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Emissions of atmospheric pollutants in Europe, 1990–99

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Executive summary

This report presents indicators and information on air emission trends in Europe 1990–99.

Atmospheric pollution contributes to several prominent environmental issues that arise due to emissions to the atmosphere (air emissions) from a variety of mainly anthropogenic (man-made) activities. This report covers air emissions that contribute to the following issues:

- acidification and eutrophication;
- tropospheric ozone;
- urban air quality (particulate matter).

This report includes information on EEA-18 member countries, as well as the following 10 accession countries: Bulgaria, the Czech Republic, Estonia, Hungary, Latvia, Lithuania, Poland, Romania, Slovenia and Slovakia. In addition to trends in national total emissions, emission indicators are also presented by main economic sector (energy, industry, transport, agriculture) showing the different contributions to the environmental issues by these sectors.

The report has been prepared by the European Topic Centre on Air and Climate Change (ETC/ACC) as part of its work programme for the European Environment Agency (EEA). The report provides information available by October 2001 and thus provides an update of information provided in earlier EEA reports.

ETC/ACC assists EEA member countries to collect and report emission data. Data used for this report is the official data submitted to EMEP by countries under the UNECE Convention on Long-range Transboundary Air Pollution (CLRTAP). ETC/ACC compiles from these country data a European emissions database (Corinair) and from this is able to provide air emissions data and indicators for the main EEA assessment reports. Where necessary these data have been supplemented with interpolated estimates to fill gaps and complete the European picture. The data and indicators presented in this report are fully consistent with the data and indicators presented in the most recent EEA indicator-based report *Environmental signals 2002* (EEA, 2002a).

Why indicators on air emissions?
Reliable (accurate), consistent, comparable, transparent, complete and timely data and indicators on air emissions are important for policy-making and policy implementation:

- to identify and quantify the pressures on the environment and to assess the impacts on the state of the environment, human health and materials;
- to develop abatement strategies and prioritise policies and measures for the main source categories (sectors) in a cost-effective way;
- to monitor the effects of implemented policies and measures in terms of reduced or avoided emissions and changes in impacts. This includes monitoring of internationally agreed emission reduction targets defined in protocols to the UNECE Convention on Long-range Transboundary Air Pollution (e.g. the Gothenburg Protocol 1999) and/or EU directives (e.g. the national emission ceiling directive 2001).
- to inform the public, by means of air emission indicators (which are an aggregation of more detailed data).

Main results
The tables below display the key assessments for emission trends 1990–99 for EU-15 and accession countries respectively. More detailed information on key messages can be found in Sections 2.1 (Acidifying substances), 3.1.(Tropospheric ozone precursors) and 4 (Emissions of particulates (PM_{10}) — EU-15 only).

Table 1 **Summary of key results for emission trends 1990–99 EU-15**

Sector	Acidifying pollutants (Chapter 2.1)	Trop. ozone precursors (Chapter 3.1)	PM_{10} [1]) (Chapter 4)
Energy (Chapter 5.1)	☺	☺	☺
Transport (Chapter 5.3)	☺	☺	☺
Industry (Chapter 5.2)	☺	☺	☺
Agriculture (Chapter 5.4)	☺	☺	☺
Total emissions	☻	☻	☻
Emissions compared to the 2010 NECD target	😐	😐	**NA**
Compared to limit values in the EU first daughter directive to the framework directive on ambient air quality	**NA**	**NA**	☹

NA: not applicable.

1) Trend in total emission of PM_{10}. Trend in emission of primary PM_{10} is very uncertain especially for individual sectors.

Table 2 **Summary of key results for emission trends 1990–99 accession countries [1])**

Sector	Acidifying pollutants (Chapter 2.1)	Trop. ozone precursors (Chapter 3.1)
Energy (Chapters 2.1.2, 2.3.2, 3.2.2)	☺	☺
Transport (Chapters 2.1.2, 2.3.2, 3.2.2)	☺	☺
Industry (Chapters 2.1.2, 2.3.2, 3.2.2)	☺	☺
Agriculture (Chapters 2.1.2, 2.3.2, 3.2.2)	☺	😐
Total emissions	☻	☻
Emissions compared to CLRTAP Gothenburg target	☻	☻

(1) Romania is excluded from this summary assessment because of incomplete reporting 1990–99.

Acidification, tropospheric ozone and urban air quality (emissions of acidifying pollutants and ozone precursors)

Within CLRTAP, national emission ceilings were agreed in a new multi-pollutant protocol in December 1999 for SO_2, NMVOC, NO_x and for the first time for NH_3 (ammonia), for many European countries, including EU Member States. In October 2001 the European Commission adopted a directive on national emission ceilings (NECD) for the same pollutants. For a number of Member States, the adopted NECD targets are more stringent than those agreed within CLRTAP.

Emissions of acidifying pollutants

Emissions of acidifying gases (SO_2, NO_x and NH_3) have decreased significantly in most EU Member States. In the European Union as a whole, emissions decreased by 38 % between 1990 and 1999 despite an increase in GDP.

The EU-15 emissions of acidifying substances have been reduced by 38 % between 1990 and 1999 and the EU is more than half way through towards the 2010 targets of the national emission ceilings directive which corresponds to a 57 % reduction from 1990 levels. The substantial fall in emissions of acidifying gases is mainly due to a 60 % reduction in SO_2 emissions since 1990. This reduction is predominately due to a switch from high sulphur solid and liquid fuels to natural gas, in the energy industries, industry and domestic sectors, as well as economic restructuring of the new *Länder* in Germany and the introduction of flue gas desulphurisation in some power plants. Nitrogen oxide reductions due to abatement in road transport and large combustion plant were to some extent off-set by increased emissions from road traffic. Ammonia emissions constitute more than 30 % of the total emission of acidifying substances in 1999 — the largest contributing sector.

Emissions from agriculture are stabilising, however, agriculture emissions are very uncertain and difficult to control.

The main sources of acidifying pollutants in the accession countries are the same as those sources in the EU Member States — fuel combustion (energy and transport) and agriculture. The emissions of acidifying pollutants fell in all 10 accession countries included in the report between 1990–99 with four countries achieving in 1999 the cumulative 2010 Gothenburg Protocol target for SO_2, NO_x and NH_3 expressed in acid equivalents. Since 1990 the structure of NO_x sources in the accession countries has changed and on average is now closer to emissions from EU Member States. The share of transport in total emissions increased from approximately 34 % to 49 % in 1999 and the share of the energy sector decreased from 60 % to approximately 48 % in 1999. Emissions of ammonia in accession countries are predominantly from agriculture. Between 1990 and 1999 emissions decreased by 46 % as a result of a reduction in livestock numbers, particularly for beef and dairy cattle, and a significant reduction in fertiliser consumption per hectare of arable land.

Emissions of ozone precursors

Four air pollutants (CH_4, CO, NMVOC and NO_x also called 'ozone precursors') contribute to the formation of tropospheric ozone. Total ozone precursor emissions have been reduced in the European Union by 27 % between 1990 and 1999.

Road transport and industry have contributed most strongly to this reduction through increased penetration of diesel and of catalytic converters for road vehicles and through the implementation of the solvents directive applied to industrial processes.

There are major differences between EU Member States with the largest (percentage) reductions occurring in Germany, Luxembourg and the United Kingdom. Emissions in Portugal and Greece have increased since 1990 and seven countries still need to make significant efforts to meet the targets in the NEC directive. However eight Member States and the European Union as a whole are more than half way towards the NECD targets for 2010.

Total ozone precursor emissions have decreased in all accession countries included in this report, and overall, emissions have been reduced by 35 % and all [1] but Hungary and the Czech Republic have already reached their target set in the CLRTAP Gothenburg Protocol. The emission reductions are mainly due to decrease in energy production and introduction of catalysts on new cars.

Emissions of particulates

Uncontrolled combustion of coal in stationary sources and diesel in transportation contribute significantly to PM_{10} emissions in Europe. EU-15 urban area PM_{10} emissions are dominated by road transport. Urban area PM_{10} emissions are influenced by high emissions from industry and energy production within the urban area.

Total EU-15 emissions of fine particulates have been reduced by 34 % between 1990 and 1999. This is mainly due to reduction in emissions of the secondary particulate precursors SO_2 and NO_x, but also to reductions of primary PM_{10} from energy industries.

Substantial further reductions are needed to reach the limit values set in the first daughter directive to the EU framework directive on ambient air quality.

Emissions by main source sectors in EU-15 (energy, industry, transport, agriculture)

Energy sector: Emissions of acidifying gases (weighted emissions of SO_2 and NO_x) from the energy sector decreased by 56 % between 1990 and 1999, while tropospheric ozone precursors (mainly NO_x) emissions decreased less, but still by 42 %. These reductions are the result of controls (end-of-pipe technology) on emissions from coal combustion and a shift from solid and liquid fuel to natural gas. Abatement measures in the energy production and refining industries have helped to reduce SO_2 emissions. In the European Union as a whole, electricity production grew by 21 % between 1990 and 1999.

Industry sector: Emissions of acidifying gases and tropospheric ozone precursors from the industry sector decreased between 1990 and 1999 by 50 % and 20 % respectively, while

(1) Note that the CLRTAP Gothenburg Protocol does not include Estonia — hence no targets for Estonia are included in this report.

industrial energy use in 1999 was at 1990 levels and value added is above 1990 levels. Emission reductions are due to a range of abatement measures and end-of-pipe technology, increased energy efficiency and a shift from solid and liquid fuel to natural gas. The large combustion plant (LCP) directive, the integrated pollution prevention and control (IPPC) directive and the 'solvents' directive are expected to contribute to further emission reductions.

Transport sector: Emissions of acidifying gases and ozone precursors from transport decreased by 22 % and 29 % respectively between 1990 and 1999, while in the same period transport activity increased (passenger road transport by 17 %) and freight tonnes km increased by 30 %. As in previous years the emission reductions are mainly due to an increasing share of petrol-driven passenger cars fitted with catalytic converters.

Agricultural sector: Emissions of methane and ammonia from agriculture have marginally decreased (by 7 % from 1990 to 1999) through reducing livestock numbers. Changes in agricultural practices will be necessary to further reduce emissions from the European Union.

Contents

1. Introduction

1.1. Background and objective

This report has been prepared by the European Topic Centre on Air and Climate Change (ETC/ACC) as part of the EEA work programme. The report provides information on air pollutants information available by October 2001, and covers air emissions that contribute to the following issues:

- acidification and eutrophication;
- tropospheric ozone;
- urban air quality (particulate matter).

In addition, the report addresses emissions from different sectors and their relative contribution to the total air emissions.

The report uses the DPSIR assessment framework for structuring, presenting, analysing and reporting the causal chain of the different environmental issues. The DPSIR approach consists in general of describing the main indicators for Driving forces (main societal and socioeconomic trends), Pressures (emissions to air, generation of waste), State (global temperature increase, air quality, deposition), Impact (adverse effects on human health, ecosystems, materials) and Responses (existing and/or proposed policies and measures and progress towards environmental targets).

Much of the policy action at EU or Member State level is at the D and P part of the causal chain, therefore many policy-relevant indicators show developments in Driving forces and Pressures. This report has a specific focus on emissions of atmospheric pollutants and the progress towards emission reduction targets and emission ceilings.

The data and indicators are fully consistent with *Environmental signals 2002* (EEA, to be published 2002).

The overall objective of this report is to provide transparent, consistent, comparable, complete and reliable indicators of emissions of atmospheric pollutants, or 'air emissions'. More specifically this report is to provide a comprehensive, yet transparent, overview of the current emission trends of air pollutants in Europe and the underlying causes of change. In addition, the report includes assessments of current emission rates in relation to agreed policies and policy targets.

The added value of this report, compared to other EEA reports, is that it provides more detail and that it presents all main air emission indicators in a comparable and consistent way in one single report.

1.2. Scope

This report covers air emissions during the period 1990 to 1999 from:

- the European Union Member States — the current 15 Member States (EU-15);
- the EEA-18 countries — the original 18 members of the European Environment Agency — EU-15 plus Iceland, Liechtenstein and Norway;
- the central and east European accession countries — Bulgaria, the Czech Republic, Estonia, Hungary, Latvia, Lithuania, Poland, Romania, Slovenia, Slovakia (these countries became EEA member countries in late 2001/2002).

The air pollutants covered in this report and the relation to these environmental issues are listed in the table below:

Air pollutant	Acidification	Tropospheric ozone	Particulate matter
Sulphur dioxide, SO_2	4		4
Nitrogen oxides (NO_2 + NO), NO_x	4	4	4
Ammonia, NH_3	4		4
Non-methane volatile organic compounds, NMVOC		4	
Carbon monoxide, CO		4	
Methane, CH_4		4	
Particulate matter <10ug			4

In addition, emissions are also presented by main economic sector (energy, industry, transport, agriculture) showing the different contributions of each sector to the environmental issue, described in this report. By also presenting trends in emissions and some key socioeconomic indicators combined in various graphs, this report provides some insights in the development of links between human activities and the pressures on the environment and presents some information on the eco-efficiency of main socioeconomic sectors.

In this report aggregated sectors are used, based on the more detailed sectors used within UNECE/EMEP/Corinair (EEA/UNECE, 1999 and 2002). The aggregation used to prepare these 'EEA' sectors for this report, and also the main EEA assessment reports, are shown in the table below.

Sectors used in this report	Corresponding UNECE/EMEP/ Corinair sectors in 1999
Energy industries	1: Combustion in energy and transformation industries
Fugitive emissions	5: Extraction and distribution of fossil fuels / geothermal energy
Industry (processes)	4: Production processes
Industry (energy)	3: Combustion in manufacturing industry
Road transport	7: Road transport
Other transport	8: Other mobile sources and machinery
Agriculture	10: Agriculture
Other (energy)	2: Non-industrial combustion plant
Other (non-energy)	6: Solvent and other product use
Waste	9: Waste treatment and disposal
Other: aggregation of sectors that individually contribute less than 1 % of the total emissions of a specific pollutant/issue in 1999	-

1.3. Data and methods

The data and indicators presented in this report are fully consistent with the data and indicators presented in the most recent EEA indicator-based report *Environmental signals 2002* (EEA, 2002).

Data used for this report are the official data submitted by countries, by October 2001, to the various international reporting obligations:

- Acidifying pollutants and ozone precursors, heavy metals: Convention on Long-range Transboundary Air Pollution (CLRTAP, including various protocols);
- Methane: UN Framework Convention on Climate Change (UNFCCC) and EU Council decision on a monitoring mechanism of Community CO_2 and other greenhouse gas emissions.

Copies of the data that have been officially reported by countries are compiled into a central database, maintained by ETC/ACC called 'Corinair'. This database was used for the preparation of this report. Since October 1999, most of these data are also publicly available on the EEA web site (http://service.eea.eu.int/).

In addition, these data have been complemented by more detailed data, submitted directly by various countries to ETC/ACC. Furthermore, for particulate matter (PM) additional data, originating from other sources of information, are presented. This was done because of incomplete data from some countries, while other useful information was available.

Due to the increasing importance of emission data in policy development and in determining compliance with agreements, governments generally prefer that officially reported emissions data be used. In addition, the EEA, assisted by the ETC/ACC, is expected to work with member countries and avoid duplication and hence the EEA will not produce separate emission estimates. However, sometimes data reported by countries does not appear to be compatible with data from other countries or time series are not consistent. Furthermore not all countries keep to the guidelines for estimating and reporting emissions or they may interpret them differently. Changes in methodology which affect emission data for recent years are not always applied to data for earlier years, which makes trend analyses less reliable. In some cases, the data supplied to different international bodies may be inconsistent as new updated data is submitted to one convention but not to the other.

For this report the ETC/ACC has excluded in some cases official data that were clearly inconsistent with the relevant reporting requirements, and used, where needed for completeness, simple interpolation to fill any gaps or used the latest reported data for years for which data were missing (see the indicator fact sheets for air emissions and climate change (www.eea.eu.int) and the EEA data warehouse (http://dataservice.eea.eu.int/dataservice/)).

1.4. Relation to main periodical indicator-based EEA reports

The DPSIR assessment framework is followed in the main comprehensive EEA reports, such as the report *Environment in the European Union at the turn of the century*, which are produced approximately every five years, but also in the more regular *Environmental signals* reports. The EEA reporting approach is increasingly being built on indicators. The main EEA indicator-based reports are aimed at policy-makers in EEA member countries and the European Union. These reports make use of environmental indicators to report on progress in a number of policy areas, and also on the reasons behind the rate of progress made in some of the main environmental policy areas and in individual countries. EEA has published three indicator-based report *Environmental signals* reports (EEA, 2000b, 2001b, 2002).

