European Topic Centre on Air Emission

CORINAIR 1990 SUMMARY REPORT 2

By

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PREFACE

CORINAIR90 is an air emission inventory for Europe for 1990, initiated by the European Council of Ministers as part of the CORINE (Coordination d'Information Environmentale) work programme. The CORINAIR system presently has been integrated in the work programme of the European Environment Agency and the work is continuing through the European Topic Centre on Air Emissions.

In the first summary report (CORINAIR90 Summary Report no. 1, final draft, 1995) an overview has been presented of the emissions of the main (11) source sectors. In this report the most important source sub-sectors (57) within the main sectors are examined in detail.

It should be noted that the data reported here from CORINAIR90 are not fully consistent with those reported in line with the IPCC Guidelines for National Greenhouse Gas Inventories under the UN Framework Climate Change Convention or the EU Decision on a Monitoring Mechanism for CO_2 and other greenhouse gases. CORINAIR90 data has been used by several countries as a basis for such reporting but this requires careful re-allocation and re-aggregation between reporting categories as highlighted in the IPCC Guidelines and some gaps and inconsistencies remain to be resolved between IPCC and the EEA.

It should also be noted that the data in CORINAIR90 are not fully consistent with those in CORINAIR85. For example the number of sources for NMVOC has been increased and emission factors for NO_x for traffic are not consistent for the two databases. Therefore no comparisons have been made between the data for 1985 and 1990.

The results of CORINAIR90 provide the most detailed, complete, consistent and transparent European atmospheric emission inventory to date. However the results are estimates of actual emissions with significant uncertainties in some cases. Furthermore some gaps and inconsistencies remain. Comments and observations on the results presented in this draft report are welcome to assist in the longer term development of the methodology.

SUMMARY

Important source sub-sectors in Europe in 1990

The CORINAIR 90 source nomenclature (SNAP90) is divided hierarchically into three levels with 11 main sectors (level 1), 57 sub-sectors (level 2) and about 270 activities (level 3). The report focusses on the 57 sub-sectors. CORINAIR 90 identified 38 of the 57 source sub-sectors as important sources for the eight pollutants investigated. These top sub-sectors contributed to more than 90% of the emissions of each of the pollutants with the exception of NMVOC and CO_2.

The most important source sub-sectors in Europe in 1990 for the eight substances investigated were:

SO_2, CO_2	Public Power and Cogeneration Plants
NO_x, CO, NMVOC	Road Transport - Passenger Cars
CH_4	Agriculture - Animal Breeding (enteric fermentation)
NH_3	Agriculture - Animal Breeding (excretions)
N_2O	Agriculture - Cultures with Fertilizer (except animal manure)

All participating countries reported their emissions for these top source sub-sectors. However, the data are not as complete for a number of the less important source sub-sectors. Consequently, the ranking for these source sub-sectors cannot be regarded as certain since the emissions concerned might have been significantly underestimated for pollutants like CH_4, N_2O and NH_3.

A number of the pollutants investigated can be traced to the same top source sub-sectors. *Commercial, Institutional and Residential Combustion Plants* is for example included in the top ten source sub-sector for six pollutants (SO_2, CO_2, NO_x, CO, N_2O and NMVOC), *Road Transport - Heavy Duty Vehicles* for five pollutants (SO_2, CO_2, NO_x, CO and NMVOC).

Contribution of countries to European top ten source sub-sectors

In 1990 the countries making the largest contribution to the emissions of the top one source sub-sector were:

SO_2, CO_2	Public Power and Cogeneration Plants	United Kingdom
CO, NMVOC	Road Transport-Passenger Cars	United Kingdom
NO_x	Road Transport - Passenger Cars	Germany (former West)
CH_4	Agriculture - Animal Breeding (enteric fermentation)	France
NH_3	Agriculture - Animal Breeding (excretions)	France
N_2O	Agriculture - Cultures with Fertilizer (except animal manure)	Poland

The countries mainly responsible for emissions from the other top ten source sub-sectors differ, first, with respect to the source sub-sector in question and, second, concerning the extent to which they contribute to the emission total.

There is clear evidence that emissions of certain top source sub-sectors are concentrated in distinct regions of Europe. Again the analysis could be improved in the future by filling the gaps already mentioned.

Comparison of per capita emissions of the top five source sub-sectors

This comparison shows that there are very large differences in per capita emissions (from one to three orders of magnitude). There is no single pollutant nor even a top source sub-sector which exhibits a similar per capita emission across the area studied (Europe). However usually the smaller the contribution of a source sub-sector to the European total, the smaller is the range recorded for per capita emission values.

It is beyond the scope of this report to analyse and interpret all of these differences or, for example, to examine whether they are due to differences in emission factors or differences in activities.

INTRODUCTION

Emission inventory

Important to any environmental policy is an emission inventory that identifies and quantifies the main sources of pollutants. Such an inventory provides a common and consistent means for comparing the relative contribution of different emission sources and hence can be a basis for policies to reduce emissions.

CORINAIR 90

CORINAIR 90 is an air emission inventory for Europe. It was part of the CORINE[1] work plan set up by the *European Council of Ministers* in 1985.

The goal of CORINAIR 90 is to provide a complete, consistent and transparent air pollutant emission inventory for Europe in 1990 within a reasonable timescale to enable widespread use of the inventory for policy, research and other purposes.

Twenty nine European countries estimated their emissions for 1990 according to the CORINAIR methodology as developed by the *European Environment Agency Task Force.*

The CORINAIR system has now been integrated in the work programme of the *European Environmental Agency* (EEA) and work continuing through the *European Topic Centre on Air Emission* (ETC/AEM). It is the task of the ETC/AEM to develop the methodology and prepare emission inventories for subsequent years as well as update the 1990 inventory.

This report

This report has been prepared by ETC/AEM as part of project SA2 of the EEA work programme.

Whereas Summary Report nr.1 addressed the 11 main source sectors, this report examines the 57 source sub-sectors within these main source sectors. This report identifies the major source sub-sectors of air emissions in Europe and provides national comparisons for each of these.

The goal is to show:

- the relevant sources of air pollution in Europe, and
- the distribution of these sources among European countries.

[1] **Co**or**In**formation **E**nvironmentale

Of all the eight pollutants investigated, the largest ten source sub-sectors are responsible for more than 90% of total emissions, with the exception of CO_2 (89%) and NMVOC (72%).

This report therefore presents the ten most important source sub-sectors of air emissions for all investigated air pollutants in CORINAIR 90 in Europe and in each of the 29 European countries.

Total and per capita emission comparisons for these top ten source sub-sectors in Europe are provided for each country.

This report makes use of the most detailed source categories as distinguished in CORINAIR 90 for the ten most important source sub-sectors in Europe.

Structure of CORINAIR 90

This emission inventory system contains information about the location and activity of sources, as well as about the emission per activity (emission factor, EF). The multiplication of activity and EF gives the emission for each source.

CORINAIR 90 distinguishes between 1480 different geographical areas within Europe. Their classification is based on the **N**omenclature of **T**erritorial **U**nits for **S**tatistics (NUTS, level 3) defined by EUROSTAT. These areas are grouped together to form NUTS level 2 (460 areas), level 1 (172 areas) and level 0 (29 countries). For this report only NUTS level 0 is considered. Further reports, yet to come, will present more disaggregated information available in CORINAIR 90.

Large point sources (LPS) are treated separately within CORINAIR 90. Their emissions are assigned not only to a specific territorial unit but also to the exact location provided in terms of longitude and latitude.

The participating countries estimated activities and EFs for the source sectors requested by the CORINAIR 90 methodology for eight pollutants.

List of pollutants

- sulphur oxides (SO_x as SO_2)
- nitrogen oxides (NO_x as NO_2)
- non-methane volatile organic compounds (NMVOC)
- methane (CH_4)
- carbon monoxide (CO)
- carbon dioxide (CO_2)
- nitrous oxide (N_2O)
- ammonia (NH_3).

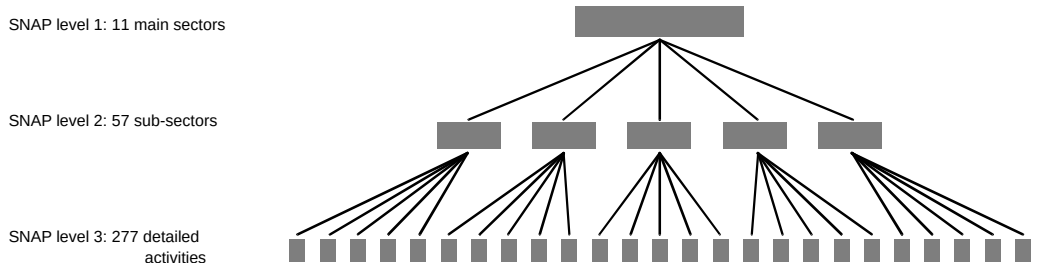
List of source sectors (SNAP code)

The CORINAIR 90 inventory distinguishes between 277 different air emission source sectors. These are named according to a **S**elected **N**omenclature of **A**ir **P**ollutants (SNAP level 3). Similar source sectors have been grouped hierarchically together under 57 sub-sectors (SNAP level 2) and 11 main sectors (SNAP level 1).

The source sub-sectors discussed in this report are identified with the 57 sub-sectors (SNAP level 2, see appendix A).

An overview of the emissions of the 11 main-sectors has been given in a previous report (CORINAIR 90: Summary Report nr. 1).

Figure 1 **Structure of emission source sectors in CORINAIR 90 (SNAP levels)**



List of countries

This emission inventory covers the whole of Europe with a few exceptions. This report will use the term 'Europe' as an equivalent expression for the 29 participating countries as listed in appendix B.

All countries (with the exception of Switzerland) have notified the EEA that their CORINAIR 90 inventory is final. 'Final' means that the inventory has been submitted to a number of consistency checks, adjustments and updates and no further changes are expected from the national expert. However, minor adjustments may be made to improve consistency between countries before publication of the Final CORINAIR 90 Report. The data should be referenced as European Environment Agency: CORINAIR 90 Data; Summary Report nr.2, December 1995.

Error estimation

Errors may vary considerably for different pollutants and for different sources. E.g. figures for SO_2 emissions that are estimated from continuous emission monitoring or figures for CO_2 emissions from fossil fuel burning usually have a small error of less than ten percent whereas figures for sources with highly uncertain emission factors and activity rates have the largest errors which can exceed a factor of two. Such large errors have to be expected e.g. for N_2O (and NH_3) emissions from nature. Furthermore, some

emissions have not been estimated at all by some countries due to a lack of information on actual rates of emission or lack of awareness of the importance of these sources (gaps).

Future developments of CORINAIR 90

The next step for CORINAIR is the emission inventory for the year 1994. This is a major improvement of the CORINAIR 90 inventory with the intention to give emissions for more pollutants in a shorter time period. For details see the corresponding study of the EEA (‘Review of CORINAIR 90 - Proposals for Air Emissions 94’).

This will build on the experience gained from the CORINAIR 90 inventory as well as other developments such as related work on the preparation of the joint EMEP/CORINAIR Emission Inventory Guidebook, IPCC Guidebook on Greenhouse Gases, USEPA AP-42 (Fifth Edition) and PARCOM/ATMOS and will provide an improved inventory for 1994 by the end of 1996.

EMISSIONS IN EUROPE IN 1990

Introduction

It is important to consider the sources of air pollution on an international scale. This chapter therefore identifies the most important source sub-sectors for Europe as a whole.

The ten most important sources of air pollution are presented here as the '*top ten source sub-sectors*' for every pollutant to indicate the most important sources of air emissions in Europe. These *top ten sub-sectors* provide guidance to possible emission reduction strategies in Europe, because with the exception of NMVOC and CO_2, they are responsible for more than 90% of total emissions.

Top Ten Source Sub-Sectors

CORINAIR 90 evaluates emissions for eight pollutants. In general these pollutants can be divided into two groups according to their sources. Group one are pollutants mainly caused by the combustion of fossil fuels. These pollutants are:

- SO_2, NO_x, CO and CO_2.

Group two are pollutants caused predominantly by agricultural and natural sources. These are:

- NH_3, N_2O and CH_4.

The remaining pollutant NMVOC covers many different substances which can be traced to a wide range of emission sources.

Figure 1 shows the *top ten source sub-sectors* for the pollutants evaluated in CORINAIR 90. For detailed data see also Appendix C. The emissions from other sources than the top ten source sub-sectors are indicated as 'other polluters'.

Figure 1 Top ten source sub-sectors for Europe (1990)

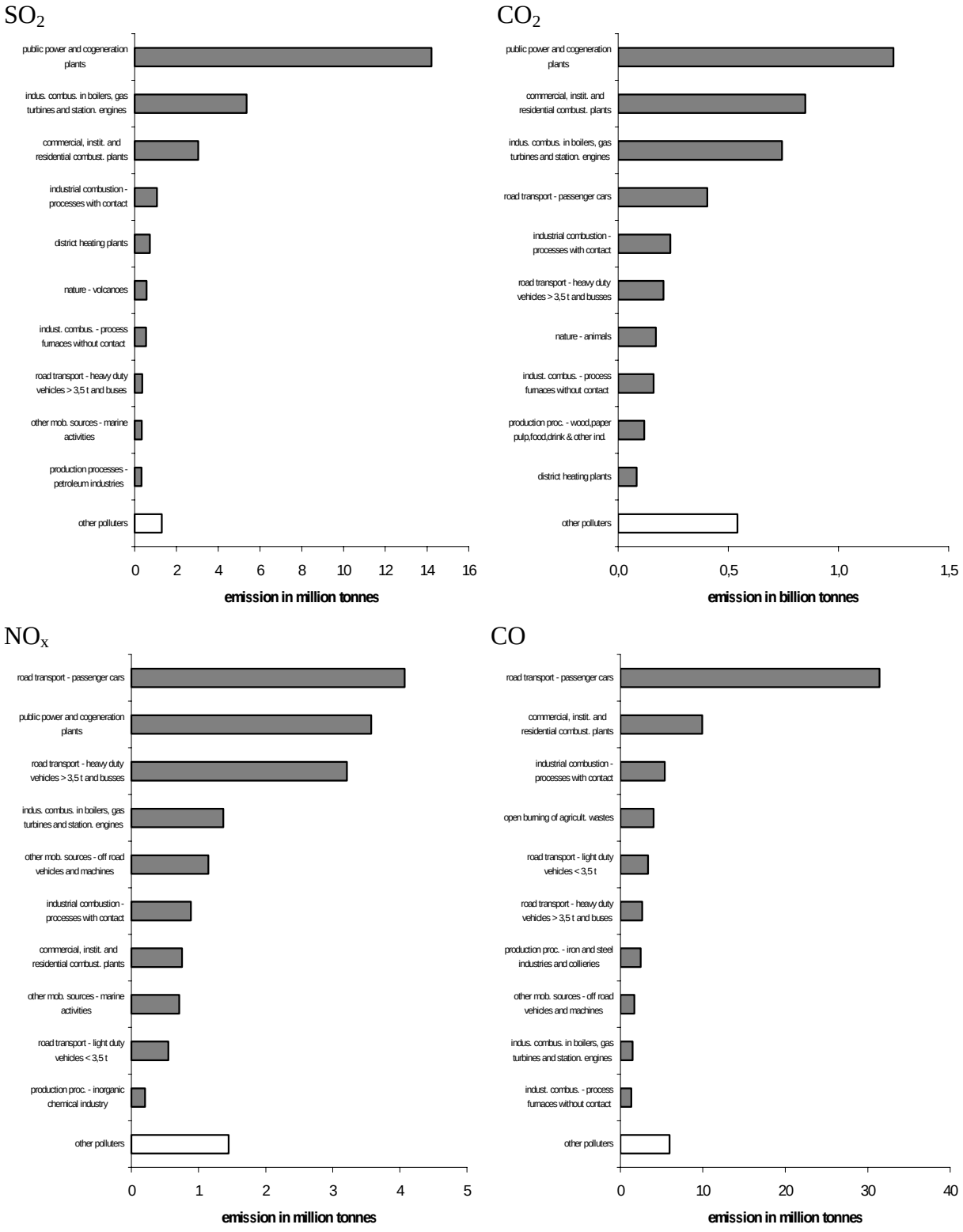
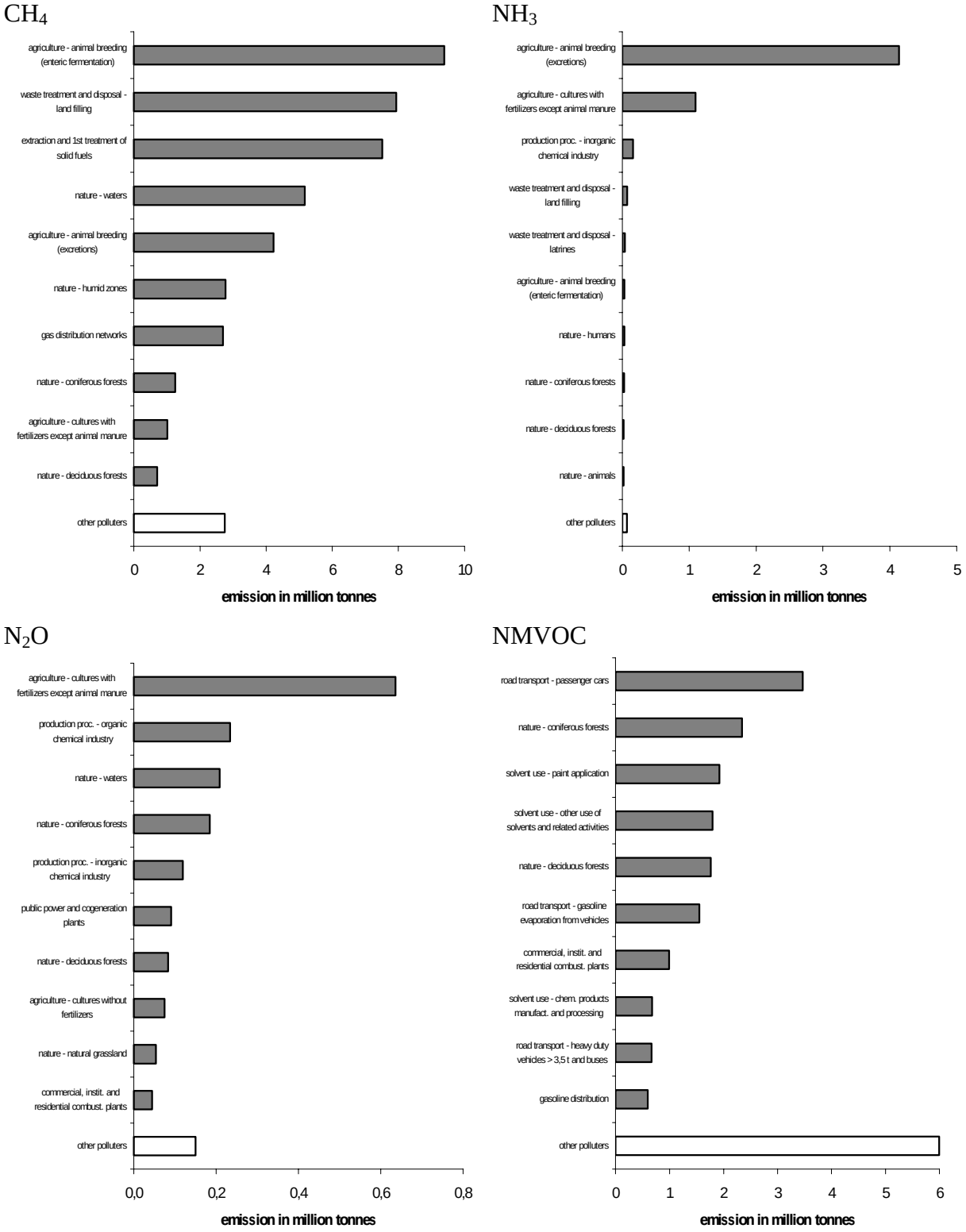


Figure 1 cont. Top ten source sub-sectors for Europe (1990)



About 80% of the SO_2 and CO_2 emissions are caused by the same seven source sub-sectors. The top sub-sector is the same for both pollutants (*Public Power and Cogeneration Plants)*, the second and third alter their positions. Emissions of nature are important for both pollutants (SO_2: top six, CO_2: top seven).

The emissions of NO_x are dominated by *Road Transport and Other Mobile Sources*. Considering the top three sub-sectors for SO_2 and CO_2 only the top sub-sector is within the top three ranking of NO_x. *Commercial, Institutional and Residential Combustion Plants* (top two sub-sector for SO_2 and top three sub-sector *for CO2)* is only in the bottom half of the top ten source sub-sectors for NO_x.

The top ten source sub-sectors of CH_4 and NH_3 are dominated by *Nature* and *Agriculture*. Six of the top ten source sub-sectors are relevant for both CH_4 and NH_3. However the ranking of the top ten and their relative contribution are different for each pollutant. Five top ten source sub-sectors of NH_3 and of CH_4 are within the top ten ranking of N_2O. Contrary to NH_3 and CH_4, there are two source sub-sectors within the N_2O top ten ranking, which cause emissions by combustion of fossil fuels. Emissions of *Production Processes* are only relevant for NH_3 and N_2O but not for CH_4.

Five of the NMVOC top ten source sub-sectors consist of polluters, which can be found within the ranking of all the previous pollutants. The ranking is especially dominated by sub-sectors like Road Transport (top one, six and nine), Nature (top two and five) and Solvent use (top three, four and eight).

More than 50% of the CO emissions are caused by *Road Transport*, two of the three sub-sectors from this sector being also within the top ten ranking of NMVOC. Top two and top three are identical to those of CO_2 . Top four and top seven are sub-sectors which are not found in the top ten ranking of any other pollutant.

Thirty eight of the 57 source sub-sectors are featured in the top ten of the eight air pollutants investigated. However only 13 of the 38 show a contribution larger 10% to the total emissions of one or more of the eight pollutants (see appendix A). The following five source sub-sectors have been identified as the top sub-sectors (see table 1).

Table 1 Top source sub-sectors for the pollutants investigated in CORINAIR90

source sub-sector	**pollutant**
Public Power and Cogeneration Plants	SO_2, CO_2
Road Transport - Passenger Cars	NO_x,CO, NMVOC
Agriculture - Animal Breeding (enteric fermentation)	CH_4
Agriculture - Animal Breeding (excretions)	NH_3
Agriculture - Cultures with Fertilizer (except animal manure)	N_2O

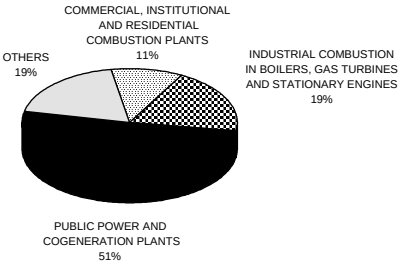
The following sections will discuss the sources of emissions in Europe pollutant by pollutant. The idea is not to deal with every source, but rather to draw attention to the most significant features on a sub-sector and activity basis.

SO_2

OVERVIEW

In 1990 28 million tonnes of SO_2 were emitted in Europe. These emissions can be traced to relatively few sub-sectors. 81% derive from the top three sub-sectors (see figure 2) and 95% from the top ten.

Figure 2 Major source sub-sectors for SO_2 in percentage of European total



The emissions from SO_2 in Europe can be traced to a few important sources. More than half of all European emissions derive from *Public Power and Cogeneration Plants* (SO_2 top one). The next chapter discusses emissions for the four most important sub-sectors in more detail which together account for 85% of Europe' s SO_2.

