, wood)	
187	Power Plants & distr. heat plants - Ex. other	Other solid-low S (biomass, waste, wood)	
188	Power Plants & distr. heat plants - Ex. wet bottom	Other solid-low S (biomass, waste, wood)	
189	Power Plants & distr. heat plants - New	Other solid-low S (biomass, waste, wood)	
190	Power Plants & distr. heat plants - total (calc)	Other solid-low S (biomass, waste, wood)	
191	Transport - Other	Other solid-low S (biomass, waste, wood)	Other transport combustion
192	Transport - Road : Cars and Heavy duty trucks	Other solid-low S (biomass, waste, wood)	Road transport combustion
193	Fuel production and Conversion - Combustion	Other solid-high S (incl. high S waste)	Industry hard coal
194	Fuel production and Conversion - Losses	Other solid-high S (incl. high S waste)	Industry hard coal
195	Households and other	Other solid-high S (incl. high S waste)	Small comb. sources hard coal
196	Industry - Combustion in boilers	Other solid-high S (incl. high S waste)	Industry hard coal
197	Industry - Other combustion total	Other solid-high S (incl. high S waste)	Industry hard coal
198	Non-energy use	Other solid-high S (incl. high S waste)	
199	Power Plants & distr. heat plants - Ex. other	Other solid-high S (incl. high S waste)	Transformation hard coal
200	Power Plants & distr. heat plants - Ex. wet bottom	Other solid-high S (incl. high S waste)	Transformation hard coal
201	Power Plants & distr. heat plants - New	Other solid-high S (incl. high S waste)	Transformation hard coal
202	Power Plants & distr. heat plants - total (calc)	Other solid-high S (incl. high S waste)	
203	Transport - Other	Other solid-high S (incl. high S waste)	Other transport combustion
204	Transport - Road : Cars and Heavy duty trucks	Other solid-high S (incl. high S waste)	Road transport combustion
205	Fuel production and Conversion - Combustion	Renewable (solar, wind, small hydro)	
206	Fuel production and Conversion - Losses	Renewable (solar, wind, small hydro)	
207	Households and other	Renewable (solar, wind, small hydro)	
208	Industry - Combustion in boilers	Renewable (solar, wind, small hydro)	
209	Industry - Other combustion total	Renewable (solar, wind, small hydro)	
210	Non-energy use	Renewable (solar, wind, small hydro)	
211	Power Plants & distr. heat plants - Ex. other	Renewable (solar, wind, small hydro)	
212	Power Plants & distr. heat plants - Ex. wet bottom	Renewable (solar, wind, small hydro)	
213	Power Plants & distr. heat plants - New	Renewable (solar, wind, small hydro)	
214	Power Plants & distr. heat plants - total (calc)	Renewable (solar, wind, small hydro)	
215	Transport - Other	Renewable (solar, wind, small hydro)	
216	Transport - Road : Cars and Heavy duty trucks	Renewable (solar, wind, small hydro)	