In addition, EEA contributes, together with Eurostat, to the development and reporting of sector indicators, in line with the EU aim of broadening policy towards the integration of environmental issues into other policy fields. Sector indicators show links between the activities of societal sectors (transport, energy, forestry, etc.) and the environment. As well as showing each sector's absolute burden on the environment and the development in its eco-efficiency, sector indicators also deal with a sector's development in size and character and its specific responses to environmental issues. Sector indicators are in various stages of development; those for air emissions are amongst the most advanced.

For **transport and the environment** a list of around 30 indicators has been agreed. The indicators have been developed and reported in the second transport and environment reporting mechanism (TERM) report, *Indicators tracking transport and environment integration in the European Union* (EEA, 2001), a joint activity of the EEA and the European Commission (including Eurostat). Furthermore, preparation for a TERM report in 2002/2003 has started. In addition, a report on energy and environment (EER) has been published by the EEA in 2002. The emission data in this report is consistent with the data in the EER and the 2002 TERM report.

1.5. Environmental policies and policy targets

Air quality is affected by emissions to the atmosphere from energy use, industry, transport and other sources. Harm to human health, the acidification and eutrophication of water and soils, and damage to natural ecosystems and crops are the main environmental issues associated with air emissions. The effects of air pollution are inter-related and have a significant transboundary contribution.

The first international treaty with strategies to reduce transboundary air pollution was the United Nations Economic Commission for Europe (UNECE) Convention on Long-range Transboundary Air Pollution (CLRTAP), which was signed in 1979 and entered into force in 1983. The need to establish air pollution abatement strategies and in addition monitor progress towards emission reduction targets within CLRTAP was a stimulus to develop European emission inventories.

Originally CLRTAP aimed at reducing acidification and ground-level ozone, resulting in several protocols that are in force for most European countries, including the EU and its Member States, requiring reductions of emissions of sulphur dioxide (sulphur dioxide), non-methane volatile organic compounds (NMVOC) and nitrogen oxides (NO_x), expressed in national emission ceilings or percentage reductions. The second sulphur protocol of CLRTAP (1994) for the first time used the approach of closure of the gap between the actual deposition levels and the critical level for such deposition for ecosystems. This protocol thereby resulted in national emission

Air emissions reduction targets for EU-15 — Table 1.1

Policy/Pollutant	Base year	Target year	Reduction (%)
UNECE-CLRTAP			
Sulphur dioxide 1)	1980	2000	62
Sulphur dioxide 4)	1990	2010	75
Nitrogen oxides 2)	1987	1994	stabilisation
Nitrogen oxides 4)	1990	2010	50
Non-methane VOCs 3)	1987	1999	30
Non-methane VOCs 4)	1990	2010	58
Ammonia 4)	1990	2010	12
5EAP			
Sulphur dioxide	1985	2000	35
Nitrogen oxides	1990	2000	30
Non-methane VOCs	1990	1999	30
NECD 5)			
Sulphur dioxide	1990	2010	78
Nitrogen oxides	1990	2010	55
Non-methane VOCs	1990	2010	62
Ammonia	1990	2010	21

1) Target from the 1994 second sulphur protocol. The different emission ceilings for each Member State correspond to a 62 % emission reduction for the EU.
2) Targets from first NO_x protocol. These are the same for individual Member States and for the EU.
3) Targets from NMVOCs protocol. These are the same for individual Member States and for the EU.
4) Targets from the multi-pollutant protocol (1 December 1999). The emission reduction target for the EU is shown, which corresponds with the overall effect of the different emission ceilings for each Member State.
5) Targets from the national emission ceilings directive (NECD) adopted in 2001. The emission reduction target for the EU is shown, which corresponds with the overall effect of the different emission ceilings for each Member State.

reduction commitments that are quite different for each country, according to ecosystem sensitivities.

In 1998 CLRTAP protocols were adopted that require reductions in the use and emissions of a number of heavy metals (such as mercury, cadmium) and persistent organic pollutants (POPs, such as dioxins).

Within CLRTAP in December 1999 national emission ceilings were agreed in a new multi-pollutant protocol for sulphur dioxide, NMVOC, NO_x and for the first time for ammonia (NH_3) for many European countries, including EU Member States. These targets are much more strict than the previously agreed targets.

In May 1999 the European Commission prepared a proposal for a directive on national emission ceilings (NECD) for the same pollutants. The directive was adopted in October 2001 and, for a number of Member States, the NECD targets are more strict than those agreed within CLRTAP.

Table 1.1 provides an overview of all current and proposed emission reduction targets and/or emission ceilings for EU-15.

Table 1.2 and Table 1.3 provide the most recent emission ceilings that are the agreed NECD and CLRTAP targets for the EU Member States and CLRTAP targets for central and east European countries.

National Emission Ceilings for SO_2, NO_x, NMVOC and NH_3 to be achieved by 2010 (European Commission, 2001b) (kTonnes) — Table 1.2

Country	SO_2	NO_x	NMVOC	NH_3
Austria	39	103	159	66
Belgium	99	176	139	74
Denmark	55	127	85	69
Finland	110	170	130	31
France	375	810	1 050	780
Germany	520	1 051	995	550
Greece	523	344	261	73
Ireland	42	65	55	116
Italy	475	990	1 159	419
Luxembourg	4	11	9	7
Netherlands	50	260	185	128
Portugal	160	250	180	90
Spain	746	847	662	353
Sweden	67	148	241	57
UK	585	1 167	1 200	297
TOTAL EU	**3 850**	**6 519**	**6 510**	**3 110**

Table 1.3 **National emission ceilings for SO_2, NO_x, NMVOC and NH_3 to be achieved by 2010 (CLRTAP Gothenburg Protocol, 1999) (kt)**

Country	SO_2	NO_x	NMVOC	NH_3
Bulgaria	856	266	185	108
Czech Republic	283	286	220	101
Estonia	-	-	-	-
Hungary	550	198	137	90
Latvia	107	84	136	44
Lithuania	145	110	92	84
Poland	1 397	879	800	468
Romania	918	437	523	210
Slovakia	110	130	140	39
Slovenia	27	45	40	20
TOTAL AC-10	NA	NA	NA	NA

NA: not applicable

To help reach the EU Member State targets, current European Community legislation aimed at reducing acidifying pollutants and ozone precursors includes:

- an EU large combustion plants directive (LCP), Directive 2001/80/EC;
- a directive on the sulphur content of certain liquids;
- directives resulting from the second auto oil programme.
- the directive on 'Stage 1' controls on gasoline storage and distribution (94/63/EC);
- the 'solvents directive' (directive on the limitation of emissions of volatile organic compounds due to the use of organic solvents in certain activities and installations (March 1999);
- the IPPC (integrated pollution prevention and control) directive of 1996 on minimisation of pollution from various point sources throughout the European Union. Implementation is through an authorisation (permit) based on the concept of best available techniques (or BAT).

In addition, several measures to reduce greenhouse gas emissions (particularly carbon dioxide) could, as a side effect, reduce acidifying substances and ozone precursors. One such measure is fuel switching to natural gas. The Kyoto Protocol requires a reduction of 8 % for greenhouse gases by 2008–12 using 1990 as the base year. For more information on greenhouse gas emission, trends and underlying causes, see the EEA Topic report No 10 *European Community and Member States greenhouse gas emission trends 1990–99* (EEA, 2001b)

1.6. Air emission inventories and indicators

The estimation, collection and presentation of data on air emissions are important aspects of policy-making and policy implementation aimed at reducing air pollution and tackling the issue of climate change. The main aims of air emission inventories and indicators are:

- to identify and quantify the pressures on the environment and to assess the impacts on the state of the environment, on human health and on materials;
- to develop abatement strategies and prioritise policies and measures for the main source categories (sectors) in a cost-effective way. This is increasingly done by making use of integrated assessment models;
- to monitor the effects of implemented policies and measures in terms of reduced or avoided emissions and change in impacts. This includes monitoring of internationally agreed emission reduction targets (EC legislation and/or international conventions);
- to inform the public, by means of air emission indicators (which are derived from more detailed data). Despite the limitations of emission inventory data from countries, as described below, the EEA believes these data have sufficient quality to use for the preparation of the main indicators on air emissions for it's reports.

To fulfil these aims there is an increasing demand for **reliable (accurate)** detailed emission estimates for the national total emissions and for the main source categories. These estimates should be **consistent** over time and should be **comparable** between countries. To increase consistency the same methodologies should be used by a country for the complete time series of data. This can mean recalculation of the complete time series when better methodologies become available. To increase comparability it is important that all countries use the same source categories. Furthermore emission estimates should be **transparent**, meaning that the assumptions and methodologies used should be clearly explained. This is essential for successful communication of information. Inventories should also be **complete**, meaning that all relevant sources are covered of the geographic area of concern (often a country, although also regional and local inventories are prepared).

For each pollutant, the potential sources are identified and listed in a hierarchical nomenclature comprising major categories and several levels of sub-categories. Except for large industrial or other 'point sources', most emissions data are estimated rather than measured directly. It is important to realise that the emission estimates are always based on a number of assumptions, complex methodologies and often incomplete data. Uncertainties are therefore inevitable in any estimate of national emissions or removals (mainly relevant for carbon dioxide). It is important that these uncertainties are understood, properly communicated and where possible reduced to improve effective policy-making and performance monitoring.

For some gases, uncertainties can be large (Eggleston, 1998) ranging broadly as follows for the total national emissions, on a gas-by-gas basis:

- SO_2: 10 %
- NO_x: 30 %
- NMVOC, NH_3: 50 %
- PM_{10}: 50–100 %

However it should be noted that uncertainties in trends are likely to be (much) smaller than uncertainties in absolute numbers (Eggleston et al., 1998). Furthermore, within the IPCC different approaches have been collected and developed to provide better quantitative estimates of uncertainty (IPCC, 2000).

On the international level the following approaches and methodologies exist for compiling and reporting national air emission inventories:

- CLRTAP/EMEP guidelines and EMEP/Corinair guidebook (acidifying and eutrophying pollutants, ozone precursors, heavy metals and persistent organic pollutants or POPs);
- UNFCCC guidelines, EU monitoring mechanism guidelines and IPCC guidelines (greenhouse gases).

Parties to CLRTAP are required to submit annual national emissions of SO_2, NO_x, NMVOC, CH_4, CO and NH_3 and various heavy metals and POPs using the 11 main source categories (Level 1 of SNAP, selected nomenclature for sources of air pollution) by 31 December of the following year. From 31 January 2002 onwards the new reporting format, NFR, of CLRTAP shall be used (UNECE/CLRTAP, 2002), by 15 February (providing a 1.5 month longer period for reporting).

Parties are also required to provide EMEP periodically with emission data within grid elements of 50 km x 50 km, as defined by EMEP and known as the EMEP grid. Parties should use the EMEP/Corinair atmospheric emission inventory guidebook both as a reference book on good emission estimation practice and as a checklist to ensure that all relevant activities are considered and their emissions quantified. In January 2002, the third edition of this guidebook was made available on the EEA web site: http://reports.eea.eu.int/technical_report_2001_3/en. The online guidebook is updated annually.

Parties to UNFCCC are required to report emissions and sink estimates by 15 April for the last year but one of carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), perfluorocarbons (PFCs), hydrofluorocarbons (HFCs) and sulphur hexafluoride (SF_6). UNFCCC requires parties to use the UNFCCC reporting guidelines on annual inventories, which refer to the use by parties of the revised 1996 IPCC guidelines for national greenhouse gas inventories (IPCC, 1997), and the associated IPCC good practice guidance and uncertainty management in national greenhouse gas inventories (IPCC, 2000).

The ongoing developments in both the EMEP/Corinair guidebook and the UNFCCC/IPCC guidelines are expected to improve inventories further, regarding all relevant quality aspects (**consistency, comparability, transparency, completeness**) and reduce the uncertainties. Of particular importance is the need for further work by countries, assisted by the EEA and ETC/ACC, the two convention secretariats, and the relevant task forces to achieve consistent time series over the full period of relevance (from 1980 onwards for UNECE/CLRTAP and from 1990 onwards for UNFCCC). This can in many cases involve recalculation of (parts of) earlier estimates.

As requirements for reporting of emissions data under CLRTAP and UNFCCC are getting more detailed, separate national databases for different purposes should merge towards a single coordinated national database.

2. Emissions of acidifying substances (SO_2, NO_x and NH_3)

2.1. Total acidifying substances

Key messages — EU-15

☺ The EU-15 emissions of acidifying substances have been reduced by 38 % between 1990 and 1999 and the EU is more than half way towards the 2010 targets of the national emissions ceilings directive. This is mainly due to flue gas treatment and use of low-sulphur fuels in power plants, which have reduced sulphur emissions.

☺ EU-15 emissions are well below the linear target path to the 2010 targets of the national emissions ceilings directive. This is mainly due to the substantial emission reductions in Germany and the UK.

☹ Four Member States (Greece, Portugal, Ireland and Spain) are less than half way to their 2010 targets and above their linear target paths towards the 2010 targets of the national emissions ceilings directive.

☹ Substantial emission reductions are still needed to reach the 2010 targets of the national emissions ceilings directive.

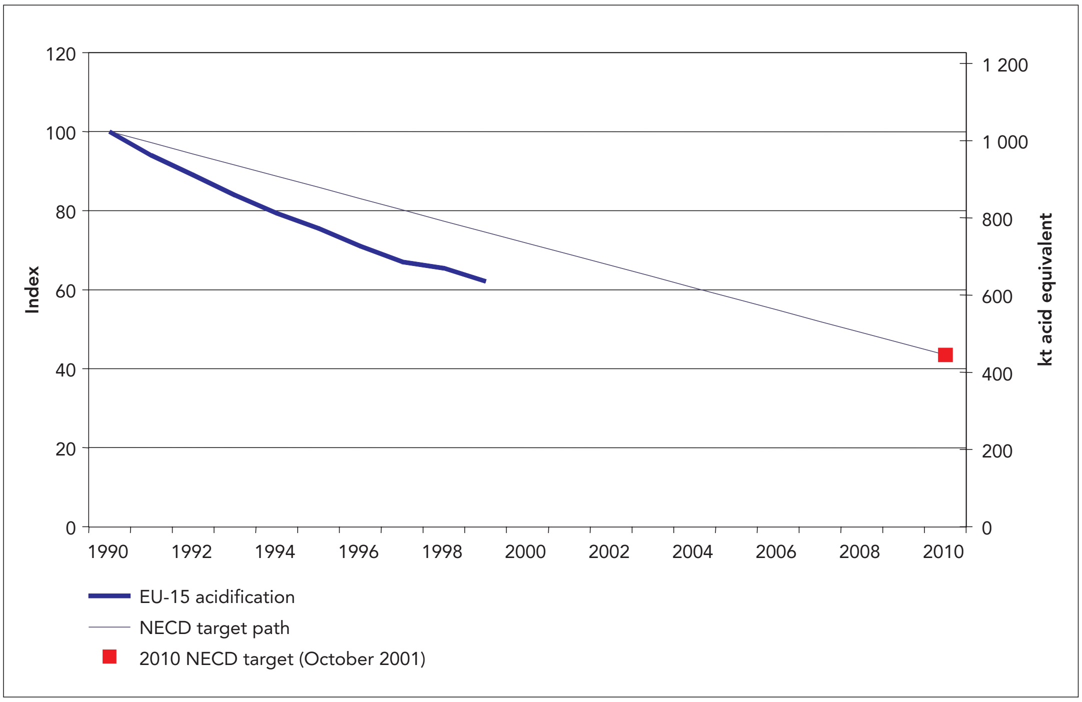
Key messages — Accession countries

☺ The emissions of acidifying substances in accession countries have been reduced by almost 50 % between 1990 and 1999. Most accession countries are close, or have reached, their 2010 overall targets of the CLRTAP Gothenburg Protocol. This is mainly due to a combined effect of implementation of market economy principles, closing inefficient plants which were major sources of emissions, less use of sulphurous fuels and increasing flue gas desulphurisation.

