Emissions of Air Pollutants in the Region of the Central European Initiative - 1988

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Preface

Reliable knowledge of the sources and magnitudes of emissions of air pollutants is an absolute requirement for any assessment of air pollution beyond the pure academic level.

A few years ago, accessible information on pollution in many eastern European countries was sparse. Nevertheless, using IIASA's position as an East-West institute, IIASA's Transboundary Air Pollution Project developed the RAINS model for the integrated assessment of international strategies to reduce transboundary air pollution in Europe. With the help of many collaborators in IIASA's member countries, the databases have been filled with the best information available at this time.

Now the situation has changed and environmental information is abundant. However, serious questions remain as to the quality and the international consistency of national data. Again, IIASA has used its scientific network to establish the first harmonized inventory of air pollutants' emissions in the region of the Central European Initiative. The task was facilitated by the fact that most countries participating in this new initiative are also members of IIASA.

Providing detailed information on emissions in the heart of Europe this inventory will serve as a valuable basis for the design of effective strategies to reduce air pollution in Europe.

Peter E. de Jánosi
Director
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Abstract

This paper presents an emission inventory of sulfur dioxide (SO_2), nitrogen oxides (NO_x), particulate matter (PM) and carbon dioxide (CO_2), for the countries cooperating in the Central European Initiative, i.e., Austria, Croatia, Czechoslovakia, Hungary, Italy, Poland, Slovenia.

The inventory is based on national and regional statistics as well as on information available from the collaborating institutions, which has not yet been internationally published. National data has been verified and converted into a common format, consistent with the database used by the European Environmental Agency and the European Community (the CORINAIR system).

The inventory describes emissions in the year 1988 (before the restructuring process began in former socialist economies). Data has been collected for three levels:

- National,
- Administrative,
- Large Point Sources (LPS).

A point source database has been created, in which specific information (e.g., capacity, commissioning year, fuel use, production) about 400 large plants in Central Europe is stored.

The result of this work represents the first consistent inventory of the sources of air pollution in Central Europe.

Acknowledgements

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The successful completion of this study is a result of the close international cooperation of many experts providing national data as raw input for this work. The authors would like to express their gratitude to the following colleagues and organizations for their unbureaucratic help and friendly assistance:

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Contents

Section 1

Introduction

Central Europe maintains a central position on the continent not only in a geographical sense. Various circumstances have also given it a central role in releasing harmful substances into the atmosphere. Recent statistics suggest, e.g., SO_2 emissions of some central and eastern European countries, expressed on a per capita basis, to be up to 50 times larger than in Scandinavia.

Reliable information on emission quantities, however, is still rare. Before the political changes of 1989/1990 environmental data was often considered confidential, providing room for vast speculations. After that time, access to information became possible; the quality and reliability of statistical material, however, are in many cases still reasons for concern, and the international consistency, and consequently the comparability, of the environmental data of this region has still to be established.

The transboundary nature of air pollution, in particular the long-range transport of the most important pollutants across national borders, makes air pollution a truly international problem. Efficient strategies to protect ecosystems in any particular country have to address, necessarily, not only domestic emission sources, but also polluters in a far reaching area.

In recognizing this need the Central European Initiative (CEI, formerly the Pentagonale), establishing cooperation among Austria, Croatia, Czechoslovakia, Hungary, Italy, Poland and Slovenia, has put also environmental questions on its agenda. Several task forces have been formed to carry out specific projects of common interest. A special task force, with Italy as the lead country, was assigned responsibility for the harmonization of environmental monitoring and data systems in Central Europe.

Among other projects this task force aims at creating a harmonized database on emissions of air pollutants of all countries in the region. With financial support from the Italian Ministry of the Environment, IIASA's Transboundary Air Pollution Project has accepted the responsibility for establishing this database.

This report presents the results of this work, i.e., an inventory of the emissions of sulfur dioxide (SO_2), nitrogen oxides (NO_x), particulate matter (PM), and carbon dioxide (CO_2) for the year 1988. Although, at the present time, the selection of the base year might appear as somewhat outdated, it has been motivated by the intention to produce a first survey of regional emissions within

a short time. Necessarily, such a preliminary estimate must be based on existing statistical material. However, work is under way to establish a more detailed inventory for the year 1990. Once established, a comparison between the 1990 data and the data for 1988, which describes the former situation of the economies with centralized planning, will provide an important basis for future analyses of the ongoing process of economic transition.

This report is organized as follows: Section 2 reviews the statistical background material available in the individual countries and introduces the methodology adopted to create the common consistent database for the region. Section 3 provides an overview of the emissions for the entire region in 1988/1989. Detailed regional results are presented in Section 4. Conclusions are drawn in Section 5.

Section 2

Methodology

In most cases emissions, i.e., the streams of substances released to the atmosphere, are not directly monitored for the main reason that monitoring equipment is rather expensive and often difficult to operate. Consequently, emission monitoring, if applied at all, is only performed at the largest sources (e.g., the largest power stations). For the majority of emitters, i.e., at all the small emitters (households, vehicles, agriculture, etc.), and in some countries even at many large point sources, no continuous monitoring is installed. Consequently, emission estimates have to be based on calculations using other more or less appropriate (and reliable) methods, e.g., extrapolating experience gained at a few sites to many other cases.

A number of circumstances result in significant differences in the systems applied to national emission inventories:

- Methodologies employed,
- Parameters assumed as characteristic for groups of similar activities,
- The availability of statistical material,
- The request for confidentiality of data related to individual enterprises,
- Differences in experience and national preferences.

In addition, the format in which emission data are finally presented usually follows the requirements of national statistics. As a result, international cross-country comparisons, e.g., of sectoral emission data, are often complicated by differences in the definition of the sectors.

All countries in the CEI region had developed and applied individual systems to estimate quantities of air pollutants' emissions within their national boundaries before a common CEI inventory was established by this study. As in other parts of the world, these initial efforts have not been internationally coordinated. Consequently, a direct comparison of data has been impossible. The fact that these data have not been published in many countries is an additional complication. In order to overcome these problems, and to enable the comparison, this study collected additional material in cooperation with national experts.

2.1 National emission inventory systems in the CEI region

2.1.1 Austria

The official emission inventory of Austria is maintained by the Umweltbundesamt in Vienna. This inventory distinguishes six source categories at the national level:

- Public power and heating plants (steam boilers ≥ 50 MW_{therm}),
- Industrial combustion and processes,
- Traffic (road transport),
- Space heating and commercial combustion,
- Solvent use,
- Straw-burning on open fields.

A regionalized inventory is available for 1988 for some 100 political districts, including emissions of SO_2, NO_x, VOC, CO, CO_2, methane and particulates. Estimates of national total emissions are available on an annual basis from 1980 to 1990.

Emission data from large steam boilers (≥ 50 MW_{therm}) is registered separately and usually based on emission declarations of the plant operators. If such information is not available, fuel specific emission factors and fuel consumption are used to estimate emissions.

Emissions from traffic are computed for line sources and area sources. For line sources (highways), a special computer program is available.

Emissions from space heating are estimated based on regional data of energy consumption collected by the Austrian Statistical Office, employing information on climate, fuel type and furnace characteristics.

2.1.2 Croatia

Although Croatia only obtained its national sovereignty in 1991, emission estimates in former Yugoslavia were already being collected at the level of the individual republic. In Croatia, this work has been based at the National Meteorological Institute in Zagreb. Due to obvious difficulties and the late access to Croatian statistics obtained for this collaborative study, data presented in this inventory includes only information about the activity of seven public power and heat plants in 1990 (Jelič-Mück *et al.*, 1992).

2.1.3 Czechoslovakia

In the area of the former Czechoslovakia several systems for estimating emissions of selected air pollutants have been used (Jilek, 1992). The most important official inventory is the Register of Emissions and Sources of Atmospheric Pollutants (REZZO). This database has been maintained at organizations of the Czech Ministry of the Environment (Czech Inspection of Environment - Air Protection Division and Czech Hydrometeorological Institute) for the area of the Czech Republic and at the Slovak Hydrometeorological Institute in Bratislava for the Slovak Republic. Four categories of activities are distinguished in this system:

REZZO 1: Large and medium-sized combustion installations (boilers and technological furnaces) with thermal output greater than 5 MW and important industrial plants. This register contains about 2,500 emission sources.

REZZO 2: Smaller stationary sources with a thermal output between 0.2 and 5 MW and other individually monitored industrial plants (some 30,000 sources).

REZZO 3: Small stationary sources with a thermal output below 0.2 MW (about 3,200,000 sources).

REZZO 4: Mobile sources (some 5,000,000 sources).

Emission sources included in REZZO 1 and 2 are monitored individually. Plants which are included in REZZO 1 are obliged to report their emissions to the authorities on an annual basis. The data collection and estimation of emissions from sources included in REZZO 3 occur every year on the basis of data on fuel sold in the administrative units. The emissions of REZZO 4 are estimated on the basis of number of cars and fuel consumption. The data collection and estimation of emissions for REZZO 2 and 4 occur every five years.

The REZZO system covers emissions of SO_2, NO_x, VOC, CO and particulates, as well as other pollutants specific for the technology monitored.

Emissions are spatially aggregated to a district level (128 districts in the former ČSFR), and in aggregates thereof (12 regions, 2 republics).

In addition to data of the REZZO inventory, the Emission Information System of Energetics (EISE) owned by the Czech Power Company was also used for this study. It contains data for public power plants and public heat-power plants which belong to the ČEZ (Organization of the Czech Power Plant

Operators). Data for the EISE system is provided annually and includes information on fuel quality and quantity, electricity and heat production, and on emissions of SO_2, NO_x and particulates.

2.1.4 Hungary

In Hungary a number of research groups have been active in establishing emission inventories. The official Hungarian inventory is now based at the Institute for Environmental Protection (Budapest). This database distinguishes the following sectors:

- Power Plants,
- Industry,
- Services,
- Public,
- Agriculture,
- Transport (national level only).

In general, data is stored for the administrative unit level, but some information for the large point sources (mainly in the power generation sector) is also available. A complete and consistent inventory is available for 1988.

To obtain a complete picture of the emission situation in Hungary in 1988, the assistance of experts from the Hungarian Power Companies Ltd., and the University of Karlsruhe was invited for this study.

2.1.5 Italy

Italy, as a member state of the European Community (EC), participated in the CORINAIR'85 (**CO**o**R**dination of **IN**formation on the **AIR**) activity of the EC. The work is based at the Italian National Agency for New Technology, Energy and Environment (ENEA) in Rome. The CORINAIR inventory now represents the official emission data for the year 1985. For other years (e.g., 1980, 1984, and in 1986-90), other estimates, not following the CORINAIR structure, are available (Gaudioso & Brini, 1991).

The main source of data used for this study is the Italian CORINAIR inventory. The estimates for area sources of the 1985 database have been modified for 1988, using recent data on national and sectoral energy

consumption, assuming that the regional components of emissions have not changed.

Data for Italian large point sources contained in this study relate to the year 1985, since more recent information is not available. However, since the differences in economic activities between 1985 and 1988 are minor, no major inaccuracies are expected. As for all other countries in the region, work is in progress to estimate the emissions of 1990.

2.1.6 Poland

Under contract for the Polish Ministry of the Environment, the Polish emission inventory system SOZAT has been developed by ATMOTERM, an Opole-based consultancy company. Currently, SOZAT is able to store information for up to 400 pollutants, at a spatial resolution of 49 districts and for the 52 largest point sources.

Unfortunately, the SOZAT system is incompatible with systems used in other countries and, in particular, with the CORINAIR system applied by the European Environmental Agency.

However, it is possible to estimate emissions based on other statistical material. For the purpose of this inventory an independent assessment has been carried out. The annual Polish fuel and energy statistics (GUS, 1989) provide appropriate information to perform national-level emission calculations as well as disaggregated to economic sectors. The emission data published by the Central Statistical Office (GUS) for the biggest polluters on a plant basis together with fuel consumption statistics of the power plant sector (CIE, 1989; CIE, 1991), have been used for preparation of the database on large point sources.

Regional estimates of the area sources emissions are based on information on industrial emissions published in the annual Polish environmental statistics (GUS, 1990); national totals of emissions from the domestic and transport sector were separated into 49 regions based on population densities, using the top-down approach.

2.1.7 Slovenia

Although Slovenia has been independent only since 1991, its emissions have been estimated regularly by the Slovenian Hydrometeorological Institute in Ljubljana.

The estimates of SO_2, NO_x, particulates and CO_2 emissions for 1988 for the territory of Slovenia are derived from fuel consumption statistics or extracted directly from the Slovenian Environmental Status report (Hrček *et al.*, 1991). In this report emission data for the following sectors are provided:

Power sector: This sector includes producers of electricity - members of the Electrical Energy Producers' Association in Slovenia (thermal power plants and heating stations as well as industrial power plants).

Industry: Estimates are based on fuel consumption data. Emissions resulting from technological process are not considered. However, the error caused by this is not considered to be higher than 2%.

Small consumers: Domestic heating and other small emission sources.

Mobile sources: Motor vehicles and other traffic.

Process emissions: Emissions are estimated based on consumption of coke for steel industry.

Table 1. National emission inventory systems in the CEI region

Country	Pollutants	Reference Years	Spatial Resolution - territorial units -
Austria	SO_2, NO_x, VOC, CO, CO_2,Particulates, CH_4	National estimates for 1980 to 1988; regional estimates for 1988	100 political districts
ČSFR	SO_2, NO_x, VOC, CO, Particulates, **	1982 to 1990 for REZZO 1; Every 5 years for REZZO 2,4	1. ČSFR; 2. Czech & Slovak Rep.; 3. Regions (12); 4. Districts (128)
Hungary	SO_2, NO_x, VOC, CO, NH_3, Particulates, Pb	1980, 1985, 1987, 1988	20 districts
Italy	SO_2, NO_x, VOC, CO, NH_3, TSP, ***	1980,1984,1985,1986; 1985/1989 at the national level***	95 provinces
Poland*	SO_2, NO_x, VOC, CO, NH_3, TSP, 400 other pollutants	Every year	49 districts
Slovenia	SO_2, NO_x, CO_2; some other pollutants for individual LPS	1980, 1985 to 1991	Slovenia

* *Applies to the SOZAT system currently under development; data not yet available.*
** *And other pollutants specific for the technology monitored.*
*** *For the years 1985/1989 emissions were estimated at the national level, disaggregated into ca. 35 activities (this inventory includes also CO_2) (Italian Report on the State of the Environment, 1992).*

Table 1. continued

Country	Sector - Classification	Large Point Sources
Austria	1. Steam boilers (>50 MW_{th}) 2. Ind. combustion and processes 3. Road transport 4. Space heating and commercial combustion 5. Solvent use 6. Straw-burning on open fields	>50 MW_{th} (industrial combustion), refineries, nitric acid plants, coke oven plants
ČSFR	1. Boilers and technological furnaces >5 MW_{th} 2. Stationary sources 0.2 - 5 MW_{th} and other technologies 3. Small sources <0.2 MW_{th} 4. Mobile sources	>5 MW_{th} and specific industries (REZZO 1)
Hungary	1. Combustion a) Power plants b) Industrial combustion c) Small sources (domestic) 2. Road transport 3. Process emissions for 1988	Public power and heating plants
Italy	1. Agriculture 2. Transport 3. Industry 4. Tertiary sector/domestic 5. Power plants for 1985 inventory CORINAIR'85 classification was adopted	As defined in CORINAIR'85
Poland	According to CORINAIR'90 classification	As defined in CORINAIR'90
Slovenia	1. Electricity generation 2. Industry 3. Households 4. Mobile sources 5. Process emissions	Large emitters of pollutants, includes industrial sources (combustion and process)

2.2 The CORINAIR inventory

To establish a common harmonized database for its entire region, the Commission of the European Communities (DG XI - Department of Environment, Consumer Protection and Nuclear Safety) initiated and carried out a major activity to introduce the CORINAIR system for all member countries. CORINAIR is part of a comprehensive Programme CORINE (**CO**o**R**dination of **IN**formation on the **E**nvironment), providing a sound basis for all kinds of environmental information (land use, air pollution, waste, water pollution, etc.) in Europe.

The CORINAIR framework, developed at CITEPA (**C**entre **I**nterprofessionnel **T**echniques d'**E**tudes de la **P**ollution **A**tmosphérique) in Paris (CITEPA, 1991), aims at eliminating national inconsistencies in data collection and presentation by specifying a rigorous system of standardized source categories (the SNAP 90 - **S**elected **N**omenclature for **A**ir **P**ollution code), fuel types (the NAPFUE - **N**omenclature for **A**ir **P**ollution **FUE**ls code), territorial units, calculation methodologies, emission factors, control devices, and pollutants. The types of pollutants and the main activities defined for the CORINAIR'90 inventory are presented in *Boxes 1* and *2*. Related computer programs and various handbooks facilitate the creation of the national databases. Data verification and validation is centrally performed. Details on the CORINAIR methodology can be found in Bouscaren (1991) and CITEPA (1992b).