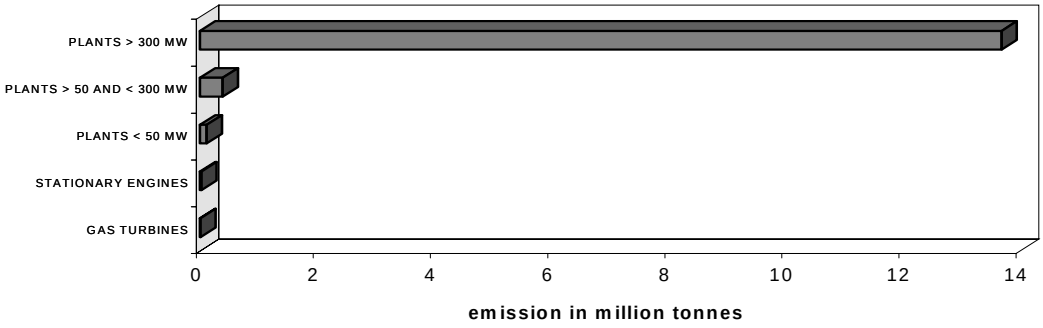
DISTRIBUTION OF MOST IMPORTANT SOURCE SUB-SECTORS

Despite improving abatement technologies *Public Power and Cogeneration Plants* are still by far the most important source for SO_2 (SO_2 top one). 49% of the European total (28 million tonnes) of SO_2 is emitted by 478 European plants (large point sources, LPS) with a thermal capacity over 300 MW (see figure 3), the top 100 accounting for 39% and the top ten for 12%

In the CORINAIR 90 inventory they have been evaluated separately as large point sources (LPS) whose exact location is known. More details to LPS will be provided in another report of the EEA describing the results of CORINAIR 90.

Figure 3 Distribution of SO_2 emission by activity within the top source sub-sector

Public Power and Cogeneration Plants

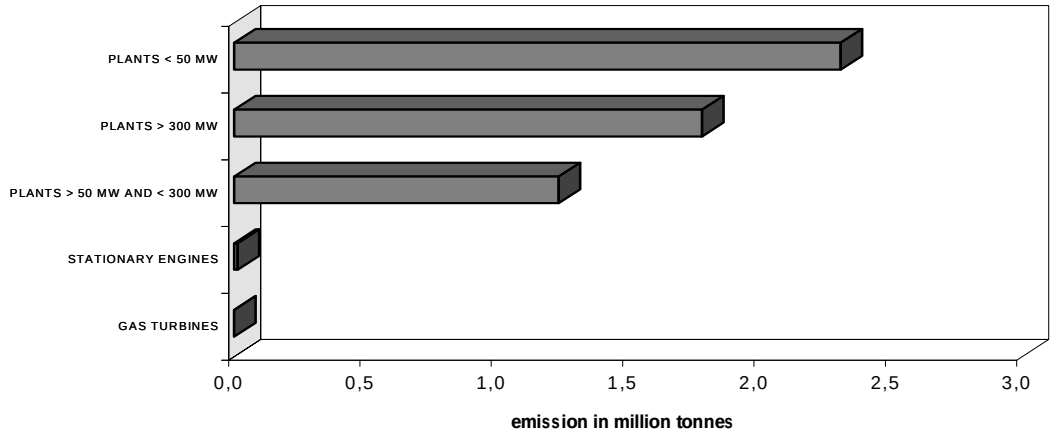


The SO_2 emission from *Industrial Combustion in Boilers, Gas Turbines and Stationary Engines* (SO_2 top two) is not as focused as the previous group (see figure 4). The main part is caused by small plants with a thermal capacity of less than 50 MW. These emissions have been reported almost entirely as area sources. Only 212 plants are responsible for the emissions of plants with a thermal capacity over 300 MW in Europe and contribute 6% of Europe's total.

Stationary Engines and *Gas Turbines* are not significant sources of European SO_2 emissions.

Figure 4 Distribution of SO_2 emission by activity within second top source sub-sector

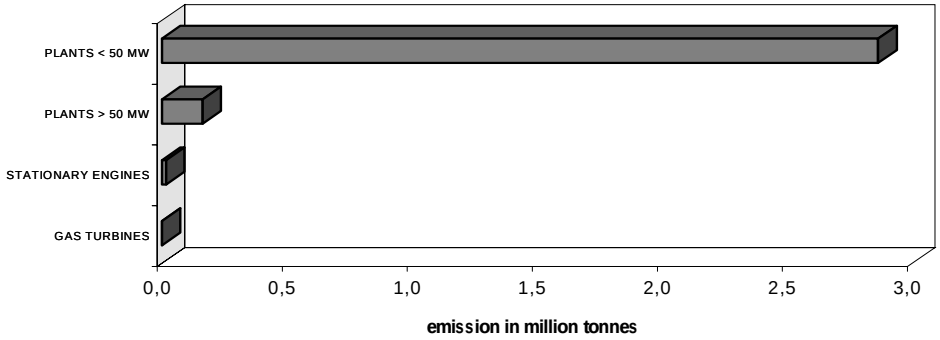
Industrial Combustion in Boilers, Gas Turbines and Stationary Engines



Commercial, Institutional and Residential Combustion Plants are the third most important source of SO_2 emissions in Europe (SO_2 top three). Almost all emissions are produced by small plants (see figure 5) and almost all of these are reported as area sources.

Figure 5 Distribution of SO_2 emission by activity within third top source sub-sector

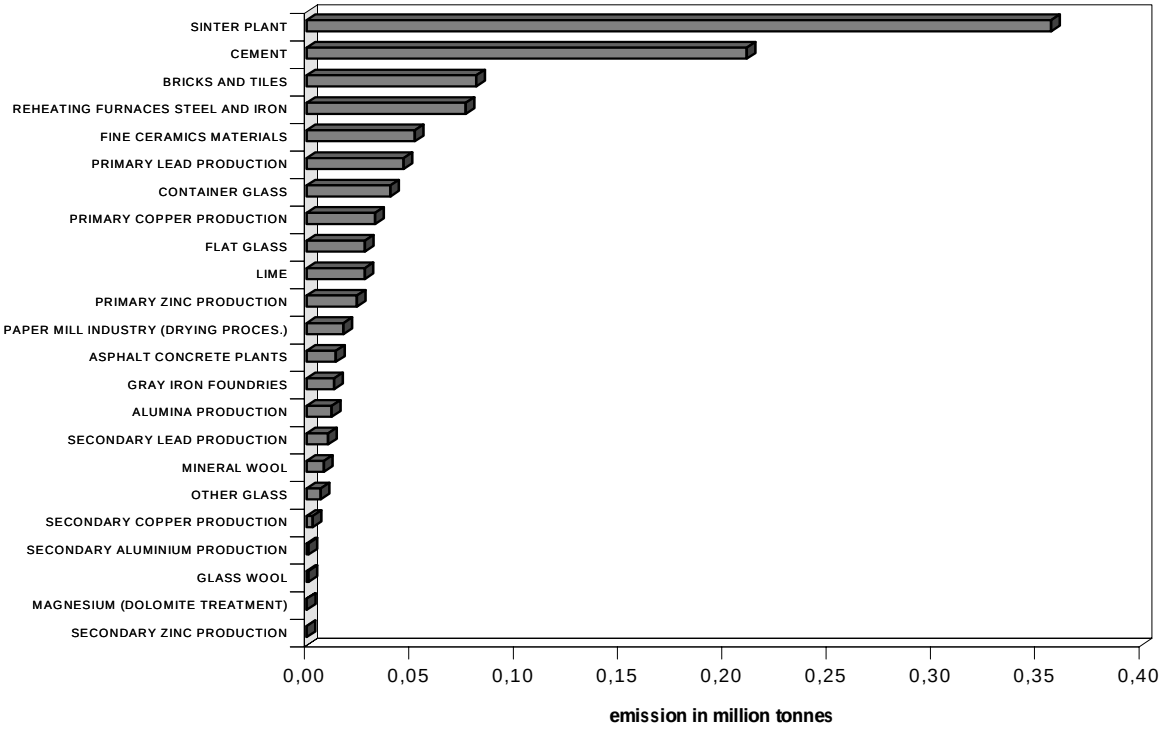
Commercial, Institutional and Residential Combustion Plants



Sinter plants (see figure 6) are the leading source of emissions for *Industrial Combustion - Processes with Contact* (SO_2 top four).

Figure 6 Distribution of SO_2 emission by activity within fourth top source sub-sector

Industrial Combustion - Processes with Contact



The ranking of the SO_2 top five sub-sector *District Heating Plants* is not very certain because many countries assigned their emissions to other sources (see also section two 'national emissions' and appendix D).

Of minor importance, but nevertheless of interest, are the emissions from volcanoes (SO_2 top six). As we will see in section two, only one country (Italy) reported such emissions. It is the only important 'natural' source of SO_2 emission, nevertheless volcanic eruptions contributed 2% of the European total in 1990.

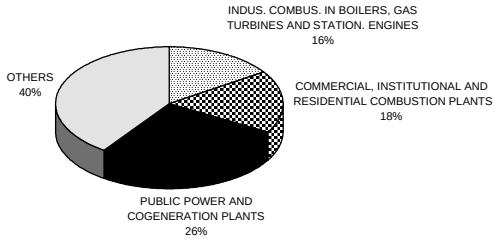
Road Transport is not very significant for SO_2 emissions with one exception. *Heavy Duty Vehicles over 3,5 tonnes and Buses* (SO_2 top eight) are responsible for 1% of the European total.

CO_2

OVERVIEW

4,7 billion tonnes CO_2 were emitted in 1990. The three most important sub-sectors (see figure 7) are the same as for SO_2. However, *Public Power and Cogeneration Plants* are not so dominant and the three biggest sub-sectors are only responsible for 60% of the European total in comparison with 81% for SO_2.

Figure 7 Major source source sub-sectors for CO_2 in percentage of European total



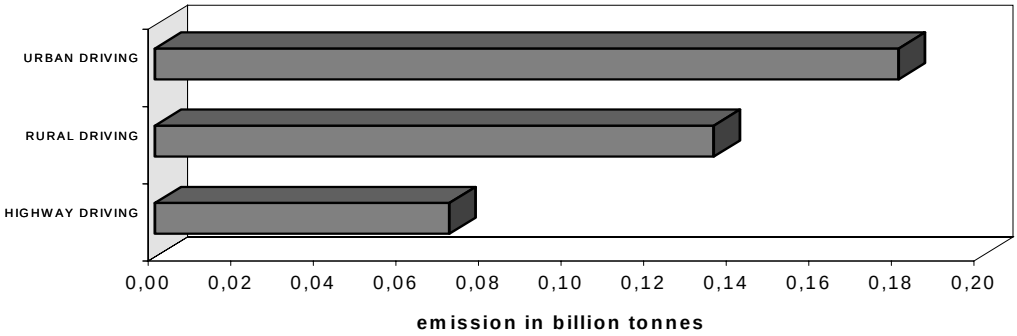
DISTRIBUTION OF MOST IMPORTANT SOURCE SUB-SECTORS

The distribution pattern of the three biggest CO_2 sources is not presented here because their distribution pattern is very similar to that of the three largest sources of SO_2.

It is interesting to note that *Passenger Cars* are responsible for 8% of European CO_2 emissions (CO_2 top four). Urban driving produces more CO_2 than rural and highway traffic (see figure 8).

Figure 8 Distribution of CO2 emission by activity within fourth top source sub-sector

Road Transport: Passenger Cars



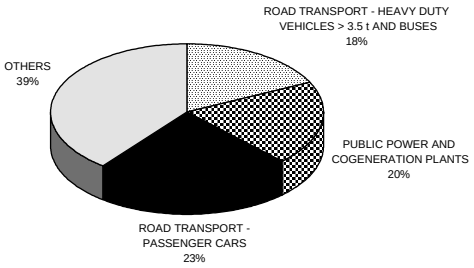
Natural sources seem to be not very important for the European CO_2 emissions. Natural CO_2 emissions including e.g. *Nature-Animals* (CO_2 top seven) have only been reported by seven countries. There is now general consensus that CO_2 emissions from animals (and humans) should not be included in emission inventories since such CO_2 is quickly recycled and hence those sources of CO_2 will not be qualified in subsequent inventories or the update of 1990 inventory.

NO_x

OVERVIEW

Europe emitted 18 million tonnes of NO_x in 1990. *Road transport* (NO_x top one and three) and *Power Plants* (NO_x top two) play a dominant role in the production of NOx emissions (see figure 9). The top three sub-sectors together account for 61% of total NO_x.

Figure 9 Major source sub-sectors for NO_x in percentage of European total

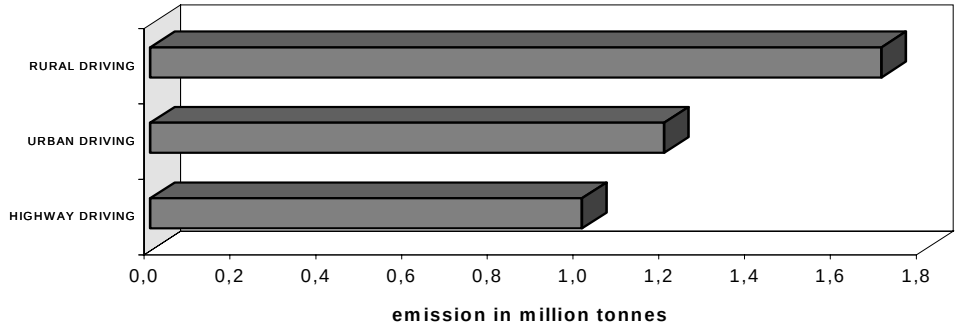


DISTRIBUTION OF MOST IMPORTANT SOURCE SUB-SECTORS

Within the top source sub-sector the use of passenger cars in rural locations is the most important source of NO_x pollution in Europe claiming 10% of the total (see figure 10).

Figure 10 Distribution of NO_x emission by activity within top source sub-sector

Road Transport - Passenger Cars

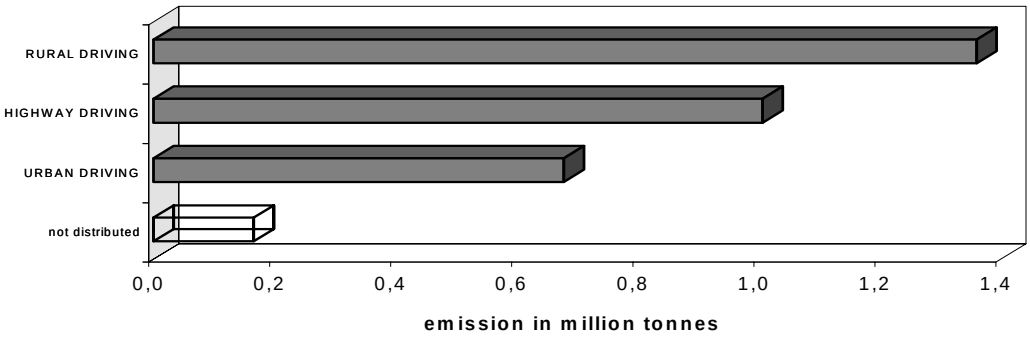


The distribution pattern for *Public Power and Cogeneration Plants* (NO_x top two) is quite similar to that of SO_2 where plants larger than 300 MW are the dominant source and is therefore not presented here.

The third biggest source is *Heavy Duty Vehicles > 3,5t and Buses* with 18% of the European total. Here, in contrast to *Passenger Cars*, highway traffic contributes more than urban traffic (see figure 11).

Figure 11 Distribution of NO_x emission by activity within third top source sub-sector

Road Transport - Heavy Duty Vehicles >3,5t and Buses



Note: Some European countries only estimated emissions for the sub-sector *Road Transport - Heavy Duty Vehicles* as a whole and did not distinguish between rural, urban and highway driving. Here the emissions from these countries have been assigned to the 'not distributed' bar in figure 11 and following.

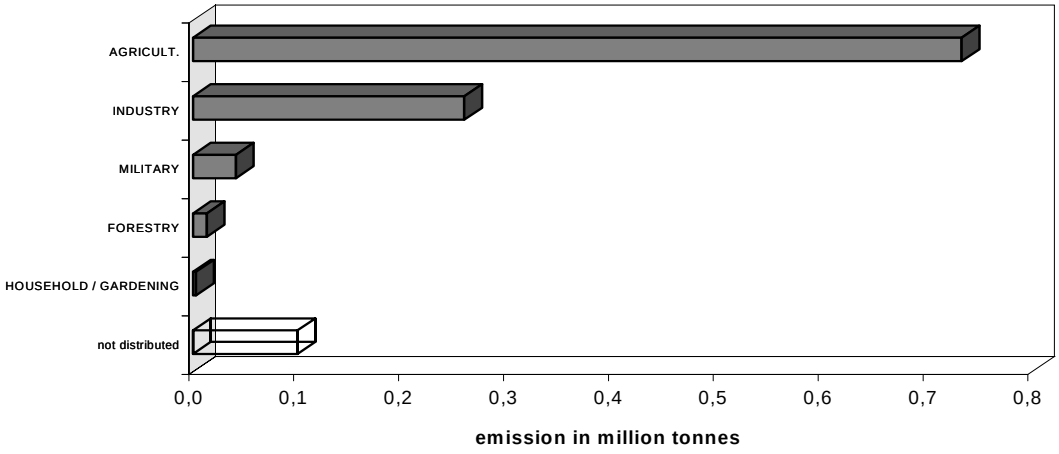
The pattern of the fourth biggest NO_x sub-sector *Industrial Combustion in Boilers, Gas Turbines and Stationary Engines* is quite similar to that of SO_2 and is therefore not presented here (see figure 4).

An interesting point is that *Other Mobile Sources* (NO_x top five) contributed 6% of the European total with major emissions from the agricultural use of other mobiles (see figure 12). About two third of the countries estimated emissions for this sub-sector. If allocated correctly this sub-sector would contribute more than 6%.

Emissions from nature are almost non-existent for NO_x. Perhaps here too, are emissions yet to be considered (e.g. lightning, forest fires).

Figure 12 Distribution of NO_x emission by activity within fifth top source sub-sector

Other Mobile Sources - Off Road Vehicles and Machines

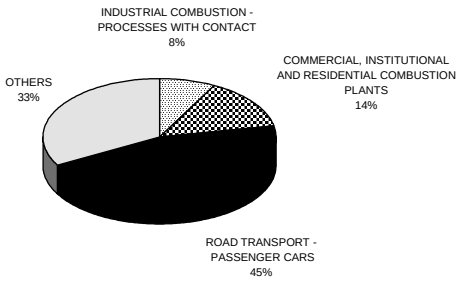


CO

OVERVIEW

The European total for CO emissions in 1990 reached 70 million tonnes. Again *Passenger Cars* are by far the most important source for CO as for NO_x (see figure 13). It is interesting to note that as far as road transport is concerned, light duty vehicles are more important than heavy duty vehicles in contrast to NO_x emissions. The top three sub-sectors account for 67 % of CO.

Figure 13 Major source sub-sectors for CO in percentage of European total

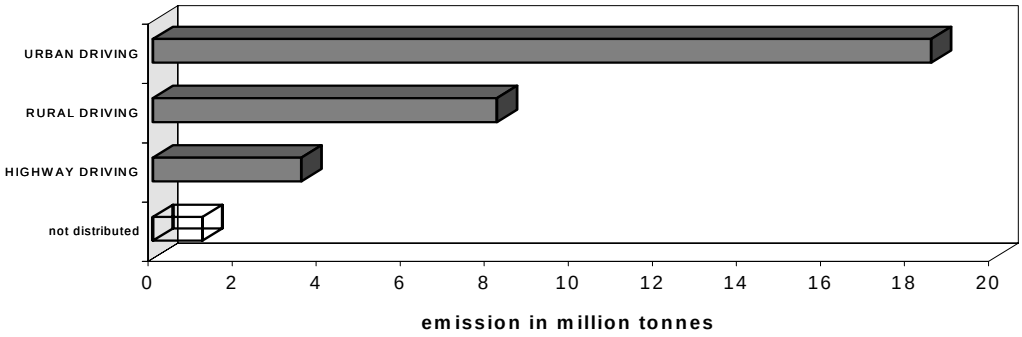


DISTRIBUTION OF MOST IMPORTANT SOURCE SUB-SECTORS

The distribution pattern of CO top one is different to that of NO_x top one: urban traffic is much more important than rural and highway traffic (see figure 14) due to higher CO emission rates during cold starts and higher NO_x emission rates during highway driving.

Figure 14 Distribution of CO emission by activity within top source sub-sector

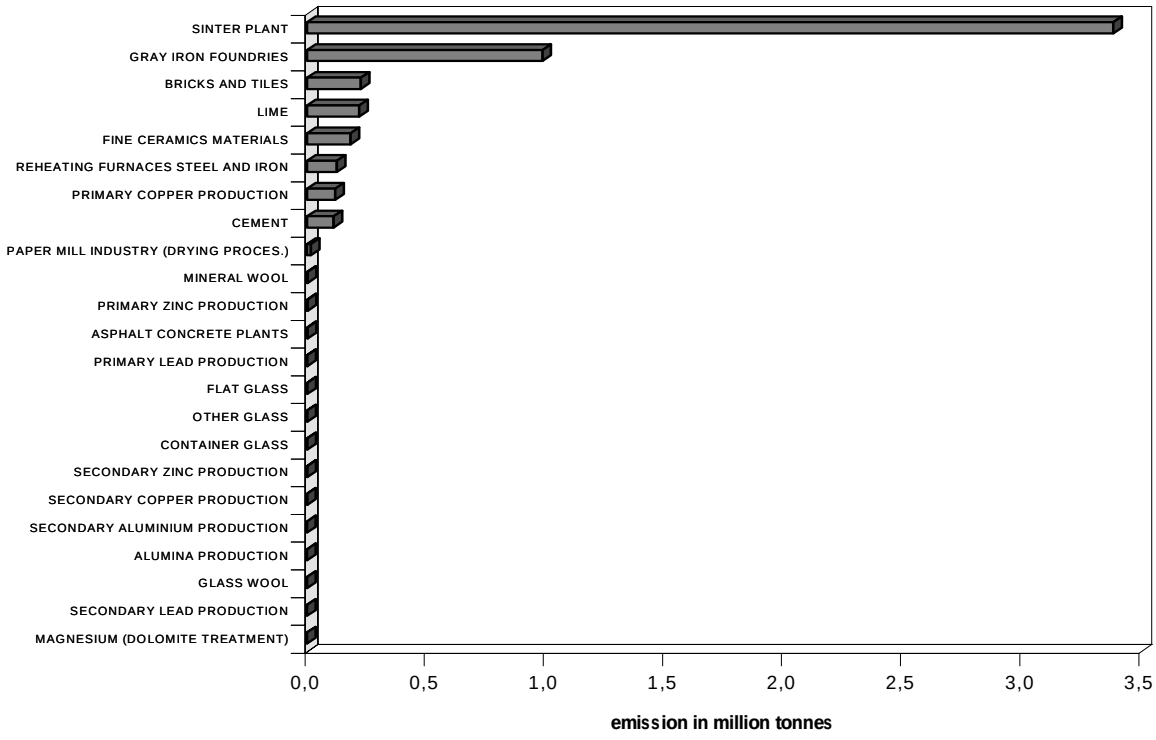
Road Transport: Passenger Cars



The distribution pattern of CO top two is quite similar to SO_2 top three (see figure 5) and is therefore not presented here. The third biggest source for CO is *Industrial Combustion - Processes with Contact* which is responsible for 8% of the European total CO emission. Here the main source of CO as for SO_2 is *Sinter Plants* (see figure 15).

Figure 15 Distribution of CO emission by activity within third top source sub-sector

Industrial Combustion - Processes with Contact



Open Burning of Agricultural Wastes is top four of CO producing 6% of the European total. The CORINAIR 90 inventory did not investigate this sub-sector any further. Only ten countries estimated emissions for this sub-sector. This may indicate that this source of CO pollution is important only in some European countries or that the emissions of this sub-sector have not been estimated or that its emissions are included elsewhere.

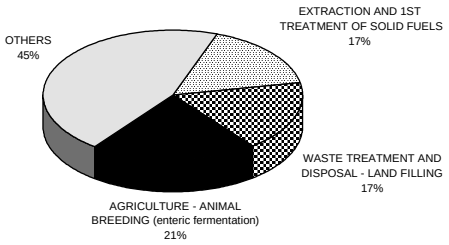
Emissions from nature are of no significance to the top ten sub-sectors for CO.

CH_4

OVERVIEW

The top three source sub-sectors *Agriculture - Animal Breeding (Enteric Fermentation), Waste Treatment and Disposal - Land Filling* and *Extraction and 1st Treatment of Solid Fuels* are responsible for 55% of the 45 million tonnes of CH_4 emitted in 1990 in Europe (see figure 16).