2.1.1. EU-15

Figure 2.1 **EU-15 emission trends of acidifying pollutants and 2010 NECD target (kt acid equivalent)**

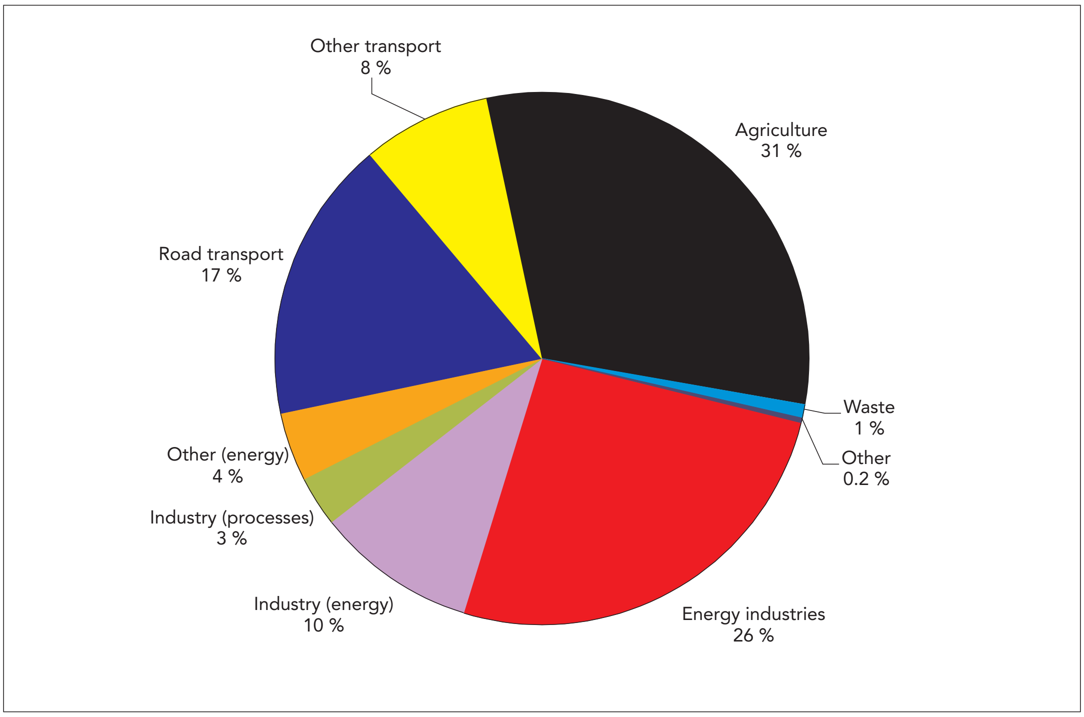
Source: EEA ETC/ACC based on data reported to the UNECE/CLRTAP/EMEP and/or also UNFCCC.



Note: The targets for 2010 are the national emissions ceilings directive agreed targets (October 2001), which specify EU Member States and European Community targets for sulphur dioxide, nitrogen oxide and ammonia individually.
Weighting factors are used to derive acid equivalents so that emissions can be combined in terms of their acidifying effect: sulphur dioxide * $^1/_{32}$, nitrogen oxide * $^1/_{46}$ and ammonia * $^1/_{17}$.
The factors used to aggregate pollutants and present a single figure for a particular issue are currently under development. They represent an over-simplified approach to a very complex process of chemical interactivity. In many cases an average effect has been taken. However, depending on atmospheric conditions and concentration loadings of different pollutants these factors could vary considerably.

Emissions of acidifying gases have decreased significantly in most EU Member States. In the European Union as a whole, emissions decreased by 38 % between 1990 and 1999 despite an increase in GDP. The most significant sources in 1999 included, agriculture (31 %), energy industries (26 %), road transport (17 %) and industry (13 %), and are represented below in Figure 2.2. Figure 2.3 shows EU-15 emissions of acidifying pollutants in 1999 are equally split between ammonia (33 %), sulphur dioxides (33 %) and nitrogen oxides (34 %).

Sector split of EU-15 emissions of acidifying pollutants in 1999 (%) Figure 2.2



Pollutant split of EU-15 emissions of acidifying pollutants in 1999 (%) Figure 2.3

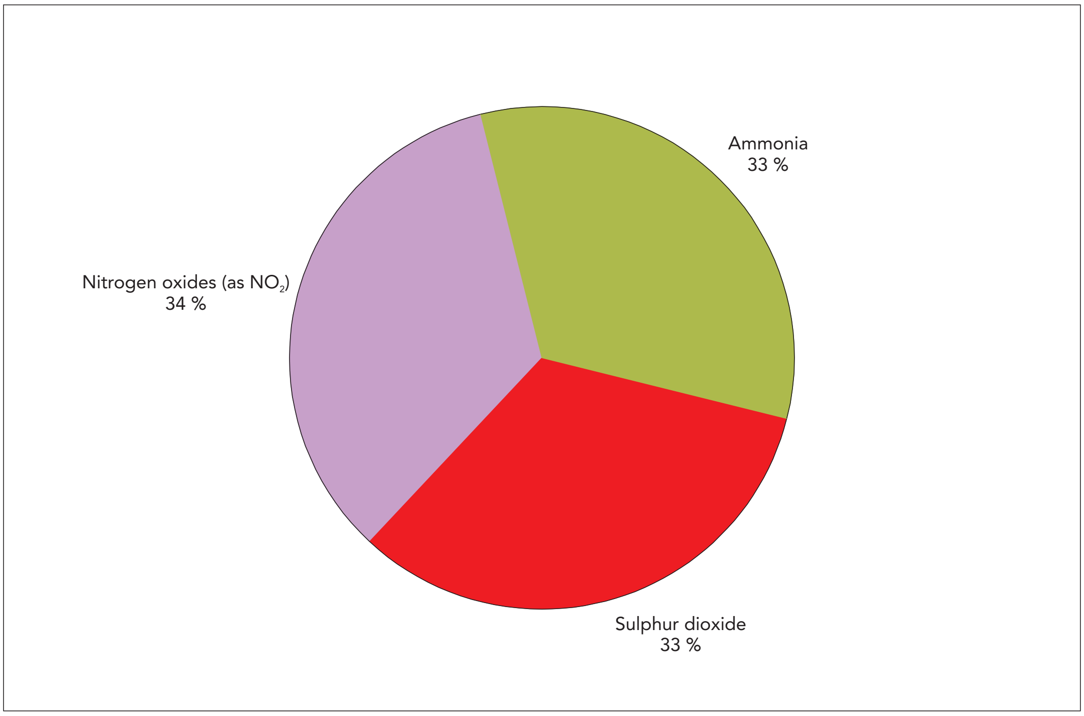
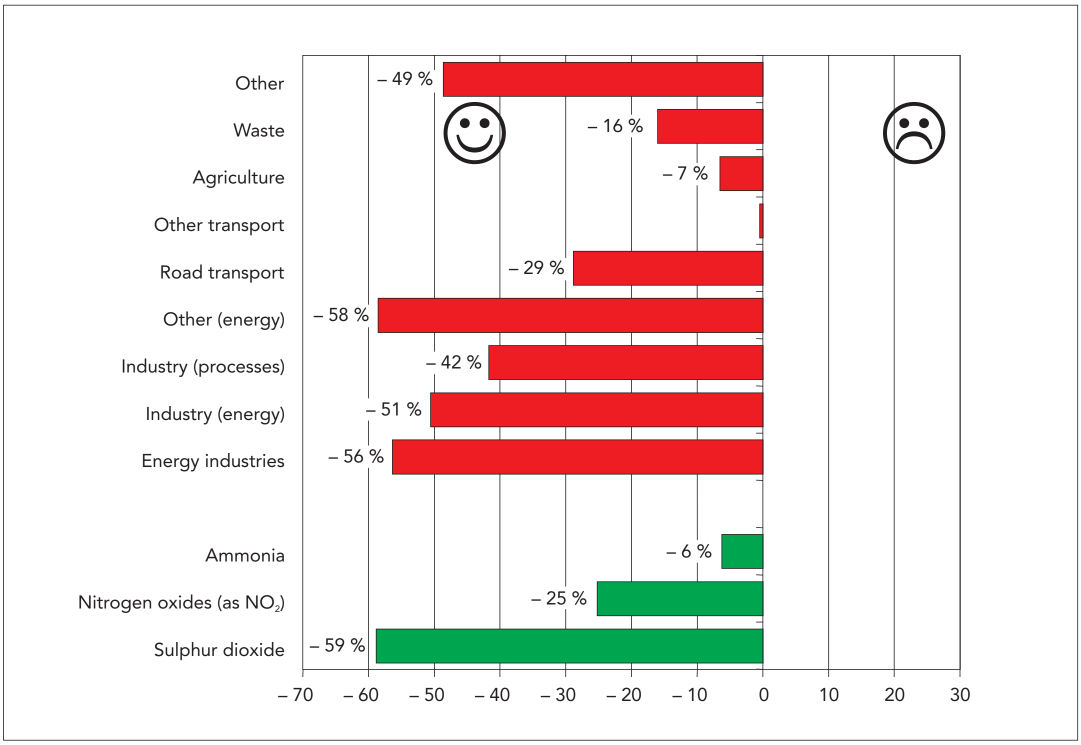


Figure 2.4 **Change in EU-15 emissions of acidifying pollutants for each sector and pollutant 1990–99 (%)**

Source: EEA ETC/ACC based on data reported to the UNECE/CLRTAP/EMEP and/or also UNFCCC.



Note: Emission targets are set through the national emissions ceilings directive — NECD (October 2001). The NECD specifies individual targets for Member States and EU-15 — for SO_2, NO_x, VOC and NH_3 respectively. To combine emissions in terms of their potential acidifying effect the following weighting factors are used (acid eq./g): $SO_2={}^1/_{32}$, $NO_x={}^1/_{46}$ and $NH_3={}^1/_{17}$.

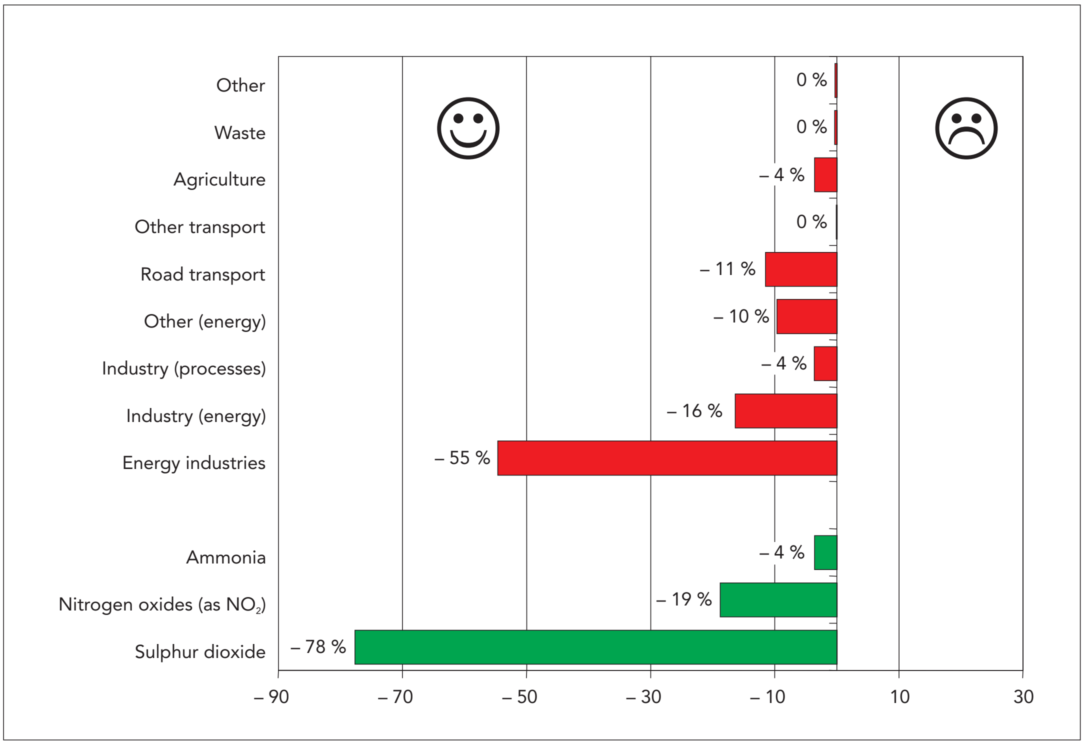
The substantial fall in emissions of acidifying gases is mainly due to a 60 % reduction of sulphur dioxide emissions since 1990. This reduction is predominately produced by switch from high sulphur, solid and liquid fuels to natural gas, in the energy industries, industry and domestic sectors, as well as economic restructuring of the new *Länder* in Germany and the introduction of flue gas desulphurisation in some power plants. Nitrogen oxide reductions due to abatement in road transport and large combustion plant were to some extent off-set by increased emissions from road traffic. Ammonia emissions are stabilising although agriculture emissions, the major source, are very uncertain and difficult to control. The percentage change in sector emissions since 1990 can be seen in Figure 2.4 and the change in national emissions across EU-15 can be seen in Figure 2.6.

The most important contribution to change in acidifying pollutant emissions between 1990–99 for EU-15 is in the energy industries sector (– 55 %). In terms of pollutants, Sulphur Dioxide (– 78 %) is the pollutant which contributed the most to change in acidifying pollutant emissions. Other sector contributions and other pollutant contributions to change in acidifying pollutant emissions between 1990–99 for EU-15 are shown in Figure 2.5.

The EU as a whole has made good progress (38 % reduction) towards the 2010 target. The main contributors are Germany (44 % of the total EU reduction) and the UK (27 % of the total EU reduction). Finland, Denmark and Sweden have also made good progress towards their targets with more than 35 % reduction since 1990. Portugal and Greece are the only Member States that have increased their emissions (8 and 12 % respectively).

Distance-to-target indicators (DTI) (Figure 2.7) show that in 1999, six Member States, and the EU as a whole, were more than 10 index points below their linear path to the NECD target — Denmark, Sweden, Luxembourg, Finland, United Kingdom and Germany. Greece and Spain were slightly higher than their linear path. Only two countries, Portugal and Ireland were more than 10 points higher than the target path.

Contribution to change in acidifying pollutant emissions for each sector 1990–99, EU-15 (%) Figure 2.5



Change in emissions of acidifying substances since 1990 compared with the 2010 NECD targets (%) Figure 2.6

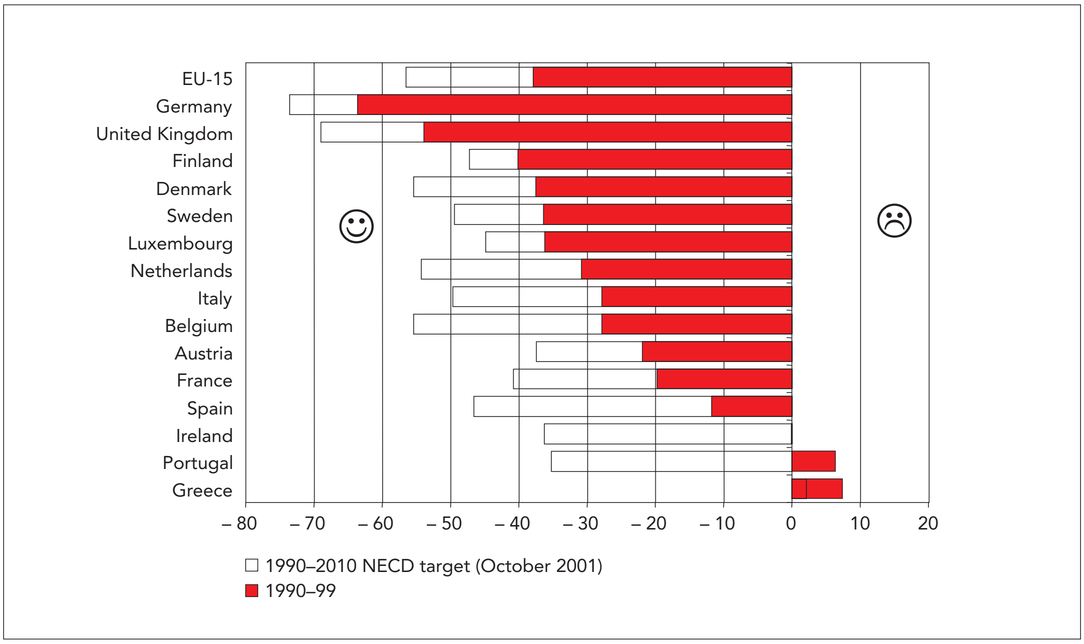
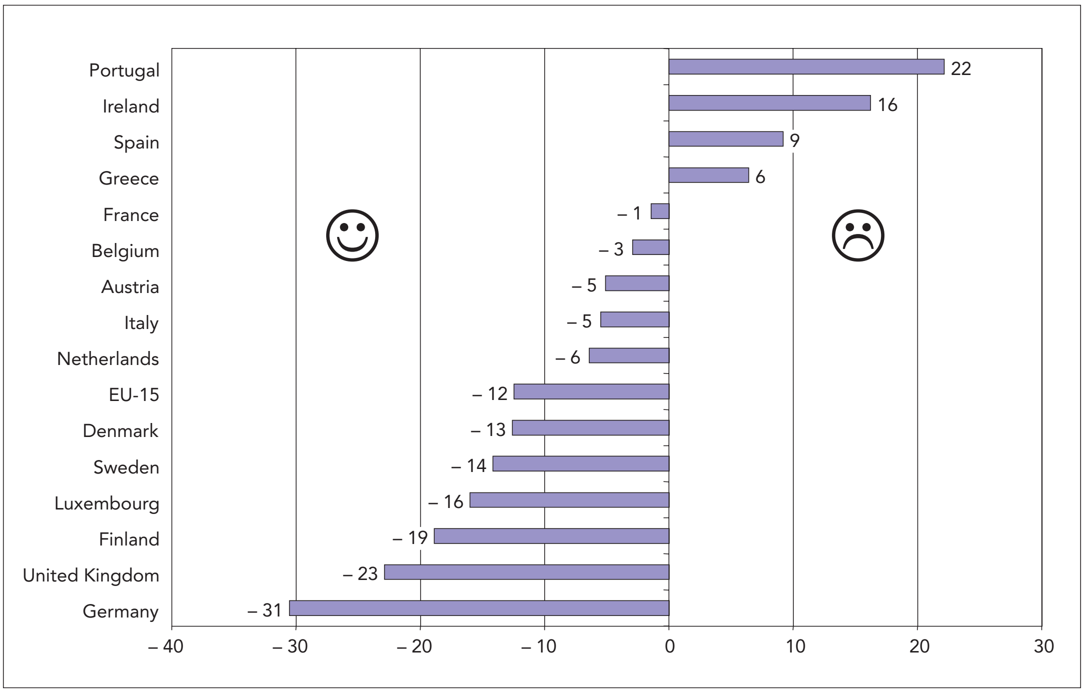