Box 1. Pollutants considered in CORINAIR'90

Sulfur Dioxide	SO_2
Nitrogen Oxides	NO_x
Non-Methane Volatile Organic Compounds	NM-VOC
Methane	CH_4
Carbon Monoxide	CO
Carbon Dioxide	CO_2
Nitrous Oxide	N_2O
Ammonia	NH_3

As a pilot study, the CORINAIR methodology has been applied to all EC member states to register the emissions of 1985 (the CORINAIR'85 inventory). For this year, the inventory includes three pollutants: SO_2, NO_x and VOC (Volatile Organic Compounds). For each of 470 statistical regions of the EC the contribution of different emission sources, separated into 120 activities gathered in eight groups, was calculated. In addition, the emissions from 1400 major point

sources were recorded individually (CEC, 1993, forthcoming).

Box 2. Main activities considered in CORINAIR'90

1. Public Power Cogeneration and District Heating Plants
2. Industrial Combustion Plants and Processes with Combustion
3. Non-Combustion Process
4. Road Transport
5. Other Transport
6. Commercial, Institutional and Residential Combustion Plants
7. Agriculture
8. Extraction and Distribution of Fossil Fuels
9. Solvent Use
10. Waste Treatment and Disposal
11. Nature

2.3 Methodology of the common CEI'88 inventory

The CORINAIR data-reporting format has been adopted as the common standard for all European countries to fulfill their obligations within the Convention on Long-range Transboundary Air Pollution of the United Nations Economic Commission for Europe (UN/ECE). Thereby, all European countries are forced to submit their emission data for the year 1990 using the CORINAIR definitions. In addition, the European Environmental Agency Task Force has also established the CORINAIR system as its official data-reporting framework. Consequently, to fulfill these obligations, all countries of the Central European Initiative, even those currently not members of the European Community, will have to present future emission data consistent with the CORINAIR system.

Recognizing this fact, a decision has been taken by all country experts involved in this study to establish the common CEI inventory in line with the CORINAIR standards. This decision will fully apply to the upcoming CEI inventory for the year 1990, for which data collection is currently performed based on the CORINAIR procedure.

However, as outlined in Section 2.1, the existing national emission databases (e.g., for the year 1988) in most of the CEI countries are not fully

compatible with the CORINAIR standards (*Table 1*). Analysis has shown that an exact transformation of the existing databases into the CORINAIR format would create major difficulties in some countries. Consequently, a procedure has been developed to establish a common data structure, as far as possible consistent with the envisaged CORINAIR'90 system, into which all existing national databases could be converted (the CEI'88 structure). *Figure 1* shows the relationship between the sector classifications of the CORINAIR'90 and the CEI'88 inventories.

The CEI'88 inventory makes a distinction between emissions from large point sources and from dispersed area sources. In order to identify the largest single polluters in the region and subsequently to design cost-effective strategies to reduce emissions, the emissions from large point sources are collected on a plant basis together with a number of techno-economic features of the emission sources. Area sources, covering all remaining emissions not counted under the large point sources category, should provide important information on the total amount of emissions in a certain region, information that is relevant to analyze the environmental impacts of air pollution.

2.3.1 Large point sources (LPS)

Large point sources include all emitters fulfilling at least one of the following criteria:

- Power plants with a capacity of more than 50 MW_{therm},
- Oil refineries,
- Plants in which sulfuric acid or nitric acid is produced,
- Plants which discharge more than 1000 tons of SO_2 or NO_x or Particulates per year into the atmosphere.

For each of these sources a set of basic information is stored in the CEI'88 database (*Box 3*). For the largest emitters, depending on the availability of information, a variety of additional technical and economic characteristics are contained (*Box 5*). Unfortunately, this in-depth information is not yet available for all large point sources across the CEI region. However, it is planned to collect the missing data during the course of establishing the 1990 inventory.

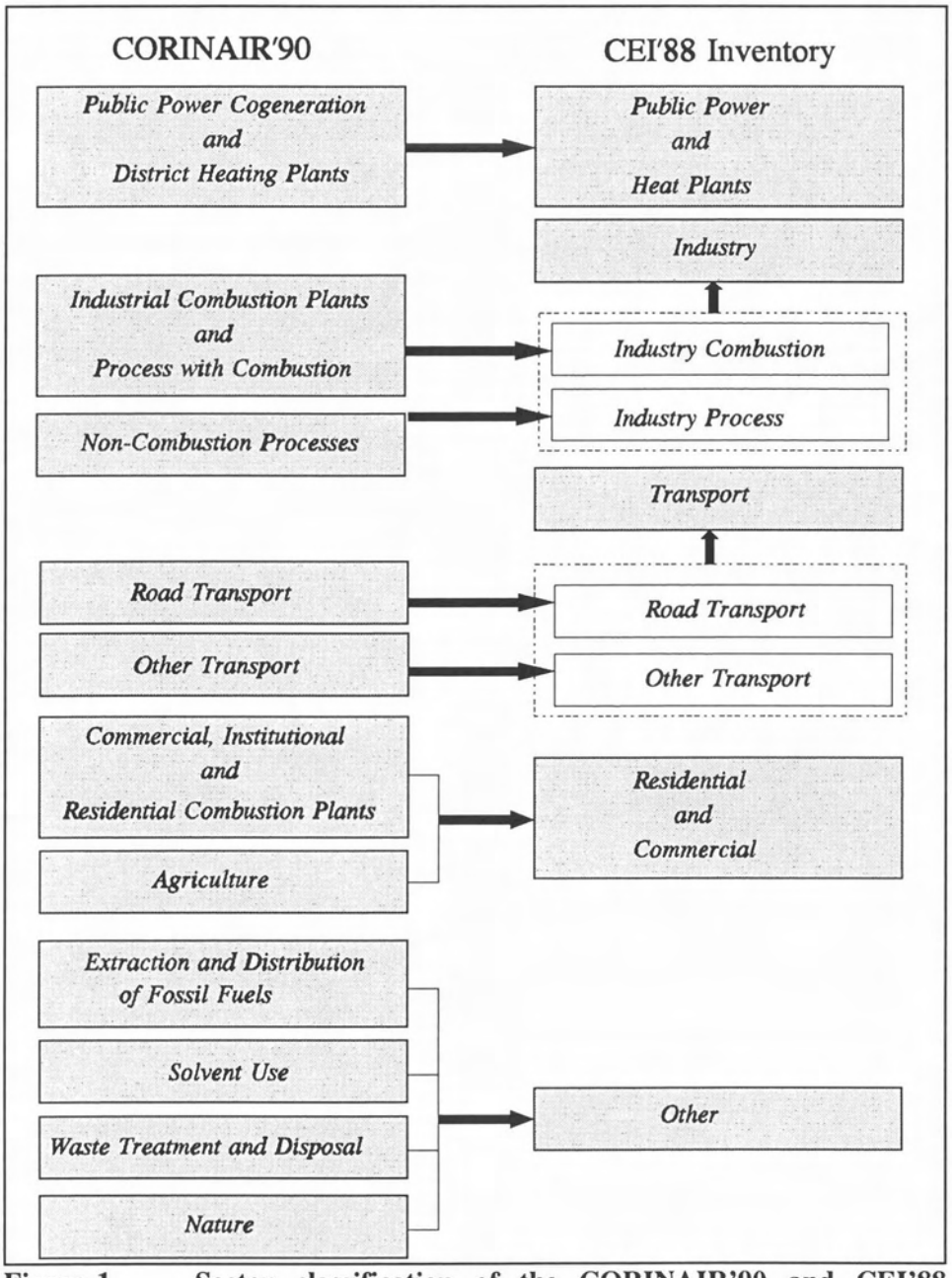


Figure 1. Sector classification of the CORINAIR'90 and CEI'88 inventories

Box 3. The LPS database of the CEI'88 inventory (set of basic information)

- Name of the plant
- Location (geographical coordinates)
- Region (administrative unit according to *Table 2*)
- Country
- CORINAIR SNAP (sector) code, into which activity falls
- Commissioning year(s)
- SO_2 emissions in reference year (1988)
- NO_x emissions in reference year (1988)
- CO_2 emissions in reference year (1988)
- PM emissions in reference year (1988)

2.3.2 Area sources

Area sources include all other stationary sources not included in the LPS database as well as all mobile sources of emissions. These data are stored as national totals, i.e., describing emissions from the individual countries of the CEI region, as well as for regional levels (according to the NUTS - **N**omenclature des **u**nités **t**erritoriales **s**tatistiques - levels as defined by the Statistical Office of the European Communities EUROSTAT (EUROSTAT, 1991; EUROSTAT, 1992)) (*Table 2*).

Box 4. Sectoral aggregation of area emissions

Public power and heat plants
Industry
Transport
Residential/Commercial
Other

On a national level, emissions from these sources are aggregated into the major activity groups (economic sectors), as far as possible compatible with the CORINAIR'90 inventory (see *Box 4* and *Figure 1*). Unfortunately, lack of information did not allow a consistent sectoral disaggregation on a regional level. Only a few of the countries considered could provide appropriate data.

Box 5. The LPS database of the CEI'88 inventory (extended data set)

- Name of the plant
- Location (geographical coordinates)
- Country
- Year to which information applies
- Fuel type
- Number of boilers
- Boiler type
- Installed capacity (thermal input, electric and heat output)
- Efficiency
- Energy production (electricity, heat)
- Capacity utilization (for electricity and heat)
- Fuel input (by fuel type)
- Fuel quality (ash and sulfur content, lower calorific value)
- Sulfur retention in ash
- Installed emission control equipment
- SO_2 emissions (given and calculated)
- NO_x emissions (given and calculated)
- CO_2 emissions (calculated)
- PM emissions (given and calculated)

2.4 Data storage of the CEI inventory

All information collected for the CEI'88 inventory has been electronically stored in a common database. The database is currently implemented on IBM-PC compatible machines, using the FOXPRO database software. With the help of the PC-based MAPINFO software various kinds of graphical output (see *Figures 13 - 24* in Section 4) can be produced.

It is planned to install the CEI'88 database system on the CEDAR (Central European Data Request Facility) system, a computer network which enables direct access to the information from all countries of the CEI.

The flow chart summarizing the steps undertaken to perform the CEI'88 inventory is presented in *Figure 2*.

Table 2. Regional disaggregation of the CEI'88 inventory

Country	Number of units	Territorial unit
Austria	9	Bundesländer
Croatia	1	Entire territory
Czechoslovakia	12	Kraj
Czech Republic	8	Kraj
Slovak Republic	4	Kraj
Hungary	20	Comitias
Italy	95	Provincie
Poland	49	Województwo
Slovenia	1	Entire territory

2.5 Reliability and accuracy of the emission inventory

The question of reliability of emission estimates is often cause for concern. Major factors influencing the accuracy of emission estimates are:

- Quality of energy and emission data,
- Data on fuel quality (sulfur content, calorific value, etc.),
- Emission factors.

The quality of statistical material available varies from country to country. As far as energy and emission data is concerned, complete statistics were available for most of the countries considered in this study. In some cases, e.g., the Czech Republic, the Slovak Republic, Italy and Slovenia, data were not complete for 1988. Therefore, appropriate statistics for other years were used. The margin of error, however, is expected to be small due to the fact that at that time economic changes were relatively slow. A more important source of inaccuracy is related to differences in the classification of sectors in raw data provided by the national experts. Although this does not affect the results on the national level, it may cause shifts between individual sectors. This is evident in the case of Czechoslovakia, where four groups of emission sources are distinguished in the

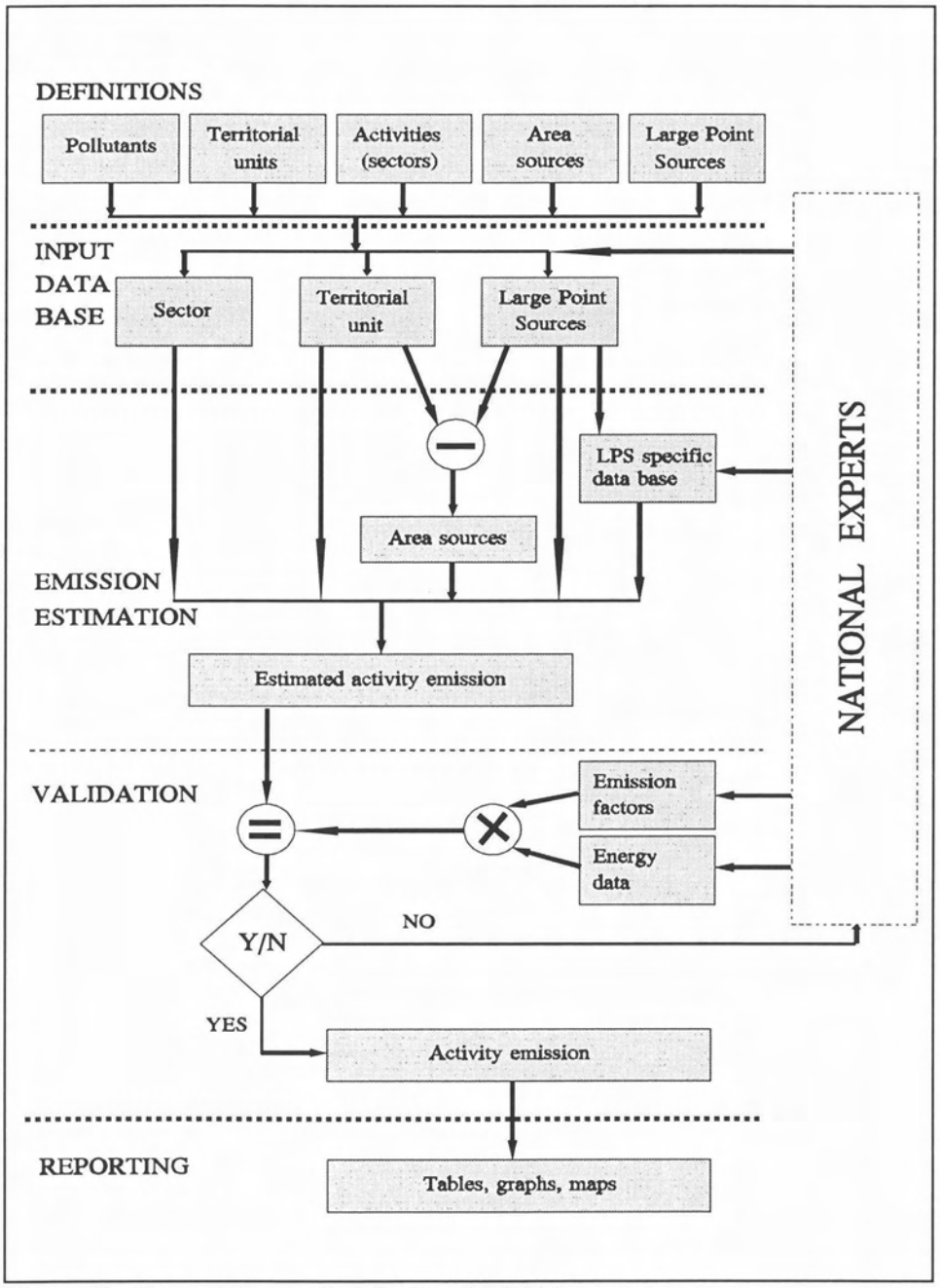


Figure 2. Procedure applied in the CEI'88 inventory

inventory system REZZO (see Section 2.1.3). These groups do not fully correspond with the sector classification applied in this inventory (see *Figure 1*).

In Czechoslovakia emissions from transportation appear to be low in relation to the number of registered cars. As long as more detailed fuel statistics for this sector are not available, it is difficult to establish better estimates. Only a few countries could provide sufficient data to perform sectoral analyses of emissions on the regional level. Therefore, in this emission inventory only total regional emissions are presented.

Fuel quality data, especially sulfur content and calorific value, is of great importance for all emission estimates. It must be stressed that data on the national level are usually consistent and reliable and include average values for individual sectors. However, calculations on the regional level, especially for the residential/commercial sector, are often based on incomplete data. This applies mainly to those countries where domestically produced solid fuels are used extensively in this sector, e.g., Poland, the Czech Republic, and the Slovak Republic.

As far as SO_2 emission factors are concerned, uncertainties are directly connected to the quality of data describing the characteristics of fuel.

In this report NO_x emission estimates are based on data provided by the national experts. The underlying NO_x emission factors are generally in accordance with the internationally accepted coefficients. There are, however, some exceptions. In the case of the Czech Republic and the Slovak Republic applied emission factors are higher. Supplied NO_x emissions for large point sources (identified in the inventory) are, in some cases, 100% higher than emissions calculated using international emission factors.

For particulate matter (PM) emissions, the values given for power plants are generally reliable. But PM emission estimates for other sectors, and especially estimations on the regional level, strongly rely on the availability and accuracy of fuel-quality data, as well as on estimates of efficiency of particulate control equipment. Again, this is a major concern in countries where solid fuels play a dominant role.

These inaccuracies do affect the final result of the emission estimation, but, in general, the estimate's error is not likely to exceed 10%. However, it is possible that the error of regional estimates is higher, especially in Poland where a comprehensive attempt of determining emission data on the regional level will be done within the upcoming work on CORINAIR'90 inventory.

In general, it can be expected that most of these inaccuracies will be eliminated in the forthcoming 1990 inventory for Central European Initiative.