Figure 16 Major source sub-sectors for CH_4 in percentage of European total



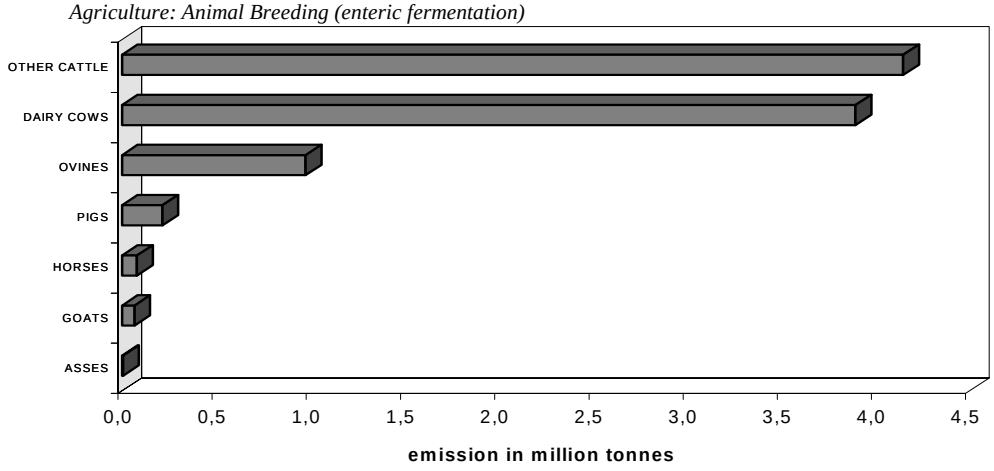
In contrast to the pollutants discussed so far, CH_4 emissions from the combustion of fossil fuels are relatively unimportant. Agriculture is the main sub-sector in Europe for CH_4 where the main source, *Animal Breeding* is responsible for 21% of the total emission.

DISTRIBUTION OF MOST IMPORTANT SOURCE SUB-SECTORS

Taking a closer look at the top-ranking sub-sector for CH_4, the dominant role of cattle is evident (see figure 17).

Figure 17 Distribution of CH_4 emission by activity within top source sub-sector

Agriculture: Animal Breeding (enteric fermentation)



Other Cattle and *Dairy Cows* are responsible for a significant portion of the European CH_4 emission.

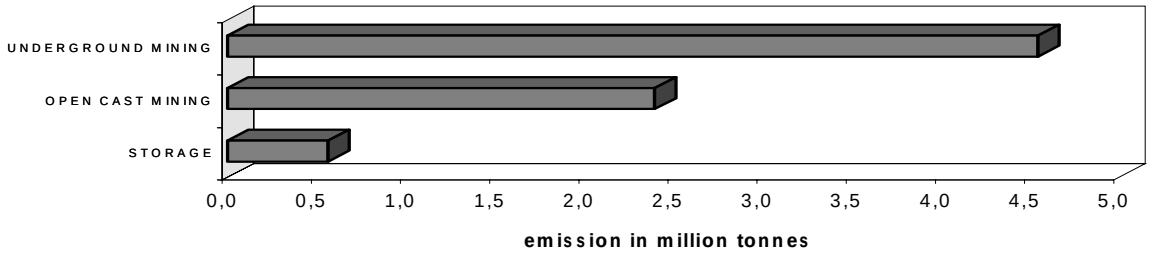
Also important for CH_4 emissions are *Waste Treatment and Disposal - Land Filling* (CH_4 top two) which contribute 17% to the European total.

Underground Mining is an important source for the third ranked sub-sector of CH_4: *Extraction and 1st Treatment of Solid Fuels* (see figure 18). Twelve countries did not report any emissions from this source. Although there is no active mining in many of these countries the storage of coal could be an emission source. These emissions are

significant as figure 18 shows. This suggests that *Extraction and 1st Treatment of Solid Fuels* may be in fact responsible for larger emissions than estimated in CORINAIR 90.

Figure 18 Distribution of CH_4 emission by activity within third top source sub-sector

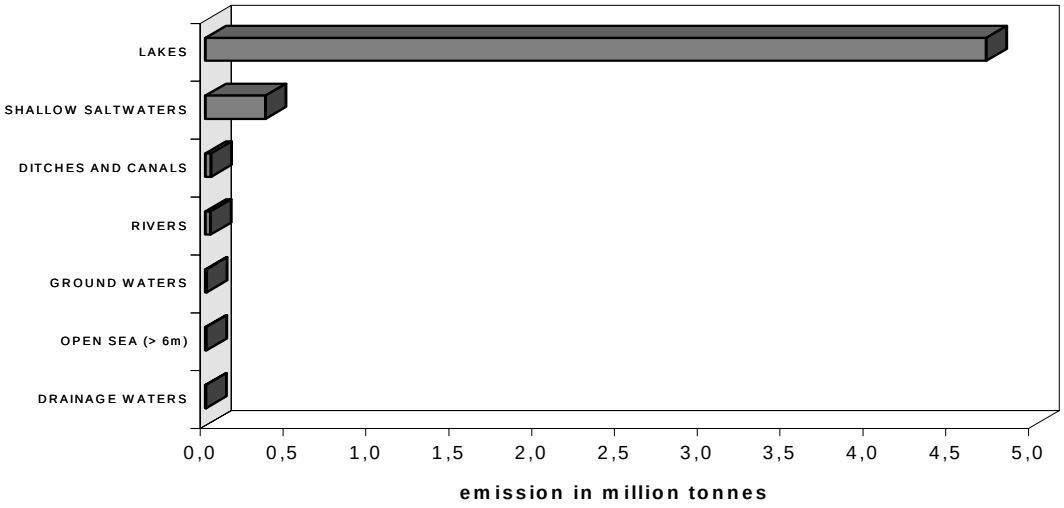
Extraction and 1st Treatment of Solid Fuels



11% of the European total is caused by *Nature - Waters*, where *Lakes* are the major source of CH_4 emissions followed by *Shallow Saltwater* (see figure 19). The large contribution of *Nature - Waters* to total CH_4 emissions has to be interpreted with some care, since 83% originate from one country (Greece) and many countries did not report figures for this source at all (see part II: National Differences within Europe).

Figure 19 Distribution of CH_4 emission by activity within fourth top source sub-sector

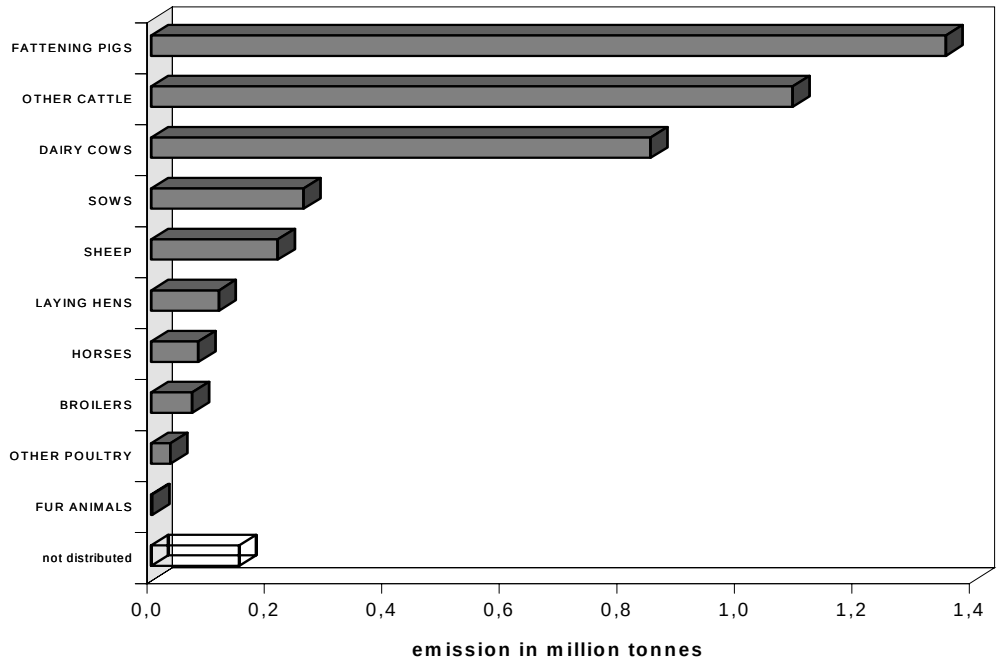
Nature - Waters



Animal Breeding (excretions) is the fifth most important emitter of CH_4 with 9% of the European total, with *Fattening Pigs* followed by *Other Cattle* and *Diary Cows* as the largest sources (see figure 20).

Figure 20 Distribution of CH_4 emission by activity within fifth top source sub-sector

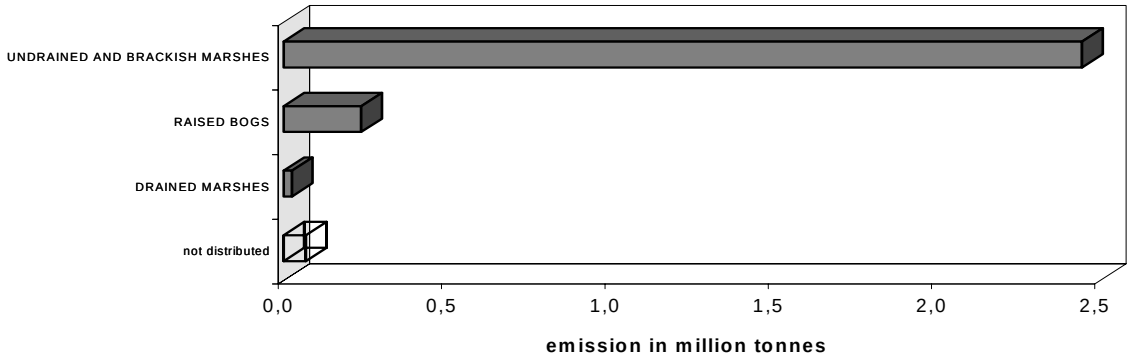
Agriculture - Animal Breeding (excretions)



Nature - Humid Zones is another natural source of CH_4 emissions with 6% of the European total (see figure 21). Again, not all countries reported emissions from this sub-sector but it is not expected that closing the gaps would result in higher CH_4 emissions for *Humid Zones* compared to the emissions from *Animal Breeding (excretion).*

Figure 21 Distribution of CH_4 emission by activity within sixth top source sub-sector

Nature - Humid Zones



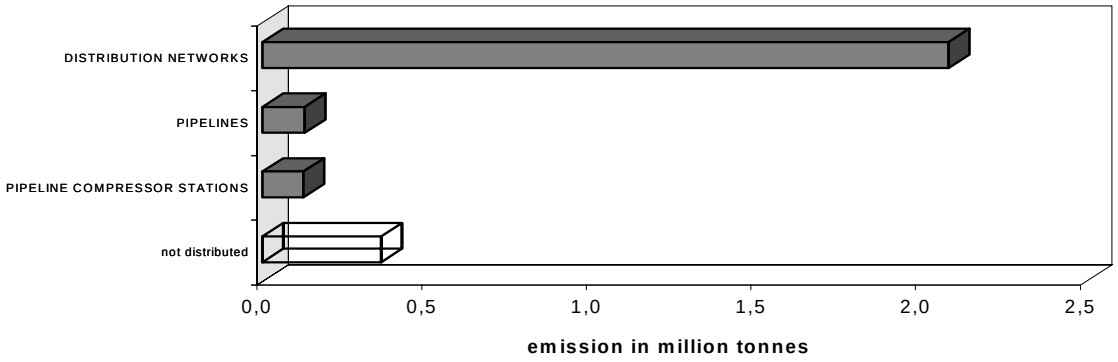
In general, up until now not so much experience has been gained in preparing emission inventories for CH_4 as e.g. for SO_2. This is reflected in the number of countries reporting for the sub-sectors. Whereas all countries reported for CH_4 top one, the ranking for the other sub-sectors is more uncertain because many countries did not report emissions (gaps). This is especially true for emissions from nature. Therefore it

can be assumed that CH_4 emissions of Europe are rather uncertain in comparison to SO_x, CO_2 and NO_x emissions and are probably underestimated.

Although *Gas Distribution Networks* (CH_4 top seven) is only responsible for 6%, it is the second largest sub-sector of emissions which is not related to Nature or Agriculture (see figure 22).

Figure 22 Distribution of CH_4 emission by activity within seventh top source sub-sector

Gas Distribution Networks



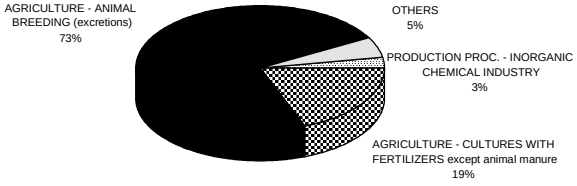
NH_3

OVERVIEW

93% of the 5,7 million tonnes of NH_3 emissions are caused by agricultural activities (NH_3 top one, two and six).

Almost all emissions are produced by the top two sub-sectors (92%). The NH_3 top one sub-sector: *Animal Breeding* (*Excretions)* is alone responsible for 73% of the total (see figure 23). In reality, NH_3 emissions may not be so exclusively dominated by these two sub-sectors, since only very few countries reported emissions for the other sources.

Figure 23 Major source sub-sectors for NH_3 in percentage of European total



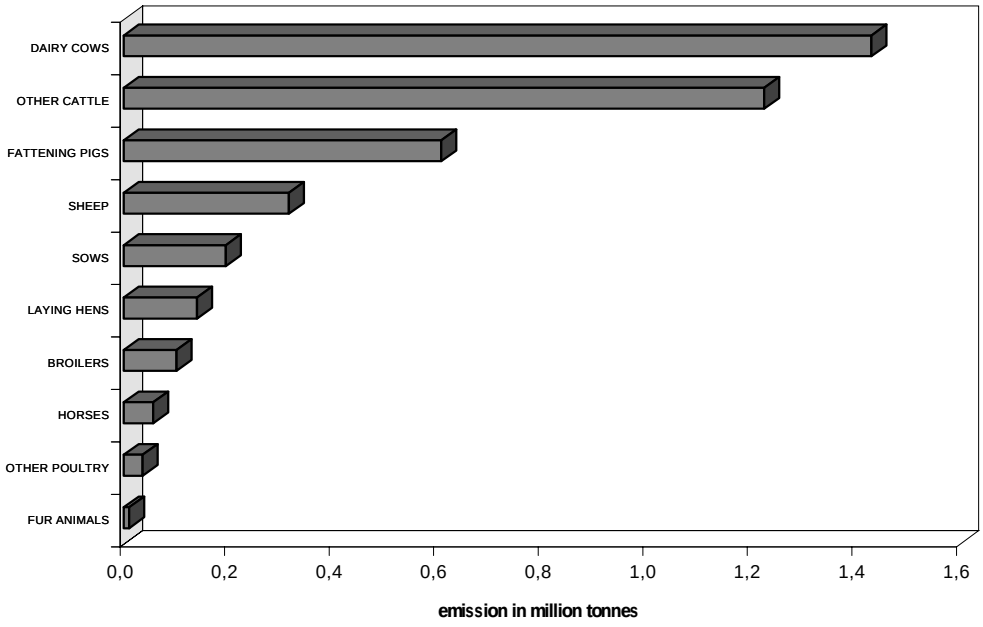
It is pointed out that *Animal Breeding* is also the major sub-sector for CH_4. But whereas *Enteric Fermentation* is more important than *Excretions* for CH_4 emissions it is the other way round for NH_3 emissions. However, only two countries (Czech Republic and Portugal) reported CH_4 as well as NH_3 figures for both source sub-sectors and the comparison of these figures shows that the result of any such comparison is highly uncertain.

DISTRIBUTION OF MOST IMPORTANT SOURCE SUB-SECTORS

As for CH_4, *Diary Cows* and *Other Cattle* are the biggest sub-sectors in Europe (see figure 24).

Figure 24 Distribution of NH_3 emission by activity within top source sub-sector

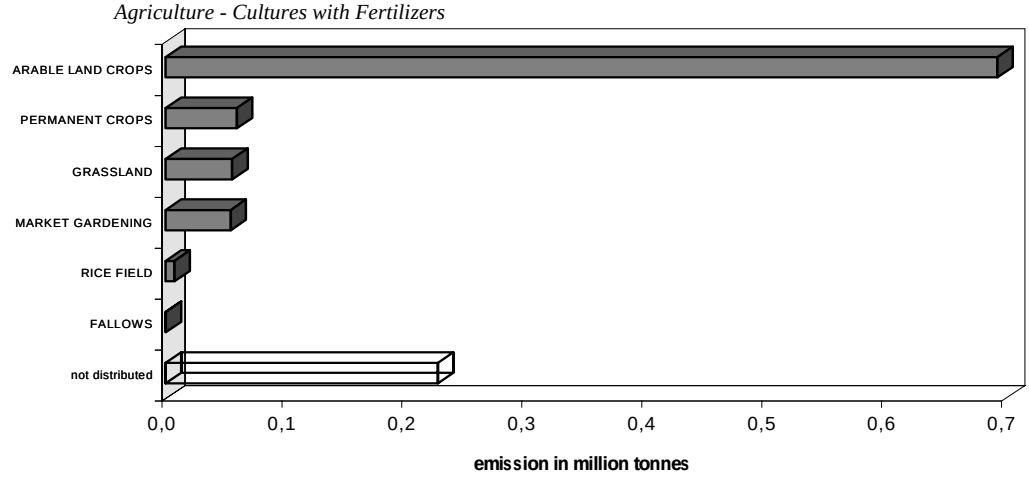
Agriculture: Animal Breeding (excretion)



The use of fertilizers is the second biggest source of NH_3 emissions being responsible for 19% of the European total (see figure 25). It is interesting to note that one country (Greece) contributes more than one third to the total European emissions for this sub-sector (see part II: National Differences within Europe). Thus the emissions of this sub-sector might have been overestimated. However this uncertainty would not change the ranking between the top three NH_3 sub-sectors.

Figure 25 Distribution of NH_3 emission by activity within second top source sub-sector

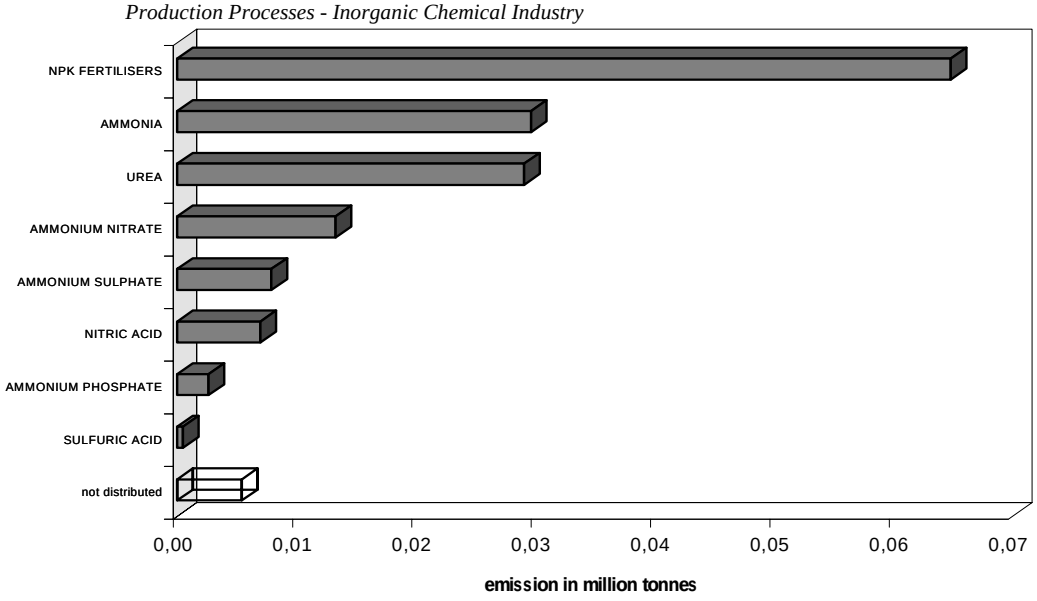
Agriculture - Cultures with Fertilizers



The *Inorganic Chemical Industry is* the third largest source of NH_3 emissions (see figure 26). The production of NPK (nitrogen, phosphor, potassium) fertilizers is the biggest source for the NH_3 top three emission.

Figure 26 Distribution of NH_3 emission by activity within third top source sub-sector

Production Processes - Inorganic Chemical Industry



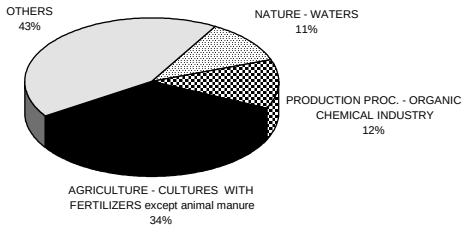
Only in recent years have the countries focused on emissions from NH_3. This is reflected in the few number of countries which reported emissions for NH_3 top four to top ten. The ranking for these sub-sectors is based mainly on emissions estimated by Poland, Netherlands, Slovak Republic, Switzerland and the United Kingdom. The NH_3 emissions might therefore have been underestimated and the relative importance of emissions of the *Inorganic Chemical Industry* may be less than indicated.

N_2O

OVERVIEW

Of the 1,9 million tonnes of N_2O emitted in Europe in 1990 *Cultures with Fertilizers* are responsible for 34%. This sub-sector is followed by the *Organic Chemical Industry and Nature - Waters* (see figure 27). The top three together account for 57%.

Figure 27 Major source sub-sectors for N_2O in percentage of European total

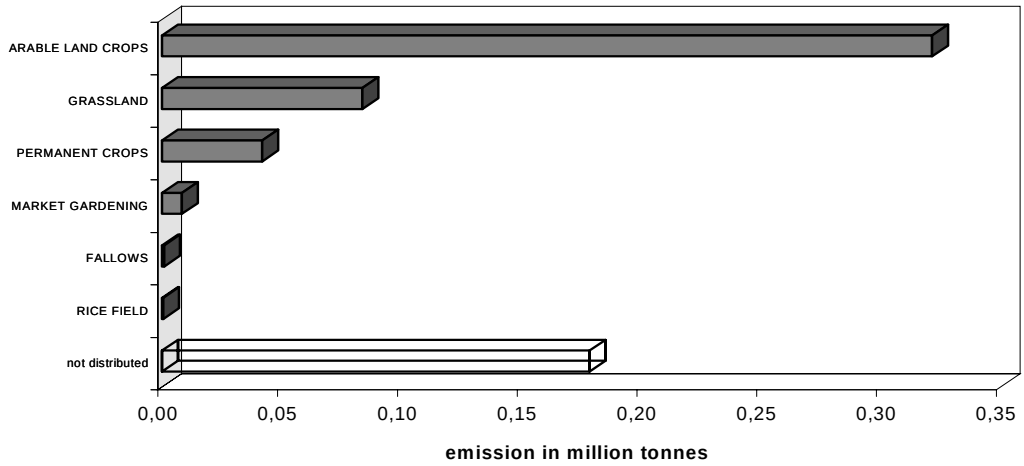


DISTRIBUTION OF MOST IMPORTANT SOURCE SUB-SECTORS

Arable Land and Crops were the major sub-sectors for N_2O in Europe in 1990 (see figure 28). The next largest class consists of emissions from countries which did not differentiate the emissions for this sub-sector category. A comparison with the two other sub-sectors which are included in agriculture shows that *Cultures with Fertilizers* clearly dominate the emissions as compared with emissions from *Cultures without Fertilizers* and *Natural Grassland*.

Figure 28 Distribution of N_2O emission by activity within top source sub-sector

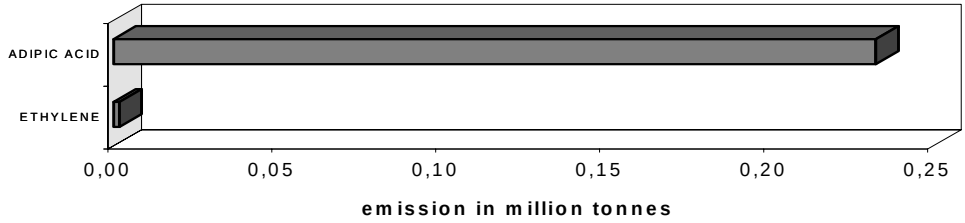
Agriculture: Cultures with Fertilizers (except animal manure)



Production Processes - Organic Chemical Industry are responsible for 12% of European N_2O emissions most of which arise from production of *Adipic Acid* (see figure 29). Such emissions have only been reported by six countries.