Figure 2.7 **Distance-to-target indicators (in index points) for the NECD targets**

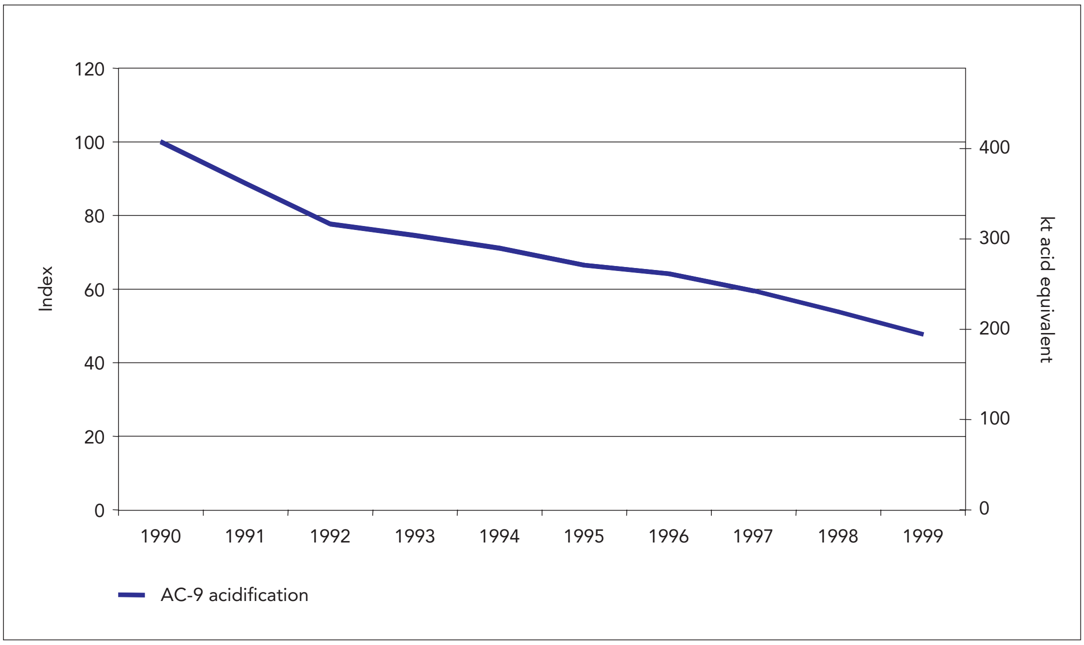
Source: EEA ETC/ACC based on data reported to the UNECE/CLRTAP/EMEP.



Note: Emission targets are set through the national emissions ceilings directive — NECD (October 2001). The NECD specifies individual targets for Member States and EU-15 — for SO_2, NO_x, VOC and NH_3 respectively. The distance-to-target indicator is a measure of how close the current emissions (1999) are to a linear path of emissions reductions from 1990 to the target set in the NECD for 2001.

Figure 2.8 **AC-9 emissions trends of acidifying gases (acid equivalents) (Romania excluded)**

Source: EEA ETC/ACC based on data reported to the UNECE/CLRTAP/EMEP.

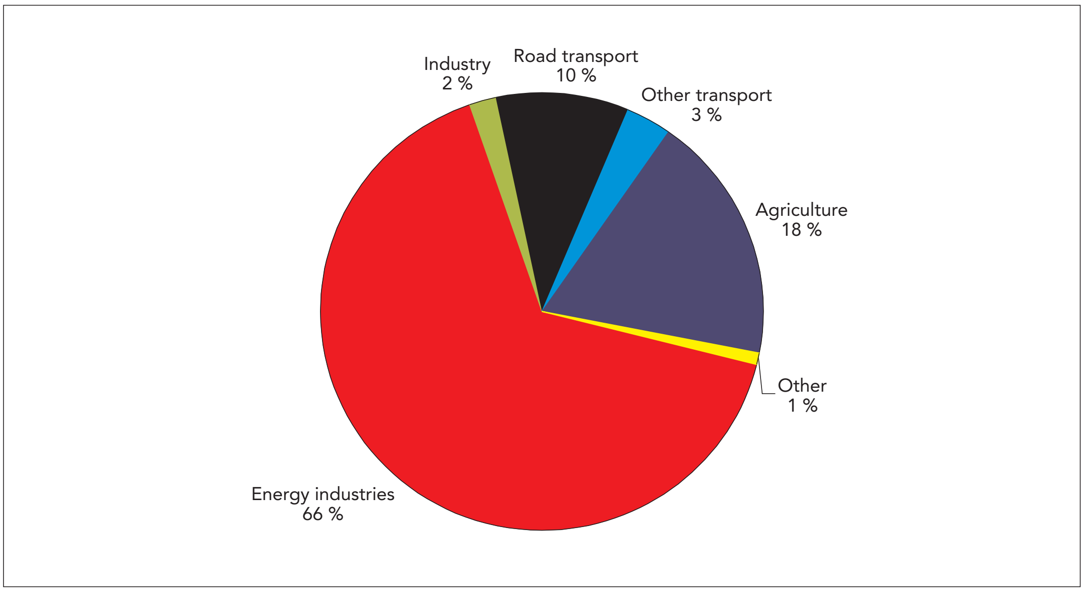


Note: Emission data for Romania were submitted only as national totals and only for years 1990 to 1994 and have not been included in this figure.
The same weighting factors are used as for EU countries. The energy industries sector covers all stationary combustion sources including emissions from combustion in industry.

2.1.2. Accession countries

The main sources of acidifying pollutants in accession countries are the same as those sources in EU Member States; fuel combustion (energy and transport) and agriculture (Figure 2.8). The emissions of acidifying pollutants fell in all 10 accession countries included in this report between 1990–99. Three countries (Bulgaria, Latvia, and Lithuania) have reached the 2010 Gothenburg Protocol target for the pollutants; SO_2, NO_x and NH_3 expressed in acid equivalents in 1999. Hungary, Poland, Slovenia and Slovakia need to implement further reduction measures to achieve these targets. Estonia is not a signatory of the Gothenburg Protocol.

Sector split of AC-9 emissions of acidifying pollutants in 1999 (%) Figure 2.9



Pollutant split of AC-9 emissions of acidifying pollutants in 1999 (%) Figure 2.10

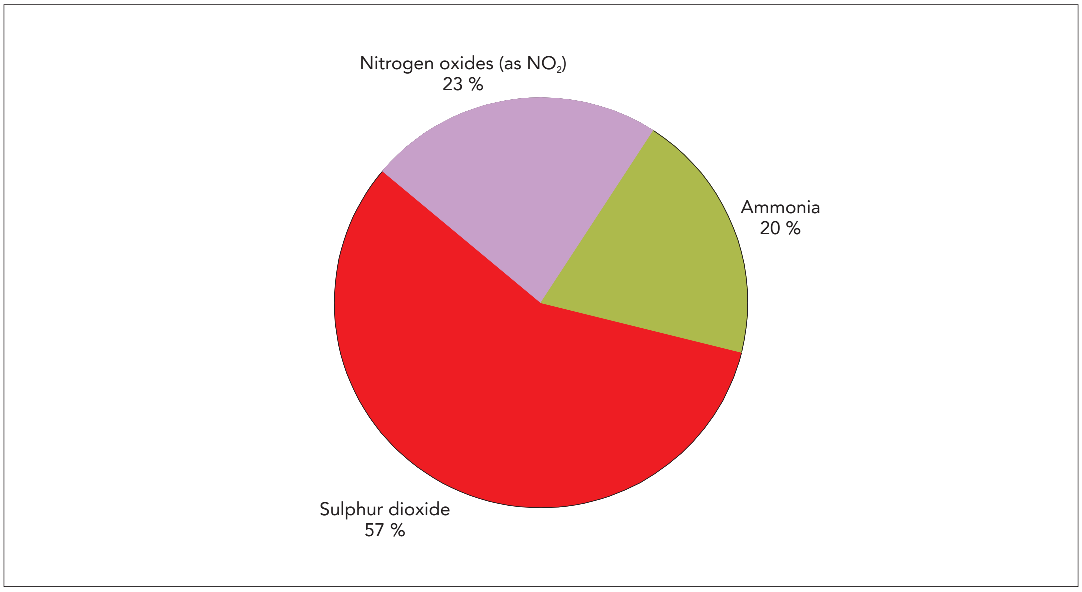


Figure 2.11 **Change in AC-9 emissions of acidifying pollutants for each sector and pollutant 1990–99, (%)**

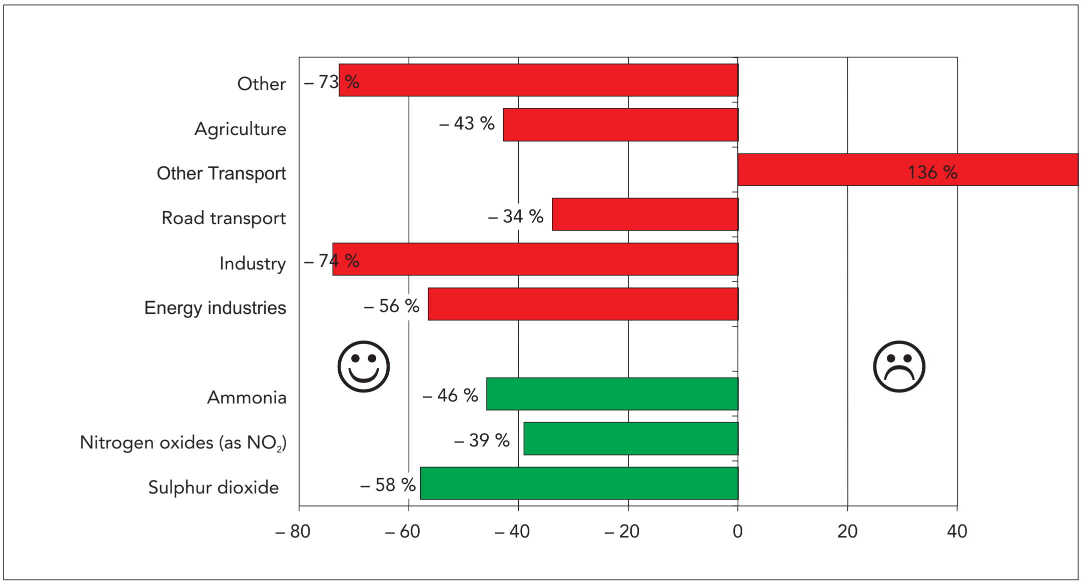
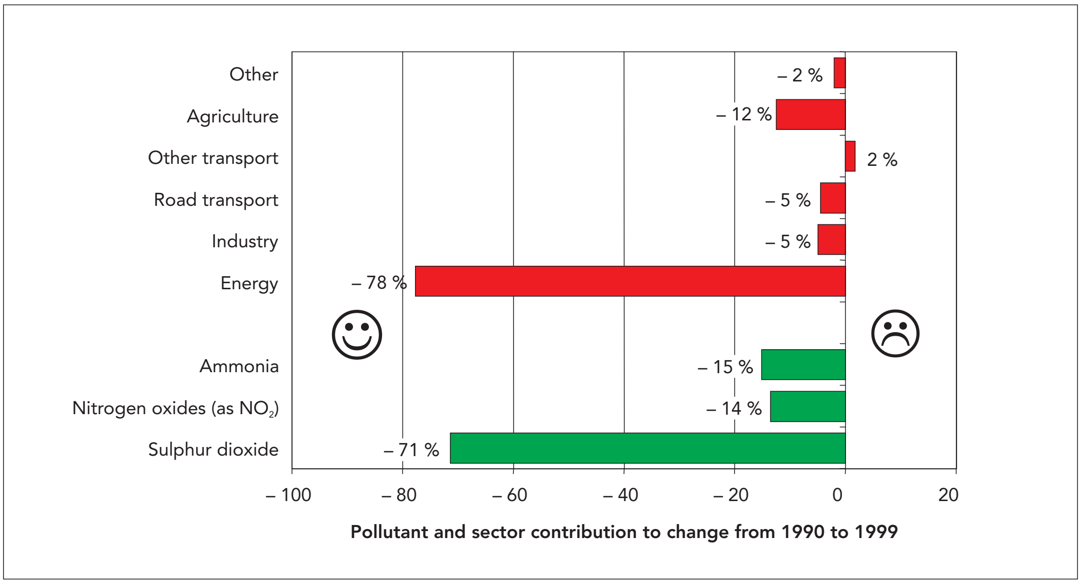


Figure 2.12 **Contribution to change in acidifying pollutant emissions for each sector 1990-99, AC-9 (%)**

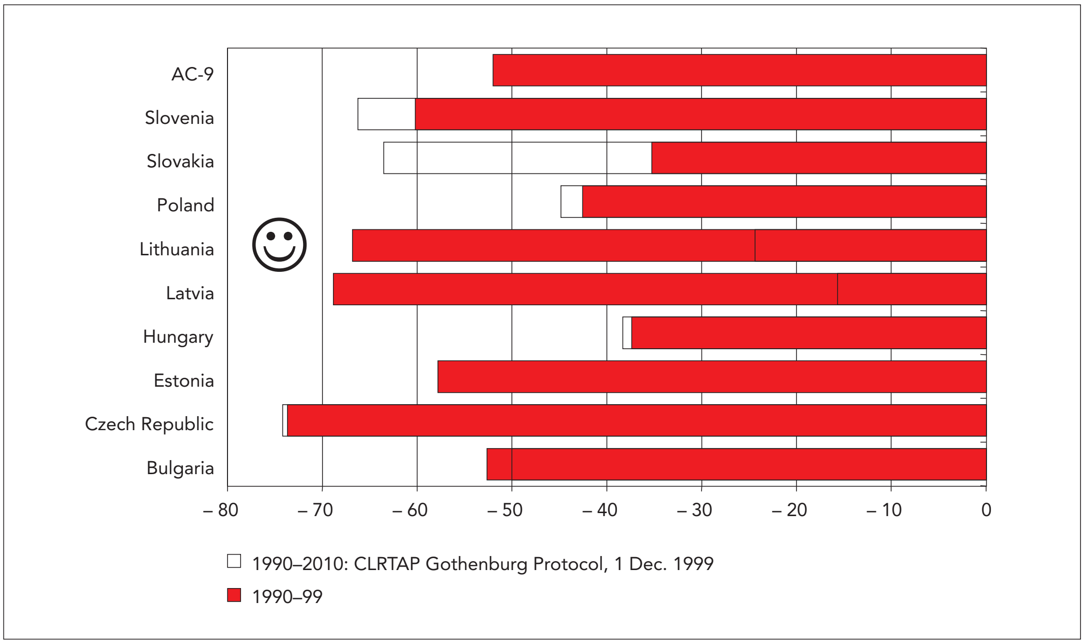


The most important contribution to change in acidifying pollutant emissions between 1990–99 for the accession countries is in the energy sector (– 78 %). In terms of pollutants, sulphur dioxide (– 71 %) is the pollutant which contributed the most to change in acidifying pollutant emissions. Other sector contributions and other pollutant contributions to change in acidifying pollutant emissions between 1990–99 for the accession countries are shown in Figure 2.12.

All accession countries have made good progress (52 % reduction since 1990). Latvia, Lithuania and Bulgaria had decreased emissions of acidifying substances beyond the 2010 targets.