Section 3

Emissions in the CEI Region in 1988

3.1 The CEI countries: statistical background

Currently, the Central European Initiative includes eight countries that occupy an area of 995,539 km^2 and had a total population in 1988 of 135.88 million people. The basic statistical data for each country is presented in *Table 3*. The population density in the whole region is shown in *Figure 3*.

Table 3. Basic statistical data for CEI region in 1988

Country	Area ($10^3 km^2$)	Population Total (million)	Population Density (inh/km^2)	GNP* Total (blnUS$)	GNP* per capita (US$/cap)
Austria	83.9	7.82	93.3	101.4	12,965
Croatia	56.5	4.76	84.2	33.3	6,996
CSFR	127.9	15.61	122.1	123.3	7,899
Czech Rep.	78.9	10.36	131.4	85.7	8,272
Slovak Rep.	49.0	5.25	107.1	37.6	7,162
Hungary	93.0	10.38	111.6	64.7	6,233
Italy	301.3	57.33	190.3	721.3	12,582
Poland	312.7	38.04	121.7	173.9	4,572
Slovenia	20.3	1.94	95.8	24.5	12,629
CEI	**995.5**	**135.88**	**136.5**	**1,242.4**	**9,144**
EUROPE**	**10,510.4**	**699.92**	**66.6**	**6,175.5**	**8,823**

* For Austria and Italy GNP value is given in purchasing power parity (PPP) (OECD Statistics, 1992 and IMF, 1992). For other CEI countries GNP value, expressed in PPP, is given as reported by PlanEcon (Vanous, 1990). All GNP numbers are for 1989.
** In the estimate for Europe, Turkey was excluded.

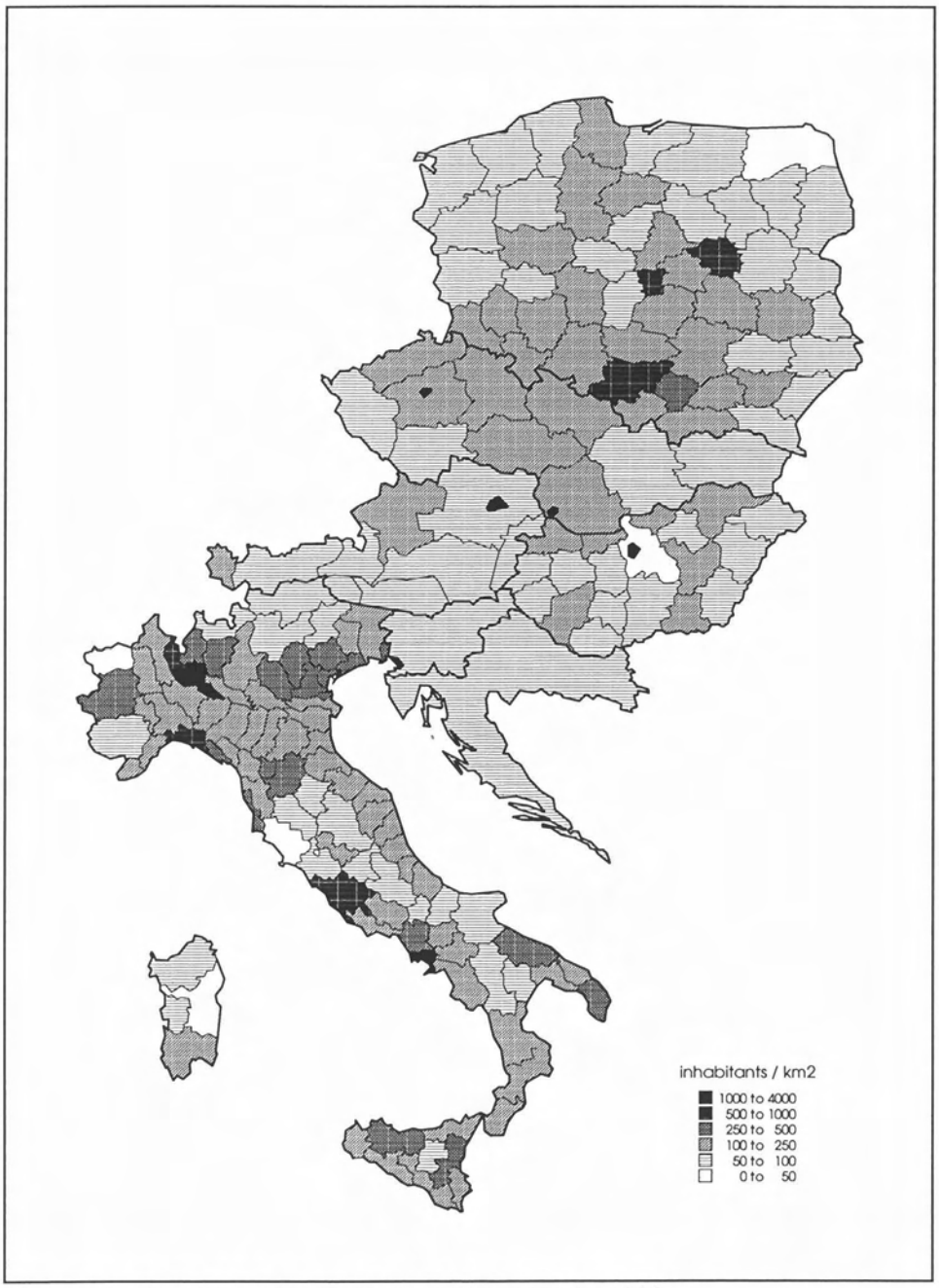


Figure 4. Population density in the CEI region in 1988

The countries of the CEI belong to the densely populated areas in Europe: compared to an average population density of 67 inhabitants per km^2 (inh/km^2), CEI countries are populated at a rate twice as high (136 inh/km^2). Major variations occur naturally also within Central Europe, with a factor of two between Croatia (84.2 inh/km^2) and Italy (190 inh/km^2).

Whereas, on the whole, the level of economic activities is close to the average European level, differences also occur within the CEI region. Gross domestic product per capita in 1988 (expressed in purchasing power parity) ranges from 4,572 US$ per capita (US$/cap) in Poland to 12,965 US$/cap in Austria. Due to structural changes in eastern Europe estimates are subject to uncertainty.

3.2 National total emissions

The aggregated results of the emission account performed in this study are displayed in *Table 4*. Emissions of sulfur dioxide in the CEI region amount to 10.3 million tons per year, which accounts for 25% of total European SO_2 emissions. At the same time, some 5 million tons of nitrogen oxides were released in this region (24% of European emissions). Particulates add up to about 4 million tons, and 1.3 billion tons of CO_2 were produced by the Central European countries.

Table 5 lists emission densities (emissions per area), per capita emissions, and emissions per unit of GDP for the CEI countries. Obviously, all three indicators reveal major differences among the countries. On a national level, emission densities vary for SO_2 by as much as a factor of 19, and for NO_x and particulates by a factor of 4 and 21, respectively. In terms of population, the largest differences occur for SO_2 emissions, ranging from about 200 kg per capita in the Czech Republic to 15 kg per capita in Austria (see also *Figure 4* and *5*). Similarly, there exists a difference in GDP-related SO_2 and PM emissions between, e.g., the Czech Republic or Poland and Austria by a factor of around 20. On the other hand, NO_x emissions per unit of GDP vary only by a factor of five. The reasons for these differences will be explored in Section 4.

Carbon intensity in the former CMEA (**C**ouncil of **M**utual **E**conomic **A**ssistance) economies (ton CO_2 per PJ energy input) is three to five times higher than in Austria, Italy, and Slovenia. It has to be noted that the high numbers of NO_x emissions in the Czech Republic and the Slovak Republic are subject to serious doubts because of the calculation method for determining NO_x emissions from power plants applied in these countries.

Table 4. National total emissions for the countries of the CEI region in 1988

Country	SO_2 (kt)	NO_x (kt)	PM (kt)	CO_2 (mlnt)
Austria	116	225	44	55
Croatia*	70	10	2	-
ČSFR	2672	1109	1144	244
Czech Rep.	2066	858	840	180
Slovak Rep.	606	251	304	64
Hungary	1171	231	222	84
Italy	2216	1982	492	443
Poland	3827	1363	2145	454
Slovenia	210	50	25	14
CEI	10282	4970	4074	1295
Europe**	40644	20546	-	7250***

* Emission data for Croatia includes only public power plants.
** Total European emissions of SO_2 and NO_x are estimated on the basis of the Economic Commission for Europe (ECE) data as of Oct. 1, 1992.
*** Total European CO_2 emission estimation is based on information stored in the database of the Environmentally Compatible Energy Strategies Project at IIASA.

Within the CEI region the contribution of individual countries to overall emissions is strongly dependent on the pollutant (*Figure 6*). For example, whereas the market economies of Austria and Italy contribute some 10 - 20% of the total CEI emissions of particulates and SO_2, they release about 40% of the NO_x and CO_2 emissions in this regions. The reason for this is the high motorization in these countries.

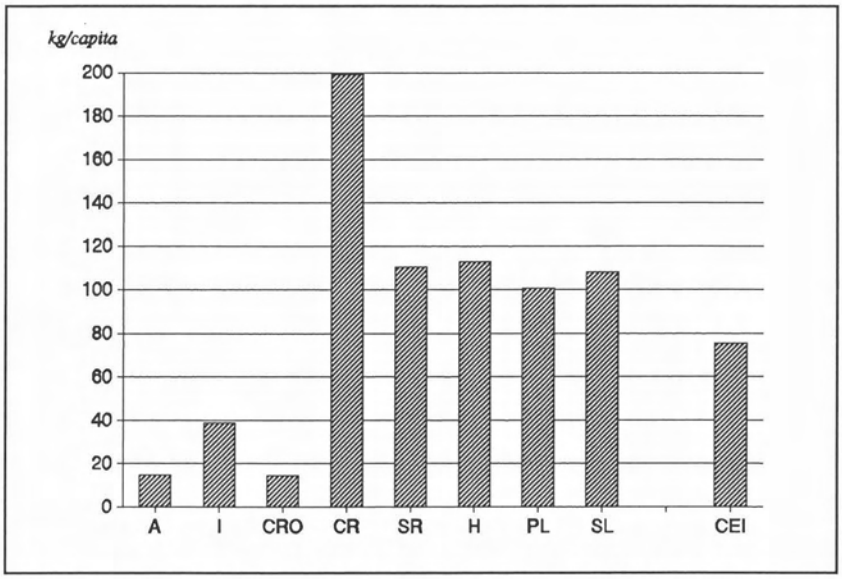


Figure 4. Per capita SO_2 emissions in the CEI region

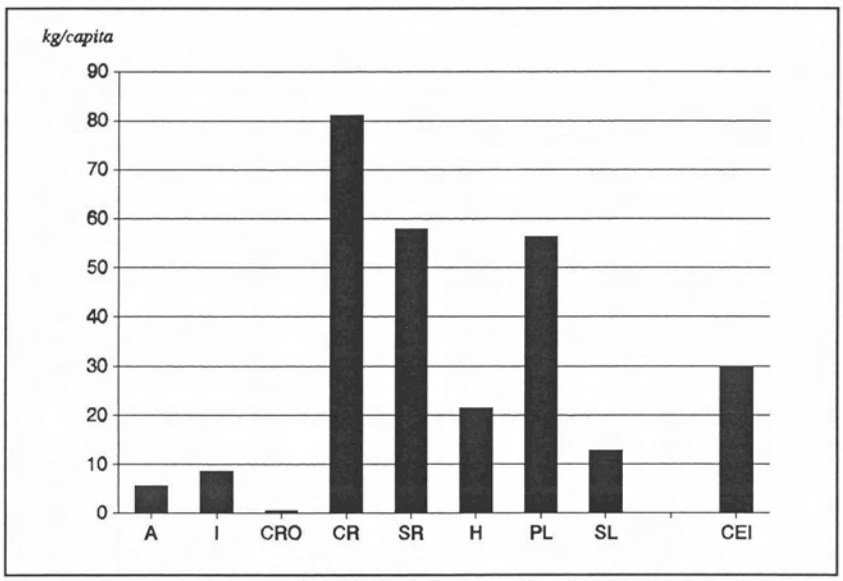


Figure 5. Per capita PM emissions in the CEI region

Table 5. Characteristics of emissions of atmospheric pollutants in the CEI region in 1988

	Emissions/capita				Emissions/km^2				Emissions/GNP			
Country	SO_2	NO_x (kg/cap)	PM	CO_2 (t/cap)	SO_2	NO_{x_2} (t/km^2)	PM	CO_2 (t/km^2)	SO_2	NO_x (kg/US$1000)	PM	CO_2 (kg/US$1)
Austria	15	29	6	7.1	1.4	2.7	0.5	0.7	1.1	2.2	0.4	0.5
Croatia*	15	2	0.5	-	1.2	0.2	0.0	-	2.1	0.3	0.1	-
ČSFR	171	71	73	15.6	20.9	8.7	8.9	1.9	21.7	9.0	9.3	2.0
Czech Rep.	199	83	81	17.4	26.2	10.9	10.7	2.3	24.1	10.0	9.8	2.1
Slovak Rep.	115	48	58	12.2	12.4	5.1	6.2	1.3	16.1	6.7	8.1	1.7
Hungary	113	22	21	8.1	12.6	2.5	2.4	0.9	18.1	3.6	3.4	1.3
Italy	39	35	9	7.7	7.4	6.6	1.6	1.5	3.1	2.8	0.7	0.6
Poland	101	36	56	11.9	12.2	4.4	6.9	1.5	22.0	7.8	12.3	2.6
Slovenia	108	26	13	7.2	10.4	2.5	1.2	0.7	8.6	2.0	1.0	0.6
CEI	76	37	30	9.5	10.3	5.0	4.1	1.3	8.2	4.0	3.3	1.0
EUROPE	58	29	n.a.	10.4	3.9	2.0	n.a.	0.7	6.6	3.3	n.a.	1.2

* Emission data for Croatia includes only public power plants

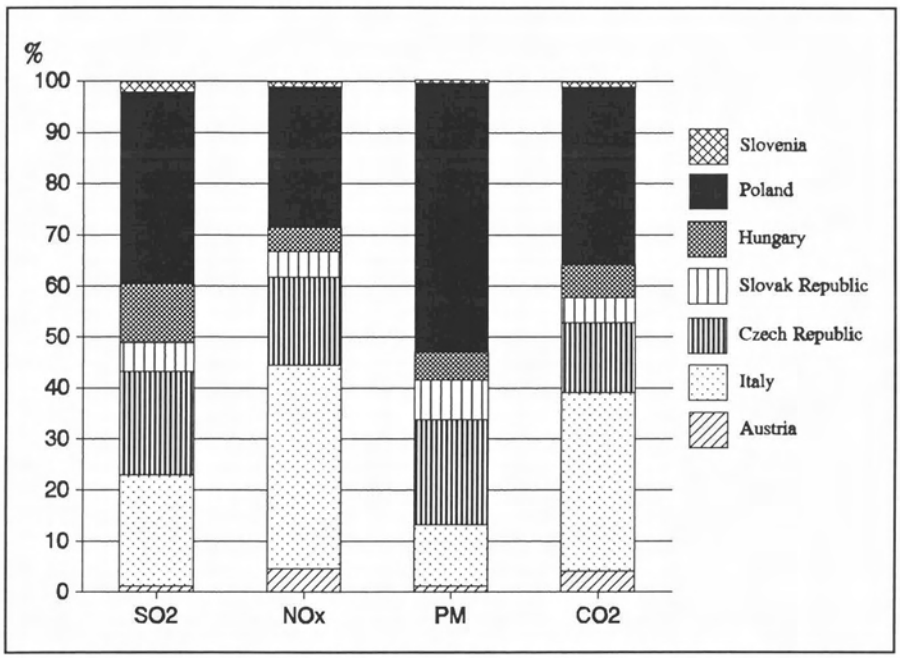


Figure 6. National contributions to total CEI emissions

Croatia's contribution to total CEI emissions is not included in the above graph. Available emission data for Croatia includes only seven public power plants (see *Table 4*). Therefore the shares of Croatian emissions of SO_2, NO_x, and PM in total emissions are only 0.7%, 0.2% and 0.05%, respectively.

3.3 Structural analysis of national emissions

The CEI'88 inventory allows for a structural in-depth analysis of national emissions. The sectoral emission data are presented in the Annex.

Important conclusions can be drawn from disaggregating national data according to the fuel types causing the emissions. As shown in *Figure 7*, the overwhelming majority of SO_2 emissions in the CEI region (70%) originates from combustion of domestic (brown and hard) coal. In the Czech and Slovak Republics, Hungary and Slovenia, the burning of these fuels creates more than 75% of the total national SO_2; in Poland as much as 90% of SO_2 emissions result from combustion of (domestic) solid fuels. On the other hand, in countries where solid fuels are to a large extent imported, i.e., in Austria and Italy, related SO_2 emissions account for less than 20% of their national totals.