Figure 29 Distribution of N_2O emission by activity within second top source sub-sector

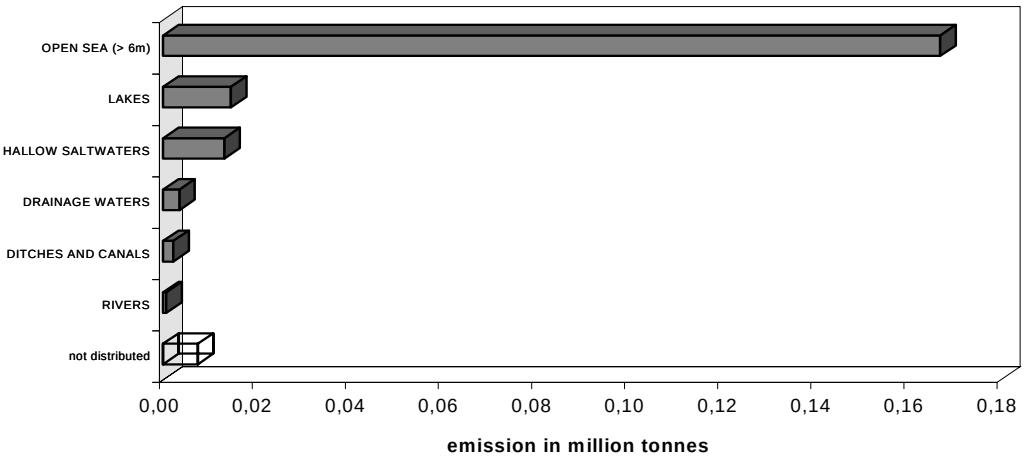
Production Processes: Organic Chemical Industry



11% of European emissions of N_2O is caused by the top three sub-sector *Nature - Waters* where the *Open Sea* is by far the biggest source (see figure 30). Again, many countries (13) did not report emissions for this source, among them large ones including the United Kingdom, Germany and Norway. However the large contribution of *Nature-Waters* to total N_2O emissions has to be interpreted with some care, since 77% appears to originate from one country (Greece).

Figure 30 Distribution of N_2O emission by activity within third top source sub-sector

Nature: Waters

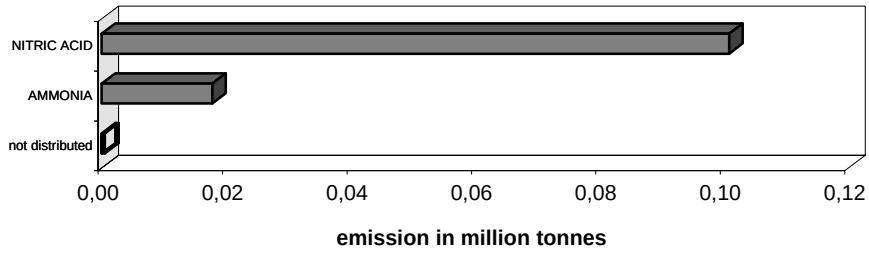


Natural emissions (N_2O top three, four, seven and nine) have not been reported by all countries. Thus the actual N_2O emissions might be significantly higher than estimated and the ranking might be changed too since the differences in emissions between top five and top nine are not large.

The production of *Nitric Acid* is the main source of the N_2O top five sub-sector (see figure 31).

Figure 31 Distribution of N_2O emission by activity within fifth top source sub-sector

Production Processes - Inorganic Chemical Industry



It is interesting to note that unlike emissions for other pollutants (like SO_2, CO, CO_2 and NO_x) N_2O emissions from *Production Processes* are significantly larger than N_2O emissions from fuel combustion.

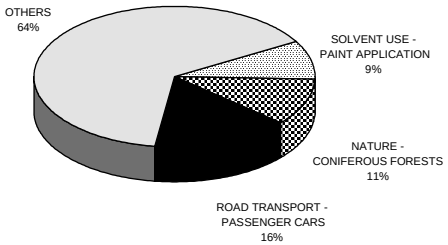
NMVOC

OVERVIEW

Only 72% of European NMVOC emissions are covered by the top ten sub-sectors. This is due to the fact that emissions of organic compounds occur in many sectors and the sources are therefore widespread. The three most important sub-sectors (see figure 32) of the European total of 22 million tonnes are *Road Transport - Passenger Cars* (16%),

followed by *Nature - Coniferous Forests* (11%) and *Solvent Use - Paint Applications* (9%). The top three together contributed only 36%.

Figure 32 Major source sub-sectors for NMVOC in percentage of European total



Road transport contributes a large part of the NMVOC total because it includes both 'tailpipe' emissions (NMVOC top one) and *Evaporation Losses* (NMVOC top six).

Car driving produces even higher NMVOC emissions since *Gasoline Distribution* (NMVOC top ten) is also connected with traffic although, in fact, it belongs to another category (*Extraction and Distribution of Fossil Fuels*).

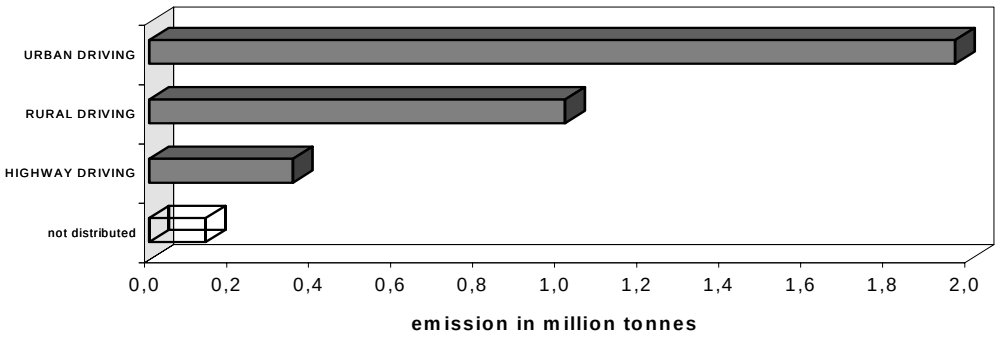
Three of the ten most important NMVOC sub-sectors are solvent related (they represent 20 % of the European total), and thus demonstrate the importance of this source type for NMVOC.

DISTRIBUTION OF MOST IMPORTANT SOURCE SUB-SECTORS

Figure 33 shows that the driving of passenger cars in urban settings contributes much more to the NMVOC emissions of passenger cars than rural and highway driving. This contrasts with the NO_x emissions of passenger cars where rural traffic is more important than urban traffic, but is similar to the distribution of CO emissions from passenger cars (figure 14).

Figure 33 Distribution of NMVOC emission by activity within top source sub-sector

Road transport - Passenger Cars

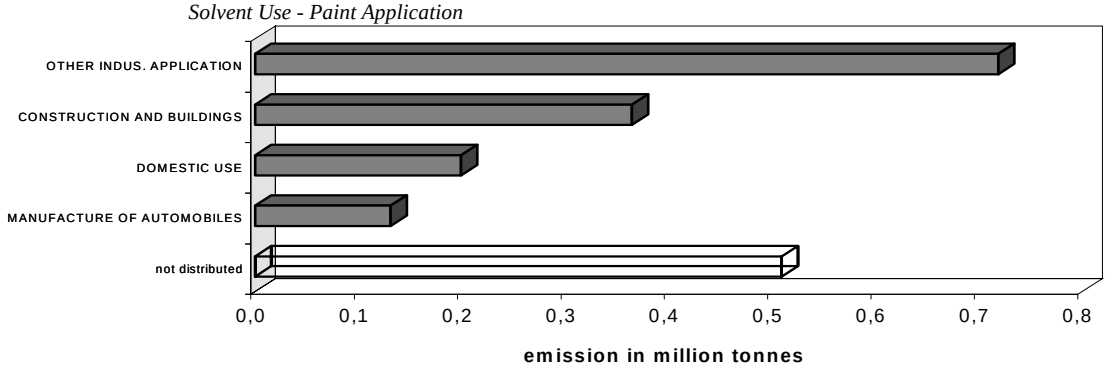


Coniferous Forests are the second largest source of NMVOC emissions, and, together with *Nature - Deciduous Forests* (NMVOC top five), are responsible for almost 20% of the European total.

Emissions from *Solvent Use - Paint Application* (NMVOC top three) are dominated by *Other Indus. Application, e*missions from the sources *Construction and Buildings*, *Domestic Use* and *Manufacture of Automobiles* being less important (see figure 34). However this ranking is not very reliable since many countries did not distinguish between different types of *Solvent Use - Paint Applications*.

Figure 34 Distribution of NMVOC emission by activity within third top source sub-sector

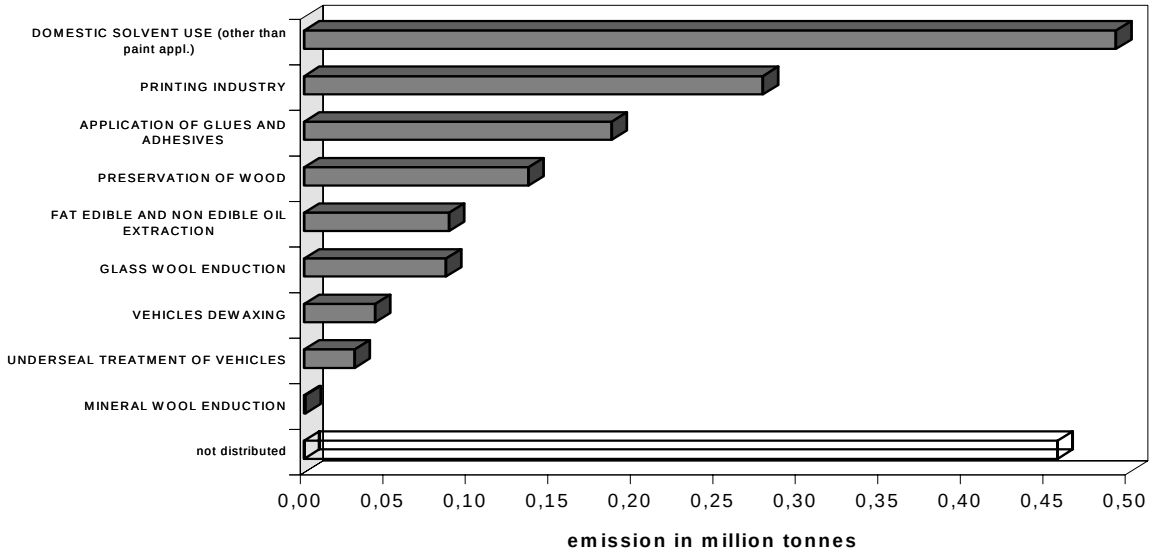
Solvent Use - Paint Application



The distribution of NMVOC top four *Solvent Use - Other Use of Solvents and Related Activities* (see figure 35) is dominated by *Domestic Solvent Use*, followed by the *Printing Industry* and several other industrial activities. Again, the distribution presented is not a very vigorous one, as many countries did not estimate individual emissions for the various sources of the NMVOC top four sub-sector.

Figure 35 Distribution of NMVOC emission by activity within fourth source sub-sector

Solvent Use - Other Use of Solvents and Related Activities



NATIONAL DIFFERENCES WITHIN EUROPE

Introduction

This chapter presents a comparison of national emission profiles for the major sources of air emissions in Europe. These sources are identical with the ten biggest sub-sectors (*top ten sub-sectors*) for each pollutant as discussed in the last chapter.

Care must be taken when comparing national emission profiles. The following points should be kept in mind as possible causes for observed differences in emission values among countries.

- different amount of activity: e. g. different number of animals.
- different emission per activity: special technologies in certain countries can lead to different emission factors.
- inconsistencies: some countries may assign emissions to different sub-sectors or do not evaluate emissions of a specific sub-sector at all (gaps) or use inappropriate activity rates or emission factors. All of these features are being examined by ETC/AEM and UNECE Task Force on Emission Inventories Expert Panels and will be considered with national experts to improve the quality of next inventories and update the 1990 inventory.

The first part of this chapter will present the total emissions in tonnes (1000 tonnes for CO_2) and percentage for each country which contributes to the ten largest sub-sectors in Europe.

Part two offers a comparison of the participating European countries on the basis of per capita emissions for the top ten sub-sectors in Europe.

Comparison of total emissions

This chapter presents those countries in which the *top ten sub-sectors* are mainly located. Countries with emissions of more than 10% of the European total of a specific sub-sector will be graphically for each top ten sub-sector (see figure 36). Countries which contribute less than 10% to the European total are summarised as ‘Others’ in figure 36. Some figures are marked with an asterisk. This indicates that emission data from less than 20 countries were available for this source sub-sector. For details on emissions for each country in tonnes per year see Appendix D, for emissions for each country in percentage of the European total (per sub-sector) see Appendix F.

Usually, sources of emissions are spread over the European countries. However, the emissions of some source sub-sectors are caused by only a few countries. The following summary gives an overview which countries contribute most to the more important source sub-sectors with emphasis on sub-sectors for which only a few countries contribute the largest share of the European emission total for this sub-sector.

SO_2

It is worth noting that the top three sub-sectors (*Public Power and Congeneration Plants; Industrial Combustion in Boilers; Commercial, Industrial and Residential Combustion Plants*) for SO_2 are dominated by the United Kingdom, Germany (former East) and Poland. This is not surprising as these countries use a lot of (domestic) coal as fuel and until 1990 did not use emission control technology like flue gas desulphurization (FGD) technology on a larger scale. Spain and Czech Republic are also countries which contribute more than 10% to one of the three top sub-sectors and also in these two countries emissions of SO_2 result mainly from the combustion of domestic coal without using best available abatement technology.

For the first time CORINAIR 90 gives a more detailed insight into the SO_2 emissions from industry on a European scale. It is interesting to note that whereas SO_2 emissions from *Industrial Combustion in Boilers* etc. are dominated by countries like Germany (former East), United Kingdom and Poland, SO_2 emissions from *Industrial Combustion - Processes with Contact* are dominated by Poland, Spain, France and Italy. Three of these countries (Spain, France and Italy) also dominate the SO_2 emissions from *Industrial Combustion from Processes without Contact*.

The emissions from the SO_2 top five (*District Heating Plants*) is dominated by Central and Eastern European countries, probably due to the extensive use of coal in these plants.

More than half of European emissions of SO_2 top nine (*Other Mobile Sources - Marine Activities)* is emitted by Greece due to a very high activity in this sub-sector. It is worth noting, that some smaller countries (Latvia, Netherlands) belong to the group of European countries with emissions of more than 10% for one of the top ten sub-sectors of SO_2 (Latvia for the top five sub-sector and the Netherlands for the top ten sub-sector).

The most focused sub-sector for the SO_2 top ten is *Nature - Volcanoes* (SO_2 top six). Only Italy reported emissions for this sub-sector.

CO_2

As is the case for SO_2, those countries with the largest CO_2 emissions present different profiles for each of the top ten sub-sectors.

Whereas the same country, namely the United Kingdom, has the largest contribution to the SO_2 and CO_2 top one sub-sector (*Public Power and Cogeneration),* not Germany (former East) but Germany (former West) is the country with the second largest CO_2

emissions from this sub-sector. Comparing the amount of SO_2 (in kg) which is emitted per ton of CO_2 in former West and East Germany this different ranking becomes clear: app. 1 kg SO_2 / t CO_2 in former West compared to 18 kg SO_2 / t CO_2 in former East. The smaller SO_2 emissions per ton CO_2 in former West Germany are the result of using fuels with lower sulphur content and application of FGD units.

Germany (former West) provides the largest contribution for the top two, three and four CO_2 sub-sectors and the second largest contribution to the top six sub-sector, probably due to it's large population and large transport sector. For the top five sub-sector (*Industrial Combustion - Processes with Contact*) the same countries as for SO_2 (Poland, France, Spain and Italy) are the largest contributors.

NO_x

The countries with the largest population and transport sector (Germany, former West; United Kingdom; France and Italy) in Europe are dominating the emissions from the top one sub-sector (*Road Transport - Passenger Cars*) and top three subsector (*Road Transport - Heavy Duty Vehicles*.) The situation is somehow different with respect to the top nine subsector (*Road Transport - Light Duty Vehicles*) as Germany, former West contributes less than 10% (app. 6,5%) to European emissions of this source sub-sector. The main contributors to the top two subsector (*Public Power and Cogeneration*) are the United Kingdom and Poland, which is comparable to the situation for SO_2. The emissions from former West Germany are relatively small (7 %), probably due to application of de-NO_x measures. The main contributing countries to the combustion related industrial sub-sectors (top four and top six NO_x sub-sectors) are the same countries as for CO_2 for the same sub-sectors (respectively former West Germany and Poland). This indicates that the emission estimates of NO_x and CO_2 for these subsectors are consistent.

It is interesting to note that Greece contributes only 28% to the NO_x top eight sub-sector compared to 51% for the SO_2 top nine sub-sector (both: *Other Mobile Sources - Marine Activity*).

Another sub-sector to mention here is NO_x top ten (*Production Proc. - Inorganic Chemical Industry*) where Poland is responsible for 30%.

Finally it is worth noting that the country with the second largest NO_x top ten emission is Bulgaria.

CO

The top one sub-sector for CO (*Road Transport - Passenger Cars*) corresponds well to the top source for NO_X and so do the main contributing countries. This is a clear indication of the consistency of the estimates for this top sub-sector and its various pollutants in the different countries.

The results with respect to the country split are not as consistent for other top sub-sectors like *Road Transport, Heavy Duty Vehicles* (top six) or *Industrial Combustion in Boilers, Gas Turbines and Stationary Engines* (top nine).

In general a smaller number of countries are responsible for emissions from the CO top ten sub-sectors than those for the pollutants described previously. CO top ten, nine and three is dominated by Poland. France emits 46% of the CO top five sub-sector (*Road Transport - Light Duty Vehicles <3,5t*) and is the country with the biggest emissions of top two (*Commercial, Institutional and Residential Combustion Plants*) and seven (*Production Processes- Iron and Steel Industries nad Collieries*) as well.

Results which indicate a need for a more detailed investigation are listed below:

- The United Kingdom and Germany (former West) are the major contributors to NO_x top three sub-sector (*Road Transport - Heavy Duty Vehicles >3,5t and Buses*), but both countries contribute less than 10% to CO emissions from the same sub-sector.

- Italy and France together contribute 63% to top eight (*Other Mobile Sources - Off Road Vehicles and Machines*). No other country contributes more than 10%. Whereas France contributes less than 10% to NO_x emissions of the same sub-sector, Germany (former West) contributes more than 10% to NO_x emissions from this sub-sector, but less than 10 % to CO emissions from the same sub-sector.

- Poland contributes 70% to the top ten sub-sector (*Industrial Combustion - Process Furnaces without Contact*). No other country contributes more than 10% to the European total.

- Poland and Germany (former East) together contribute 67% to top nine (*Industrial Combustion in Boilers, Gas Turbines and Stationary Engines*).

CH_4

The European countries with large population and area (France; United Kingdom; Germany, former West) dominate the emissions for the top sub-sector *Agriculture - Animal Breeding*. The emissions of the top two sub-sector *(Waste Treatment and Disposal - Land Filling*) is also dominated by European countries with large population and area (Germany, former West; Italy; United Kingdom) whereas the countries with high coal mining activity (Poland; Germany, former West; Czech Republic an United Kingdom) are those with the largest contribution with respect to *Extraction an 1st Treatment of Solid Fuels (*the top 3 sub-sector).

Looking at the top five sub-sector, *Agriculture - Animal Breeding (excretions)* however, only one of the larger European countries (Germany, former West) is among those with

a contribution larger 10%. This is an indication that the results for CH_4 emissions are less consistent compared to SO_2 or CO_2 .

Another unexpected result is the large emission for the CH_4 top four sub-sector (*Nature - Waters*) reported by Greece. This high value is due to the large area of app. 860 000 km^2 which has been taken into account. However, fifteen countries did not report any CH_4 emission for this sub-sector, among them large countries as Germany and the United Kingdom. Noteworthy is furthermore that Poland contributes 46% to the top nine (*Agriculture - Cultures with Fertilizers*) and Sweden 43% to the top six sub-sector (*Nature - Humid Zones*). Such unexpected results are mainly due to the fact that for the top four to top ten sub-sectors only a few countries have reported emissions.

Spain reports the largest CH_4 emissions for *Coniferous and Deciduous Forests* in Europe. The other five countries which contribute more than 10% have quite different profiles (Poland and Austria reported the largest emissions for *Coniferous Forests*, Italy and Greece for *Deciduous Forests*).

In general the results for CH_4 are less complete and consistent than the results for SO_2 and CO_2.

NH_3

The emissions of the top sub-sector *(Agriculture - Animal Breeding*), which dominates overall European NH_3 emissions (see figure 23), are dominated by France and Germany (former West). This is consistent with the results for the CH_4 emissions of the same source. NH_3 emissions are dominated by *Animall Breeding (excretions)* whereas CH_4 emissions are dominated by *Animal Breeding (enteric fermentation).*

The largest emissions for the top two sub-sector (*Agriculture - Cultures with Fertilizers*) were reported by Greece due to the use of a very high emission factor. Poland, Italy and France are the countries with a contribution larger 10% for top three sub-sector (*Production Processes-Inorganic Chemical Industry).*

European emissions for the other NH_3 top ten sub-sectors are dominated by a few countries. With the exception of the three most important sub-sectors, only one or two countries are responsible for almost all of the European total. This is due to the fact that only a few countries have reported emissions for those sub-sectors.

N_2O

Most countries provided values for the N_2O top ten sub-sectors. As can be expected large countries like Poland and the United Kingdom are the European countries with the largest N_2O emissions for the top sub-sector (*Agriculture-Cultures with Fertilizers*). This result corresponds quite well with the fact that for the same sub-sector the United Kingdom is among the European countries with the largest NH_3 emissions and Poland the country with the largest CH_4 emissions.

Germany (former West), the United Kingdom and France are responsible for 93% of the emissions from top two sub-sector (*Production Processes-Organic Chemical Industry).* However only two other countries reported emissions for this sub-sector the results being an order of magnitude lower compared to the above mentioned countries.

Remarkable is top three (*Nature - Waters*) with Greece being responsible for more than three quarters of the European total (see also comment for CH_4). However, it should be noted that thirteen countries did not report any emissions for this sub-sector, among them such large countries as Germany (former West) and the United Kingdom. Spain is as for CH_4 the country with the largest N_2O emissions for *Coniferous and Deciduous Forests,* the top four N_2O sub-sector.

NMVOC

The NMVOC emissions for the top sub-sector *Road Transport - Passenger Cars* compare quite well to the results for the NO_X - emissions from the same sub-sector with the same four countries (United Kingdom; France; Italy and Germany former West) each contributing more than 10% to the European total of this sub-sector. As can be expected the same four countries are dominating the emissions of the top three sub-sector *Solvent Use and Paint Application* and the top four sub-sector *Solvent Use - other Use of Solvent and Related Activities* as well.

It is noteworthy that only two countries, Germany (former West) and the United Kingdom, are responsible for together 51% of the emissions from the top ten sub-sector (*Gasoline Distribution*). No other country contributed more than 10% to this sub-sector. In contrast to this, Germany (former West) and the United Kingdom contributed only 30% to NMVOC emissions from the top one sub-sector (*Road Transport - Passenger Cars*) and the United Kingdom alone contributed less than 10%. These results seem inconsistent and could be investigated in more detail.

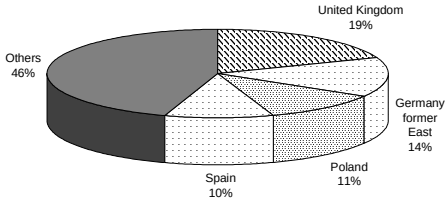
As for CH_4 and N_2O Spain is the country with the largest NMVOC emissions from *Forests* (both *Coniferous and Deciduous*), the top two and top five sub-sector for NMVOC respectively. However, it is surprising to find Austria, one of the smaller European countries, recorded twice among countries with the largest emissions for a sub-sector (rank two for top eight - *Solvent Use-Chemical Products Manufacturing or Processing* - and rank three for top seven - *Commercial, Institutional and Residential Combustion Plants*). The high contribution to top seven (as well that of Sweden) can be attributed to the large amount of wood burned in small furnaces.

Summarised the stability of the ranking for all pollutants seems reliable for the three biggest sources but becomes less reliable from there on for SO_2, CO_2, NO_x, CO and NMVOC. The emissions for CH_4, N_2O and NH_3 have not been evaluated as consistently and comprehensively. The ranking for these pollutants is therefore more uncertain.