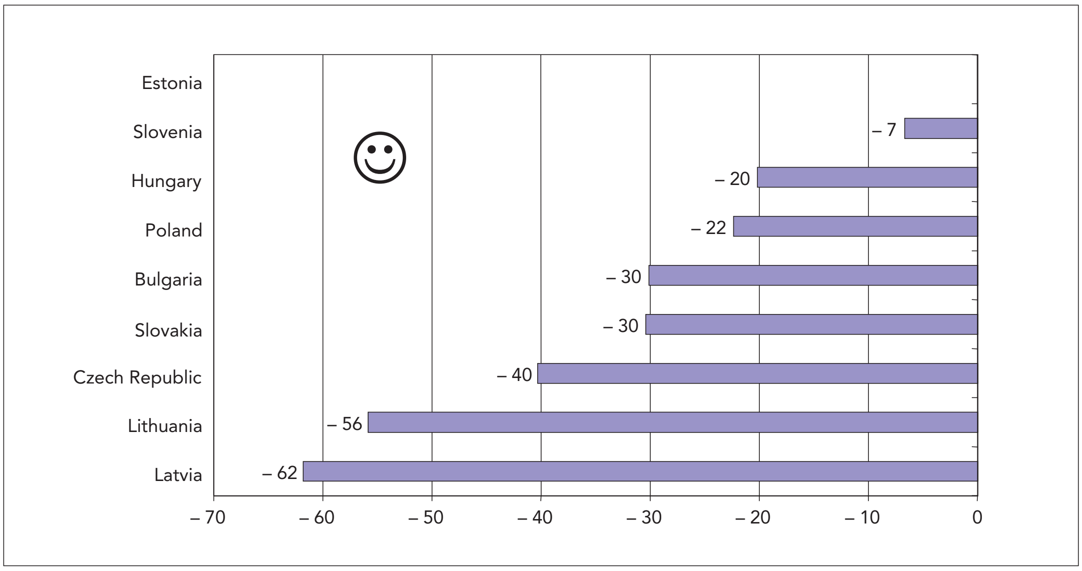
Distance-to-target indicators (DTI) (Figure 2.14) show that in 1999, all accession countries were more than seven index points below their linear path to the Gothenburg Protocol targets.

AC-9 (excluding Romania) percentage change in national emissions of acidifying substances since 1990 compared with the 2010 targets (%) Figure 2.13



Note: The targets for 2010 are Gothenburg Protocol agreed targets (December 1999), which specify country targets for sulphur dioxide, nitrogen oxide and ammonia individually. Estonia is not a signatory of this protocol.

Distance-to-target indicators (in index points) for the 2010 targets Figure 2.14



Note: The 2010 targets — CLRTAP Gothenburg Protocol (1 Dec. 1999). Estonia is not a signatory of the Gothenburg Protocol. The distance-to-target indicator is a measure of the deviation of actual emissions in 1999 from the (hypothetical) linear path to the target set in the Gothenburg Protocol.

2.2. Sulphur dioxide (SO_2)

Key messages — EU-15

☺ The EU-15 emissions of SO_2 have been reduced by nearly 60 % since 1990. This is mainly due to flue gas treatment and use of low-sulphur fuels in power plants.

☺ The EU-15 emissions of SO_2 are significantly below the linear target path towards the 2010 target of the national emissions ceilings directive. This is mainly due to the substantial emission reductions in Germany and the UK.

☺ Most EU Member States have reduced their SO_2 emissions well below their linear target paths and are approaching or have reached the 2010 target of the national emissions ceilings directive.

☹ Greece, Portugal, Ireland need to make significant reductions to reach the 2010 target of the national emissions ceilings directive.

Key messages — Accession countries

☺ The SO_2 emissions in accession countries have been reduced by nearly 60 % since 1990. This is mainly due to significant reduction in the energy sector — implementation market economy principles, closing of inefficient plants, less use of sulphurous fuels and flue gas desulphurisation.

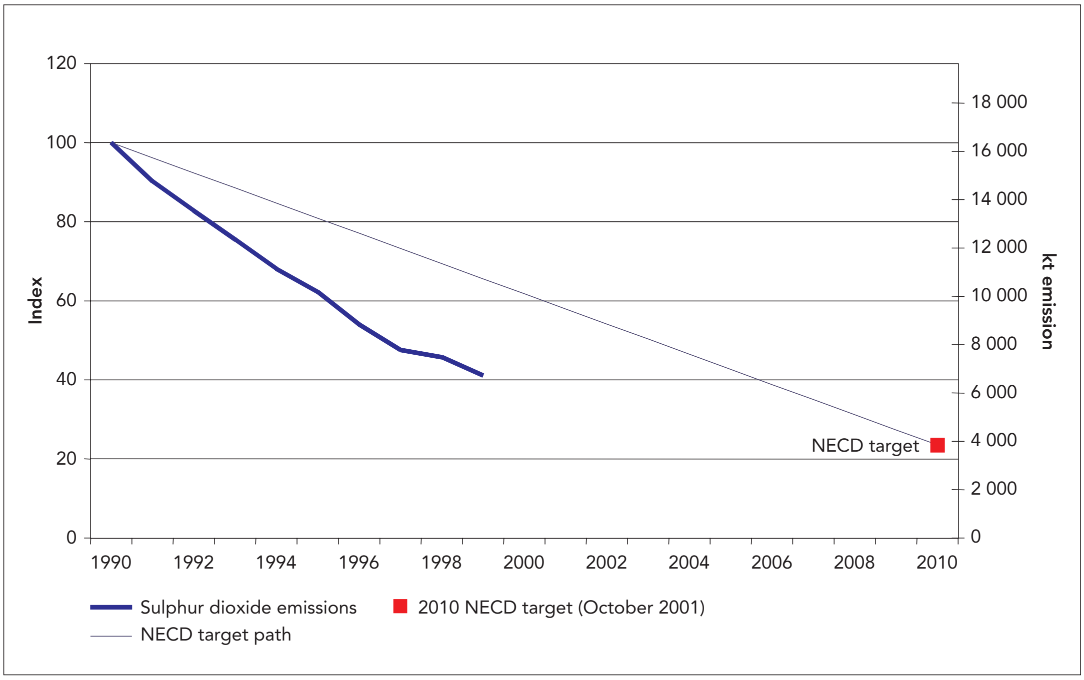
☺ All accession countries have reduced their SO_2 emissions well below their linear target paths and are approaching or have reached the 2010 target of the Gothenburg Protocol.

☺ The Czech Republic, Latvia, Lithuania and Romania have reached their 2010 emission targets of the CLRTAP Gothenburg Protocol. The remaining accession countries are close to their 2010 targets of the CLRTAP Gothenburg Protocol.

2.2.1. EU-15

Figure 2.15 **EU-15 emission trends of SO_2 and 2010 NECD target (kt)**

Source: EEA ETC/ACC based on data reported to the UNECE/CLRTAP/EMEP.

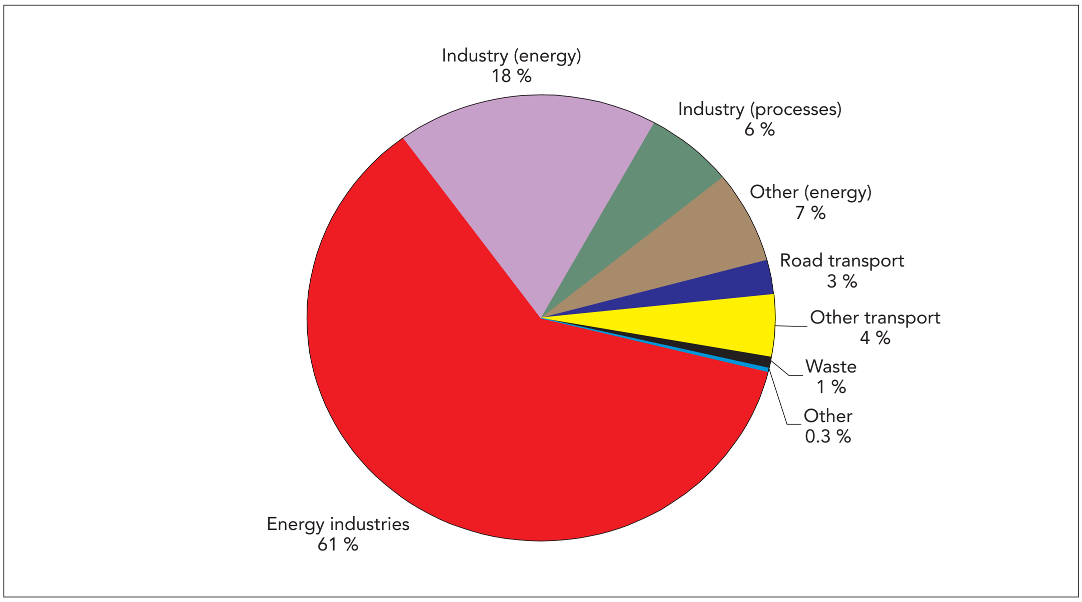


Note: Emission targets are set through the national emissions ceilings directive — NECD (October 2001). The NECD specifies individual targets for Member States and EU-15 — for SO_2, NO_x, VOC and NH_3 respectively.

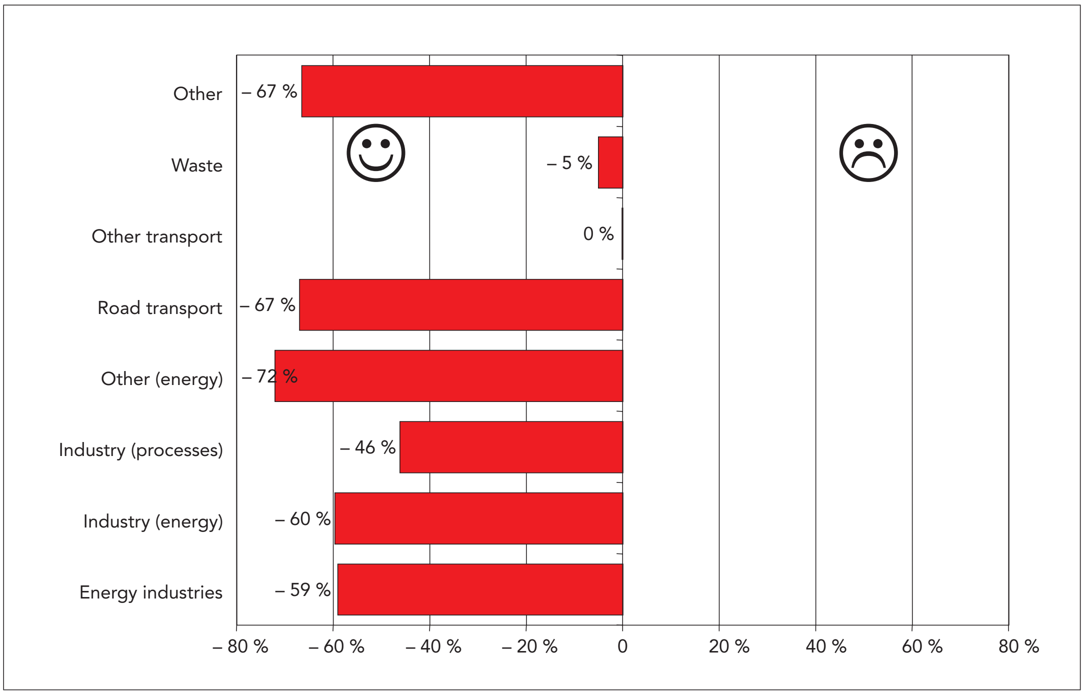
Sulphur dioxide emissions in the EU Member States have reduced by more than 70 % between 1980 and 1999, and by more than 60 % between 1990 and 1999. The target value for the European Union for 2000 of 62 % from 1980 (see Table 1.1) has been achieved. For the EU Member States, the 5 EAP target of 35 % reduction from 1985 levels has also been met — emissions have been reduced by 55 %. This is predominately due to a switch from high sulphur solid and liquid fuels to natural gas, in the energy industries, industry and domestic sectors, as well as construction of new power plant and the use of low sulphur coal and flue gas desulphurisation.

The emission of sulphur dioxide originates mainly from the combustion of sulphur containing fuels. The main sources in 1999 are the energy sector (61 %), industry (24 %), commercial and domestic combustion (7 %) and transport (7 %).

Sector split of EU-15 SO_2 emissions in 1999 (%) Figure 2.16



Change in SO_2 emissions for each sector 1990–99, EU-15 (%) Figure 2.17



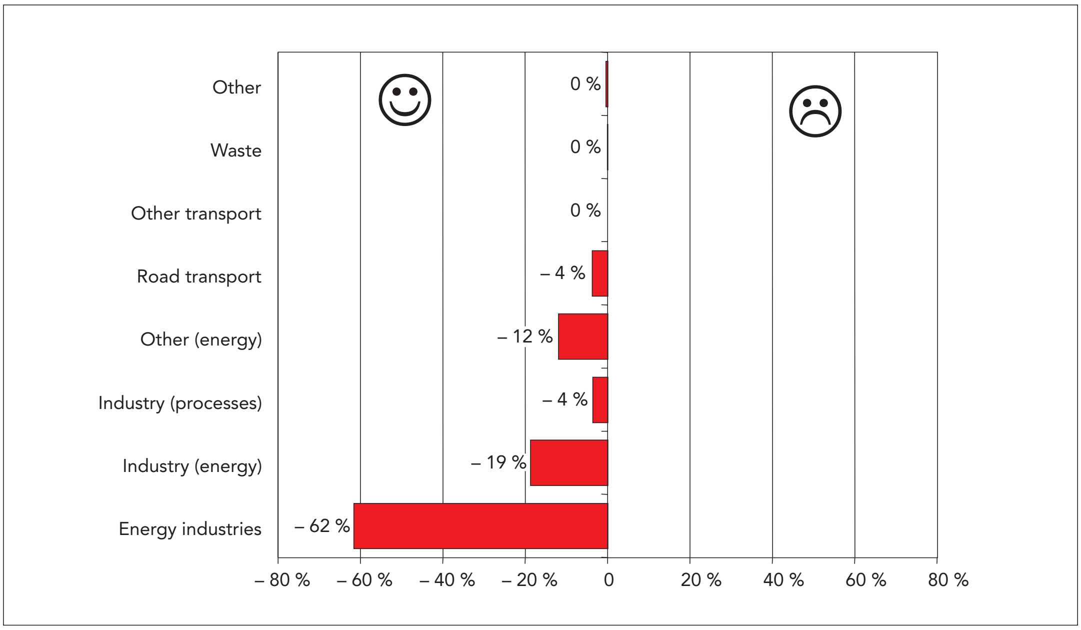
Figures 2.17 and 2.18 show the relative change in emission per sector 1990–99 and the relative contribution to the overall emission change 1990–99 respectively. Figure 2.17 shows that the emissions from many sectors have been reduced by around 60 % and more since 1990. However, the emission changes in energy industries are dominating the contribution to the overall emission reductions (Figure 2.18). This reduction is mainly due to a switch from high sulphur solid and liquid fuels to natural gas, in the energy industries, industry and domestic sectors, as well as economic restructuring of the new *Länder* in Germany and the introduction of flue gas desulphurisation in some power plants.

The percentage change in national sulphur dioxide emissions (1990–99) is compared with the NECD targets (June 2000) to be achieved by 2010, for EU Member States (Figure 2.19).

Figure 2.18

Contribution to change in SO_2 emissions for each sector 1990–99, EU-15 (%)

Source: EEA ETC/ACC based on data reported to the UNECE/CLRTAP/EMEP.

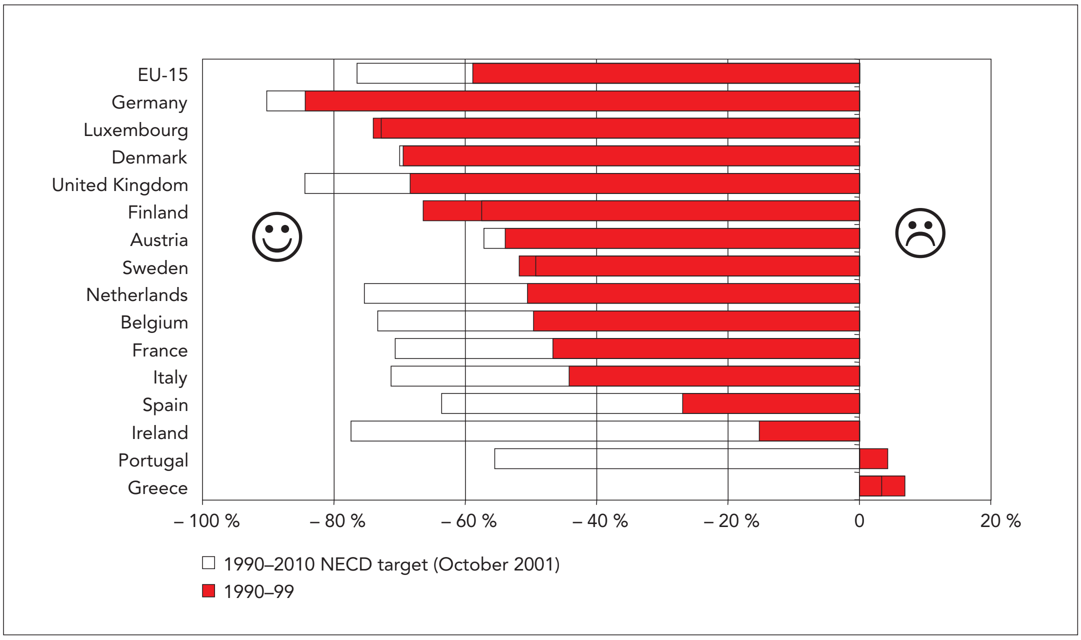


Note: Emission targets are set through the national emissions ceilings directive — NECD (October 2001). The NECD specifies individual targets for Member States and EU-15 — for SO_2, NO_x, VOC and NH_3 respectively.