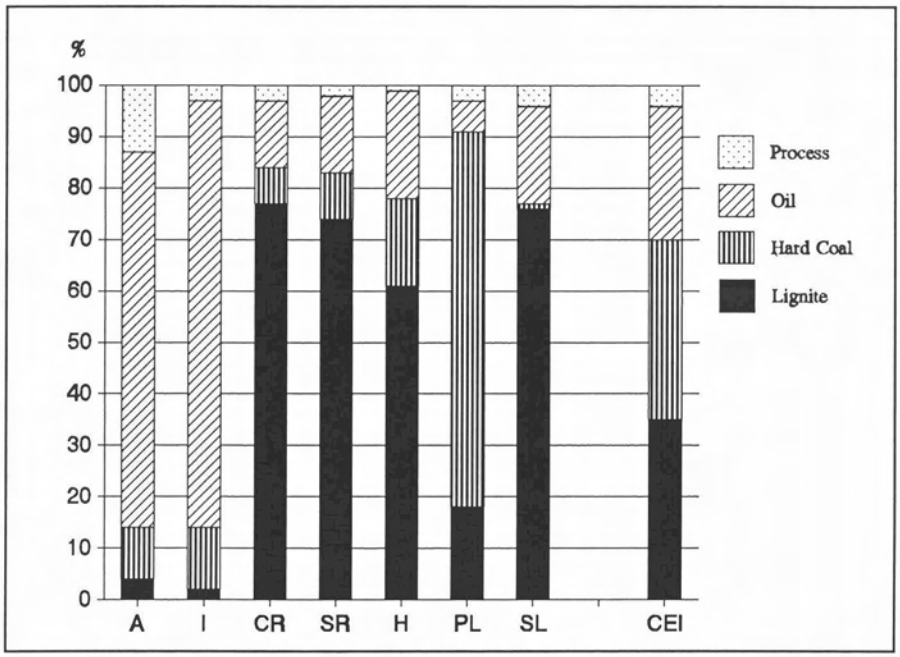


Figure 7. SO_2 emissions by fuels in the CEI region

As a consequence, it may be concluded that a simple fuel substitution policy in order to decrease emissions, i.e., replacing high-sulfur hard coal by other forms of (imported) energy, will have significant economic effects on the domestic coal-mining activities in eastern European countries.

A similar situation also exists for emissions of particulates. The high emissions specific to solid fuels are aggravated by the fact that, in contrast to western European standards, many power stations in the former CMEA countries are still operated without adequate equipment to capture particulates, such as electrostatic precipitators (see *Figure 8*).

The contribution of western countries to total NO_x and CO_2 emissions in the CEI region is substantially higher than their contribution to SO_2 and PM emissions. Higher traffic density in Austria and Italy results in higher NO_x emissions (*Figure 9*).

A similar situation is also present for carbon dioxide emissions. Higher CO_2 emissions due to the energy intensity in the former CMEA countries are partly counterbalanced by higher transport emissions in western market economies (*Figure 10*).

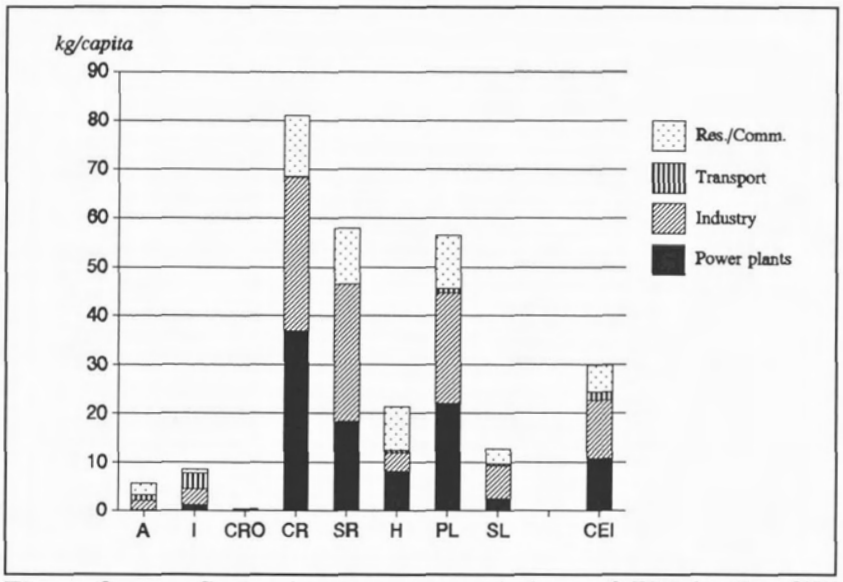


Figure 8. Sectoral per capita emissions of PM in the CEI region

3.4 Large point sources

The CEI'88 emission inventory comprises a database with detailed techno-economic information on the largest pollution sources in the region. Currently, this database identifies 402 individual sources, to which the large point source definition established in Section 2.3.1 applies (*Table 6*).

Within the individual countries, these point sources contribute varying amounts to the total national emissions (*Table 7*). Across the CEI region, 60% of SO_2 is emitted from the large point sources. On the other hand, only about one-third of NO_x originates from these large emitters.

The contributions of large point sources to total national emissions are shown in *Figure 11* (tables for all pollutants are provided in the Annex). In the majority of the CEI countries LPS contribute more than 60% to national sulfur dioxide emissions. The only exception is Austria, where a rigorous desulfurization program applied to large boilers lowered the contribution to about 25%.

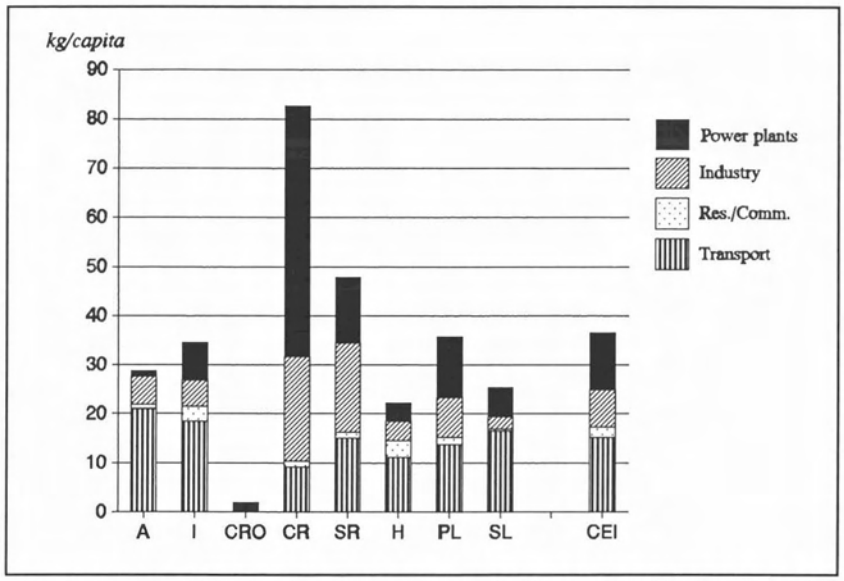


Figure 9. Sectoral per capita emissions of NO_x in the CEI region

Public power plants

Out of the 402 large point sources identified in the CEI'88 inventory, 204 units belong to the category of public power plants. Thereby, the generation of electricity causes almost half (46.3%) of the total SO_2 emissions of the region.

Consequently, power plants are major candidates for reducing SO_2 emissions in the region. However, any effective emission reduction strategy should not only focus on environmental aspects alone, but also consider the broader economic context, in particular the energy efficiency of national economies, the age and technical performance of the equipment, and changes in energy demand caused by structural changes in the economy.

As indicated in Section 2.3.1, the CEI'88 database contains various techno-economic parameters of the large point sources. With this information important conclusions for potential restructuring processes can be drawn.

As an example, *Figure 12* displays national SO_2 emissions in public power stations according to the age classes of the boilers, i.e., differentiated according to the commissioning year of the source. Over 50% of SO_2 emissions from public power plants within the CEI region is produced in plants older than

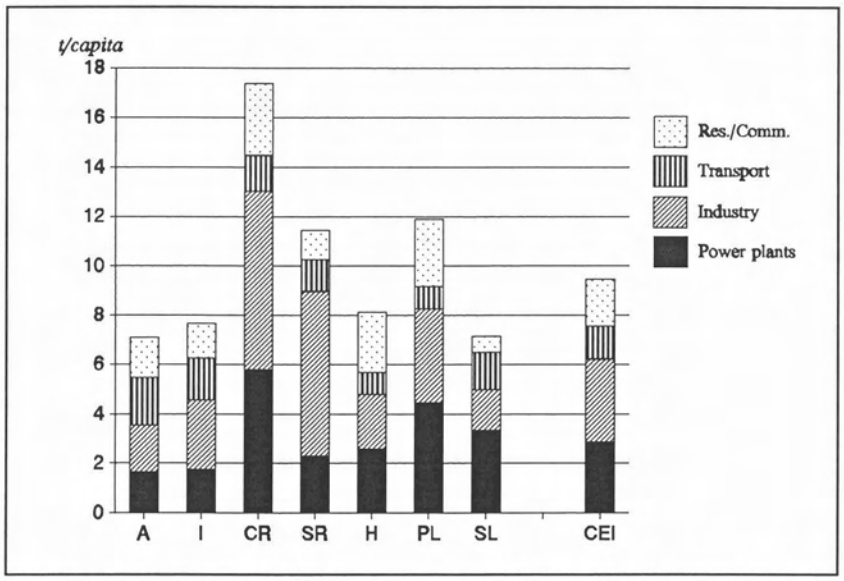


Figure 10. Sectoral per capita emissions of CO_2 in the CEI region

20 years. An important exception is Austria where power stations older than 20 years using sulfur-containing fuels operate only in peak mode. In Hungary, on the other hand, more than 80% of the SO_2 was produced in boilers older than 20 years.

In general, boilers usually reach the end of a technical lifetime within 20 to 40 years. Consequently, it does not seem promising to promote strategies for retrofitting plants older than 20 years with desulfurization equipment, but, if economically feasible, it would be preferable to replace the entire plant by new installations. Such new installations will also have a higher combustion efficiency than the old boilers, thereby reducing the required volume of fuel input (e.g., coal) to produce the same amount of electricity. According to the CEI'88 database most of the power plants in the former CMEA countries older than 20 years are operating with efficiency of between 28 and 32%. For new conventional plants, however, energy efficiencies range between 40 and 43%. This means that when electricity demand is constant, just replacing old obsolete equipment with new installations (without applying any emission control) could reduce SO_2 emissions by 30 to 40%. The application of standard emission

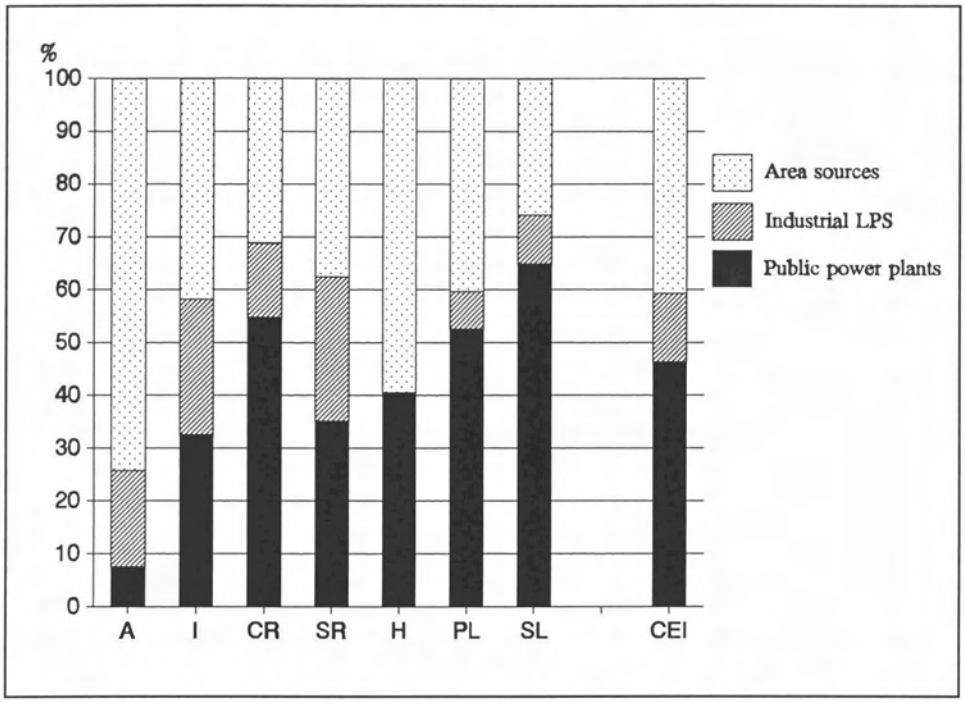


Figure 11. Share of large point sources in national SO_2 emissions

control technologies (such as flue gas desulfurization) or fuel substitution could reduce emissions even further.

Data collected for this inventory also enable the ranking of the largest sources according to their emission volumes within the region. *Tables 8* to *10* list the 25 largest polluters of SO_2, NO_x and PM, respectively.

Particularly high emissions occur at many power plants in Eastern Europe. The largest emitter, the power plant in Belchatow (Poland) emits 342 kt of SO_2, which is almost three times higher than all Austrian sources together (116 kt SO_2). As can be seen from *Table 8*, this is not an exception; there are some 10 additional plants whose emissions surpass those of all of Austria. In total, these 25 plants (out of the 402 LPS identified in the region) listed in *Table 8* are responsible for about 30% of total SO_2 emissions in the CEI region.

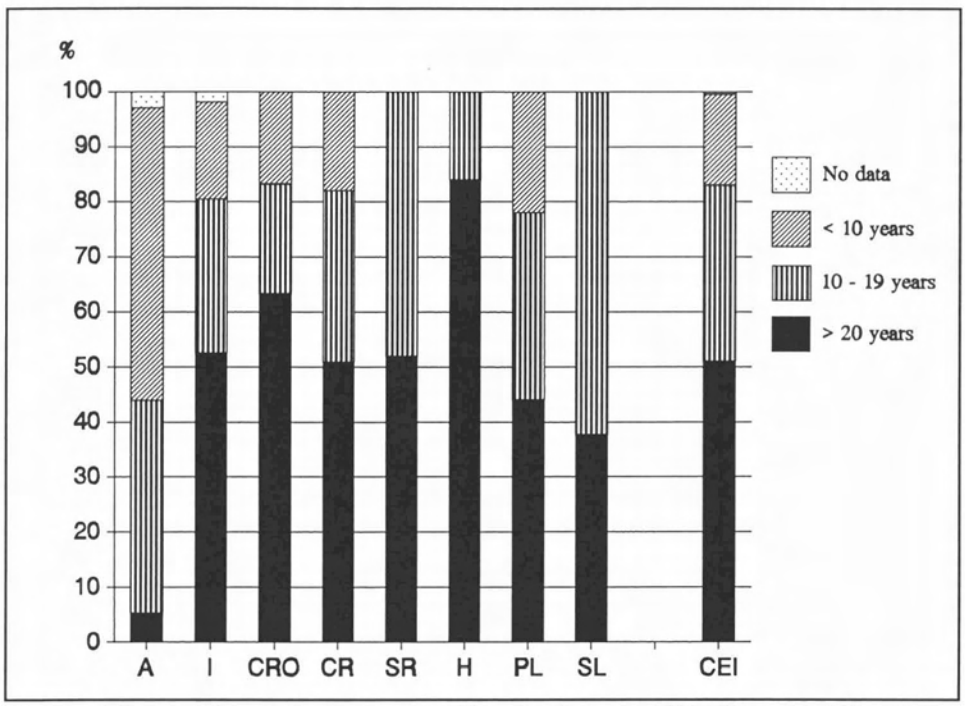


Figure 12. **SO_2 emissions according to the age of boilers (public power plants only)**

Table 6. **Number of point sources included in the CEI'88 database**

Country	Total	Public Power Plants
Austria	49	22
Croatia	7	7
Czechoslovakia	151	56
Czech Republic	101	43
Slovak Republic	50	13
Hungary	24	24
Italy	63	26
Poland	90	66
Slovenia	18	3
Total	**402**	**204**

Table 7. Sectoral emissions of large point sources (LPS) (in kilotons per year)

Sector	Sulfur Dioxide			Nitrogen Oxides			Particulate Matter		
	Total	Area Sources	LPS	Total	Area Sources	LPS	Total	Area Sources	LPS
Public Power Plants	5601	842	4759	1587	418	1169	1460	367	1093
Industry	2898	1571	1327	1020	511	509	1580	994	586
Transport	274	274	-	2066	2066	-	240	240	-
Other	1509	1509	-	297	297	-	794	794	-
Total	**10282**	**4196**	**6086**	**4970**	**3292**	**1678**	**4074**	**2395**	**1679**
Share	100%	40.8%	59.2%	100%	66.2%	33.8%	100%	58.8%	41.2%