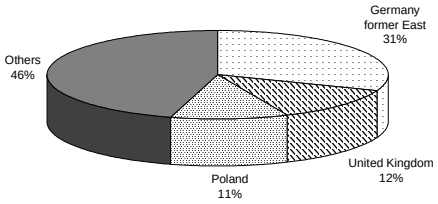
Figure 36 **National contributions to the ten most important polluters in Europe**

SO_2

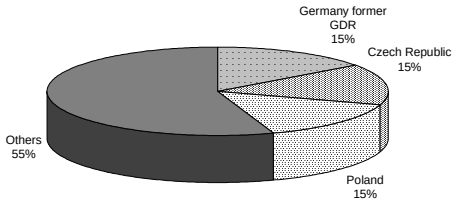
TOP ONE
PUBLIC POWER AND COGENERATION PLANTS



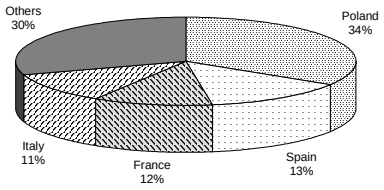
TOP TWO
INDUS. COMBUS. IN BOILERS, GAS TURBINES AND STATION ENGINES



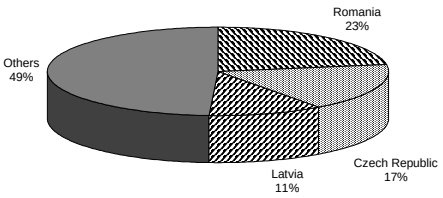
TOP THREE
COMERCIAL, INSTITUTIONAL AND RESIDENTAL COMBUSTION PLANTS



TOP FOUR
INDUSTRIAL COMBUSTION - PROCESS WITH CONTACT



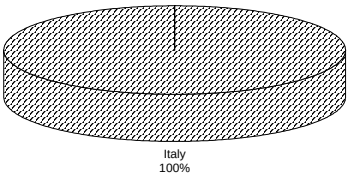
TOP FIVE
DISTRICT HEATING PLANTS



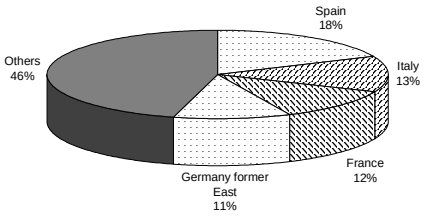
* ... less than 20 countries provided emission estimates

A

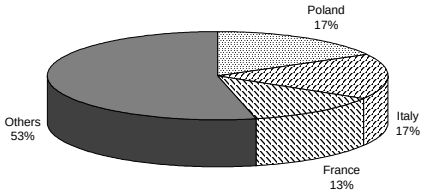
TOP SIX*
NATURE- VOLCANOES



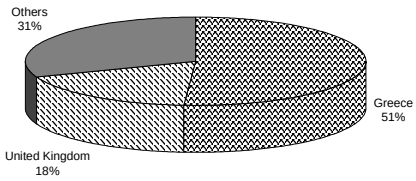
TOP SEVEN
INDUSTRIAL COMBUSTION - PROCESS FURNANCES WITHOUT CONTACT



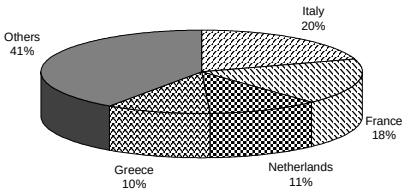
TOP EIGHT
ROAD TRANSPORT - HEAVY DUTY VEHICLES > 3.5 t AND BUSSES



TOP NINE*
OTHER MOB. SOURCES - MARINE ACTIVITIES



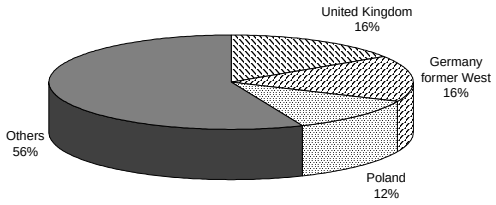
TOP TEN
PRODUCTION PROCESSES - PETROLEUM INDUSTRIES



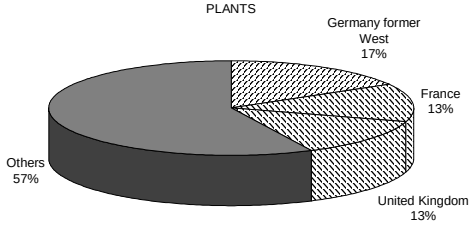
B

CO_2

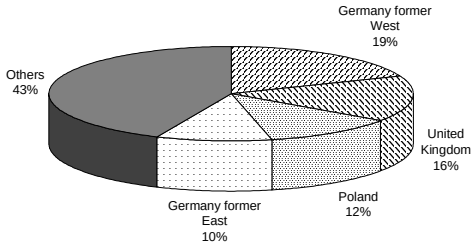
TOP ONE
PUBLIC POWER AND COGENERATION PLANTS



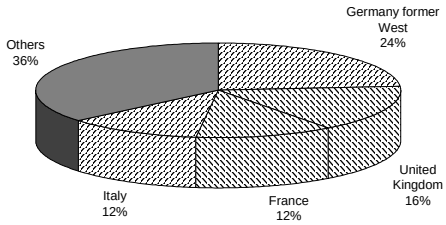
TOP TWO
COMMERCIAL, INSTITUTIONAL AND RESIDENTIAL COMBUSTION
PLANTS



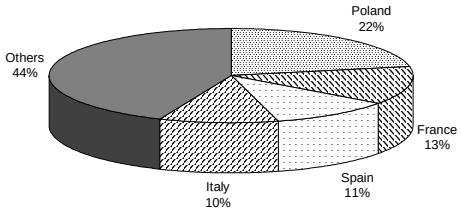
TOP THREE
INDUS. COMBUS. IN BOILERS, GAS TURBINES AND STATION.
ENGINES



TOP FOUR
ROAD TRANSPORT - PASSENGER CARS

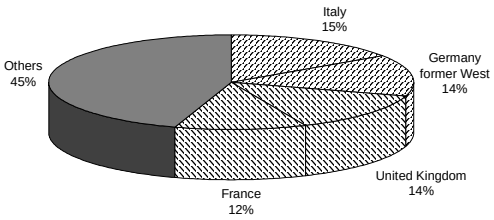


TOP FIVE
INDUSTRIAL COMBUSTION - PROCESSES WITH CONTACT

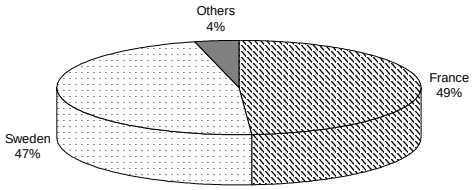


* ... less than 20 countries provided emission estimates

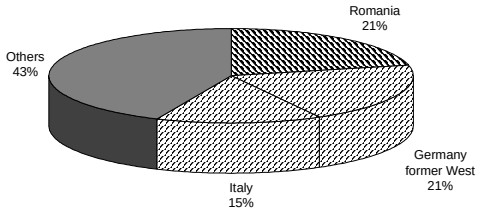
TOP SIX
ROAD TRANSPORT - HEAVY DUTY VEHICLES > 3.5 t AND BUSES



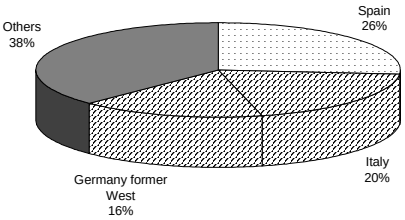
TOP SEVEN*
NATURE - ANIMALS



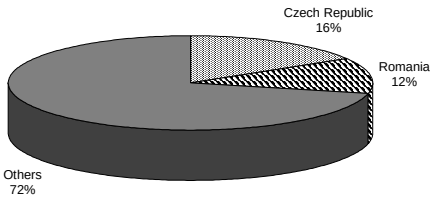
TOP EIGHT
INDUSTRIAL COMBUSTION - PROCESS FURNACES WITHOUT CONTACT



TOP NINE
PRODUCTION PROC. - WOOD,PAPER PULP,FOOD,DRINK & OTHER IND.

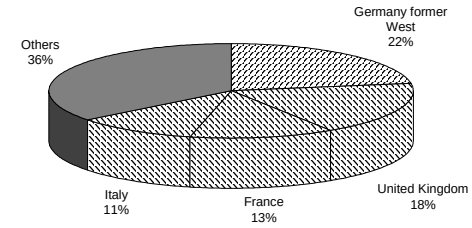


TOP TEN
DISTRICT HEATING PLANTS

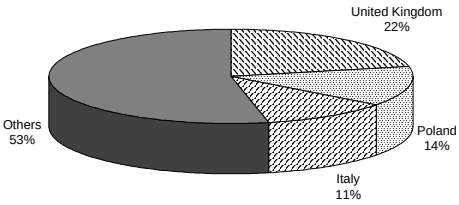


NO_x

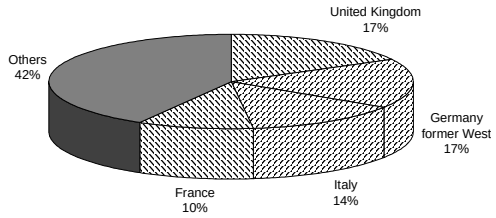
TOP ONE
ROAD TRANSPORT - PASSENGER CARS



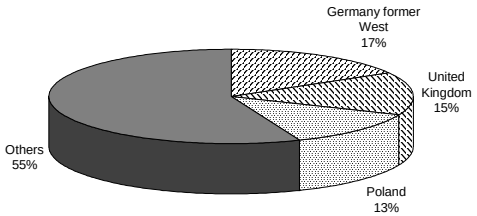
TOP TWO
PUBLIC POWER AND COGENERATION PLANTS



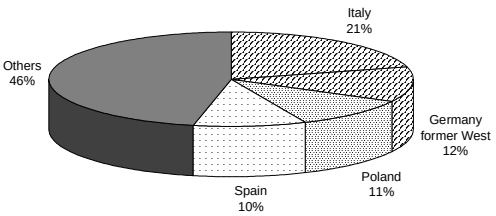
TOP THREE
ROAD TRANSPORT - HEAVY DUTY VEHICLES > 3.5 t AND BUSES



TOP FOUR
INDUS. COMBUS. IN BOILERS, GAS TURBINES AND STATION. ENGINES

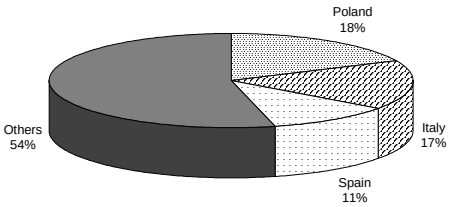


TOP FIVE
OTHER MOB. SOURCES - OFF ROAD VEHICLES AND MACHINES

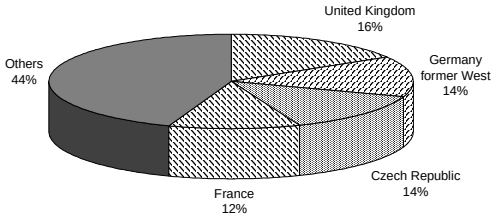


* ... less than 20 countries provided emission estimates

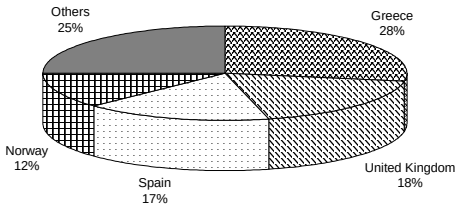
TOP SIX
INDUSTRIAL COMBUSTION - PROCESSES WITH CONTACT



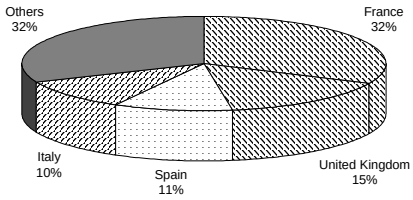
TOP SEVEN
COMMERCIAL, INSTITUTIONAL AND RESIDENTIAL COMBUSTION PLANTS



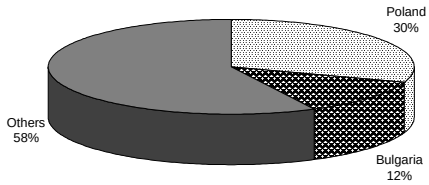
TOP EIGHT*
OTHER MOB. SOURCES - MARINE ACTIVITIES



TOP NINE
ROAD TRANSPORT - LIGHT DUTY VEHICLES < 3.5 t

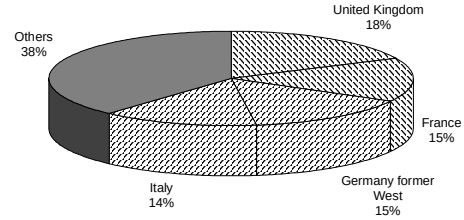


TOP TEN
PRODUCTION PROC. - INORGANIC CHEMICAL INDUSTRY

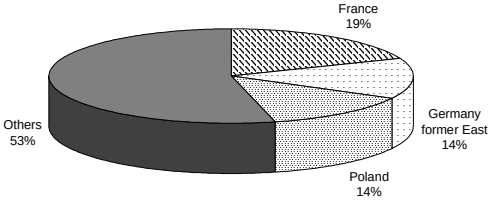


CO

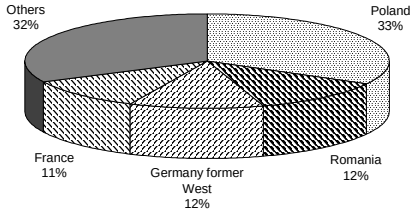
TOP ONE
ROAD TRANSPORT - PASSENGER CARS



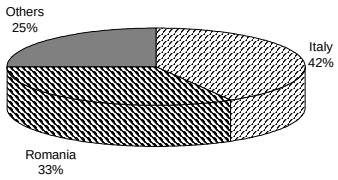
TOP TWO
COMMERCIAL, INSTITUTIONAL AND RESIDENTIAL COMBUSTION
PLANTS



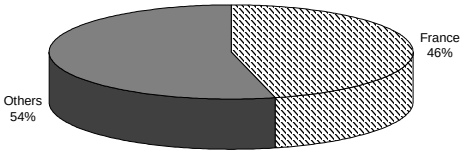
TOP THREE
INDUSTRIAL COMBUSTION - PROCESSES WITH CONTACT



TOP FOUR*
W.T.D. - OPEN BURNING OF AGRICULTURAL WASTES (except
10.03)

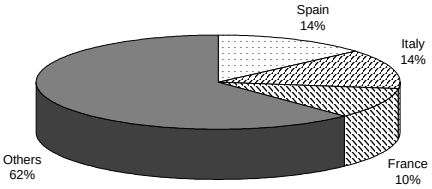


TOP FIVE
ROAD TRANSPORT - LIGHT DUTY VEHICLES < 3.5 t

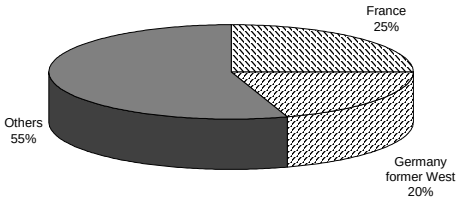


* ... less than 20 countries provided emission estimates

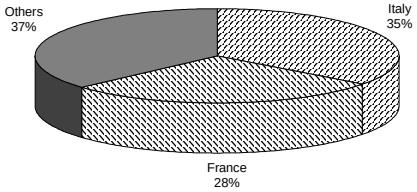
TOP SIX
ROAD TRANSPORT - HEAVY DUTY VEHICLES > 3.5 t AND BUSES



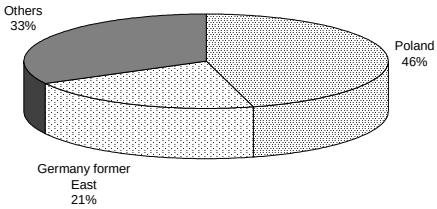
TOP SEVEN*
PRODUCTION PROC. - IRON AND STEEL INDUSTRIES AND COLLIERIES



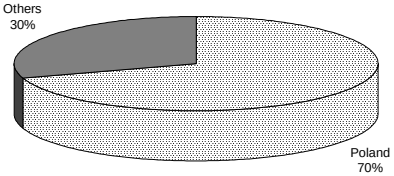
TOP EIGHT
OTHER MOB. SOURCES - OFF ROAD VEHICLES AND MACHINES



TOP NINE
INDUS. COMBUS. IN BOILERS, GAS TURBINES AND STATION. ENGINES

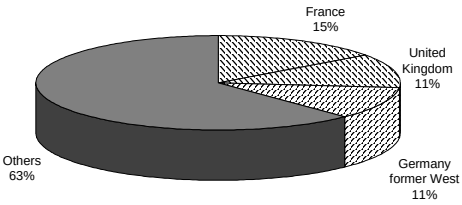


TOP TEN
INDUSTRIAL COMBUSTION - PROCESS FURNACES WITHOUT CONTACT

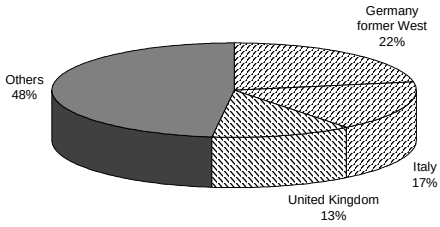


CH_4

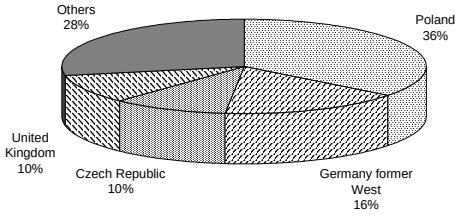
TOP ONE
AGRICULTURE - ANIMAL BREEDING (enteric fermentation)



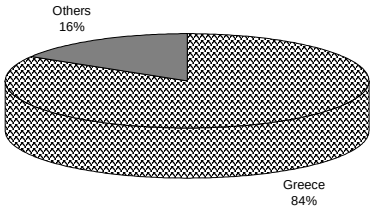
TOP TWO
WASTE TREATMENT AND DISPOSAL - LAND FILLING



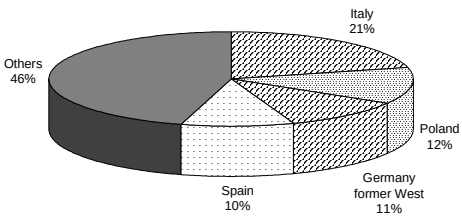
TOP THREE*
EXTRACTION AND 1ST TREATMENT OF SOLID FUELS



TOP FOUR*
NATURE - WATERS

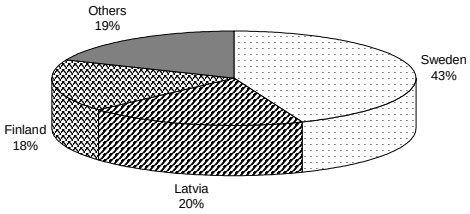


TOP FIVE
AGRICULTURE - ANIMAL BREEDING (excretions)

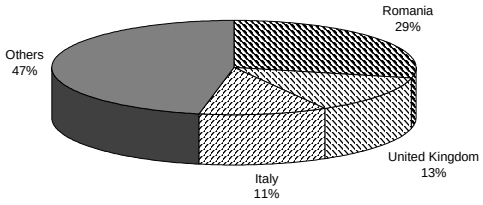


* ... less than 20 countries provided emission estimates

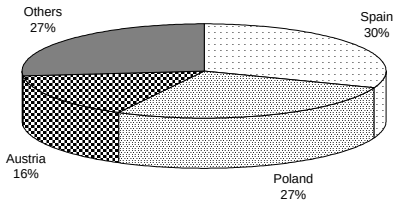
TOP SIX*
NATURE - HUMID ZONES



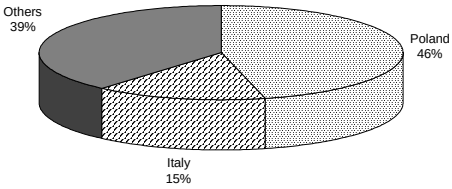
TOP SEVEN
GAS DISTRIBUTION NETWORKS



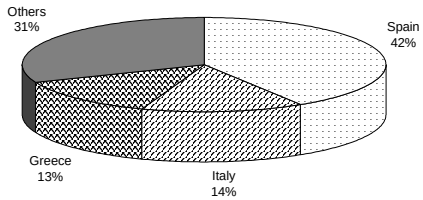
TOP EIGHT*
NATURE - CONIFEROUS FORESTS



TOP NINE*
AGRICULTURE - CULTURES WITH FERTILIZERS except animal manure

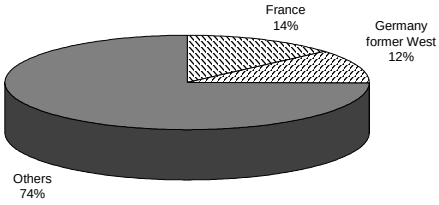


TOP TEN*
NATURE - DECIDUOUS FORESTS

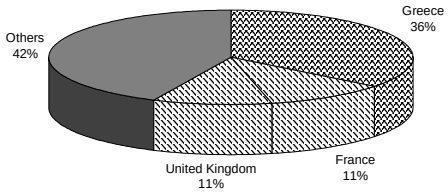


NH_3

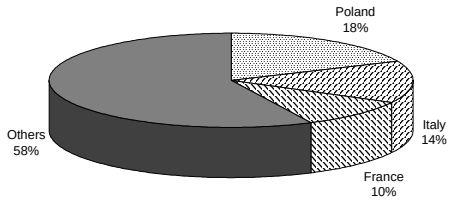
TOP ONE
AGRICULTURE - ANIMAL BREEDING (excretions)



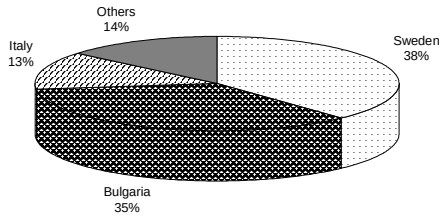
TOP TWO
AGRICULTURE - CULTURES WITH FERTILIZERS except animal manure



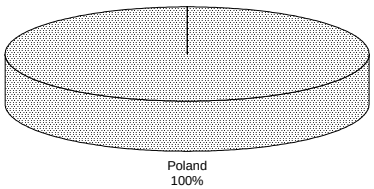
TOP THREE
PRODUCTION PROC. - INORGANIC CHEMICAL INDUSTRY



TOP FOUR*
WASTE TREATMENT AND DISPOSAL - LAND FILLING

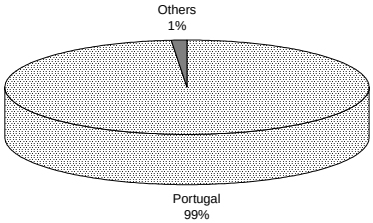


TOP FIVE*
WASTE TREATMENT AND DISPOSAL - LATRINES

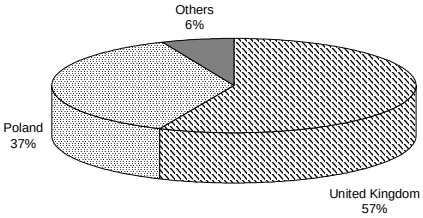


* ... less than 20 countries provided emission estimates

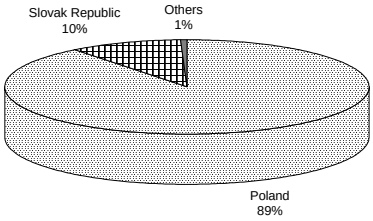
TOP SIX*
AGRICULTURE - ANIMAL BREEDING (enteric fermentation)