Figure 2.19

Change in EU Member States national sulphur dioxide emissions since 1990 compared with the 2010 targets NECD targets (%)

Source: EEA ETC/ACC based on data reported to the UNECE/CLRTAP/EMEP and/or also UNFCCC.



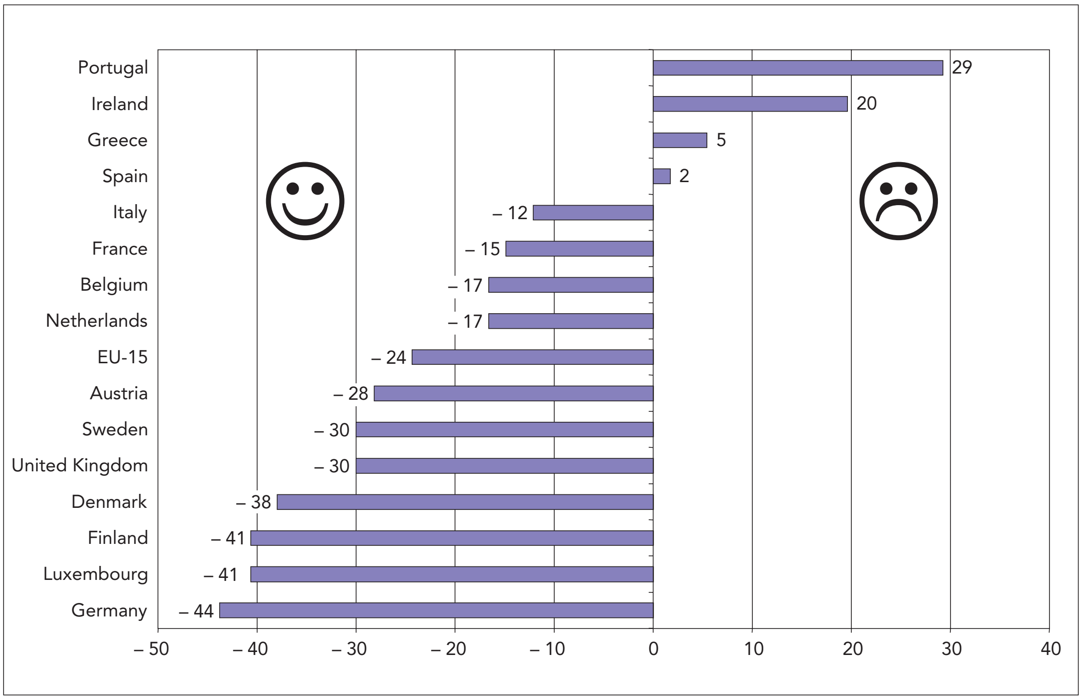
Note: Emission targets are set through the national emissions ceilings directive — NECD (October 2001). The NECD specifies individual targets for Member States and EU-15 — for SO_2, NO_x, VOC and NH_3 respectively. In this graph the targets are expressed as a percentage change based on 1990 emissions.

Most EU Member States have reduced their emissions by more than 50 % and several are approaching their NECD targets for 2010. Germany's emissions did not fall until after unification and the subsequent closure and replacement of inefficient plant and industry in the former East Germany (economic restructuring process).

The distance-to-target indicators (DTI) (Figure 2.20) show that EU-15 and most Member States have made significant progress and are more than half way to the 2010 NECD targets. The EU-15 emissions were more than 20 index points below its linear target path. This is mainly due to the substantial emission reductions in Germany and the UK. Eleven Member States were more than 10 index points below their linear path to the NECD target in 1999, representing substantial progress. Emissions from Portugal, Ireland and Greece were substantially higher than the target path and these Member States need to make significant reductions to reach the 2010 target of the national emissions ceilings directive.

Figure 2.21 presents national per capita and per GDP emissions of sulphur dioxide. The differences between countries reflect differences in fuel mix used. The emissions are low in the Netherlands (high share of sulphur free natural gas), Austria and Sweden (high share of hydropower). Greece, Ireland, Portugal and Spain show relatively high emissions of sulphur dioxide, both per capita and per GDP, although in most cases a downward trend is observed between 1990 and 1999. For most Member States both emissions per GDP and emissions per capita have decreased significantly since 1990, the main exceptions are Greece and Portugal. The high emissions for Greece are due to a high share lignite used in power/heat production.

Distance-to-target indicators (in index points) for the 2010 NECD targets Figure 2.20

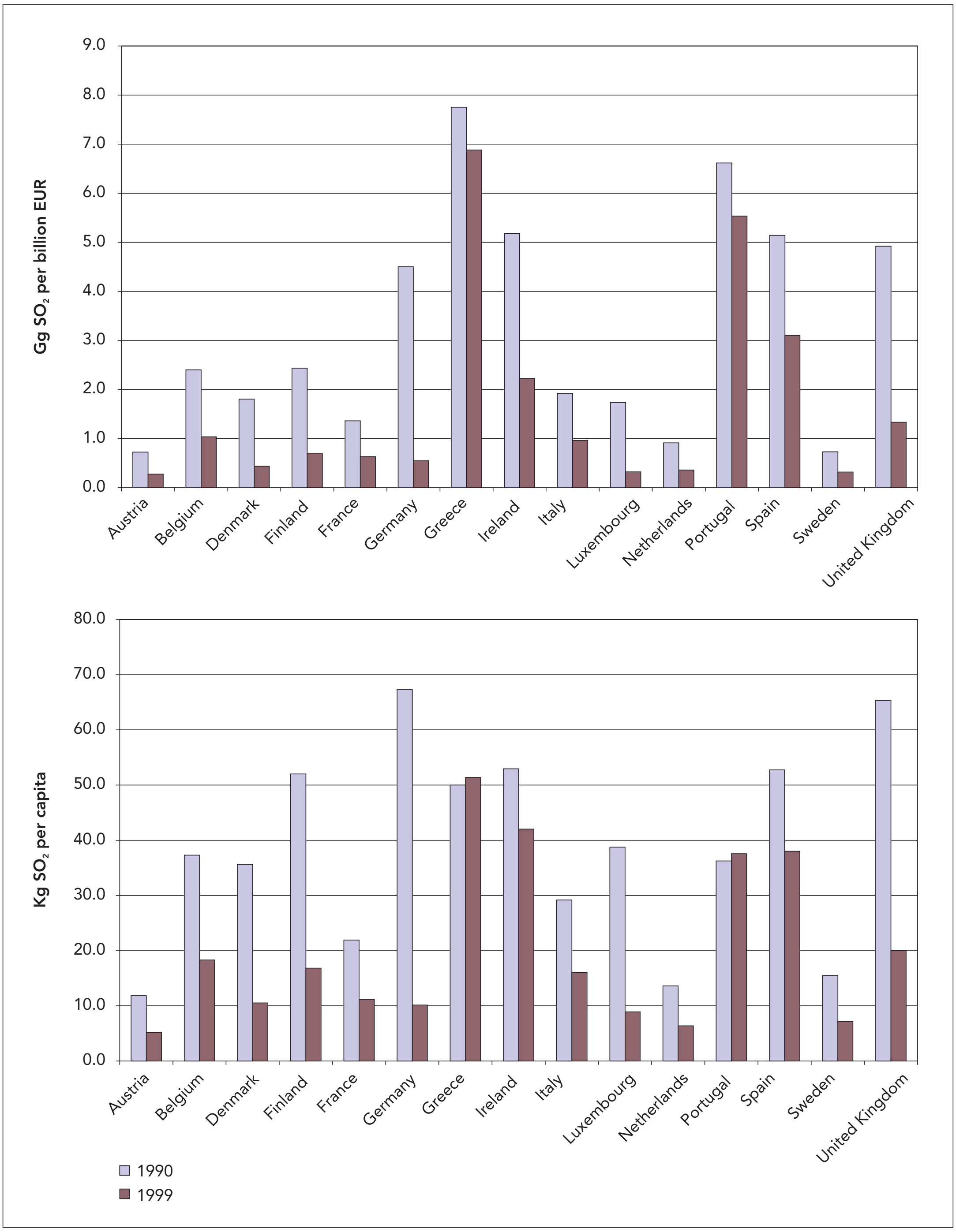


Note:the distance-to-target indicator is a measure of the deviation of actual emissions in 1999 from the (hypothetical) linear path to the target set in the NECD.

Other EEA-18 countries:
Norway shows a 46 % decrease in emissions of SO_2 between 1990 and 1999. A further reduction of 23 % is needed for Norway to meet its 2010 Gothenburg Protocol emission targets of 22 000 tonnes. Liechtenstein has reduced emissions by 10 % between 1990 and 1999. However targets for 2010 are less strict and will allow an increase of 34 % on 1999 emission levels to 110 tonnes.

Figure 2.21 **Per GDP (Gg/billion EUR) and per capita (kg/capita) emissions of sulphur dioxide in EU Member States**

Source: GDP and population: Eurostat.



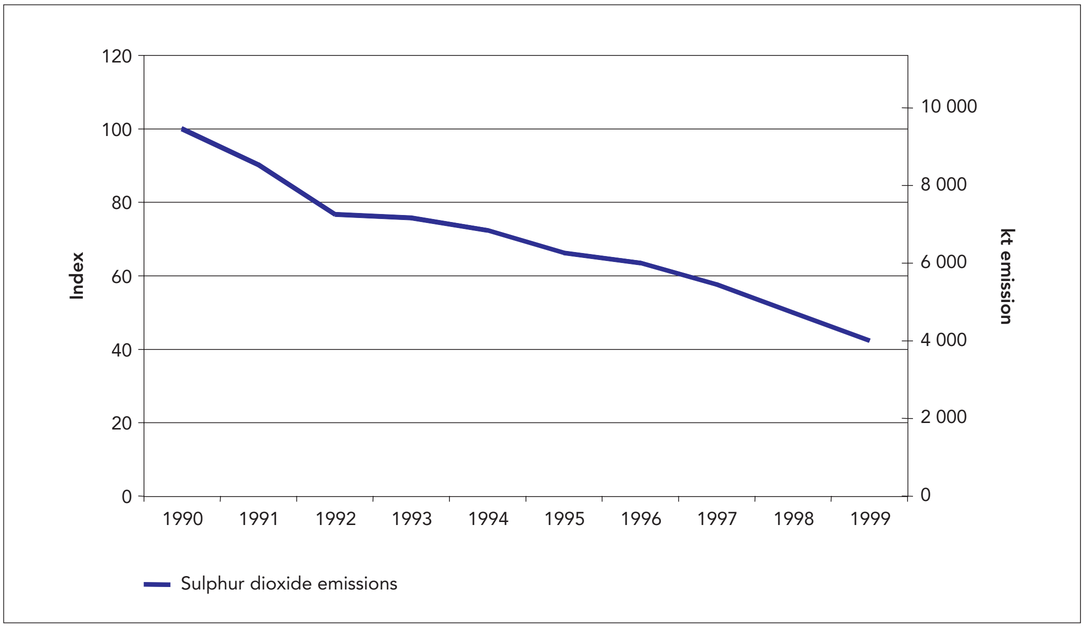
2.2.2. Accession countries

SO_2 emissions have been significantly reduced in all accession countries by between 42 % and 86 %, due to a combination of factors including the economic restructuring process, a general switch from high sulphur content coal to gas and the installation of new desulphurisation units at power plants (Figure 2.22).

The emission of sulphur dioxide originates mainly from the combustion of sulphur containing fuels. The contribution of other sectors is negligible (Figure 2.23).

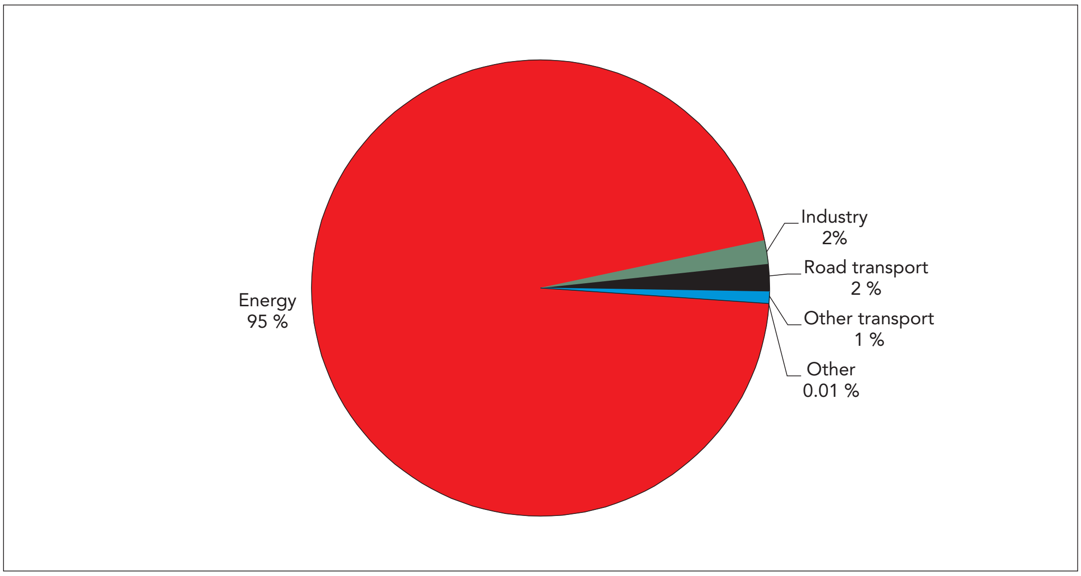
Figure 2.24 shows the change in SO_2 emissions for each sector 1990–99. Changes are generally large however with different importance for the total emissions (Figure 2.25).The most important contribution to change in SO_2 emissions between 1990–99 for the accession countries is in the energy sector (– 94 %). Other sector contributions to change in SO_2 emissions are negligible (Figure 2.25).

AC-9 emission trends of SO_2 (Romania excluded) Figure 2.22



Source: EEA ETC/ACC based on data reported to the UNECE/CLRTAP/EMEP and/or also UNFCCC.