Table 8. The 25 largest emitters of SO_2 in the CEI region in 1988

	Name of the Plant	Country	Region	SO_2 Emission (kt/year)
1	PPP Belchatow	Poland	Piotrkow Trybunalski	341.6
2	PPP Prunerov	Czech Rep.	Northern Bohemia	273.5
3	PPP Turow	Poland	Jelenia Gora	205.4
4	PPP Tusimice	Czech Rep.	Northern Bohemia	196.3
5	PPP Polaniec	Poland	Tarnobrzeg	149.8
6	PPP Jaworzno III	Poland	Katowice	131.4
7	PPP Pocerady	Czech Rep.	Northern Bohemia	126.9
8	PPP	Italy	Roma	123.9
9	PPP Kozienice	Poland	Radom	116.2
10	PPP Kostolany	Slovak Rep.	Central Slovakia	114.7
11	PPP Siersza	Poland	Katowice	111.5
12	PPP Rybnik	Poland	Katowice	97.1
13	PPP Gagarin	Hungary	Heves	94.6
14	PPP Tisova	Czech Rep.	Western Bohemia	86.2
15	Refinery	Italy	Messina	85.1
16	PPP Sostanj	Slovenia	Slovenia	84.7
17	PPP Patnow-Konin	Poland	Konin	84.0
18	PPP	Italy	Rovigo	80.3
19	PPP Melnik	Czech Rep.	Central Bohemia	79.1
20	PPP Dolna Odra	Poland	Szczecin	78.3
21	PPP Laziska	Poland	Katowice	77.6
22	PPP Borsod	Hungary	Borsod-Abauj-Zemplen	68.9
23	PPP Tisza	Hungary	Borsod-Abauj-Zemplen	67.4
24	Refinery Plock	Poland	Plock	67.3
25	Chemopetrol	Czech Rep.	Northern Bohemia	65.7
Total				3007.5

PPP - Public Power Plant

Table 9. The 25 largest emitters of NO_x in the CEI region in 1988

	Name of the Plant	Country	Region	NO_x Emission (kt/year)
1	PPP Belchatow	Poland	Piotrkow Trybunalski	60.6
2	PPP Tusimice	Czech Rep.	Northern Bohemia	50.4
3	PPP Prunerov	Czech Rep.	Northern Bohemia	48.5
4	PPP Procerday	Czech Rep.	Northern Bohemia	39.4
5	PPP Laziska	Poland	Katowice	39.4
6	PPP Ostroleka	Poland	Ostroleka	39.1
7	PPP	Italy	La Spezia	36.5
8	PPP Siersza	Poland	Katowice	35.8
9	PPP Kozienice	Poland	Radom	34.8
10	PPP	Italy	Savona	32.3
11	Chemical Ind.*	Italy	Venezia	31.3
12	VSZ Kosice**	Slovak Rep.	Eastern Slovakia	31.0
13	PPP Kostolany	Slovak Rep.	Central Slovakia	30.6
14	PPP	Italy	Roma	29.4
15	PPP Rybnik	Poland	Katowice	28.8
16	Chemopetrol	Czech Rep.	Northern Bohemia	28.3
17	Chemical Ind.	Italy	Brindisi	26.6
18	PPP Vojany	Slovak Rep.	Eastern Slovakia	25.6
19	PPP Melnik	Czech Rep.	Central Bohemia	24.8
20	PPP	Italy	Mantova	23.9
21	PPP Dolna Odra	Poland	Szczecin	22.7
22	Huta Lenina**	Poland	Krakow	21.6
23	PPP	Italy	Cosenza	21.5
24	PPP Chvaletice	Czech Rep.	Eastern Bohemia	19.9
25	Refinery	Italy	Messina	18.2
Total				800.8

PPP - Public Power Plant
* Refinery and nitric and sulfuric acid production
** Steel mill

Table 10. The 25 largest emitters of PM in the CEI region in 1988

	Name of the Plant	Country	Region	PM emissions (kt/year)
1	PPP Turow	Poland	Jelenia Gora	89.6
2	Oswiecim*	Poland	Bielsko-Biala	58.4
3	Huta Lenina**	Poland	Krakow	50.1
4	CHP Zeran	Poland	Warszawa	36.7
5	Huta Katowice**	Poland	Katowice	35.7
6	PPP Dolna Odra	Poland	Szczecin	35.3
7	PPP Belchatow	Poland	Piotrków Trybunalski	34.0
8	PPP Stalowa Wola	Poland	Tarnobrzeg	33.7
9	PPP Ostroleka	Poland	Ostroleka	33.6
10	PPP Konin	Poland	Konin	32.1
11	PPP Kostolany	Slovak Rep.	Central Slovakia	31.2
12	PPP Nov. 7th	Hungary	Veszprem	30.2
13	CHP Lodz II	Poland	Lodz	29.8
14	PPP Kozienice	Poland	Radom	29.8
15	CHP Siekierki	Poland	Warszawa	28.3
16	PPP Vojany	Slovak Rep.	Eastern Slovakia	28.0
17	PPP Skawina	Poland	Krakow	26.7
18	PPP Blachowina	Poland	Opole	26.3
19	PPP Adamow	Poland	Konin	25.7
20	F.Dziersynski***	Poland	Tarnow	24.9
21	Huta Laziska**	Poland	Katowice	22.4
22	PPP Rybnik	Poland	Katowice	22.4
23	PPP Ajka	Hungary	Veszprem	21.9
24	CHP Komorany	Czech Rep.	Northern Bohemia	20.5
25	Ogrodzieniec****	Poland	Katowice	20.5
Total				827.8

PPP - Public Power Plant
CHP - Combined Heat and Power Production
* Chemical industry
** Steel mill
*** Fertilizer production
**** Cement production

Section 4

Spatial Distribution of SO_2, NO_x and PM Emissions in the CEI Region

The CEI'88 inventory also contains a database with SO_2, NO_x and particulate emissions allocated to the territorial units listed in *Table 2*. Tables with detailed data are contained in the Annex to this report.

This section presents maps of the CEI region. The maps display the emission densities of the various pollutants, indicate the location of the point sources, and compare the magnitudes of emissions from large point sources with area sources on a regional level. Emission estimates for Croatia are based on data for only seven public power plants and therefore emission densities for this country, shown in the maps (*Figures 13, 17, 21*), are low. Consequently, the emission densities of area sources (presented in *Figures 14, 18, 22*) could not be calculated for Croatia.

4.1 SO_2 emissions

Figure 13 displays the emission densities of SO_2 in the individual administrative regions throughout the CEI region. Area-related emissions range from below one ton of SO_2 per km^2 per year (SO_2/km^2/year) in Austria, northern Poland, and many regions in Italy to above 100 tons SO_2/km^2/year in Northern Bohemia and Upper Silesia.

The major reason for this wide range can be derived from a comparison of the emission densities of area sources (*Figure 14*) with those of point sources (*Figure 15*). Area source emissions show relatively little variations, with peaks in densely populated areas (e.g., in Prague, Warsaw, Budapest and Milan), and in districts around coal mines, where local coal is burned in small appliances (e.g., Northern Bohemia and eastern Hungary). Large point sources, however, can dominate total emissions in a region. *Figure 15* shows the emission densities of the LPS in the individual administrative units of the CEI. The absolute peak occurs in Northern Bohemia (with more than 100 tons SO_2/km^2/year from LPS);

many areas, however, have low or even no LPS emissions. The locations of the individual large point sources of SO_2 are displayed in *Figure 16*.

4.2 NO_x emissions

Regional densities of NO_x emissions show less variation than regional densities of SO_2 emissions (*Figure 17*). High emissions occur in many regions of Italy and in the industrialized areas of Poland and Czechoslovakia. NO_x emission densities of area sources and point sources in the CEI region are displayed in *Figure 18* and *19*, respectively. The major source of NO_x emissions in most Italian regions is from area sources, only in a few regions (e.g., Gorizia, La Spezia) do point sources contribute substantially. In Czechoslovakia and Poland, point source emissions have higher shares in total regional emissions than in other CEI countries. The main reason for this is the higher motorization in western countries and the fact that in Czechoslovakia and Poland the number of identified (in this inventory) large point sources is larger than e.g., in Hungary, where data on industrial sources is missing. The locations of the NO_x point sources are displayed in *Figure 20*.

4.3 Emissions of particulate matter

Figure 21 shows the regional distribution of particulate emissions. The strong reliance on low-quality coal combustion without appropriate control technologies in the former CMEA countries causes considerable emissions in this region, whereas in countries where high-efficiency electrostatic precipitators are standard equipment of coal-fired boilers, emission densities are significantly lower. The low relevance of PM emissions in EC countries, where such standards generally apply, resulted in the omission of PM estimates in the CORINAIR'85 inventory. The role of particulate emissions from large point sources is illustrated in *Figure 22*. Since the CEI'88 database for Italy is mainly drawn from the Italian CORINAIR information, no data on PM emissions from LPS are provided for Italy. *Figure 23*, displaying the PM emissions from area sources, highlights those areas in the former CMEA countries where coal combustion plays a major role. *Figure 24* contains the locations of the large point sources of particulate matter (excluding Italy). Note that some sources in Hungary, Poland, and Czechoslovakia are major emitters, e.g., of SO_2 (compare *Figure 16*), but have less importance for PM emissions (due to installed control equipment).

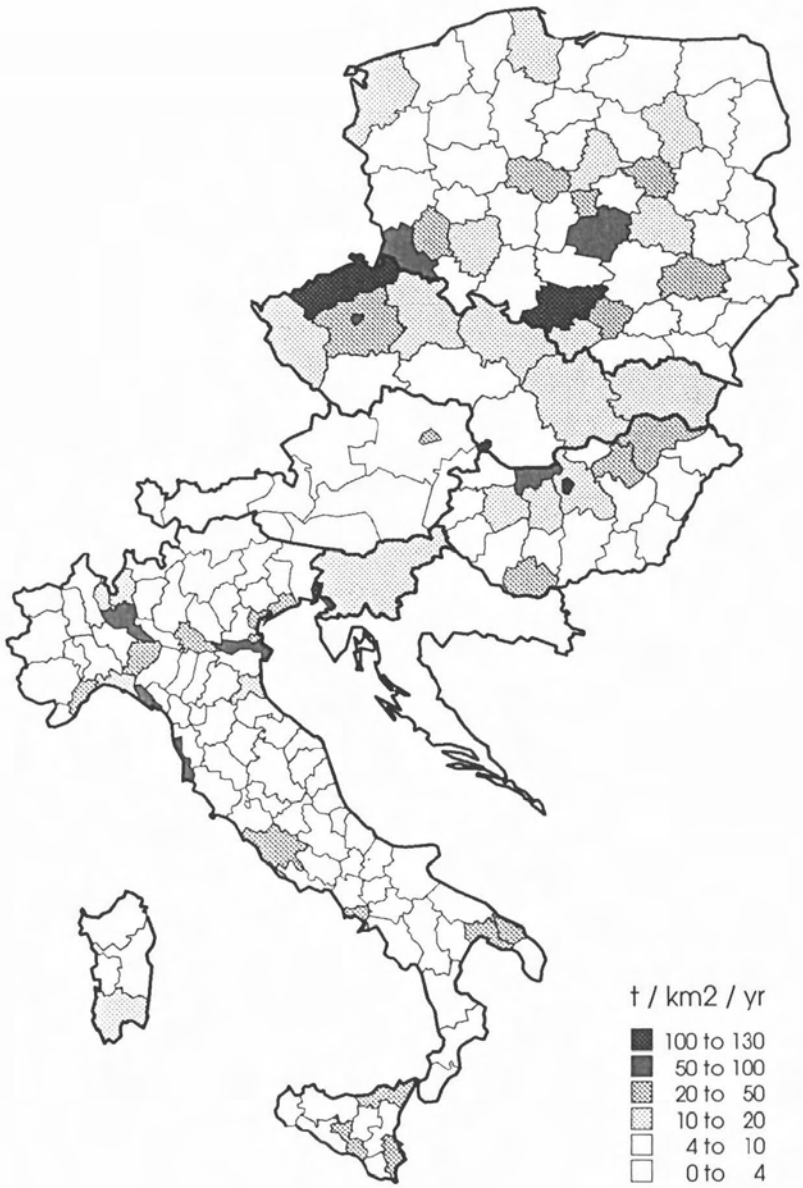
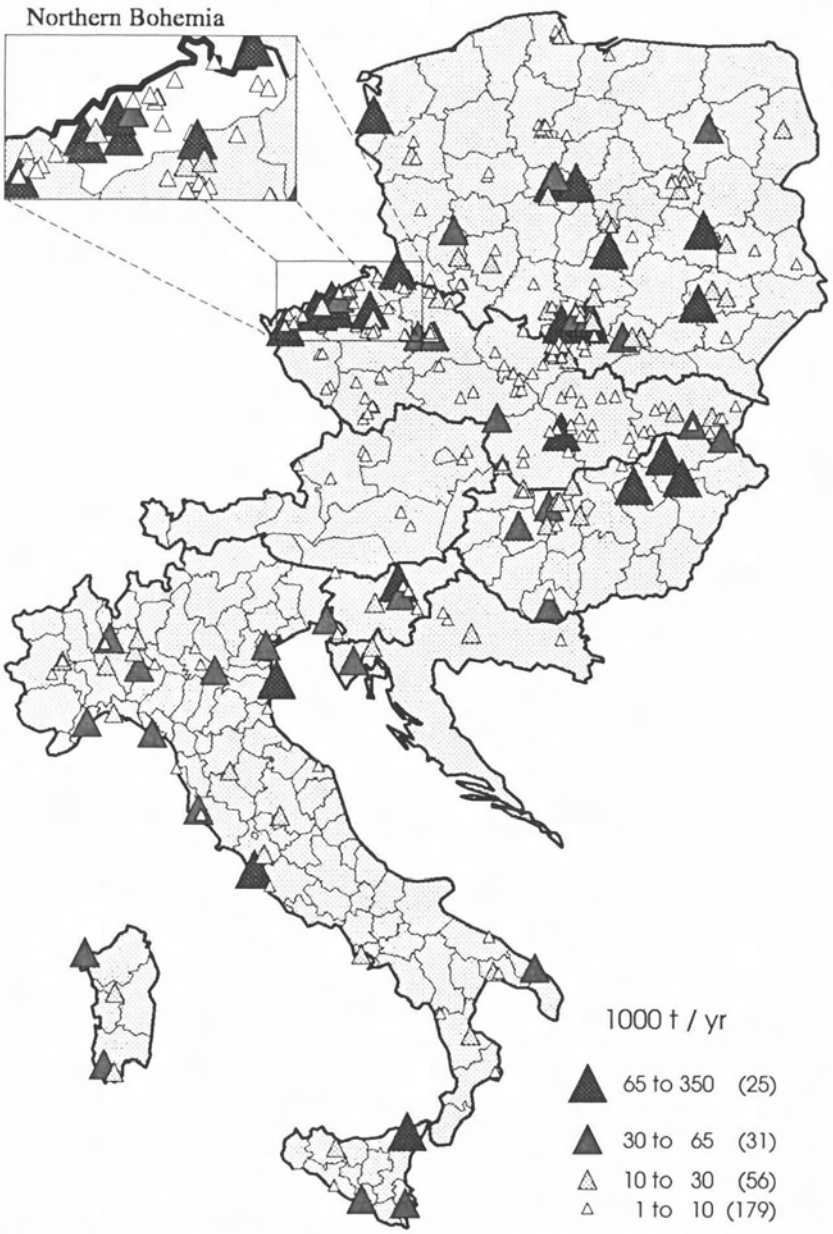


Figure 13. SO_2 emissions from all sources

Figure 14. SO_2 emissions from area sources

Figure 15. SO_2 emissions from point sources



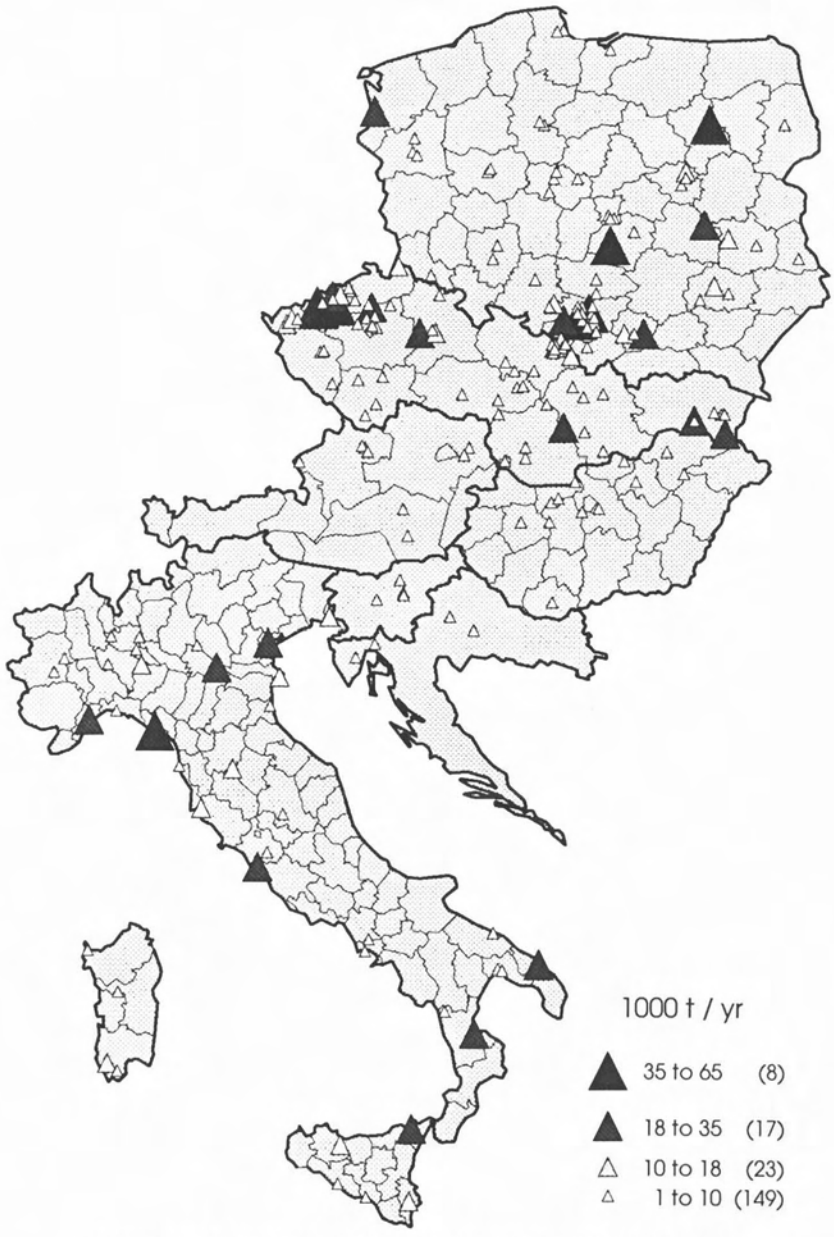
Numbers in parentheses indicate the number of LPS in each range