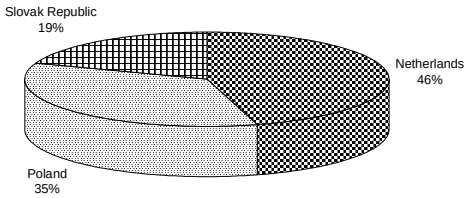
TOP SEVEN*
NATURE - HUMANS



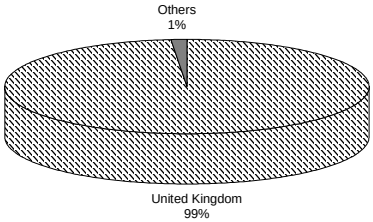
TOP EIGHT*
NATURE - CONIFEROUS FORESTS



TOP NINE*
NATURE - DECIDUOUS FORESTS

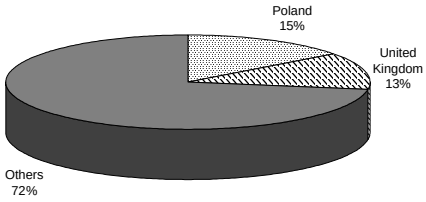


TOP TEN*
NATURE - ANIMALS

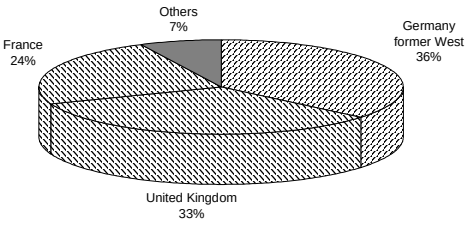


N_2O

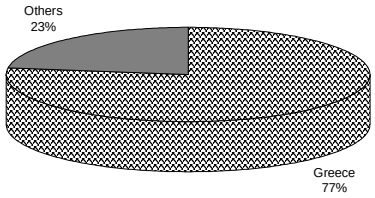
TOP ONE
AGRICULTURE - CULTURES WITH FERTILIZERS except animal manure



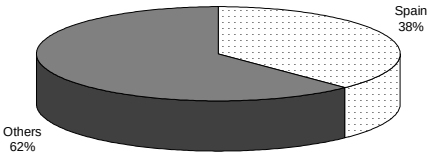
TOP TWO*
PRODUCTION PROC. - ORGANIC CHEMICAL INDUSTRY



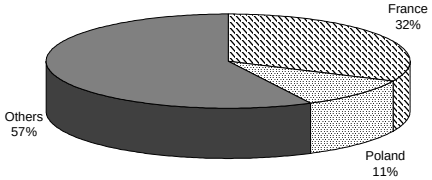
TOP THREE*
NATURE - WATERS



TOP FOUR
NATURE - CONIFEROUS FORESTS



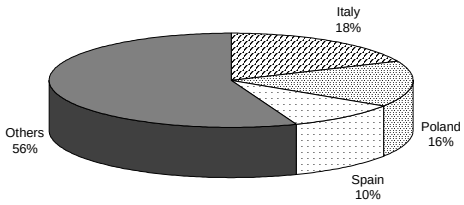
TOP FIVE*
PRODUCTION PROC. - INORGANIC CHEMICAL INDUSTRY



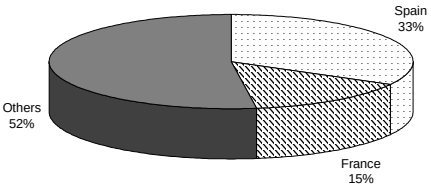
* ... less than 20 countries provided emission estimates

A

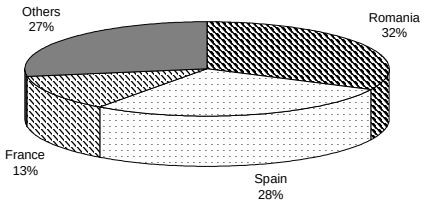
TOP SIX
PUBLIC POWER AND COGENERATION PLANTS



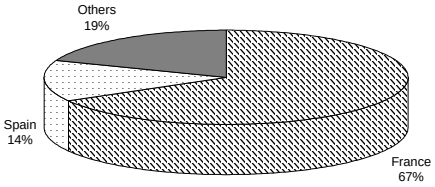
TOP SEVEN
NATURE - DECIDUOUS FORESTS



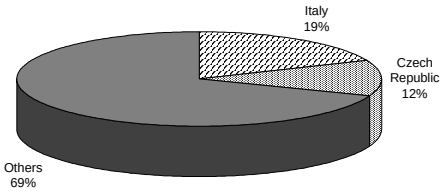
TOP EIGHT*
AGRICULTURE - CULTURES WITHOUT FERTILIZERS



TOP NINE*
NATURE - NATURAL GRASSLAND



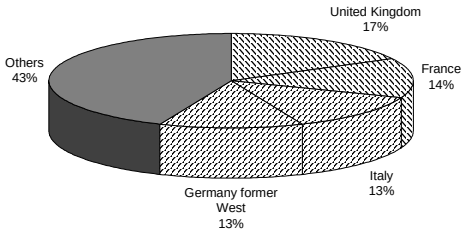
TOP TEN
COMMERCIAL, INSTITUTIONAL AND RESIDENTIAL COMBUSTION PLANTS



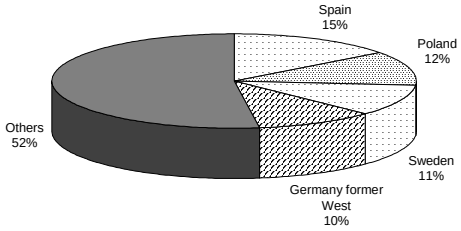
N

NMVOC

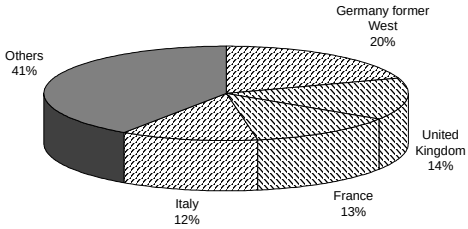
TOP ONE
ROAD TRANSPORT - PASSENGER CARS



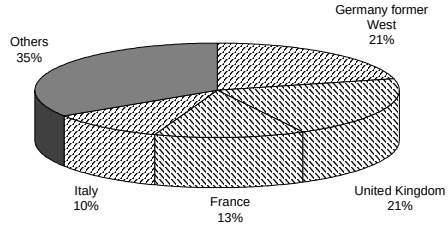
TOP TWO
NATURE - CONIFEROUS FORESTS



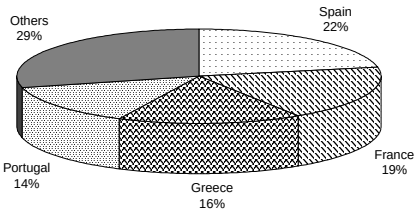
TOP THREE
SOLVENT USE - PAINT APPLICATION



TOP FOUR
SOLVENT USE - OTHER USE OF SOLVENTS AND RELATED
ACTIVITIES

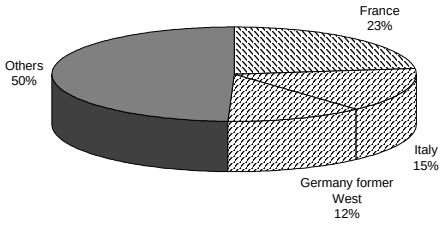


TOP FIVE
NATURE - DECIDUOUS FORESTS

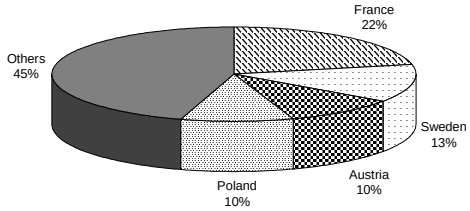


* ... less than 20 countries provided emission estimates

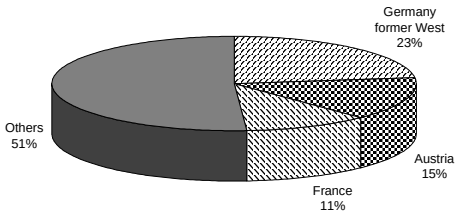
TOP SIX
ROAD TRANSPORT - GASOLINE EVAPORATION FROM VEHICLES



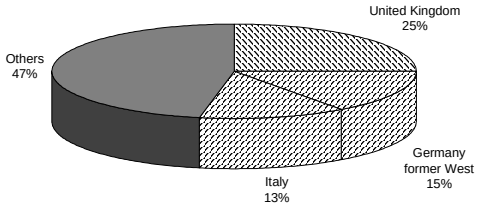
TOP SEVEN*
COMMERCIAL, INSTITUTIONAL AND RESIDENTIAL COMBUSTION PLANTS



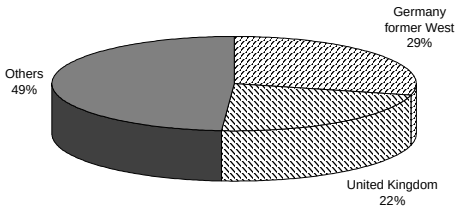
TOP EIGHT
SOLVENT USE - CHEMICALS PRODUCTS MANUFACTURING OR PROCESSING



TOP NINE
ROAD TRANSPORT - HEAVY DUTY VEHICLES > 3.5 t AND BUSES



TOP TEN
GASOLINE DISTRIBUTION



Comparison of per capita emissions

This chapter describes points of interest concerning the per capita emissions in 29 European countries of the top five emitters for the eight pollutants investigated in CORINAIR 90 (see figure 37). The corresponding figures can be found in Appendix E. For the per capita average values for Europe, EU-12, EFTA-5 and PHARE-10 we refer to Summary report 1.

SO_2

The per capita emissions of each country differ considerably for the top one sub-sector *Public Power and Cogeneration Plants*. In general, EFTA-5 countries record the smallest figures, EU-12 countries report figures in the middle of the range and PHARE-10 countries exhibit the highest values. However, the United Kingdom (the EU-12 country with the largest per capita emissions of the top one sub-sector) reported even larger figures than some PHARE-10 countries.

Due to the use of state-of-the-art abatement technology since the middle of the 1980s and to the contribution of low emission energy sources e. g. water power plants or nuclear power plants and a higher energy efficiency, former EFTA-5 countries and EU-12 countries produce on average 100 times less than the per capita SO_2 emissions of some PHARE-10 countries, such as Bulgaria, Germany (former East), Estonia and Czech Republic. For the majority of the countries (21) the per capita SO_2 emissions are highest for the top one sub-sector.

In general, the per capita emissions for the SO_2 top two sub-sector *Industrial Combustion in Boilers, Gas Turbines and Stationary Engines* exhibit a quite similar ranking to the previous one. The gap between the per capita emissions of the former EU-12 and EFTA-5 countries is on average smaller than for the top one sub-sector. Curiously, some PHARE-10 countries with very high per capita emissions for the top one sub-sector have quite low per capita emissions for the SO_2 top two sub-sector. Germany (former East) is the only country with similar per capita emissions for the SO_2 top two sub-sector (with a value of app. 100 kg SO_2 per capita) compared to the top one sub-sector. Four countries (Austria, France, Germany, former West and Sweden) reported the per capita emissions of the top two sub-sector as the highest ones. This difference between the per capita emissions of the top one and top two sub-sector can be due to the broader implementation of FGD and other measures in the public power sector than in the industrial sector.

The per capita SO_2 emissions for the top three sub-sector *Commercial, Institutional and Residential Combustion Plants* of the EFTA-5 and EU-12 countries are quite similar to the emissions of the top two sub-sector and are about three times lower than the European average. The per capita SO_2 emissions of the PHARE-10-countries can be grouped into two groups. One group consists of countries with per capita emissions quite similar to those of the EFTA-5 and EU-12 countries. The second group consists of countries with per capita emissions that are between two and three times higher.

The per capita emissions for the top four sub-sector *Industrial Combustion, Processes with Contact* differ widely between the EFTA-5, EU-12 and PHARE-10 country-

groups. In each grouping countries could be found with high, medium and low per capita emissions. The exceptions are Luxembourg for the EU-12 countries and Poland for the PHARE-10 countries which have significant higher per capita emissions.

The per capita emissions of the top five sub-sector *District Heating Plants* in the PHARE-10 countries are between five and ten times higher than those of the EFTA-5 and EU-12 countries. High per capita emissions can be trailed to a less intensive use of low-sulfur fuels and abatement technologies and/or to a high contribution of district heating to the production of heat.

CO_2

Estonia reported by far the largest per capita CO_2 emission for the top one sub-sector (*Public Power and Cogeneration Plants*) with more than 10 000 kg per capita, this figure being nearly twice as large as that of the country (Germany, former East) with the next largest value. This striking result is due to the fact that Estonia operated several large power plants fuelled by oil shale. The electricity produced was exported to other regions of the former USSR. Meanwhile the emissions as well as the export of electricity declined significantly. Since 1990 such significant changes have taken place not only in Estonia but in many other PHARE-10 countries as well.

Norway and Switzerland reported extremely low figures (2 and 44 kg CO_2 per capita) which are mainly due to the utilization of non-fuel combustion energy sources (hydroelectric and hydroelectric and nuclear) for power production in both countries.

It is interesting to note that the third largest per capita CO_2 emission (8 494 kg CO_2 per capita) has been estimated for *Industrial Combustion-Processes with Contact* in Luxembourg indicating that emissions from the (steel) industry dominate in this country.

Romania is the country with by far the lowest CO_2 emission for the top sub-sectors in the traffic sector; the per capita emission for *Road Transport with Passenger Cars* is 16 times lower in Romania than in Belgium (Wallonie region), the country with the largest per capita emission (1 632 kg CO_2 per capita) for this sub-sector.

NO_X

The detailed split of the CORINAIR methodology allows to identify three groups of countries. The first group of countries can be characterized as those with the highest per capita emissions of NO_X originating from *Road Transport, Passenger Cars* (usually EU-12 countries or EFTA-5 countries like Belgium, Germany West or Switzerland and Sweden). The second group of countries is dominated by PHARE-10 countries and can be characterized as those with the highest per capita emissions of NO_X originating from *Public Power an Cogeneration Plants*. However also Ireland and the United Kingdom are part of this group. The third group of countries is very special: there is Luxembourg with the highest per capita NO_X emissions from one sub-sector (*Industrial Combustion - Processes with Contact*) and Norway, Greece and Latvia with the per capita emissions from *Marine activities*, the top eight sub-sector, being highest.

Furthermore it is interesting to note that Romania has the lowest per capita emissions with respect to NO_x top one and three sub-sectors (*Road Transport - Passenger Cars* and *Heavy Duty Vehicles*) as for CO_2.

The per capita NO_x emissions show less differences between the European countries compared to those for SO_2. This finding corresponds well with the fact that, unlike the case with SO_2, no European countries have until 1990 achieved significant NO_x emission reductions.

CO

In 19 of the investigated 29 countries the main source with the highest per capita emissions in 1990 was *Road Transport - Passenger Cars*. The figures range from 26,8 kg CO/capita in Slovenia to nearly 152 kg CO/capita in Norway.

As for NO_x per capita emissions Luxembourg had the highest figure (259 kg CO/capita) originating from the same top sub-sector as for NO_X (*Industrial Combustion - Processes with Contact*).

Three countries (Austria, Bulgaria and Germany, former East) reported its highest per capita CO emissions of a country from *Commercial, Institutional and Residential Combustion Plants.* The per capita emissions for this sub-sector span a very wide range from 0,0 kg CO/capita (Ireland and Greece) to 101,9 kg CO/capita (Austria*).* One country (Romania) reported its highest per capita CO emissions from *Open Burning of Agricultural Wastes*, a sub-sector which has not been investigated at all by many countries.

CH_4

Eleven countries reported its highest per capita CH_4 emissions from top one sub-sector *Animal Breeding* (*enteric fermentation*), the figures for this sub-sector being as high as app. 160 kg CH_4 / capita (Ireland), this exceptional high figure being due to the large number of cattle in this country in relation to the number of inhabitants.

Five countries, among them both Germanys (former East and former West) estimated the highest per capita emissions for the top two sub-sector, *Waste Treatment and Disposal - Land Filling* and in four countries (usually countries with extensive mining activities like Poland and Czech Republic) per capita CH_4 emissions for the top three subsector, *Extraction and 1st Treatment of Solid Fuels* , were highest.

Only one country (Romania) reported, that the per capita emissions from *Gas Distribution Networks* were its highest. In five countries per capita emissions from natural sources (*Waters or Humid Zones*) were highest, the per capita CH_4 emissions from *Waters* in Greece being the single largest contribution from one country for one sub-sector (430 kg CH_4 per capita; however it was already mentioned that Greece reported an unreliable area for this sub-sector).

NH_3

Regarding the dominating share of NH_3 emissions from the top one subsector *Animal Breeding* (*excretions*) it is not surprising that 25 countries reported its highest per capita emissions for this sub-sector. However the largest per capita emission for a top sub-sector (Greece, 39 kg NH_3 per capita) was reported for top two *Agriculture - Cultures with Fertilizers except Animal Manure*, which as already mentioned is due to the use of a very high emission factor. The figures for other sub-sectors (top 3 to top 10), estimated in countries like Poland, Switzerland, Slovak Republic, the Netherlands and the United Kingdom, show that these sub-sectors do not contribute much to the total emissions of NH_3.

N_2O

The top one sub-sector *Cultures with Fertilizers* is dominating, being the source with the highest per capita emissions in 21 countries. Ireland reported the highest figure (11 kg N_2O /capita). However a comparison with the results for the per capita NH_3 emissions of the same sub-sector may indicate some uncertainties with respect to NH_3 and N_2O emission factors for this sub-sector.

Production of Organic Chemical Industry is the most important sub-sector in France and Germany, former West, and *Nature - Waters* the most important one in Greece and Sweden. It is remarkable, that for this sub-sector Greece estimated the highest figure for the per capita emissions of a top N_2O sub-sector (16 kg N_2O per capita) as for CH_4 but again this high figure is due to the unreliable area taken into account.

Agriculture - Cultures without Fertilizers produced the largest contribution to the per capita emissions in Romania as well as in Slovenia. However this country was the only one which did not report figures for cultures with fertilizers.

Production of Inorganic Chemical Industry dominated the per capita emissions in Norway whereas in Spain the sub-sector with the highest per capita emissions was *Nature - Coniferous Forests*.

NMVOC

As for NO_x and CO *Road Transport - Passenger Cars* is the sub-sector with the largest contribution to the per capita NMVOC emissions for most countries (14).

The largest NMVOC per capita emission from *Road Transport - Passenger Cars* was estimated for Germany (former East) with app. 20 kg NMVOC per capita. This high figure was not due to the many passenger kilometres travelled, as Germany (former East) is only 17th rank of the CO_2 emission per capita from the same sub-sector. The large specific emissions from the two-stroke engines may have dominated the emissions of the national car fleet at this time. The second largest figure for NMVOC top sub-sector one (18,2 kg NMVOC per capita) was estimated for Belgium (Wallonie region). This corresponds well with the high CO_2 emission per capita for this sub-sector.

Nature - Coniferous Forests is the sub-sector with the largest contribution to the per capita NMVOC emissions for five countries. These countries like Finland, Austria and

Sweden usually have a large forested area. The per capita emissions of this sub-sector for Finland show the highest per capita emissions of a top sub-sector for NMVOC (46 kg per capita).

In the more southern countries like Bulgaria, Greece and Spain the per capita NMVOC emissions of *Deciduous Forests* are the dominating ones.

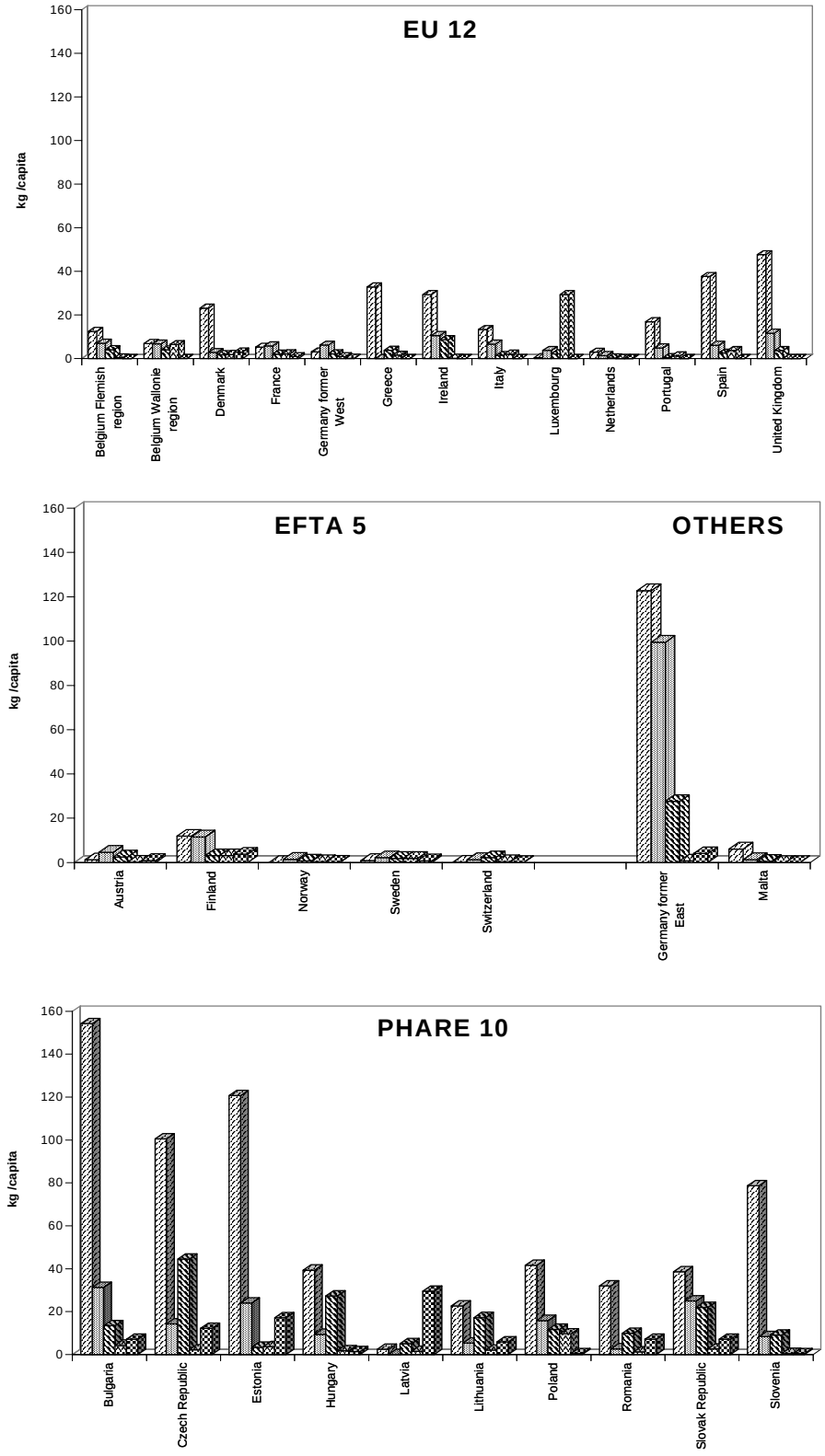
Road Transport-Gasoline Evaporation from Vehicles is the sub-sector with the largest per capita emission in Ireland. This country is the only one with lower NMVOC emissions per capita from *Passenger Cars* compared to *Evaporation from Vehicles*.

The range of per capita emissions is much larger for the top three (*Solvent Use - Paint Application*) and top four sub-sector (*Solvent Use - Other Use of Solvents and Related Activities*). The largest figure was reported by the Slovak Republic (8,1 kg NMVOC/capita) for the top three sub-sector. The country with the smallest figure reported is Latvia with 0,0 kg NMVOC per capita.