Sector split of AC-9 SO_2 emissions in 1999 (%) Figure 2.23



SO_2 sector % change from 1990 to 1999 in AC-9 Figure 2.24

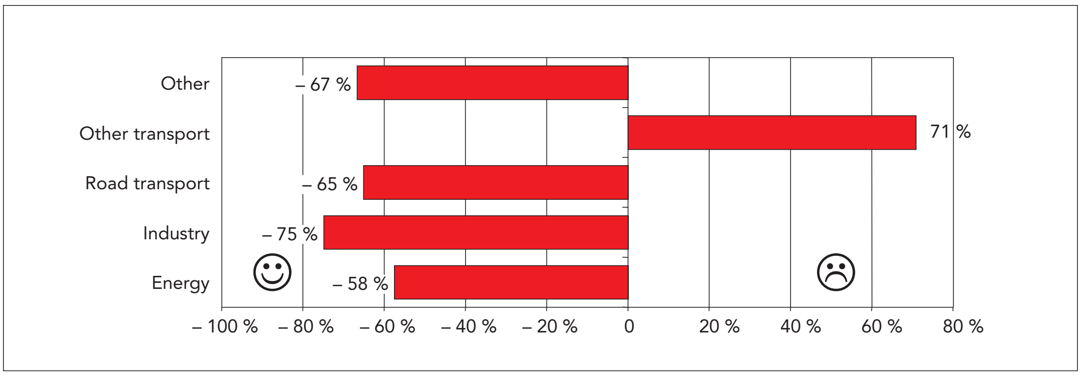


Figure 2.25 **Contribution to change in total SO_2 emissions by each sector 1990–99, AC-9 (%)**

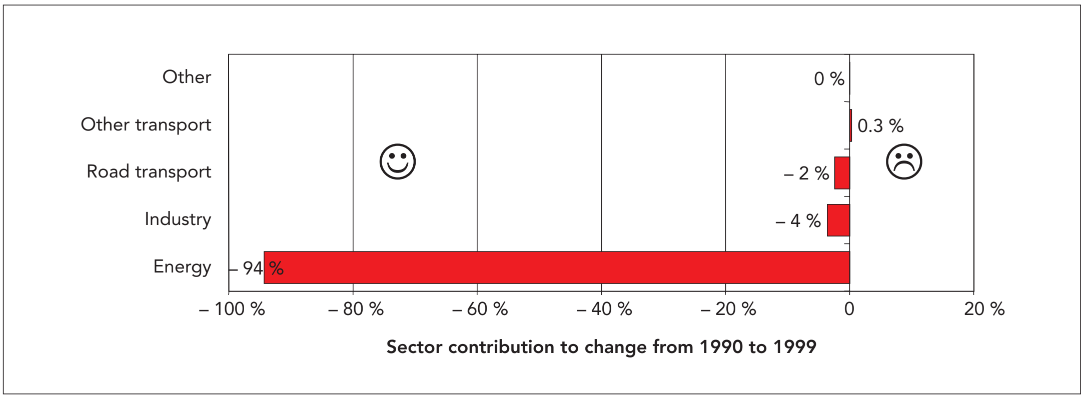


Figure 2.26 **Change in accession country sulphur dioxide emissions 1990–99 compared with the 2010 CLRTAP targets (%)**

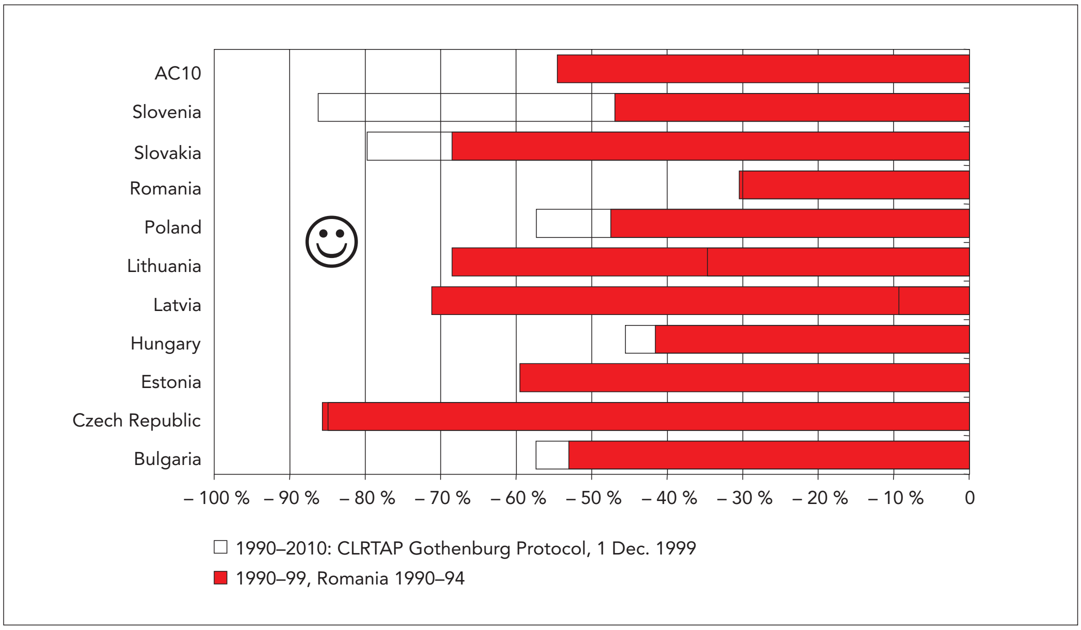
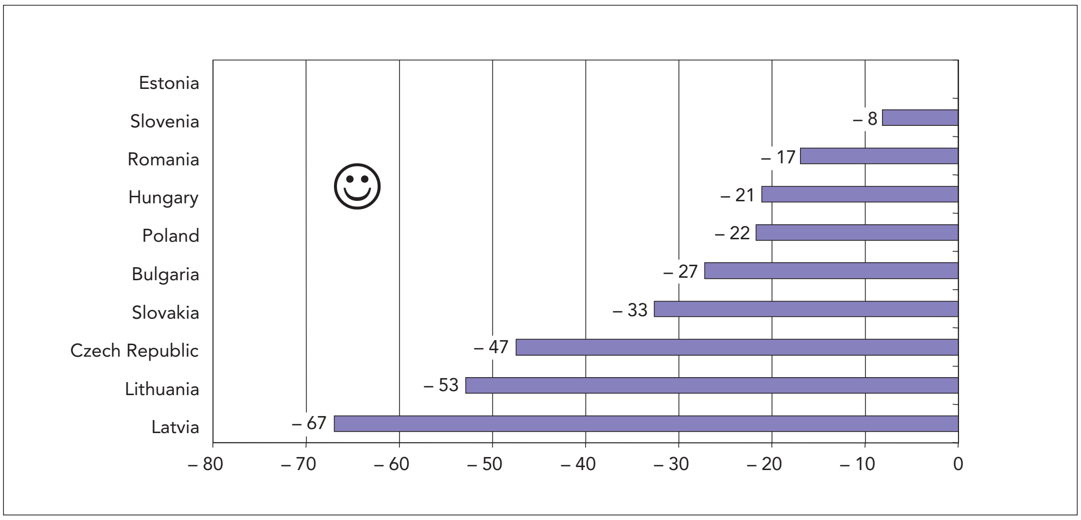


Figure 2.27 **Distance-to-target indicators (in index points) for the 2010 targets**



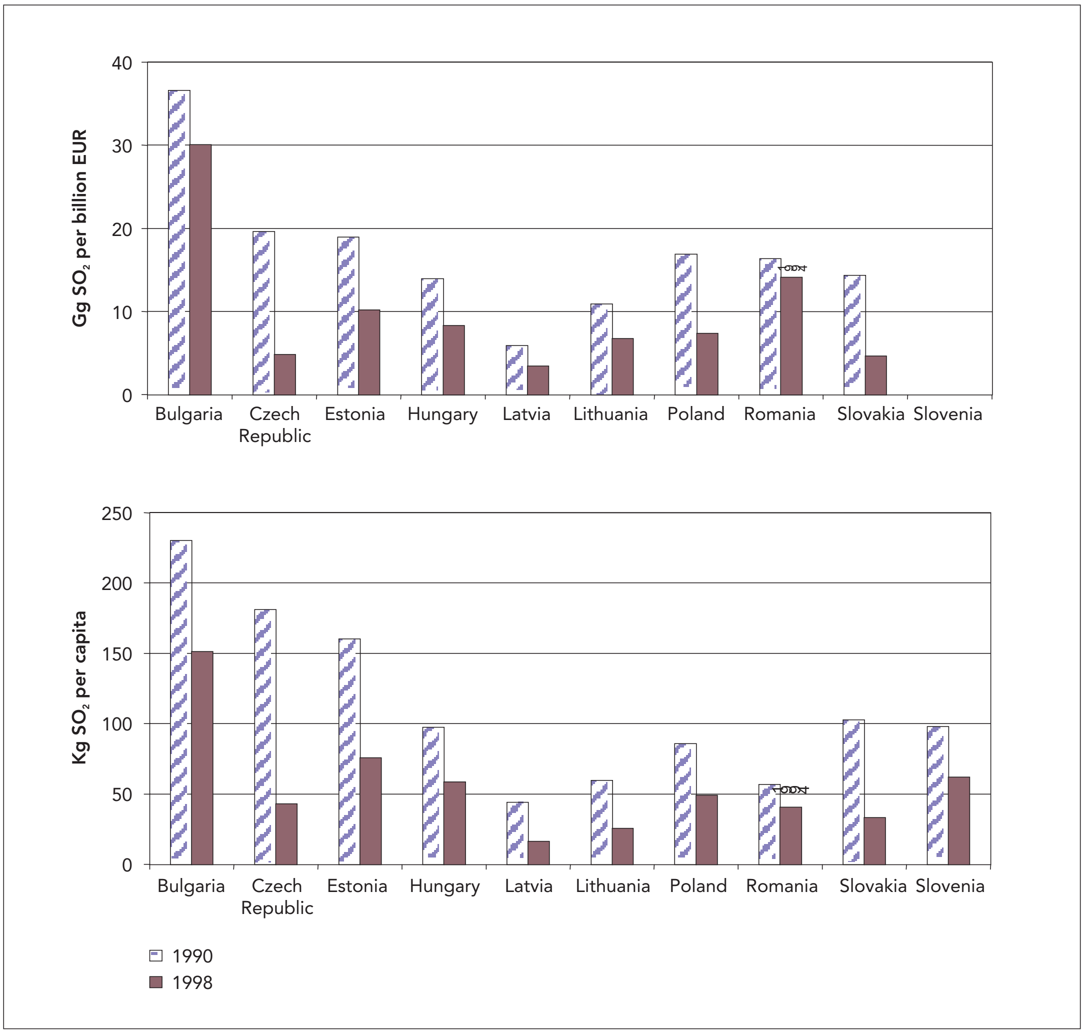
Note: Emission targets for sulphur dioxide are set through the CLRTAP Gothenburg Protocol (1 Dec. 1999). Estonia is not a signatory of the Gothenburg Protocol. The targets are expressed as a percentage change based on 1990 emissions. The distance-to-target indicator is a measure of the deviation of actual emissions in 1999 (Romania 1994) from the (hypothetical) linear path to the target set in the Gothenburg Protocol.

The percentage change since 1990 is compared with the 2010 CLRTAP targets of the Gothenburg Protocol, which are also expressed as a percentage change of the 1990 emission. It is clear that some countries, notably the Baltic States and the Czech Republic are well on course or have reduced emissions more than required. Equally, Slovakia, Slovenia, Poland, Hungary and Bulgaria need further reductions to meet their sulphur dioxide targets (Figure 2.26).

Figure 2.26 and distance-to-target indicators (DTI) (Figure 2.27) show that the accession countries have made significant progress and are more than half way to the 2010 targets. All countries were below their linear path to the 2010 target in 1999.

The per capita and per GDP emissions of sulphur dioxide (Figure 2.28) show considerable variation amongst the countries and are higher than in the EU region. The apparently highest per capita emissions were in Bulgaria. In the period between 1990 and 1999 the emissions of SO_2 were decreasing in the whole region on a per GDP basis as well as on per capita basis.

Per GDP (Gg/billion USD) and per capita (kg/capita) emissions of sulphur dioxide of the accession countries Figure 2.28



Note: GDP (1990 billion USD using PPPs) and population data source IEA Statistics. GDP data for Slovenia were not available.

2.3. Nitrogen oxides (NO_x)

Key messages — EU-15

☺ The EU-15 NO_x emissions have been reduced by 25 % since 1990. This is mainly due to the introduction of catalytic converters for cars and from fuel switching and plant improvement in the energy industries.

☺ The NO_x emissions of EU-15 are slightly below the linear target path towards the 2010 target of the national emissions ceilings directive. This is mainly due to the substantial emission reductions in Germany and the UK.

☹ Nine Member States have emissions above their linear target paths towards the 2010 target of the national emissions ceilings directive. Four Member States (Portugal, Ireland, Spain and Greece) have emissions substantially above their linear target paths.

☹ Substantial emission reductions are required in most EU Member States to reach the 2010 targets of the national emissions ceilings directive.

Key messages — Accession countries

☺ The NO_x emissions of the accession countries have been reduced by 20 % since 1990. This is mainly due to the decrease in energy production, fuel switching in the energy sector and introduction of catalytic converters for cars.

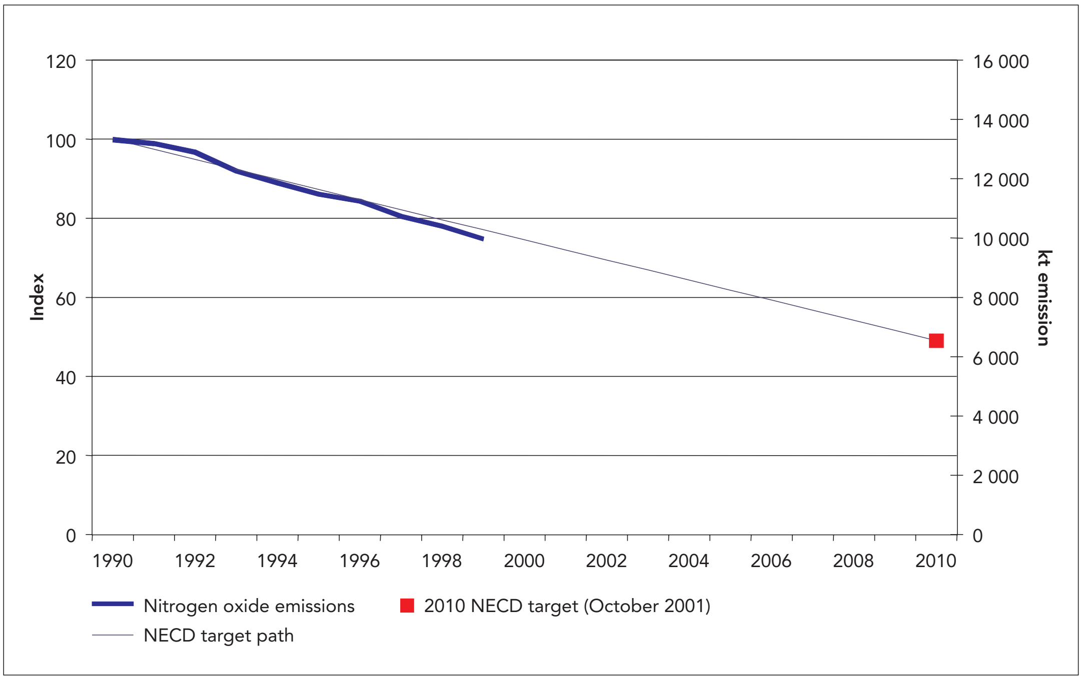
☺ Slovakia, Romania, Lithuania, Latvia and Bulgaria have reached their 2010 emission targets of the CLRTAP Gothenburg Protocol. Most remaining accession countries are close to their 2010 targets of the CLRTAP Gothenburg Protocol.

☹ Substantial emission reductions are required for Slovenia and Hungary to reach the 2010 targets of the CLRTAP Gothenburg Protocol.

2.3.1. EU-15

Figure 2.29 **EU-15 emissions of NO_x compared to the 2010 NECD target (Kt)**

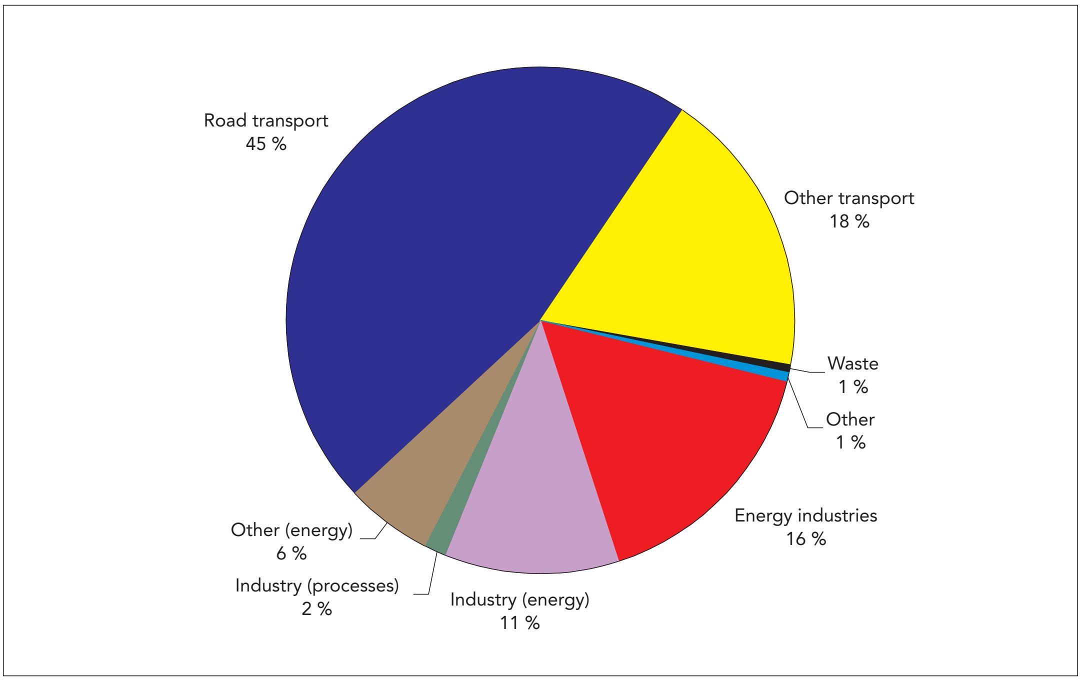
Source: EEA ETC/ACC based on data reported to the UNECE/CLRTAP/ EMEP.