Figure 16. Locations of large point sources of SO_2 emissions

Figure 17. NO_x emissions from all sources

Figure 18. NO_x emissions from area sources

Figure 19. NO_x emissions from point sources



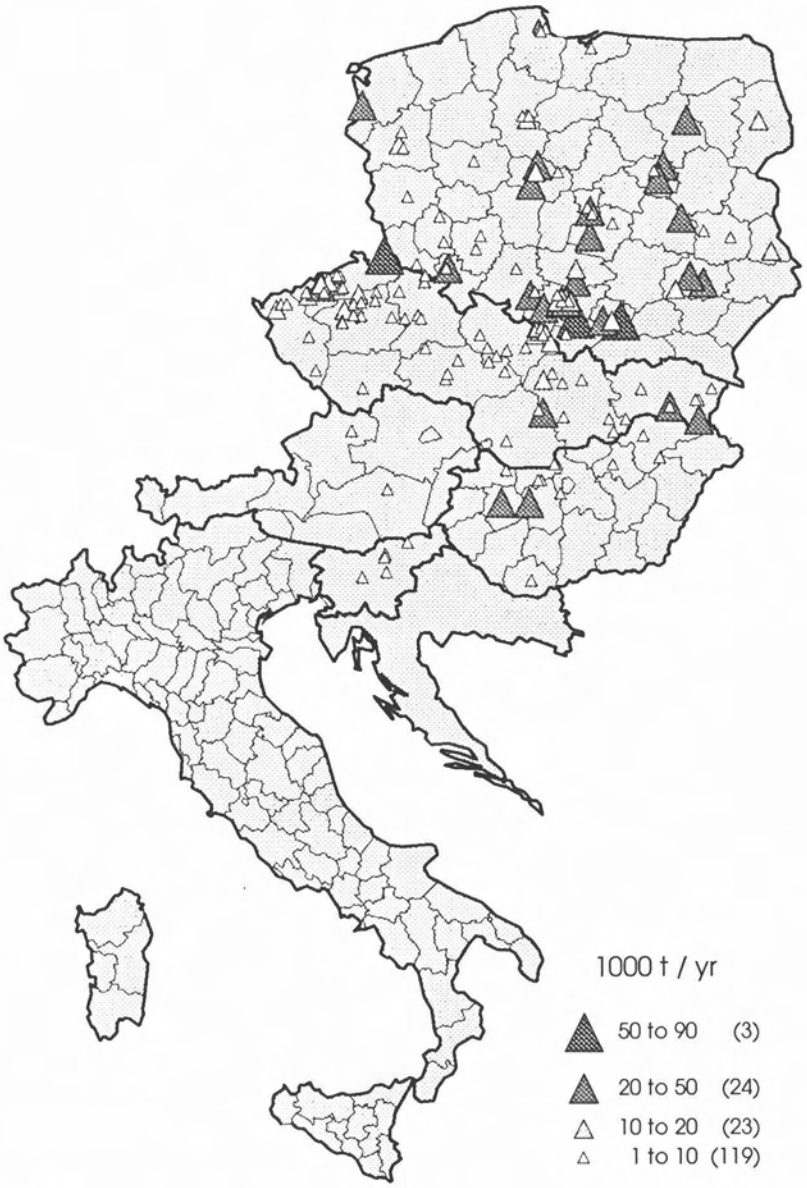
Numbers in parentheses indicate the number of LPS in each range

Figure 20. Locations of large point sources of NO_x emissions

Figure 21. PM emissions from all sources

Figure 22. PM emissions from area sources

Figure 23. PM emissions from point sources



Numbers in parentheses indicate the number of LPS in each range

Figure 24. Locations of large point sources of PM emissions

Section 5

Conclusions

The emission inventory of the Central European Initiative (the CEI'88 inventory) described in this report provides a first, consistent overview of emissions of sulfur dioxide (SO_2), nitrogen oxides (NO_x), particulate matter (PM), and carbon dioxide (CO_2) of the region. The inventory describes the situation in the year 1988 for Austria, Croatia, Czechoslovakia (separated into the Czech and Slovak Republics), Hungary, Italy, Poland and Slovenia. The database provides the following:

- An estimate of the overall quantity of emissions (regionally disaggregated into 187 administrational units),
- A description of the most important techno-economic parameters of the main individual emission sources in the region (402 sources are considered).

The study shows that central Europe contributes substantially to total European emissions of air pollutants. The reasons for this dominant role are the high population density and the high level of economic activities occurring in the region. Even more important, however, are the high-energy intensities of the former centrally planned economies, where energy is mainly supplied by the combustion of domestic dirty fuels without appropriate emission control equipment.

The CEI'88 inventory provides important information for in-depth analysis of air pollution, not only for central Europe, but, due to the long-range transport of pollutants, also for the whole of Europe. The information contained in the database is an essential element for any design of cost-effective strategies to reduce air pollution.

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Annex

The CEI'88 emission database

National and regional data

GENERAL INFORMATION ABOUT 'CEI' COUNTRIES AND THEIR REGIONS

AUSTRIA

Population [10^3]	**Area [km^2]**	**GDP [bln$US]**
7825.0	83857.1	101.4

Emissions of: *[kt/year, CO2-Mt/year]*	***SO2***	***NOx***	***PM***	***CO2***
	115.7	225.2	44.0	55.4
[kg/cap,CO2-t/cap]	14.8	28.8	5.6	7.1
[t/km^2]	1.4	2.7	0.5	660.6
[kg/1000US$,CO2-kg/1US$]	1.1	2.2	0.4	0.5

Basic Regional Data for *Austria*

Name	***Population*** *[10^3]*	***Area*** *[km^2]*	***Emissions [kt/yr]*** *SO2*	*NOx*	*PM*
Burgenland	271	3966	2	7	3
Kaernten	551	9533	11	15	3
Niederoesterreich	1463	19174	21	48	14
Oberoesterreich	1348	11980	29	49	12
Salzburg	485	7154	5	13	2
Steiermark	1197	16387	19	37	6
Tirol	640	12647	12	16	2
Wien	1536	415	14	32	2
Voralberg	333	2601	3	8	1

CROATIA

Population [10^3]	**Area [km^2]**	**GDP [bln$US]**
4760.3	56538.0	33.3

Emissions of: *[kt/year, CO2-Mt/year]*	***SO2***	***NOx***	***PM***	***CO2***
	69.4	9.6	2.0	-
[kg/cap,CO2-t/cap]	14.6	2.0	0.4	-
[t/km^2]	1.2	0.2	0.0	-
[kg/1000US$,CO2-kg/1US$]	2.1	0.3	0.1	-

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GENERAL INFORMATION ABOUT 'CEI' COUNTRIES AND THEIR REGIONS

Basic Regional Data for *Croatia*

Name	*Population* [10^3]	*Area* [km^2]	*Emissions [kt/yr]* SO2	NOx	PM
Croatia	4760	56538	69	10	2

CZECH REPUBLIC

Population [10^3]	**Area [km^2]**	**GDP [bln$US]**
10356.4	78864.5	85.7

Emissions of: [kt/year, CO2-Mt/year]	*SO2*	*NOx*	*PM*	*CO2*
	2065.8	857.7	840.3	180.0
[kg/cap,CO2-t/cap]	199.5	82.8	81.1	17.4
[t/km^2]	26.2	10.9	10.7	2282.4
[kg/1000US$,CO2-kg/1US$]	24.1	10.0	9.8	2.1

Basic Regional Data for *Czech Republic*

Name	*Population* [10^3]	*Area* [km^2]	*Emissions [kt/yr]* SO2	NOx	PM
Praha	1215	496	47	24	20
Central Bohemia	1118	10994	236	108	138
Southern Bohemia	699	11345	66	29	35
Western Bohemia	869	10875	177	75	78
Northern Bohemia	1190	7819	964	330	212
Eastern Bohemia	1240	11240	217	85	96
Southern Moravia	2058	15028	145	59	103
Northern Moravia	1972	11067	213	149	160

GENERAL INFORMATION ABOUT 'CEI' COUNTRIES AND THEIR REGIONS

HUNGARY

Population [10^3]	**Area [km^2]**		**GDP [bln$US]**	
10377.0	93033.0		64.7	
Emissions of:	***SO2***	***NOx***	***PM***	***CO2***
[kt/year, CO2-Mt/year]	1171.1	231.0	222.4	84.5
[kg/cap,CO2-t/cap]	112.9	22.3	21.4	8.1
[t/km^2]	12.6	2.5	2.4	908.3
[kg/1000US$,CO2-kg/1US$]	18.1	3.6	3.4	1.3

Basic Regional Data for *Hungary*

Name	***Population*** *[10^3]*	***Area*** *[km^2]*	***Emissions [kt/yr]*** *SO2*	*NOx*	*PM*
Budapest	2016	525	53	23	9
Baranya	419	4487	90	15	10
Bacs-Kiskun	545	8362	25	10	7
Bekes	412	5632	19	6	5
Borsod-Abauj-Zemplen	762	7247	286	33	28
Csongrad	439	4263	13	6	4
Fejer	421	4373	78	13	10
Gyor-Sopron	425	4012	35	8	9
Hajdu-Bihar	549	6211	27	8	7
Heves	335	3637	123	15	17
Komarom-Esztergom	426	2251	150	14	16
Nograd	315	2544	12	3	3
Pest	227	6394	67	33	15
Somogy	950	6036	12	6	3
Szabolcs-Szatmar-Ber	345	5938	34	7	9
Jasz-Nagykun-Szolnok	572	5607	25	7	6
Tolna	254	3704	15	5	4
Vas	276	3337	15	3	3
Veszprem	382	4689	87	15	57
Zala	307	3784	7	3	2

GENERAL INFORMATION ABOUT 'CEI' COUNTRIES AND THEIR REGIONS

ITALY

Population [10^3]	**Area [km^2]**	**GDP [bln$US]**
57326.7	301276.9	721.3

Emissions of: *[kt/year, CO2-Mt/year]*	***SO2***	***NOx***	***PM***	***CO2***
	2215.9	1982.4	491.5	442.7
[kg/cap,CO2-t/cap]	38.7	34.6	8.6	7.7
[t/km^2]	7.4	6.6	1.6	1469.4
[kg/1000US$,CO2-kg/1US$]	3.1	2.7	0.7	0.6

Basic Regional Data for *Italy*

Name	***Population*** *[10^3]*	***Area*** *[km^2]*	***Emissions [kt/yr]*** *SO2*	*NOx*	*PM*
Torino	2289	6830	57	54	7
Vercelli	384	3001	14	13	2
Novara	502	3594	13	14	2
Cuneo	547	6903	14	20	6
Asti	211	1511	4	7	2
Alessandria	451	3560	17	22	8
Valle d'Aosta	114	3262	6	5	1
Imperia	222	1155	2	6	2
Savona	293	1545	55	53	2
Genova	1004	1836	30	32	5
La Spezia	236	882	61	53	1
Varese	793	1199	13	23	5
Como	785	2067	23	26	10
Sondrio	176	3212	3	4	1
Milano	3980	2762	153	101	11
Bergamo	915	2760	21	33	12
Brescia	1032	4783	20	33	7
Pavia	501	2965	25	17	3
Cremona	329	1771	6	9	1
Mantova	373	2339	88	46	2
Bolzano-Bozen	436	7400	6	14	2
Trento	445	6218	6	14	3
Verona	784	3097	10	22	5
Vicenza	738	2722	10	21	3
Belluno	217	3678	6	6	1
Treviso	733	2476	15	21	5

GENERAL INFORMATION ABOUT 'CEI' COUNTRIES AND THEIR REGIONS

Basic Regional Data for *Italy*

Name	*Population* [10^3]	*Area* [km^2]	*Emissions [kt/yr]* SO2	NOx	PM
Venezia	836	2460	61	61	5
Padova	817	2142	10	25	8
Rovigo	251	1789	91	28	1
Pordenone	276	2273	4	9	3
Udine	527	4893	13	18	3
Gorizia	141	467	47	24	1
Trieste	269	212	16	9	3
Piacenza	273	2590	70	31	6
Parma	396	3449	6	13	2
Reggio nell'Emilia	415	2292	7	12	2
Modena	596	2690	8	15	5
Bologna	916	3702	17	24	4
Ferrara	372	2632	8	8	2
Ravenna	353	1859	20	19	4
Forli	609	2911	6	14	3
Massa-Carrara	205	1157	2	6	1
Lucca	383	1773	10	10	2
Pistoia	266	965	3	6	1
Firenze	1197	3880	11	25	7
Livorno	345	1213	99	35	6
Pisa	389	2448	5	10	1
Arezzo	314	3232	31	22	4
Siena	253	3821	2	6	2
Grosseto	221	4504	6	4	1
Perugia	592	6334	32	26	11
Terni	227	2122	5	8	2
Pesaro e Urbino	336	2892	3	9	2
Ancona	438	1940	9	11	2
Macerata	295	2774	3	8	3
Ascoli Piceno	360	2087	3	9	1
Viterbo	277	3612	1	7	2
Rieti	146	2749	-	3	1
Roma	3759	5352	162	99	21
Latina	465	2251	3	8	1
Frosinone	480	3239	4	12	3
Caserta	808	2639	6	24	9
Benevento	299	2071	1	6	1
Napoli	3099	1171	46	58	11
Avellino	449	2792	3	13	2
Salerno	1057	4923	5	26	6
L'Aquila	299	5035	3	13	3

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GENERAL INFORMATION ABOUT 'CEI' COUNTRIES AND THEIR REGIONS

Basic Regional Data for *Italy*

Name	*Population* [10^3]	*Area* [km^2]	*Emissions [kt/yr]* SO2	NOx	PM
Teramo	280	1948	2	9	1
Pescara	294	1225	3	10	5
Chieti	383	2587	3	13	2
Isernia	94	1529	-	3	1
Campobasso	241	2909	2	7	2
Foggia	701	7185	4	19	4
Bari	1519	5129	12	32	9
Taranto	598	2437	80	34	16
Brindisi	407	1838	56	40	1
Lecce	810	2759	2	17	4
Potenza	413	6546	1	10	3
Matera	209	3447	5	7	4
Cosenza	779	6650	35	51	7
Catanzaro	773	5247	9	21	6
Reggio di Calabria	592	3183	3	14	3
Trapani	438	2462	1	11	2
Palermo	1254	4992	33	37	7
Messina	670	3247	94	39	3
Agrigento	490	3042	9	11	4
Caltanissetta	295	2128	57	14	1
Enna	198	2562	1	6	1
Catania	1065	3552	4	20	5
Ragusa	289	1614	2	6	4
Siracusa	411	2109	85	33	4
Sassari	449	7520	48	19	3
Nuoro	278	7044	37	13	3
Oristano	160	2631	-	3	1
Cagliari	762	6895	116	47	7

GENERAL INFORMATION ABOUT 'CEI' COUNTRIES AND THEIR REGIONS

POLAND

Population [10^3]	**Area [km^2]**	**GDP [bln$US]**
38038.4	312683.0	173.9

Emissions of: *[kt/year, CO2-Mt/year]*	***SO2***	***NOx***	***PM***	***CO2***
	3826.5	1362.5	2144.6	454.4
[kg/cap,CO2-t/cap]	100.6	35.8	56.4	11.9
[t/km^2]	12.2	4.4	6.9	1453.2
[kg/1000US$,CO2-kg/1US$]	22.0	7.8	12.3	2.6

Basic Regional Data for *Poland*

Name	***Population*** *[10^3]*	***Area*** *[km^2]*	***Emissions [kt/yr]*** *SO2*	*NOx*	*PM*
Warszawa	2419	3788	144	69	113
Biala Podlaska	305	5348	10	5	5
Bialystok	690	10055	36	15	25
Bielsko-Biala	895	3704	49	26	80
Bydgoszcz	1107	10349	79	40	75
Chelm	246	3866	13	7	30
Ciechanow	427	6362	14	8	8
Czestochowa	776	6182	40	19	38
Elblag	477	6103	20	11	22
Gdansk	1423	7394	87	38	55
Gorzow Wielkopolski	498	8484	30	16	31
Jelenia Gora	517	4378	229	25	110
Kalisz	708	6512	26	14	17
Katowice	3968	6650	791	270	383
Kielce	1126	9211	71	33	42
Konin	468	5139	171	29	88
Koszalin	504	8470	17	9	11
Krakow	1228	3254	126	65	119
Krosno	492	5702	22	11	11
Legnica	512	4037	91	12	24
Leszno	385	4154	13	7	8
Lublin	1013	6792	57	40	41
Lomza	346	6684	17	8	9
Lodz	1143	1523	73	23	62
Nowy Sacz	692	5576	21	12	12
Olsztyn	749	12327	27	14	15