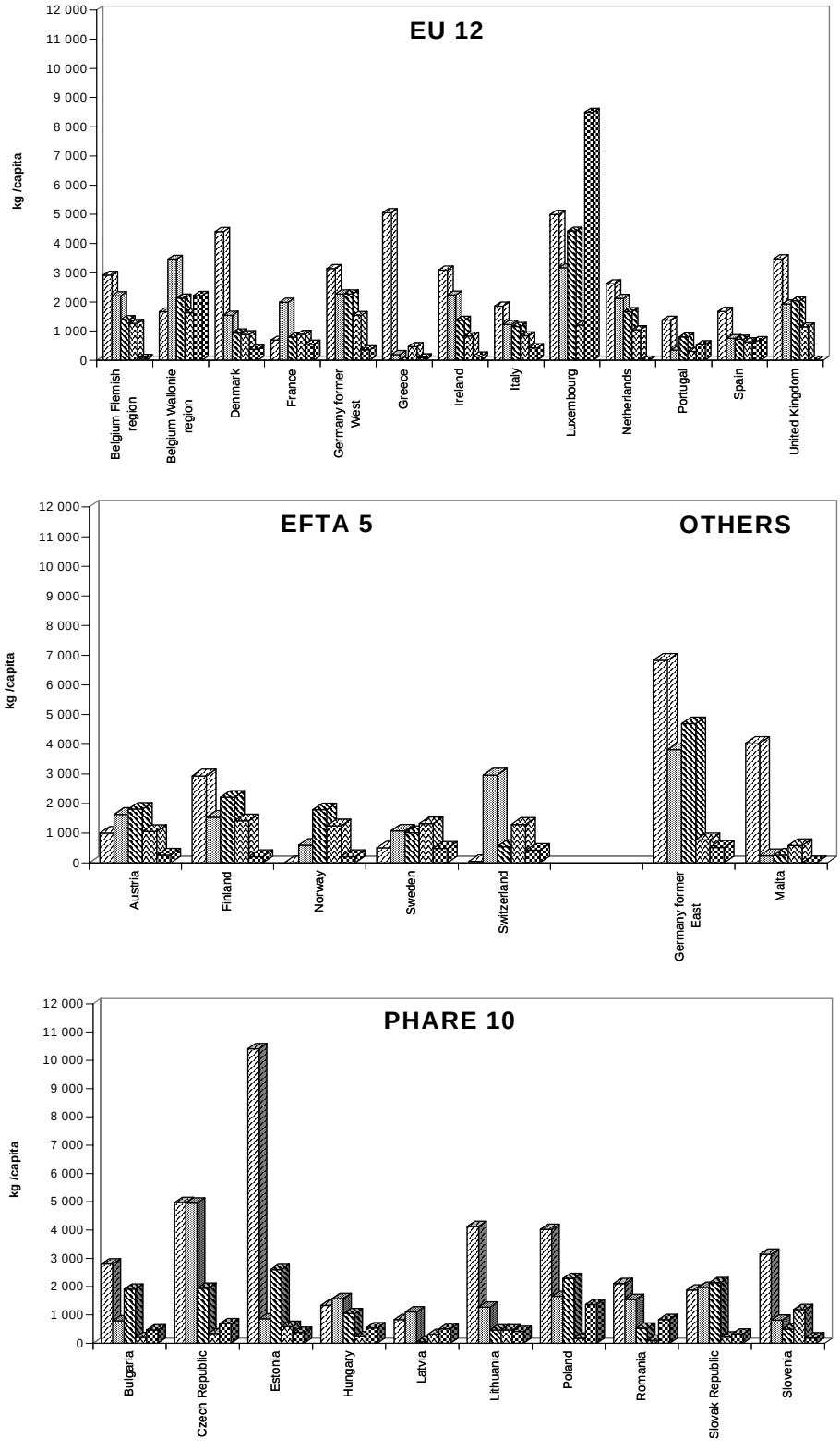
For top four the highest and lowest values were recorded respectively by Switzerland (11,7 kg NMVOC per capita) and Slovenia (0,0 kg NMVOC per capita). These discrepancies might not only indicate differences in the economic structure of these countries but also the uncertainty of these figures. Furthermore the distinction between these two sub-sectors was not very clear. A large part of these emissions was not distributed by many countries (see figure 34 and 35).

Figure 37 Emission per capita for the top five sub-sectors

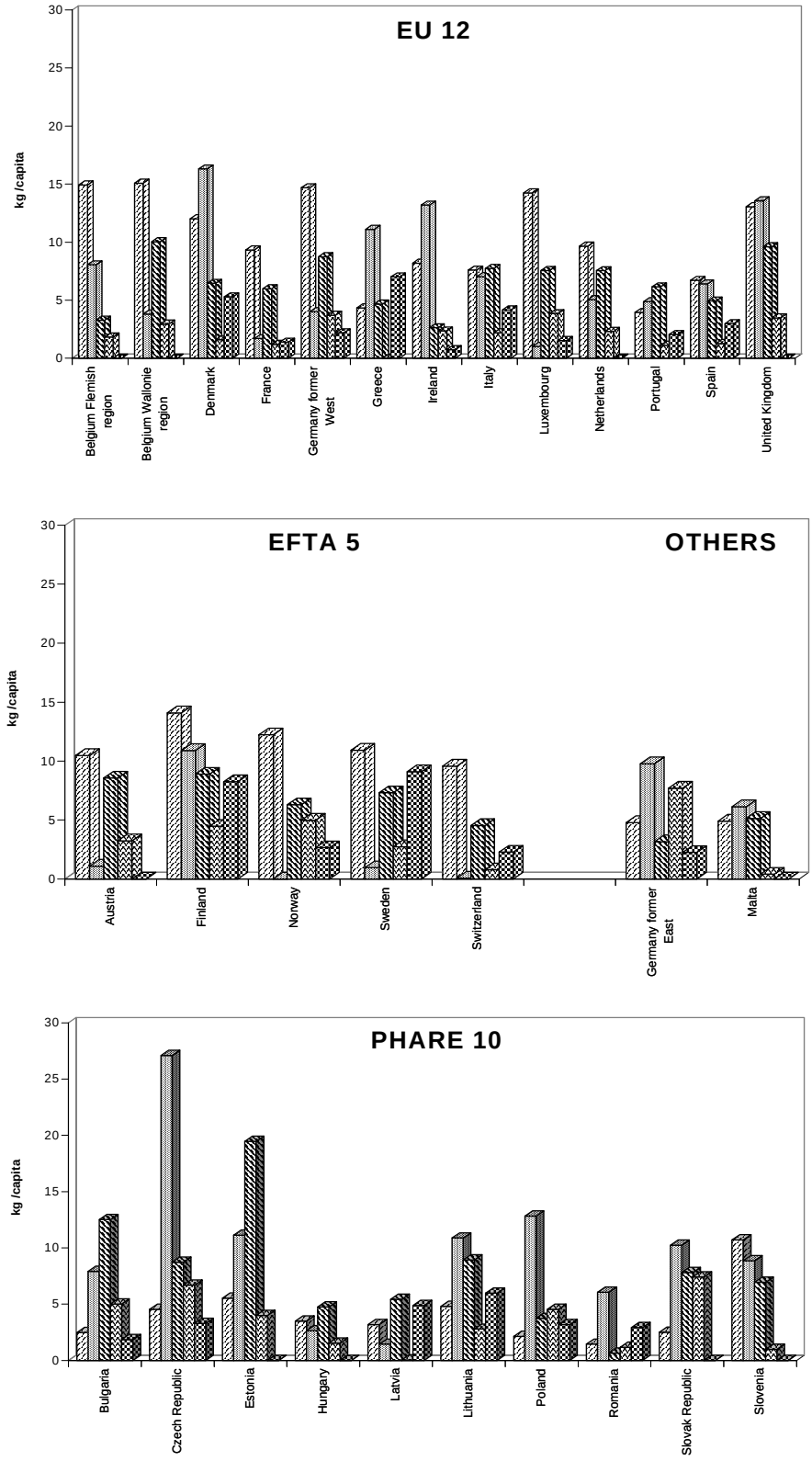
SO_2



CO_2

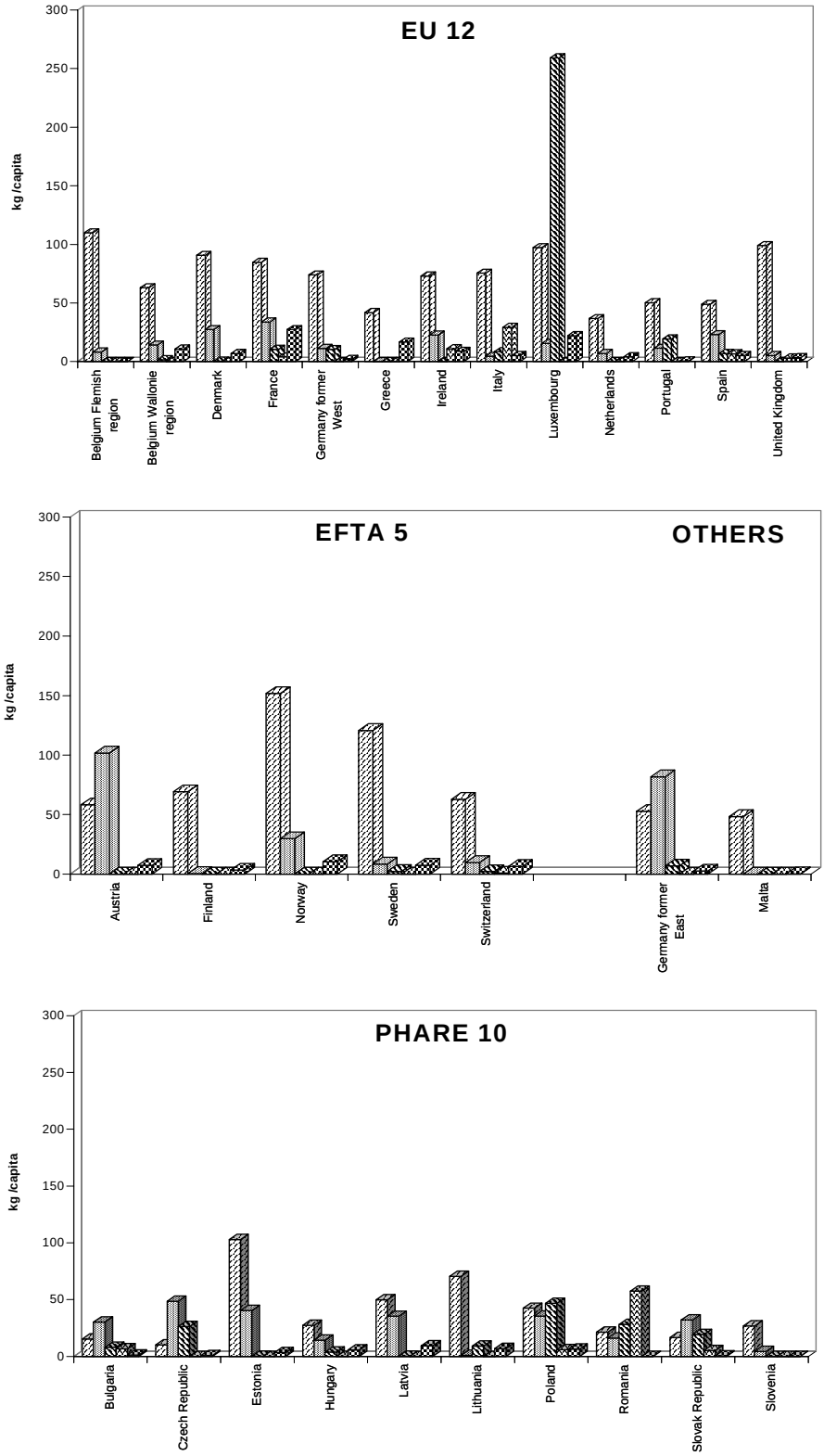

EU 12
kg /capita
12 000
11 000
10 000
9 000
8 000
7 000
6 000
5 000
4 000
3 000
2 000
1 000
0
Belgium Flemish region
Belgium Wallonie region
Denmark
France
Germany former West
Greece
Ireland
Italy
Luxembourg
Netherlands
Portugal
Spain
United Kingdom
EFTA 5
OTHERS
Austria
Finland
Norway
Sweden
Switzerland
Germany former East
Malta
PHARE 10
Bulgaria
Czech Republic
Estonia
Hungary
Latvia
Lithuania
Poland
Romania
Slovak Republic
Slovenia
TOP1: PUBLIC POWER AND COGENERATION PLANTS
TOP2: COMMERCIAL, INSTITUTIONAL AND RESIDENTIAL COMBUSTION PLANTS
TOP3: INDUS. COMBUS. IN BOILERS, GAS TURBINES AND STATION. ENGINES
TOP4: ROAD TRANSPORT - PASSENGER CARS
TOP5: INDUSTRIAL COMBUSTION - PROCESSES WITH CONTACT

NO_x


EU 12
kg /capita
30
25
20
15
10
5
0
Belgium Flemish region
Belgium Wallonie region
Denmark
France
Germany former West
Greece
Ireland
Italy
Luxembourg
Netherlands
Portugal
Spain
United Kingdom
EFTA 5
OTHERS
kg /capita
Austria
Finland
Norway
Sweden
Switzerland
Germany former East
Malta
PHARE 10
kg /capita
Bulgaria
Czech Republic
Estonia
Hungary
Latvia
Lithuania
Poland
Romania
Slovak Republic
Slovenia
TOP1: ROAD TRANSPORT - PASSENGER CARS
TOP2: PUBLIC POWER AND COGENERATION PLANTS
TOP3: ROAD TRANSPORT - HEAVY DUTY VEHICLES > 3,5 t AND BUSES
TOP4: INDUS. COMBUS. IN BOILERS, GAS TURBINES AND STATION. ENGINES
TOP5: OTHER MOB. SOURCES - OFF ROAD VEHICLES AND MACHINES

A

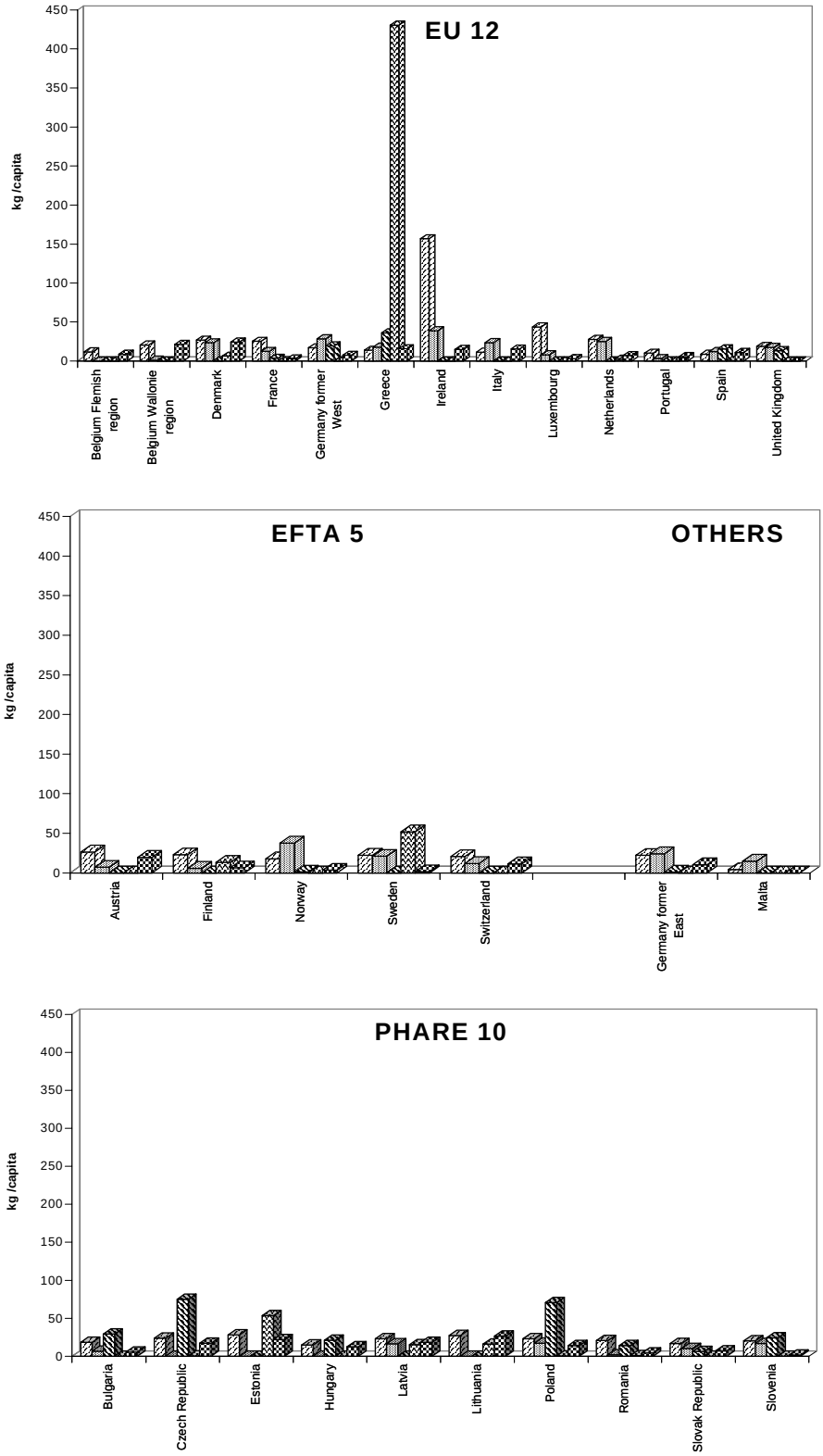
CO


EU 12
kg /capita
300
250
200
150
100
50
0
Belgium Flemish region
Belgium Wallonie region
Denmark
France
Germany former West
Greece
Ireland
Italy
Luxembourg
Netherlands
Portugal
Spain
United Kingdom
EFTA 5
OTHERS
Austria
Finland
Norway
Sweden
Switzerland
Germany former East
Malta
PHARE 10
Bulgaria
Czech Republic
Estonia
Hungary
Latvia
Lithuania
Poland
Romania
Slovak Republic
Slovenia
TOP1: ROAD TRANSPORT - PASSENGER CARS
TOP2: COMMERCIAL, INSTITUTIONAL AND RESIDENTIAL COMBUSTION PLANTS
TOP3: INDUSTRIAL COMBUSTION - PROCESSES WITH CONTACT
TOP4: OPEN BURNING OF AGRICULTURAL WASTES
TOP5: ROAD TRANSPORT - LIGHT DUTY VEHICLES < 3,5 t

Y

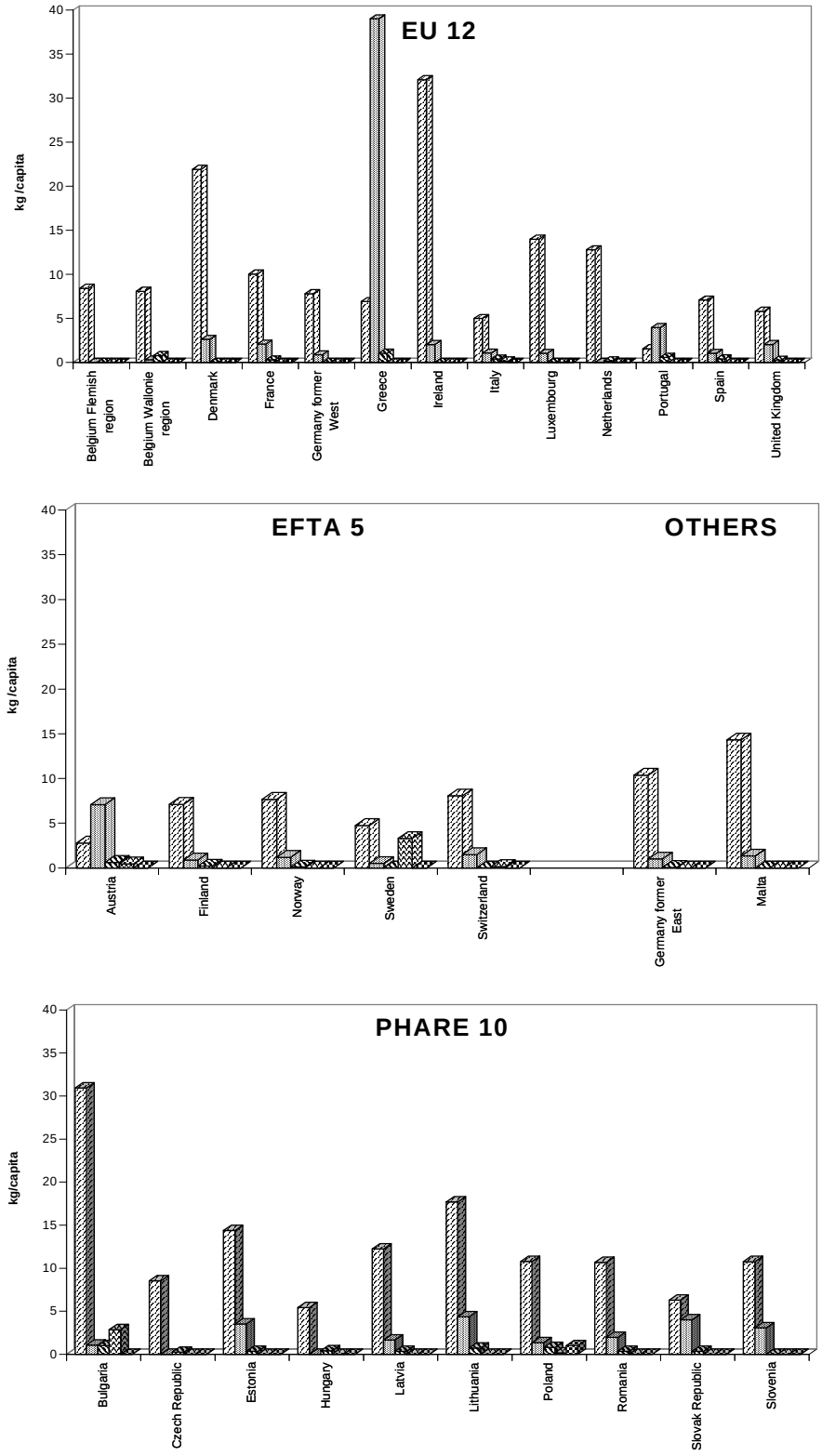
A

CH_4

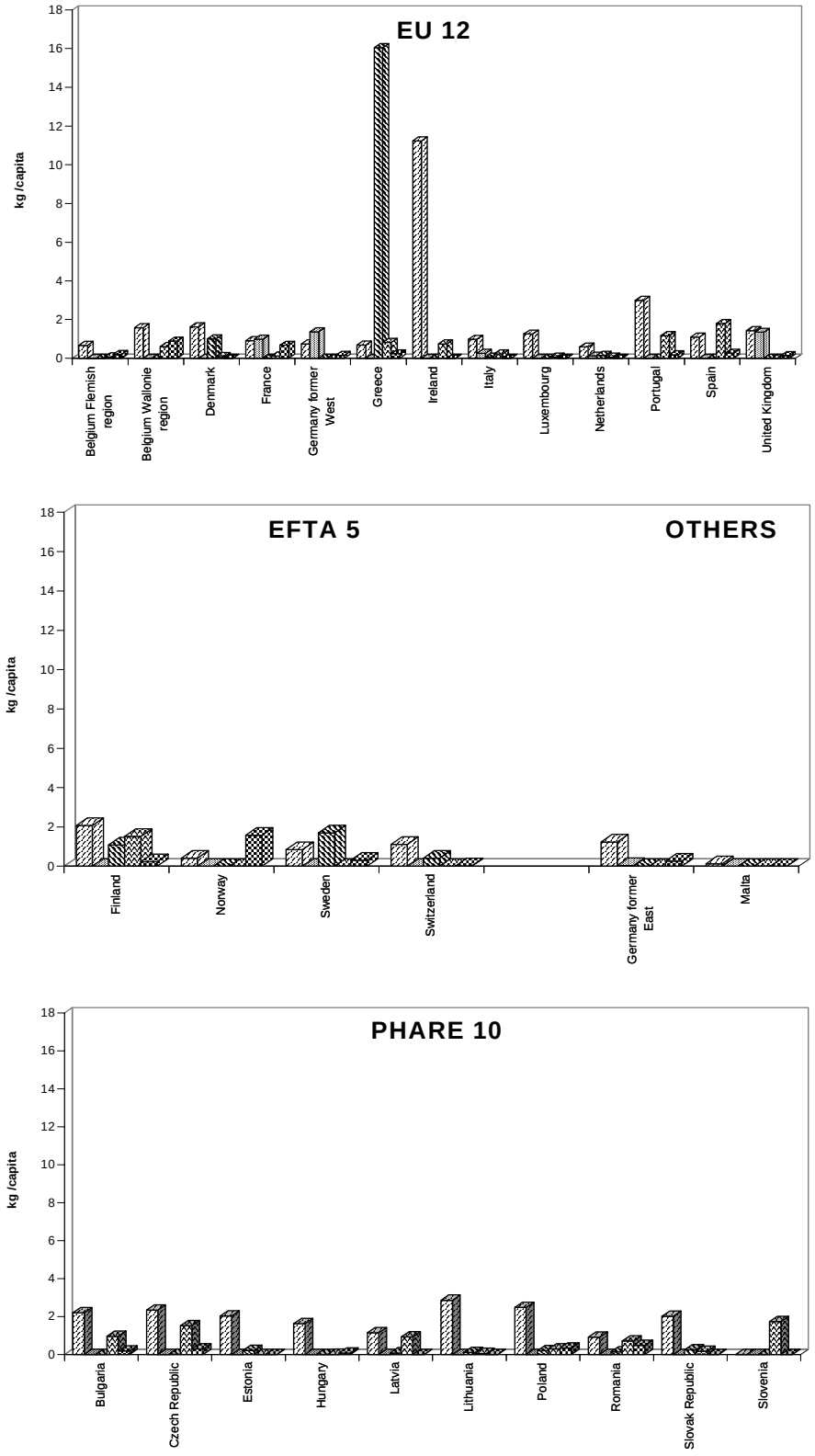

EU 12
kg /capita
0
50
100
150
200
250
300
350
400
450
Belgium Flemish region
Belgium Wallonie region
Denmark
France
Germany former West
Greece
Ireland
Italy
Luxembourg
Netherlands
Portugal
Spain
United Kingdom
EFTA 5
OTHERS
Austria
Finland
Norway
Sweden
Switzerland
Germany former East
Malta
PHARE 10
Bulgaria
Czech Republic
Estonia
Hungary
Latvia
Lithuania
Poland
Romania
Slovak Republic
Slovenia
TOP1: AGRICULTURE - ANIMAL BREEDING (enteric fermentation)
TOP2: WASTE TREATMENT AND DISPOSAL - LAND FILLING
TOP3: EXTRACTION AND 1ST TREATMENT OF SOLID FUELS
TOP4: NATURE - WATERS
TOP5: AGRICULTURE - ANIMAL BREEDING (excretions)