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GENERAL INFORMATION ABOUT 'CEI' COUNTRIES AND THEIR REGIONS

Basic Regional Data for *Poland*

Name	*Population* *[10^3]*	*Area* *[km^2]*	*Emissions [kt/yr]* *SO2*	*NOx*	*PM*
Opole	1015	8535	85	45	87
Ostroleka	395	6498	70	46	41
Pila	478	8205	15	8	15
Piotrkow Trybunalski	642	6266	372	75	51
Plock	515	5117	85	14	12
Poznan	1328	8151	53	27	34
Przemysl	405	4437	14	7	8
Radom	748	7294	145	50	57
Rzeszow	717	4397	32	17	15
Siedlce	649	8499	21	11	12
Sieradz	408	4869	18	7	17
Skierniewice	418	3960	16	8	10
Slupsk	410	7453	17	8	10
Suwalki	466	10490	18	10	11
Szczecin	967	9981	140	43	73
Tarnobrzeg	596	6283	199	31	63
Tarnow	666	4151	38	27	42
Torun	656	5348	35	15	16
Walbrzych	741	4168	38	18	46
Wloclawek	429	4402	25	12	15
Wroclaw	1126	6287	67	36	50
Zamosc	490	6980	18	9	9
Zielona Gora	657	8868	27	14	17

SLOVAK REPUBLIC

Population [10^3]	**Area [km^2]**		**GDP [bln$US]**	
5251.1	49036.0		37.6	
Emissions of:	***SO2***	***NOx***	***PM***	***CO2***
[kt/year, CO2-Mt/year]	605.8	251.2	304.4	63.7
[kg/cap,CO2-t/cap]	115.4	47.8	58.0	12.1
[t/km^2]	12.4	5.1	6.2	1299.0
[kg/1000US$,CO2-kg/1US$]	16.1	6.7	8.1	1.7

GENERAL INFORMATION ABOUT 'CEI' COUNTRIES AND THEIR REGIONS

Basic Regional Data for *Slovak Republic*

Name	*Population* [10^3]	*Area* [km^2]	*Emissions [kt/yr]* SO2	NOx	PM
Bratislava	441	367	39	15	5
Western Slovakia	1728	14492	107	52	59
Central Slovakia	1615	17986	235	89	137
Eastern Slovakia	1504	16191	200	96	103

SLOVENIA

Population [10^3]	**Area [km^2]**	**GDP [bln$US]**
1937.0	20251.0	24.5

Emissions of: [kt/year, CO2-Mt/year]	*SO2*	*NOx*	*PM*	*CO2*
	209.7	49.4	24.9	13.9
[kg/cap,CO2-t/cap]	108.3	25.5	12.9	7.2
[t/km^2]	10.4	2.4	1.2	686.4
[kg/1000US$,CO2-kg/1US$]	8.6	2.0	1.0	0.6

Basic Regional Data for *Slovenia*

Name	*Population* [10^3]	*Area* [km^2]	*Emissions [kt/yr]* SO2	NOx	PM
Slovenia	1937	20251	210	49	25

Sectoral emissions

SECTORAL EMISSIONS OF POLLUTANTS IN CEI COUNTRIES IN 1988
[kt/year, for CO2 million t/year]

Country/Sector	*SO2*	*NOx*	*PM*	*CO2*
Austria				
Public Power & Heat Plants	8.7	9.4	0.8	12.9
Total Industry	81.0	45.1	15.8	14.8
- Industry combustion	-	-	-	12.4
- Industry process	-	-	-	2.4
Total Transport	6.8	164.5	9.0	15.1
- Road transport	-	-	-	-
- Other transport	-	-	-	-
Residential/Commercial	19.2	6.3	7.5	12.6
Other	-	-	11.0	-
Total	***115.7***	***225.2***	***44.0***	***55.4***
Croatia				
Public Power & Heat Plants	69.4	9.6	2.0	0.0
Total Industry	0.0	0.0	0.0	0.0
- Industry combustion	-	-	-	-
- Industry process	-	-	-	-
Total Transport	0.0	0.0	0.0	0.0
- Road transport	-	-	-	-
- Other transport	-	-	-	-
Residential/Commercial	0.0	0.0	0.0	0.0
Other	-	-	-	-
Total	***69.4***	***9.6***	***2.0***	***0.0***
Czech Republic				
Public Power & Heat Plants	1409.3	529.6	382.0	60.0
Total Industry	493.4	221.0	326.6	75.0
- Industry combustion	401.0	163.7	242.3	69.0
- Industry process	92.4	57.3	84.3	6.0
Total Transport	8.3	95.0	1.7	15.0
- Road transport	8.3	95.0	1.7	-
- Other transport	-	-	-	-
Residential/Commercial	154.9	12.1	130.0	30.0
Other	-	-	-	-
Total	***2065.8***	***857.7***	***840.3***	***180.0***

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SECTORAL EMISSIONS OF POLLUTANTS IN CEI COUNTRIES IN 1988
[kt/year, for CO2 million t/year]

Country/Sector	*SO2*	*NOx*	*PM*	*CO2*
Hungary				
Public Power & Heat Plants	474.4	39.5	84.4	26.8
Total Industry	353.6	40.3	39.5	23.0
- Industry combustion	-	-	-	-
- Industry process	-	-	-	-
Total Transport	16.9	115.2	5.8	9.2
- Road transport	16.9	115.2	5.8	-
- Other transport	-	-	-	-
Residential/Commercial	326.1	35.9	92.6	25.5
Other	-	-	-	-
Total	***1171.1***	***231.0***	***222.4***	***84.5***
Italy				
Public Power & Heat Plants	1115.4	442.3	66.8	99.9
Total Industry	796.8	310.6	193.2	161.7
- Industry combustion	618.9	156.2	10.7	74.3
- Industry process	177.9	154.4	182.5	87.4
Total Transport	136.9	1058.1	185.0	97.3
- Road transport	92.6	1010.0	182.4	90.9
- Other transport	44.3	48.1	2.6	6.5
Residential/Commercial	162.5	163.2	30.3	80.0
Other	4.3	8.2	16.2	3.8
Total	***2215.9***	***1982.4***	***491.5***	***442.7***
Poland				
Public Power & Heat Plants	2107.2	475.4	835.3	169.9
Total Industry	913.5	307.7	863.5	144.4
- Industry combustion	775.2	197.3	522.2	136.9
- Industry process	138.3	110.4	341.3	7.5
Total Transport	102.2	522.0	37.5	35.3
- Road transport	60.9	380.4	17.7	23.2
- Other transport	41.3	141.6	19.8	12.1
Residential/Commercial	703.6	57.5	408.3	102.2
Other	-	-	-	2.7
Total	***3826.5***	***1362.5***	***2144.6***	***454.4***

SECTORAL EMISSIONS OF POLLUTANTS IN CEI COUNTRIES IN 1988
[kt/year, for CO2 million t/year]

Country/Sector	*SO2*	*NOx*	*PM*	*CO2*
Slovak Republic				
Public Power & Heat Plants	254.1	69.5	83.9	12.0
Total Industry	231.6	90.7	128.1	35.1
- Industry combustion	171.3	61.2	76.1	31.5
- Industry process	60.3	29.5	52.0	3.6
Total Transport	0.0	78.9	0.0	6.8
- Road transport	-	78.9	-	6.6
- Other transport	-	-	-	0.2
Residential/Commercial	120.1	12.2	92.4	6.2
Other	-	-	-	-
Total	***605.8***	***251.2***	***304.4***	***63.7***
Slovenia				
Public Power & Heat Plants	162.5	11.7	5.0	6.5
Total Industry	27.9	4.8	13.2	3.2
- Industry combustion	27.1	4.7	6.7	-
- Industry process	0.9	0.1	6.6	-
Total Transport	2.9	32.0	0.8	2.9
- Road transport	-	-	-	-
- Other transport	-	-	-	-
Residential/Commercial	16.5	0.9	6.0	1.3
Other	-	-	-	-
Total	***209.7***	***49.4***	***24.9***	***13.9***
TOTAL 'CEI' Emissions	**10279.9**	**4969.0**	**4074.1**	**1294.6**

Basic Large Point Source data

LARGE POINT SOURCES' EMISSIONS [t/a]

AUSTRIA

Name of the Plant	*SNAP'90*	*SO2*	*NOx*	*PM*
Arsenal	1	201	104	21
Donaustadt	1	582	472	16
Duernrohr VKG+EVN	1	382	414	26
Graz FHKW	1	58	45	19
Kagran	1	166	54	3
Kirchdorf a.d.K.	1	-	20	-
Klagenfurt FHKW	1	801	330	18
Korneuburg EVN/VKG	1	-	232	-
Leopoldau	1	-	60	-
Linz FHKW	1	2220	1138	123
Mellach FHKW	1	94	364	107
Neudorf-Werndorf	1	92	63	1
Pernegg	1	70	46	1
Riedesbach (I + II)	1	1706	1732	144
Salzburg Mitte	1	80	163	1
Simmering WEW	1	1150	2207	38
St.Andrae	1	19	7	1
St.Polten FHKW-N.	1	78	33	2
Theiss II+III	1	54	153	131
Timelkam (II + III)	1	443	589	47
Voitsberg	1	446	1006	68
Wels FHKW	1	-	26	-
Total Public Power and Heat Plants		***8642***	***9258***	***767***
AMAG Ranshofen	3	360	78	937
BBU Arnoldstein	3	1400	-	42
Chemie Linz	3	28	3027	415
Donawitz	3	1763	1030	1700
Enns (Kristein)	3	115	154	8
Frohnleiten	3	-	81	-
Gratkorn	3	1098	898	59
Hallein	3	997	568	28
Hohenau	3	166	36	4
Huette Linz	3	6440	4517	4225
Kematen/Ybbs	3	48	89	3
Lenzing (I + II)	3	3680	740	354
Leopoldsdorf	3	103	22	3
Nettingsdorf	3	313	255	14
Pitten DK3/WSK4	3	87	127	10

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LARGE POINT SOURCES' EMISSIONS [t/a]

Poels (II + III)	3	304	382	19
Raffineria OEMV (Schwechat)	3	3450	4500	264
Simmering EBS	3	78	104	5
St.Gertraud	3	486	594	30
St.Polten Glanzst	3	5	35	-
Traiskirchen	3	-	26	-
Total Industrial Combustion		***20921***	***17263***	***8120***
Ebensee	4	86	25	2
Laakirchen	4	-	32	-
Steyr Puch	4	-	26	-
Steyrermuhl, EZ	4	-	84	-
Theresienthal	4	-	67	-
Zuckerfabrik Tulln	4	-	18	-
Total Non-combustion Process		***86***	***252***	***2***
TOTAL *Austria*		**29649**	**26773**	**8889**

CROATIA

Name of the Plant	*SNAP'90*	*SO2*	*NOx*	*PM*
EL-TO Zagreb	1	1473	822	116
PTE Jertovec	1	1	323	2
TE Plomin	1	43991	2685	119
TE Rijeka	1	10434	1474	741
TE Sisak	1	10270	2527	805
TE-TO Zagreb	1	2043	1075	161
TE-TO Osijek	1	1191	342	88
Total Public Power and Heat Plants		***69403***	***9248***	***2032***
TOTAL *Croatia*		**69403**	**9248**	**2032**

CZECH REPUBLIC

Name of the Plant	*SNAP'90*	*SO2*	*NOx*	*PM*

LARGE POINT SOURCES' EMISSIONS [t/a]

CEZ E301 Tepl.Brno (Spitalka)	1	1916	324	279
CEZ Elektrarna OSLAVANY	1	9212	3966	3742
CEZ Elektrarny PORICI	1	14617	8358	3450
CEZ Tep.Praha Treboradice	1	1172	1150	102
CEZ Tep.Zav.,Zav.Elektr.Kolin	1	2693	904	6623
CEZ Tepl. Veleslavin (Praha 6)	1	1836	372	1033
CEZ Teplarna Malesice (Praha)	1	8411	2626	129
CEZ Teplarna Michle (Praha)	1	2826	612	1035
CEZ Teplarna Vysocany (Praha9)	1	2643	615	242
CEZ-OKE Elektrarna TREBOVICE	1	6261	4524	6047
CEZ-OKE Teplarna Olomouc	1	9379	2014	1323
CEZ-OKE Teplarna Ostrava	1	2358	1085	1290
CEZ-OKE Teplarna Prerov	1	2287	1578	4368
CEZ-OKE Vytopna Fr.-Mistek	1	1421	498	258
CEZ-OKE-ZRT Vytopna Krnov	1	1060	260	740
JCE Ceske Bud. (Pisek)	1	2369	1105	123
JCE SP Strakonice	1	4578	1068	373
JCE SP Teplarna Ceske Budejov.	1	7974	3330	1979
JCE SP Teplarna Tabor	1	1494	210	230
JCP SP Mydlovary	1	1699	941	557
Okresni Bytovy Podnik Dacice	1	1039	208	60
SCT SP Odstepny Zav.Tep.Trmice	1	6244	4177	3278
SCT SP Teplarna Komorany	1	34300	4826	20500
SCT SP Teplarna Liberec	1	3842	778	14
SCT SP Teplice-Novosedlice	1	1590	200	170
Tepl. zavod Karlovy Vary	1	2369	1126	1060
Teplarna CS Armady (Karvina)	1	1435	1235	1430
Teplarna Havirov Sucha	1	2047	1613	1400
Teplarna Karvina	1	1277	866	1950
Teplarna Nachod	1	3048	650	432
Teplarna Plzen	1	1564	1763	600
Teplarna SP Otrokovice	1	9527	2266	513
ZCE Plzen (Ostrov n.Ohri)	1	1019	515	451
CEZ Elektrarna CHVALETICE	1	62200	19916	4610
CEZ Elektrarna LEDVICE	1	38700	14537	18000
CEZ Elektrarna MELNIK	1	79103	24801	13453
CEZ Elektrarna TISOVA	1	86200	14909	12300
CEZ OZ Elektrarna HODONIN	1	30200	8505	902
CEZ OZ PKE Tusimice (I+II)	1	196300	50400	15193
CEZ SP Elektrarna DETMAROVICE	1	21500	12656	2810
CEZ-OKE Elektr.J.Sverma(Ostr.)	1	1910	839	1597
CEZ-OZ Elektrarny OPATOVICE	1	60202	12835	3055
Elektrarna POCERADY	1	126900	39391	8923
Elektrarna PRUNEROV (I+II)	1	273500	48516	7174

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LARGE POINT SOURCES' EMISSIONS [t/a]

Total Public Power and Heat Plants		***1132222***	***303068***	***153798***
AGROSTROJ Jicin SP	3	334	57	1250
CARBORUNDUM Electrite Spoj.Zav	3	337	56	1024
CEVA Kraluv Dvur AS	3	291	590	2012
CHEMOPETROL KP Kralupy n.Vl.	3	18349	4661	5957
CHEMOPETROL S.P.(Litvinov)	3	65686	28263	13089
Cement.a Vapen.(Hranice na M.)	3	932	659	2138
Cement.a Vapen.SP (Cizkovice)	3	318	725	2033
Chemicke Zavody Sokolov AS	3	1127	242	187
Cukrovary Olomouc SP (Kojetin)	3	706	158	2376
DEZA AS (Valasske Mezirici)	3	2609	3272	888
DUL CSM SP (Stonava)	3	1156	657	4771
GLAV UNION AS (Sokolov)	3	2667	509	176
Jihostroj Velesin (Demoradice)	3	1044	207	739
KORAMO S.P. Kolin	3	1594	250	73
Karlovarsky Porcelan SP Zav.02	3	1017	212	372
Kralodvorske zelezarny(Kr.Dvu	3	530	489	1353
Krkonosske Papirny (Hostinne)	3	1590	278	364
LIAZ Zav.01 (Jablonec n.Nisou)	3	1134	189	55
Lucebni Zav.S.P.Kolin Cech I	3	1161	27	76
MORAVIA GLASS S.A.S.Kyjov	3	1	1013	89
Moravske Chemicke Zav.(Ostrava	3	3443	472	79
Moravske Samot (Velke Opatov.)	3	439	76	3990
Nova Hut SP Ostrava	3	15632	17619	14008
OKD-OKK OZ (Ostrava)	3	3549	963	2060
PARAMO SP (Pardubice)	3	1900	480	115
POLDI Kladno Spojene Ocel S.P.	3	7814	5545	18038
Palivovy Kombinat (Usti n L.)	3	1453	1144	1265
Prerovske Chemicke Zavody SP	3	2511	96	552
Rosicke Uhel D.(Zbysov u Brna)	3	603	91	1746
SKODA Automobilovy Koncern	3	6200	1435	1832
SKODA K.A.S. Plzen	3	7071	3722	5211
SOLO ST.P. (Susice)	3	1895	475	1578
SPOLANA SP Neratovice	3	11796	3295	2295
SVIT OP Zavodni Teplarna	3	4671	1805	6819
Sev.Cs. Tukove Zav.(Usti n L.)	3	2222	890	138
Severoceske Chem.Zav.Lovosice	3	6593	1394	1224
Severoceske Papirny Zav.Steti	3	6848	2919	759
Slevarna SKODA SP (C.Budejov.)	3	3113	269	678
TATRA Kombinat Koprivnice	3	1254	866	1902
TON SP Bystrice p.Host.	3	1260	187	748
TONASO SP (Nestemice)	3	3699	896	1667
Trinecke zelezarny	3	11475	13142	10212
Unicovske Strojirny SP (Unicov	3	1385	126	1250