Z

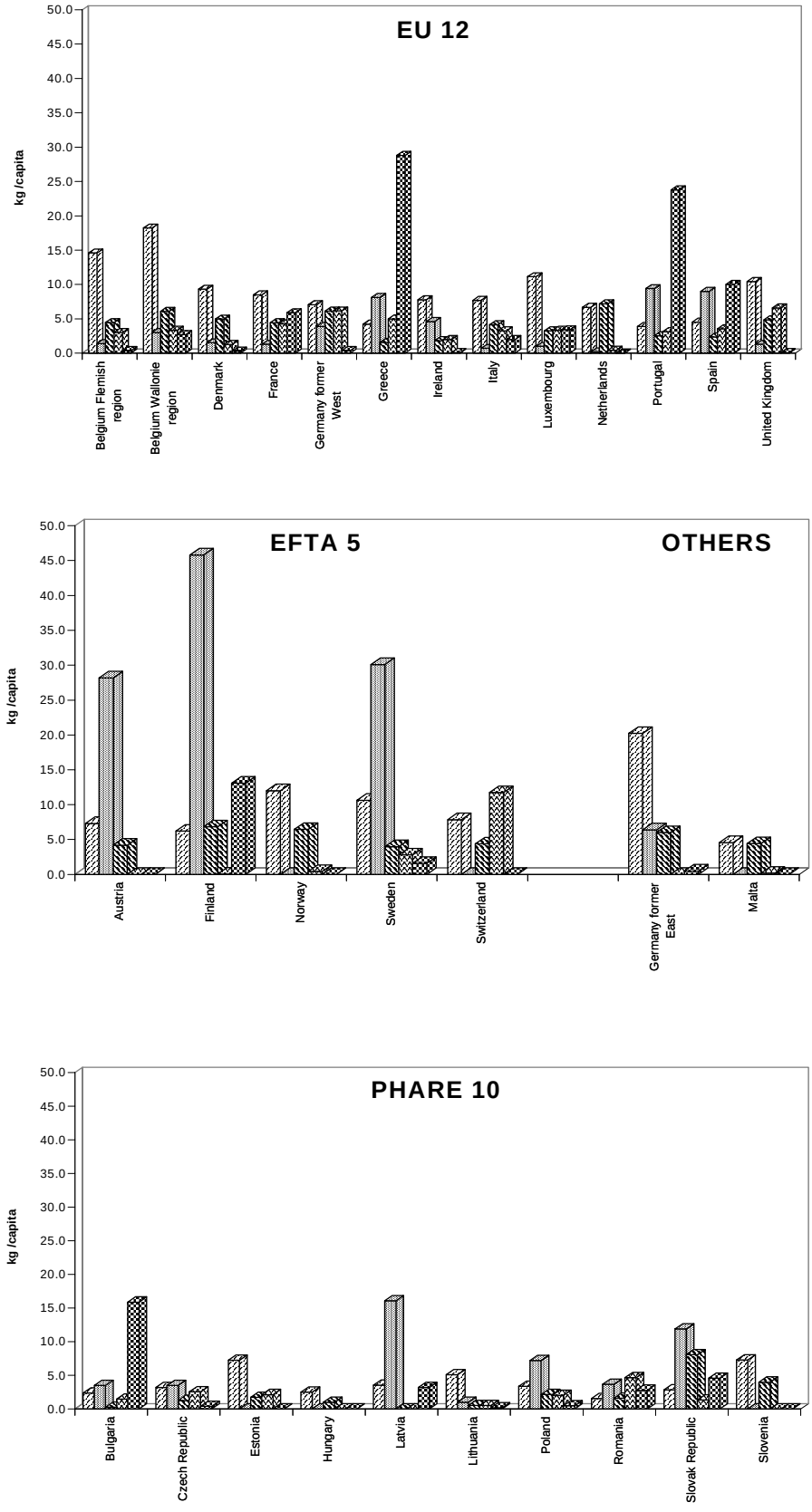
NH_3


EU 12
kg /capita
0
5
10
15
20
25
30
35
40
Belgium Flemish region
Belgium Wallonie region
Denmark
France
Germany former West
Greece
Ireland
Italy
Luxembourg
Netherlands
Portugal
Spain
United Kingdom
EFTA 5
OTHERS
kg /capita
Austria
Finland
Norway
Sweden
Switzerland
Germany former East
Malta
PHARE 10
kg/capita
Bulgaria
Czech Republic
Estonia
Hungary
Latvia
Lithuania
Poland
Romania
Slovak Republic
Slovenia
TOP1: AGRICULTURE - ANIMAL BREEDING (excretions)
TOP2: AGRICULTURE - CULTURES WITH FERTILIZERS except animal manure
TOP3: PRODUCTION PROC. - INORGANIC CHEMICAL INDUSTRY
TOP4: WASTE TREATMENT AND DISPOSAL - LAND FILLING
TOP5: WASTE TREATMENT AND DISPOSAL - LATRINES

N_2O


EU 12
kg /capita
18
16
14
12
10
8
6
4
2
0
Belgium Flemish region
Belgium Wallonie region
Denmark
France
Germany former West
Greece
Ireland
Italy
Luxembourg
Netherlands
Portugal
Spain
United Kingdom
EFTA 5
OTHERS
kg /capita
Finland
Norway
Sweden
Switzerland
Germany former East
Malta
PHARE 10
kg /capita
Bulgaria
Czech Republic
Estonia
Hungary
Latvia
Lithuania
Poland
Romania
Slovak Republic
Slovenia
TOP1: AGRICULTURE - CULTURES WITH FERTILIZERS except animal manure
TOP2: PRODUCTION PROC. - ORGANIC CHEMICAL INDUSTRY
TOP3: NATURE - WATERS
TOP4: NATURE - CONIFEROUS FORESTS
TOP5: PRODUCTION PROC. - INORGANIC CHEMICAL INDUSTRY

NMVOC


EU 12
kg /capita
50.0
45.0
40.0
35.0
30.0
25.0
20.0
15.0
10.0
5.0
0.0
Belgium Flemish region
Belgium Wallonie region
Denmark
France
Germany former West
Greece
Ireland
Italy
Luxembourg
Netherlands
Portugal
Spain
United Kingdom
EFTA 5
OTHERS
Austria
Finland
Norway
Sweden
Switzerland
Germany former East
Malta
PHARE 10
Bulgaria
Czech Republic
Estonia
Hungary
Latvia
Lithuania
Poland
Romania
Slovak Republic
Slovenia
TOP1: ROAD TRANSPORT - PASSENGER CARS
TOP2: NATURE - CONIFEROUS FORESTS
TOP3: SOLVENT USE - PAINT APPLICATION
TOP4: SOLVENT USE - OTHER USE OF SOLVENTS AND RELATED ACTIVITIES
TOP5: NATURE - DECIDUOUS FORESTS

A

DD

Appendix A List of Source Sub-Sectors (Snap Level 2) with Percentage of European Total Emission

SNAP		source sub-sectors	SO_2	NO_x	NM-VOC	CH_4	CO	CO_2	N_2O	NH_3
level 1	level 2									
1	1	PUBLIC POWER AND COGENERATION PLANTS	51%	20%				26%	5%	
	2	DISTRICT HEATING PLANTS	3%					2%		
2	0	COMMERCIAL, INSTITUTIONAL AND RESIDENTIAL COMBUSTION PLANTS	11%	4%	5%		14%	18%	2%	
3	1	INDUS. COMBUS. IN BOILERS, GAS TURBINES AND STATION. ENGINES	19%	8%			2%	16%		
	2	INDUSTRIAL COMBUSTION - PROCESS FURNACES WITHOUT CONTACT	2%				2%	3%		
	3	INDUSTRIAL COMBUSTION - PROCESSES WITH CONTACT	4%	5%			8%	5%		
4	1	PRODUCTION PROCESSES - PETROLEUM INDUSTRIES	1%							
	2	PRODUCTION PROC. - IRON AND STEEL INDUSTRIES AND COLLIERIES					4%			
	3	PRODUCTION PROC. - NON FERROUS METAL INDUSTRY								
	4	PRODUCTION PROC. - INORGANIC CHEMICAL INDUSTRY		1%					6%	3%
	5	PRODUCTION PROC. - ORGANIC CHEMICAL INDUSTRY							12%	
	6	PRODUCTION PROC. - WOOD,PAPER PULP,FOOD,DRINK & OTHER IND.						2%		
	7	PRODUCTION PROC. - COOLING PLANTS								
5	1	EXTRACTION AND 1ST TREATMENT OF SOLID FUELS				17%				
	2	EXTRACTION, 1ST TREATMENT AND LOADING OF LIQUID FUELS								
	3	EXTRACTION, 1ST TREATMENT AND LOADING OF GASEOUS FUELS								
	4	LIQUID FUEL DISTRIBUTION (except gasoline)								
	5	GASOLINE DISTRIBUTION			3%					
	6	GAS DISTRIBUTION NETWORKS				6%				
6	1	SOLVENT USE - PAINT APPLICATION			9%					
	2	SOLVENT USE - DEGREASING AND DRY CLEANING								
	3	SOLVENT USE - CHEMICALS PRODUCTS MANUFACTURING OR PROCESSING			3%					
	4	SOLVENT USE - OTHER USE OF SOLVENTS AND RELATED ACTIVITIES			8%					
7	1	ROAD TRANSPORT - PASSENGER CARS		23%	16%		45%	8%		
	2	ROAD TRANSPORT - LIGHT DUTY VEHICLES < 3,5 t		3%			5%			
	3	ROAD TRANSPORT - HEAVY DUTY VEHICLES > 3,5 t AND BUSES	1%	18%	3%		4%	4%		
	4	ROAD TRANSPORT - MOPEDS AND MOTORCYCLES < 50 CM^3								
	5	ROAD TRANSPORT - MOTORCYCLES > 50 CM^3								
	6	ROAD TRANSPORT - GASOLINE EVAPORATION FROM VEHICLES			7%					
8	1	OTHER MOB. SOURCES - OFF ROAD VEHICLES AND MACHINES		6%			2%			
	2	OTHER MOB. SOURCES - RAILWAYS								
	3	OTHER MOB. SOURCES - INLAND WATERWAYS								
	4	OTHER MOB. SOURCES - MARINE ACTIVITIES	1%	4%						
	5	OTHER MOB. SOURCES - AIRPORTS (LTO cycles and ground act.)								
9	1	WASTE TREATMENT AND DISPOSAL - WASTE WATER TREATMENT								
	2	WASTE TREATMENT AND DISPOSAL - WASTE INCINERATION								
	3	WASTE TREATMENT AND DISPOSAL - SLUDGE SPREADING								
	4	WASTE TREATMENT AND DISPOSAL - LAND FILLING				17%				1%
	5	WASTE TREATMENT AND DISPOSAL - COMPOST PRODUCTION FROM WASTE								
	6	WASTE TREATMENT AND DISPOSAL - BIOGAS PRODUCTION								
	7	OPEN BURNING OF AGRICULTURAL WASTES					6%			
	8	WASTE TREATMENT AND DISPOSAL - LATRINES								1%
10	1	AGRICULTURE - CULTURES WITH FERTILIZERS except animal manure				2%			34%	19%
	2	AGRICULTURE - CULTURES WITHOUT FERTILIZERS							4%	
	3	AGRICULTURE - STUBBLE BURNING								
	4	AGRICULTURE - ANIMAL BREEDING (enteric fermentation)				21%				1%
	5	AGRICULTURE - ANIMAL BREEDING (excretions)				9%				73%
11	1	NATURE - DECIDUOUS FORESTS				2%			4%	0%
	2	NATURE - CONIFEROUS FORESTS			11%	3%			10%	0%
	3	NATURE - FOREST FIRES								
	4	NATURE - NATURAL GRASSLAND							3%	
	5	NATURE - HUMID ZONES				6%				
	6	NATURE - WATERS				11%			11%	
	7	NATURE - ANIMALS						4%		0%
	8	NATURE - VOLCANOES	2%							
	9	NATURE - NEAR SURFACE DEPOSITS								
	10	NATURE - HUMANS								1%
		Percentage contribution of top ten sub-sectors to the European total	95%	92%	72%	94%	91%	89%	92%	99%

Appendix B **Participating Countries**

countries / regions
Austria
Belgium Flemish region
Belgium Wallonie region
Bulgaria
Czech Republic
Denmark
Estonia
Finland
France
Germany (former East)
Germany (former West)
Greece
Hungary
Ireland
Italia
Latvia
Lithuania
Luxembourg
Malta
Netherlands
Norway
Poland
Portugal
Romania
Slovak Republic
Slovenia
Spain
Sweden
Switzerland
United Kingdom

Appendix C **European Top Ten Source Sub-Sectors 1990**

Emission in tonnes per year (1000 tonnes for CO_2)

Pollutant	Rank	Source sub-sectors	emission		European total
SO_2	1	PUBLIC POWER AND COGENERATION PLANTS	**14 219 986**	51%	
SO_2	2	INDUS. COMBUS. IN BOILERS, GAS TURBINES AND STATION. ENGINES	**5 360 737**	19%	
SO_2	3	COMMERCIAL, INSTITUTIONAL AND RESIDENTIAL COMBUSTION PLANTS	**3 045 692**	11%	
SO_2	4	INDUSTRIAL COMBUSTION - PROCESSES WITH CONTACT	**1 064 152**	4%	
SO_2	5	DISTRICT HEATING PLANTS	**727 518**	3%	
SO_2	6	NATURE - VOLCANOES	**569 584**	2%	
SO_2	7	INDUSTRIAL COMBUSTION - PROCESS FURNACES WITHOUT CONTACT	**543 175**	2%	
SO_2	8	ROAD TRANSPORT - HEAVY DUTY VEHICLES > 3.5 t AND BUSES	**367 396**	1%	
SO_2	9	OTHER MOB. SOURCES - MARINE ACTIVITIES	**339 488**	1%	
SO_2	10	PRODUCTION PROCESSES - PETROLEUM INDUSTRIES	**334 087**	1%	
		Other Source sub-sectors	**1 301 718**	5%	**27 873 531**
Pollutant	**Rank**	**Source sub-sectors**	**emission**		**European total**
NO_x	1	ROAD TRANSPORT - PASSENGER CARS	**4 069 128**	23%	
NO_x	2	PUBLIC POWER AND COGENERATION PLANTS	**3 572 027**	20%	
NO_x	3	ROAD TRANSPORT - HEAVY DUTY VEHICLES > 3.5 t AND BUSES	**3 209 226**	18%	
NO_x	4	INDUS. COMBUS. IN BOILERS, GAS TURBINES AND STATION. ENGINES	**1 366 757**	8%	
NO_x	5	OTHER MOB. SOURCES - OFF ROAD VEHICLES AND MACHINES	**1 146 938**	6%	
NO_x	6	INDUSTRIAL COMBUSTION - PROCESSES WITH CONTACT	**888 791**	5%	
NO_x	7	COMMERCIAL, INSTITUTIONAL AND RESIDENTIAL COMBUSTION PLANTS	**753 956**	4%	
NO_x	8	OTHER MOB. SOURCES - MARINE ACTIVITIES	**714 076**	4%	
NO_x	9	ROAD TRANSPORT - LIGHT DUTY VEHICLES < 3.5 t	**550 921**	3%	
NO_x	10	PRODUCTION PROC. - INORGANIC CHEMICAL INDUSTRY	**204 626**	1%	
		Other Source sub-sectors	**1 446 066**	8%	**17 922 513**
Pollutant	**Rank**	**Source sub-sectors**	**emission**		**European total**
NMVOC	1	ROAD TRANSPORT - PASSENGER CARS	**3 467 051**	16%	
NMVOC	2	NATURE - CONIFEROUS FORESTS	**2 342 106**	11%	
NMVOC	3	SOLVENT USE - PAINT APPLICATION	**1 924 333**	9%	
NMVOC	4	SOLVENT USE - OTHER USE OF SOLVENTS AND RELATED ACTIVITIES	**1 798 227**	8%	
NMVOC	5	NATURE - DECIDUOUS FORESTS	**1 765 785**	8%	
NMVOC	6	ROAD TRANSPORT - GASOLINE EVAPORATION FROM VEHICLES	**1 549 946**	7%	
NMVOC	7	COMMERCIAL, INSTITUTIONAL AND RESIDENTIAL COMBUSTION PLANTS	**989 437**	5%	
NMVOC	8	SOLVENT USE - CHEMICALS PRODUCTS MANUFACTURING OR PROCESSING	**672 991**	3%	
NMVOC	9	ROAD TRANSPORT - HEAVY DUTY VEHICLES > 3.5 t AND BUSES	**665 251**	3%	
NMVOC	10	GASOLINE DISTRIBUTION	**596 838**	3%	
		Other Source sub-sectors	**5 997 844**	28%	**21 769 808**
Pollutant	**Rank**	**Source sub-sectors**	**emission**		**European total**
CH_4	1	AGRICULTURE - ANIMAL BREEDING (enteric fermentation)	**9 385 194**	21%	
CH_4	2	WASTE TREATMENT AND DISPOSAL - LAND FILLING	**7 932 129**	17%	
CH_4	3	EXTRACTION AND 1ST TREATMENT OF SOLID FUELS	**7 505 490**	17%	
CH_4	4	NATURE - WATERS	**5 164 057**	11%	
CH_4	5	AGRICULTURE - ANIMAL BREEDING (excretions)	**4 221 491**	9%	
CH_4	6	NATURE - HUMID ZONES	**2 775 875**	6%	
CH_4	7	GAS DISTRIBUTION NETWORKS	**2 697 699**	6%	
CH_4	8	NATURE - CONIFEROUS FORESTS	**1 259 173**	3%	
CH_4	9	AGRICULTURE - CULTURES WITH FERTILIZERS except animal manure	**1 017 880**	2%	
CH_4	10	NATURE - DECIDUOUS FORESTS	**704 053**	2%	
		Other Source sub-sectors	**2 751 726**	6%	**45 414 767**
Pollutant	**Rank**	**Source sub-sectors**	**emission**		**European total**
CO	1	ROAD TRANSPORT - PASSENGER CARS	**31 425 405**	45%	
CO	2	COMMERCIAL, INSTITUTIONAL AND RESIDENTIAL COMBUSTION PLANTS	**9 946 613**	14%	
CO	3	INDUSTRIAL COMBUSTION - PROCESSES WITH CONTACT	**5 379 895**	8%	
CO	4	OPEN BURNING OF AGRICULTURAL WASTES (except 10.03)	**4 013 882**	6%	
CO	5	ROAD TRANSPORT - LIGHT DUTY VEHICLES < 3.5 t	**3 326 557**	5%	
CO	6	ROAD TRANSPORT - HEAVY DUTY VEHICLES > 3.5 t AND BUSES	**2 645 991**	4%	
CO	7	PRODUCTION PROC. - IRON AND STEEL INDUSTRIES AND COLLIERIES	**2 478 137**	4%	
CO	8	OTHER MOB. SOURCES - OFF ROAD VEHICLES AND MACHINES	**1 689 745**	2%	
CO	9	INDUS. COMBUS. IN BOILERS, GAS TURBINES AND STATION. ENGINES	**1 481 818**	2%	
CO	10	INDUSTRIAL COMBUSTION - PROCESS FURNACES WITHOUT CONTACT	**1 338 775**	2%	
		Other Source sub-sectors	**5 985 617**	9%	**69 712 434**
Pollutant	**Rank**	**Source sub-sectors**	**emission**		**European total**
CO_2	1	PUBLIC POWER AND COGENERATION PLANTS	**1 248 504**	26%	
CO_2	2	COMMERCIAL, INSTITUTIONAL AND RESIDENTIAL COMBUSTION PLANTS	**849 638**	18%	
CO_2	3	INDUS. COMBUS. IN BOILERS, GAS TURBINES AND STATION. ENGINES	**744 131**	16%	
CO_2	4	ROAD TRANSPORT - PASSENGER CARS	**404 174**	8%	
CO_2	5	INDUSTRIAL COMBUSTION - PROCESSES WITH CONTACT	**236 406**	5%	
CO_2	6	ROAD TRANSPORT - HEAVY DUTY VEHICLES > 3.5 t AND BUSES	**206 722**	4%	
CO_2	7	NATURE - ANIMALS	**170 594**	4%	
CO_2	8	INDUSTRIAL COMBUSTION - PROCESS FURNACES WITHOUT CONTACT	**160 118**	3%	
CO_2	9	PRODUCTION PROC. - WOOD,PAPER PULP,FOOD,DRINK & OTHER IND.	**118 901**	2%	
CO_2	10	DISTRICT HEATING PLANTS	**83 687**	2%	
		Other Source sub-sectors	**541 588**	11%	**4 764 463**
Pollutant	**Rank**	**Source sub-sectors**	**emission**		**European total**
N_2O	1	AGRICULTURE - CULTURES WITH FERTILIZERS except animal manure	**635 735**	34%	
N_2O	2	PRODUCTION PROC. - ORGANIC CHEMICAL INDUSTRY	**234 307**	12%	
N_2O	3	NATURE - WATERS	**208 475**	11%	
N_2O	4	NATURE - CONIFEROUS FORESTS	**184 477**	10%	
N_2O	5	PRODUCTION PROC. - INORGANIC CHEMICAL INDUSTRY	**119 195**	6%	
N_2O	6	PUBLIC POWER AND COGENERATION PLANTS	**90 753**	5%	
N_2O	7	NATURE - DECIDUOUS FORESTS	**83 332**	4%	
N_2O	8	AGRICULTURE - CULTURES WITHOUT FERTILIZERS	**74 649**	4%	
N_2O	9	NATURE - NATURAL GRASSLAND	**53 902**	3%	
N_2O	10	COMMERCIAL, INSTITUTIONAL AND RESIDENTIAL COMBUSTION PLANTS	**44 919**	2%	
		Other Source sub-sectors	**149 940**	8%	**1 879 684**
Pollutant	**Rank**	**Source sub-sectors**	**emission**		**European total**
NH_3	1	AGRICULTURE - ANIMAL BREEDING (excretions)	**4 137 309**	73%	
NH_3	2	AGRICULTURE - CULTURES WITH FERTILIZERS except animal manure	**1 096 301**	19%	
NH_3	3	PRODUCTION PROC. - INORGANIC CHEMICAL INDUSTRY	**160 218**	3%	
NH_3	4	WASTE TREATMENT AND DISPOSAL - LAND FILLING	**73 675**	1%	
NH_3	5	WASTE TREATMENT AND DISPOSAL - LATRINES	**37 496**	1%	
NH_3	6	AGRICULTURE - ANIMAL BREEDING (enteric fermentation)	**30 356**	1%	
NH_3	7	NATURE - HUMANS	**29 991**	1%	
NH_3	8	NATURE - CONIFEROUS FORESTS	**27 315**	0%	
NH_3	9	NATURE - DECIDUOUS FORESTS	**19 431**	0%	
NH_3	10	NATURE - ANIMALS	**19 242**	0%	
		Other Source sub-sectors	**69 659**	1%	**5 700 993**