LARGE POINT SOURCES' EMISSIONS [t/a]

VCHZ SYNTHESIA SP (Pardubice)	3	15318	4419	5398
VELVETA SP (Varnsdorf)	3	1427	476	197
VITKOVICE KP (Ostrava)	3	10844	11508	6223
Valcovny Trub SP (Chomutov)	3	12440	2143	894
Vych.Cs.Uhelne D. (Zacler)	3	320	60	2940
Zdarske stroj.a slevarny SP	3	2052	527	1096
Zelez.a dratovny SP Bohumin	3	913	462	2388
Zelezarny SP Chomutov	3	173	1015	-
Zelezarny a stroj. KG KP	3	299	1116	393
Total Industrial Combustion		***253195***	***122147***	***136717***
BIOCEL SP Paskov	4	1225	2483	131
Jihoceske papirny SP Vetrni	4	5389	1334	672
SILON SP (Plana)	4	4306	2364	44
VLNAP AS Nejdek	4	1460	216	287
Total Non-combustion Process		***12380***	***6397***	***1134***
Palivovy Komb. S.P. Vresova	5	22661	13763	3745
Total Extr.& Distr. of Fossil Fuels		***22661***	***13763***	***3745***
TOTAL *Czech Republic*		**1420458**	**445375**	**295394**

HUNGARY

Name of the Plant	*SNAP'90*	*SO2*	*NOx*	*PM*
Ajka	1	45484	4983	21921
Banhida	1	29536	1804	4375
Borsod	1	68917	2527	2896
Dorog	1	10677	616	616
Dunamenti (I+II)	1	22310	6916	2896
Gagarin (Matrai)	1	94554	1022	7890
Komlo	1	3182	291	202
November 7th (Inota)	1	18390	2301	30172
Oroszlany	1	35351	2123	716
Pecs	1	48554	4084	3094
Tatabanya	1	19990	863	5753
Tisza (I+II)	1	67405	6403	2072
Angyalfold	1	18	161	-
Debrecen	1	303	140	-

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LARGE POINT SOURCES' EMISSIONS [t/a]

Gyor (I+II)	1	4845	385	1576
Kelenfold	1	814	1123	-
Kispest	1	378	364	-
Kobanya	1	391	643	-
Nyiregyhaza	1	100	72	8
Revesz u.	1	-	174	-
Salgotarjan	1	1121	1971	109
Sopron	1	205	46	92
Szekesfehervar	1	1888	159	54
Ujpest	1	7	355	-
Total Public Power and Heat Plants		***474420***	***39526***	***84442***
TOTAL *Hungary*		**474420**	**39526**	**84442**

ITALY

Name of the Plant	*SNAP'90*	*SO2*	*NOx*	*PM*
I1-PPP	1	2640	2130	-
I12-PPP	1	56000	36500	-
I14-PPP	1	21800	5910	-
I15-PPP	1	44600	9210	-
I2-PPP	1	7123	1261	-
I23-PPP	1	57200	23890	-
I25-PPP	1	3914	1639	-
I38-PPP	1	80300	16450	-
I40-PPP	1	41700	16300	-
I42-PPP	1	60600	13810	-
I44-PPP	1	-	390	-
I51-PPP	1	21300	4580	-
I52-PPP	1	42500	10200	-
I54-PPP	1	26600	10030	-
I58-PPP	1	10400	2340	-
I59-PPP	1	10700	4540	-
I63-PPP	1	123900	29370	-
I68-PPP	1	-	1205	-
I7-PPP	1	-	44	-
I72-PPP	1	5100	3400	-
I8-PPP	1	41600	32270	-
I82-PPP	1	9400	1570	-
I83-PPP	1	17200	21450	-
I86-PPP	1	27800	10400	-

LARGE POINT SOURCES' EMISSIONS [t/a]

I90-PPP	1	6400	1410	-
I20-CHP	1	721	623	-
Total Public Power and Heat Plants		***719498***	***260922***	***0***
I109-REFINERY	3	21950	7100	-
I13-REFINERY	3	300	46	-
I16-REFINERY	3	14450	2383	-
I21-REFINERY	3	13880	1871	-
I22-REFINERY	3	2311	220	-
I26-REFINERY	3	3231	528	-
I27-CHEMICAL	3	44019	31260	-
I41-REFINERY	3	4550	690	-
I5-REFINERY	3	5517	526	-
I53-REFINERY	3	6962	1219	-
I61-REFINERY	3	5000	800	-
I66-REFINERY	3	4241	650	-
I69-REFINERY	3	21345	8655	-
I73-REFINERY	3	8156	1099	-
I88-REFINERY	3	85126	18199	-
I9-REFINERY	3	13400	6585	-
I95-REFINERY	3	62323	16581	-
I74-STEEL MILL	3	27614	7160	-
I108-NON-FERROUS FOUNDRY	3	56564	15048	-
I102-CHEMICAL	3	40267	8650	-
I106-CHEMICAL	3	13622	2815	-
I30-CHEMICAL	3	-	892	-
I45-CHEMICAL	3	7139	6000	-
I79-CHEMICAL	3	46840	26608	-
I91-CHEMICAL	3	51011	6884	-
Total Industrial Combustion		***559818***	***172469***	***0***
I18-S_ACID	4	90	-	-
I19-S_ACID	4	75	-	-
I39-S_ACID	4	135	-	-
I55-S_ACID	4	4686	-	-
I6-S_ACID	4	777	-	-
I71-S_ACID	4	85	-	-
I84-S,N_ACID	4	1910	795	-
I34-N_ACID	4	-	193	-
I60-N_ACID	4	-	940	-
Total Non-combustion Process		***7758***	***1928***	***0***
I4-AUTO	6	-	-	-

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LARGE POINT SOURCES' EMISSIONS [t/a]

I67-AUTO	6	-	-	-
I87-AUTO	6	-	-	-
Total Solvent Use		***0***	***0***	***0***
TOTAL *Italy*		**1287074**	**435319**	**0**

POLAND

Name of the Plant	*SNAP'90*	*SO2*	*NOx*	*PM*
CHP Bielsko-Biala	1	9222	3162	3616
CHP Bydgoszcz I	1	1659	657	568
CHP Bydgoszcz III	1	1276	625	7101
CHP Chorzow	1	6539	2129	4769
CHP Czechnica	1	4773	1742	5145
CHP Elblag	1	2337	1610	9946
CHP Gdynia I	1	2050	615	7464
CHP Gdynia II	1	2427	796	4934
CHP Gdynia III	1	5596	1897	2421
CHP Kalisz	1	833	353	286
CHP Lodz I	1	2438	855	2414
CHP Lodz III	1	10148	3824	5928
CHP Lodz IV	1	9936	3602	3208
CHP Olowianka	1	1113	354	1629
CHP Powisle	1	1408	892	1150
CHP Poznan-Garbary	1	2742	1120	5800
CHP Poznan-Karolin	1	6766	1983	790
CHP Pruszkow	1	1249	569	689
CHP Szczecin	1	5833	1756	5125
CHP Szombierki	1	1608	886	1659
CHP Zabrze	1	4189	1992	5280
CHP Zielona Gora	1	2469	752	1044
HP Bielsk-Komorowice	1	1212	606	696
HP Cieszyn	1	1407	327	252
HP Czestochowa	1	718	166	834
HP Grudziadz	1	530	203	372
HP Katowice	1	3371	933	753
HP Kaweczyn	1	3122	1663	570
HP Lublin-Wrotkow	1	4900	1786	1495
HP Rzeszow-Zaleze	1	3667	771	835
HP Torun-Grebocin	1	2263	694	746
HP Tychy	1	3104	1251	1520

LARGE POINT SOURCES' EMISSIONS [t/a]

HP Wola	1	6495	978	-
HP Zamosc-Szopinek	1	462	86	142
PPP Halemba	1	12171	3897	2887
PPP Jaworzno I	1	11526	1792	9303
PPP Miechowice	1	3696	2110	5537
PPP Pomorzany	1	8129	2236	7304
CHP BEDZIN Bedzin	1	6742	3667	16306
CHP BIALYSTOK II Bialystok	1	11265	2874	12468
CHP BYDGOSZCZ II Bydgoszcz	1	13135	8726	13773
CHP GDANSK II Gdansk	1	19908	7178	9905
CHP GORZOW Gorzow Wielkopolski	1	10441	6878	17175
CHP LEG Krakow	1	16535	3199	14151
CHP LODZ II Lodz	1	11755	1185	29846
CHP SIEKIERKI Warszawa	1	28904	4908	28331
CHP WROCLAW Wroclaw	1	17296	7944	6704
CHP ZERAN Warszawa	1	26830	16112	36727
PP ADAMOW Korytkow	1	20017	6825	25699
PP BELCHATOW Rogowiec	1	341636	60559	34030
PP BLACHOWNIA Kedzierzyn-Kozle	1	19429	3682	26255
PP DOLNA ODRA Nowy Czarnow	1	78327	22688	35319
PP JAWORZNO II Jaworzno	1	34005	4880	10932
PP JAWORZNO III Jaworzno	1	131392	12280	10985
PP KONIN Konin-Goslawice	1	50699	3983	32090
PP KOZIENICE Swierze Gorne	1	116146	34844	29799
PP LAGISZA Bedzin	1	48753	1092	12926
PP LAZISKA Laziska Gorne	1	77616	39377	16700
PP OSTROLEKA Ostroleka	1	57440	39078	33570
PP PATNOW-KONIN Konin	1	84020	9529	17694
PP POLANIEC Polaniec	1	149818	8898	12187
PP RYBNIK Rybnik	1	97114	28813	22360
PP SIERSZA Trzebinia	1	111533	35773	6270
PP SKAWINA Skawina	1	45313	17389	26661
PP STALOWA WOLA Stalowa Wola	1	23398	9543	33714
PP TUROW Bogatynia	1	205410	12628	89573
Total Public Power and Heat Plants		***2008261***	***466202***	***776362***
GLOGOW I Zukowice	3	52132	71	1460
HUTA KATOWICE Dabrowa Gornicza	3	21074	4907	35689
HUTA LAZISKA Laziska Gorne	3	2366	1891	22426
Huta BOBREK Bytom	3	2572	387	4933
Huta KOSCIUSZKO Chorzow	3	3622	2869	7411
Huta Lenina Krakow-Nowa Huta	3	24487	21571	50131
Huta Miedzi LEGNICA Legnica	3	14798	7	6787
Huta im.Bieruta Czestochowa	3	6863	4436	10754
MZRP Plock	3	67261	5611	1252

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LARGE POINT SOURCES' EMISSIONS [t/a]

OSWIECIM Oswiecim	3	9741	3872	58424
Z.A.KEDZIERZYN K.Kozle	3	6584	10007	9694
Z.A.PULAWY Pulawy	3	11366	16459	9903
Z.A.im.F.Dzierzynskiego Tarnow	3	11432	11723	24884
Z.A.im.P.Findera Chorzow	3	1505	1620	15174
Z.K.MAKOSZOWY Zabrze	3	2038	708	3251
Z.K.WALBRZYCH Walbrzych	3	2155	907	3220
Z.K.im.P.Slaskich Zdzieszowice	3	9782	3362	7301
ZCiP Swiecie n/Wisla	3	7103	4199	8141
CHELM Chelm	3	2304	1910	15809
WIEK Ogrodzieniec	3	777	805	20482
Total Industrial Combustion		***259962***	***97322***	***317126***
CHEMITEX-CELWISKOZA J.Gora	4	2153	1197	3504
CHEMITEX-WISTOM Tomaszow Maz.	4	4252	1212	2868
Total Non-combustion Process		***6405***	***2409***	***6372***
Gas Works Wroclaw	5	701	220	614
VIKTORIA Walbrzych	5	4890	493	20342
Total Extr.& Distr. of Fossil Fuels		***5591***	***713***	***20956***
TOTAL *Poland*		**2280219**	**566646**	**1120816**

SLOVAK REPUBLIC

Name of the Plant	*SNAP'90*	*SO2*	*NOx*	*PM*
Bratislava TP II	1	2009	752	145
ENO Z.Kostolany	1	114722	30564	31207
Elektraren Vojany	1	62933	25603	27975
TP Kosice	1	5020	4516	1113
Bratislava TP South	1	1833	368	107
Bratislava TP West	1	2357	636	50
TP Handlova	1	1816	457	404
Kotolna Svidnik	1	-	19	1
TP Martin	1	5956	1303	5998
TP Zilina	1	9284	4259	1809
Kotolna Trebisov	1	1266	313	903
TP Zvolen	1	1824	350	527
Kotolna Spisska V.Ves	1	1335	187	803

LARGE POINT SOURCES' EMISSIONS [t/a]

Total Public Power and Heat Plants		***210355***	***69327***	***71042***
Nickel Huta Sered	3	3380	1336	922
Kovohuty Krompachy	3	11805	-	173
CHEMKO Strazske	3	6481	2480	1240
CHEMLON Humene	3	5511	1295	2347
JCP Sturovo	3	10549	3540	1935
SCP Ruzomberok	3	4945	1307	8747
VSZ Kosice	3	32553	31046	20223
BIOTIKA Slovenska Lupca	3	1981	504	525
BUKOZA Vranov	3	11140	2255	665
CHEMOSVIT Svit	3	1	206	8
Cukrovar R.Sobota	3	1865	514	2152
Duslo Sala	3	8290	8313	2483
Kozeluzne Bosany	3	1438	262	821
LAVITEX Levice	3	1590	318	93
MAYTEX Lipt Mikulas	3	2078	417	118
Paperne Slavosovce	3	832	112	15
Petrochemia Dubova	3	2473	195	856
SLZ Hnusta	3	1838	367	2614
Svermove Zeleziarne Podbrezova	3	62	68	3
TP Strojarne P.Bystrica	3	6183	707	16929
VAB Banovce	3	1590	382	763
VIHORLAT Snina	3	1469	521	4680
ZSNP Ziar n.Hronom	3	6291	2284	1232
ZTS Dubnica	3	691	253	308
zav.29 Augusta Partizanske	3	1914	282	1039
Celulozka G.Horka	3	672	106	1233
Cementarne Rohoznik	3	261	554	512
Magnezitka Jelsava	3	1056	724	633
Skloobal Nemsova	3	-	1577	1
Zeleznorudne Bane Rudnany	3	2798	26	3029
Zlievaren Hronec	3	102	25	160
SLOVNAFT Bratislava	3	22394	3197	920
Zeleznorudne Bane N.Slana	3	4075	-	903
Total Industrial Combustion		***158308***	***65173***	***78282***
Nickel Huta Sered	4	-	25	88
CHZ Juraja	4	766	121	76
CHZ Zilina	4	116	488	-
Total Non-combustion Process		***882***	***634***	***164***
Compressor Station V.Zlievce	5	-	5727	-

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LARGE POINT SOURCES' EMISSIONS [t/a]

Total Extr.& Distr. of Fossil Fuels	*0*	*5727*	*0*
TOTAL *Slovak Republic*	**369545**	**140861**	**149488**

SLOVENIA

Name of the Plant	*SNAP'90*	*SO2*	*NOx*	*PM*
TE Sostanj	1	84670	8467	2937
TE Trbovlje	1	30258	1210	731
TE TO Ljubljana	1	20921	2092	1281
Total Public Power and Heat Plants		*135849*	*11769*	*4949*
Cementarna Trbovlje	3	260	-	1200
Salonit Anhovo	3	9	316	188
IGM Zagorje	3	-	-	102
Steklarna Hrastnik	3	-	1087	-
Termika Skofja Loka	3	46	6	2
Zelezarna Jesenice	3	330	250	182
Zelezarna Ravne	3	65	72	4515
Zelezarna Store	3	5	78	416
Cinkarna Celje	3	2183	-	46
Toplinica Svinca Mezica	3	2	-	12
Total Industrial Combustion		*2900*	*1809*	*6663*
TGA Kidricevo	4	8877	41	10
Tovarna Dusika Ruse	4	900	400	6400
EMO Celje	4	-	69	116
Lesonit Ilirska Bistrica	4	146	-	19
Papirnica Videm, Krsko	4	6720	-	-
Total Non-combustion Process		*16643*	*510*	*6545*
TOTAL *Slovenia*		**155392**	**14088**	**18157**
TOTAL LPS EMISSIONS IN CEI REGION		**6086160**	**1677836**	**1679218**