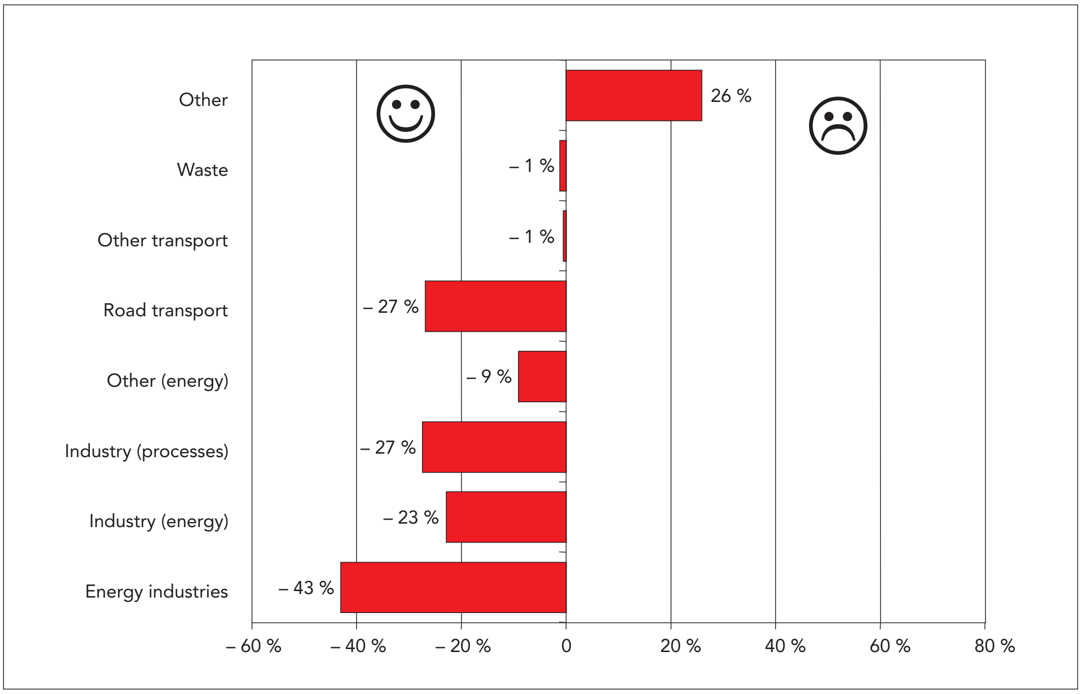
Note: Emission targets are set through the national emissions ceilings directive — NECD (October 2001). The NECD specifies individual targets for Member States and EU-15 — for SO_2, NO_x, VOC and NH_3 respectively.

Emissions of nitrogen oxides increased steadily during the second half of the 1980s due to increasing road traffic. Since 1990 NO_x emissions have decreased by 25 % in EU Member States, mainly due to the introduction of catalysts on new cars in western Europe and improved abatement and the introduction of combined cycle gas turbine (CCGT) power generation in the energy and industry sectors. Increasing road travel has partly offset reductions achieved by emission abatement. The main sources of NO_x in 1999 were transport (64 %), energy industries (16 %) and industry (13 %) (see Figure 2.20).

Sector split of EU-15 NO_x emissions in 1999 (%) Figure 2.30



Change in NO_x emissions for each sector 1990–99, EU-15 (%) Figure 2.31



Since 1990 the emissions from road transport have been reduced by 27 % and emissions from the energy sector by 43 % (Figure 2.31). The emission reduction is mainly due to the introduction of catalysts on new cars in western Europe and improved abatement and the introduction of combined cycle gas turbine (CCGT) power generation in the energy and industry sectors. Increasing road travel has, however, partly offset reductions achieved by emission abatement.

Road transport and energy industries sector the are the most important contributors to the reduction of NO_x emissions in EU between 1990–99 (– 51 % and – 36 % respectively) (Figure 2.32).

Figure 2.32 **Contribution to change in total NO_x emissions by sector 1990–99, EU-15 (%)**

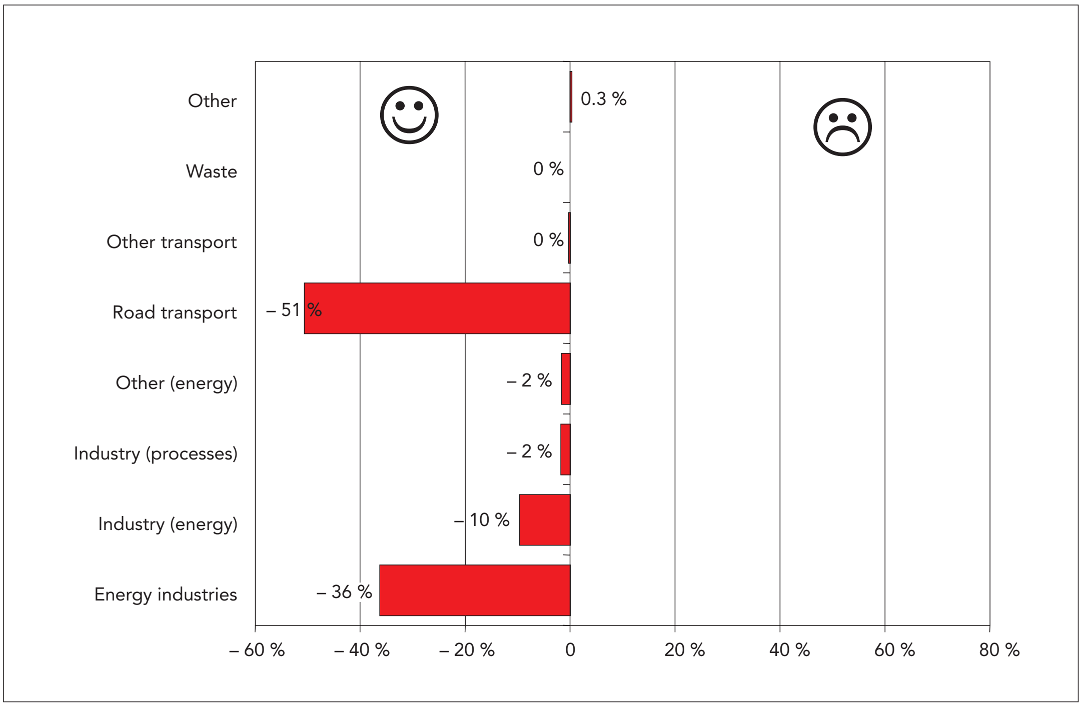
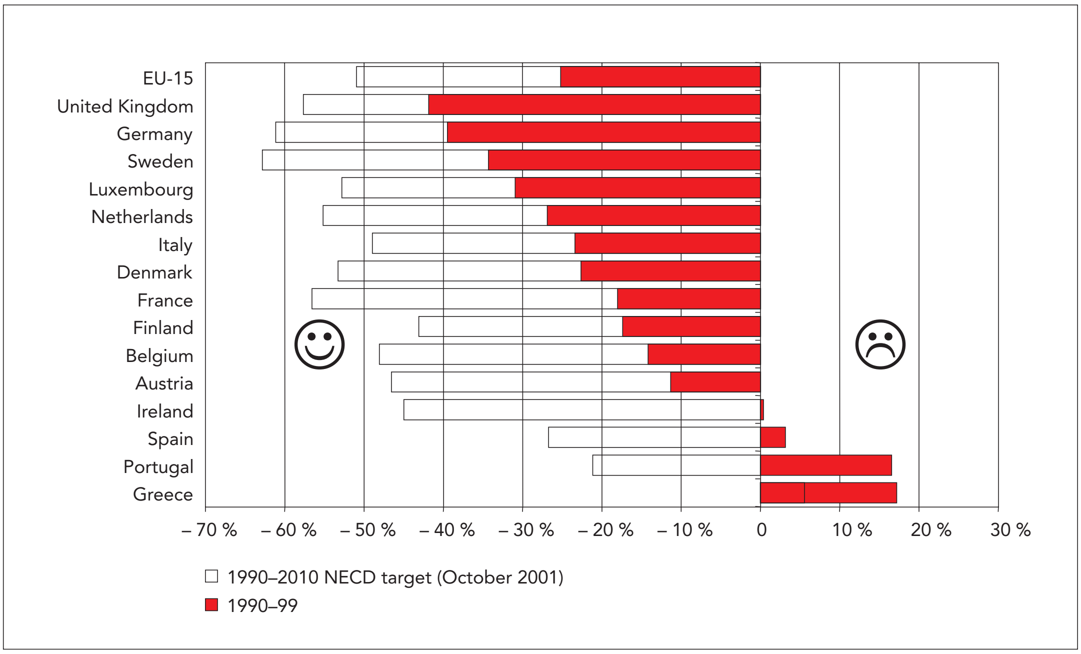


Figure 2.33 **Change in national NO_x emissions since 1990 compared with the 2010 NECD targets (%)**



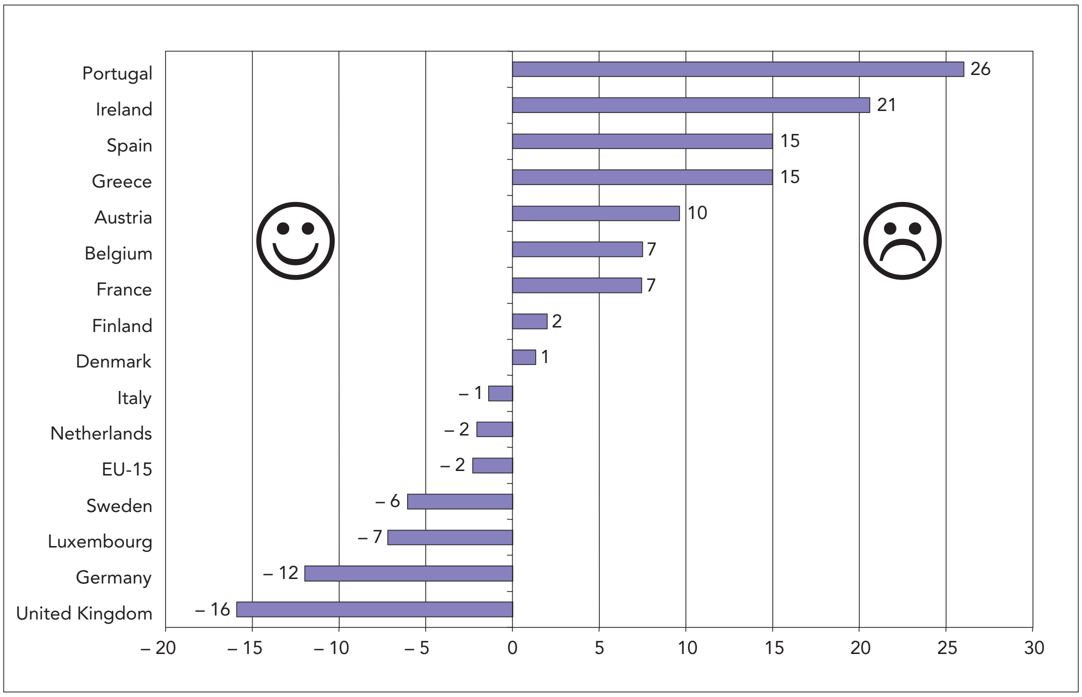
Note: 2010 NECD targets (October 2001), for each Member State expressed as a percentage change of the 1990 emissions.

The first CLRTAP NO_x protocol (Sofia, 1988) which requires the stabilisation of emissions at the 1987 levels by 1994 was achieved by the European Union. However not all EU Member States individually reached this target (some even showed an increase). Meeting the 2010 targets of the NECD and the Gothenburg Protocol will require substantial further emission reductions.

In Figure 2.33, the percentage change in national NO_x emissions (1990–99) is compared with the NECD targets (October 2001) to be achieved by 2010, for EU Member States.

Eleven Member States have reduced emissions below their 1987 levels and the CLRTAP target of stabilisation has been

Distance-to-target indicators (in index points) for the NECD targets Figure 2.34



Note: The distance-to-target indicator is a measure of the deviation of actual emissions in 1999 from the (hypothetical) linear path to the target set in the NECD.

Other EEA-18 countries:
Norway shows a 5 % increase in emissions of NO_x between 1990 and 1999. A further reduction of 32 % is needed for Norway to meet its 2010 Gothenburg Protocol emission targets of 156 000 tonnes. Liechtenstein has reduced emissions by 18 % between 1990 and 1999. A further 23 % reduction is necessary for Liechtenstein to meet its Gothenburg Protocol targets of 370 tonnes in 2010.

achieved for the European Union as a whole. Reaching the Gothenburg and common position targets for 2010 will require substantial further emissions reductions.

Emission reduction for NO_x is generally more difficult than for sulphur dioxide where a relatively small number of well-known large sources (power plants and some industries) are responsible for the majority of emissions. Switching to natural gas from oil only provides small NO_x emission reductions. The low NO_x burners fitted to many large power plants are not as effective in reducing emissions as FGD is for sulphur dioxide. Furthermore, the large and increasing number of motor vehicles is difficult to control. Increased use of public transport, which is more emission and energy efficient, would help to reduce NO_x emissions in the future.

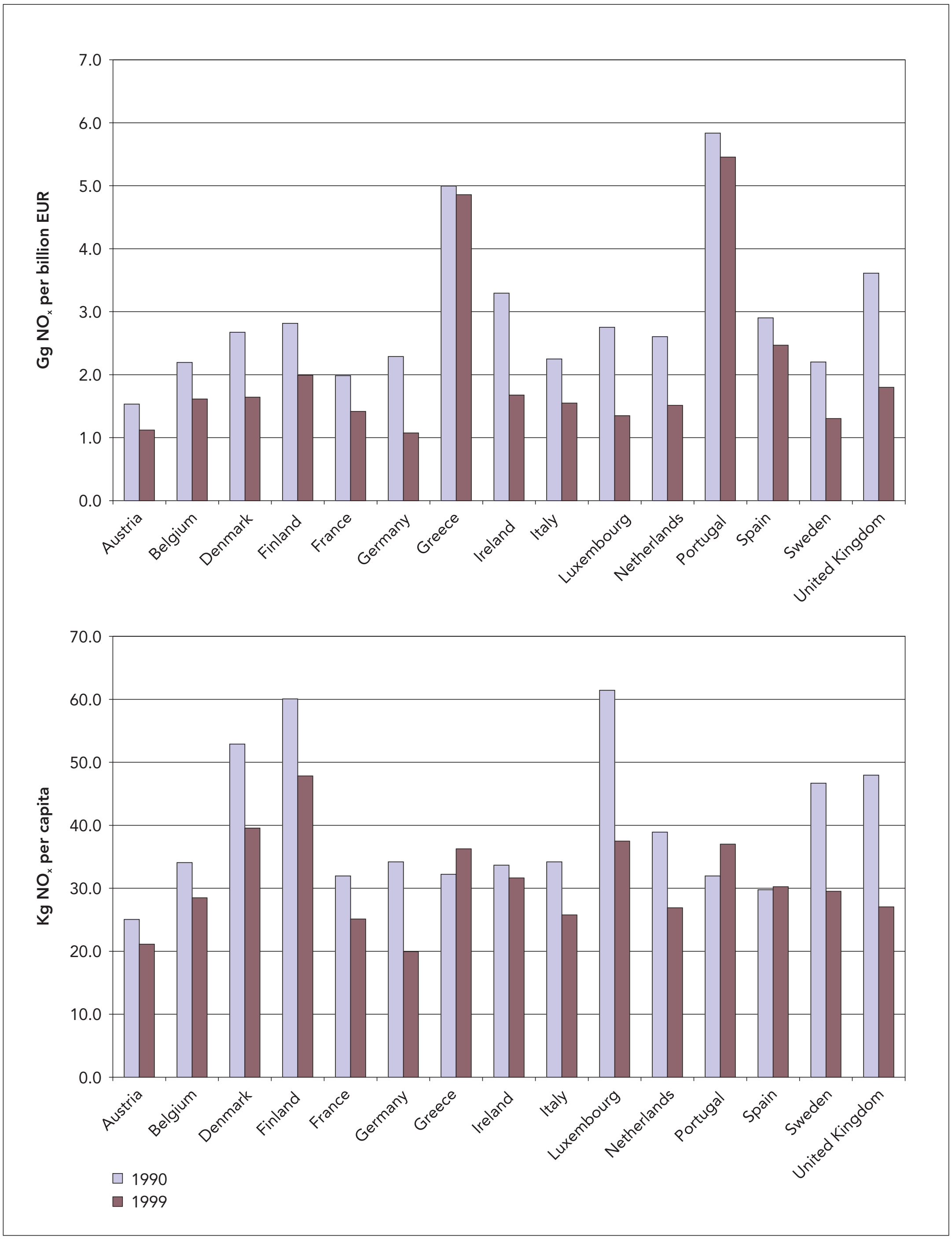
Distance-to-target indicators (DTI) show that six Member States were below their NO_x emission target path in 1999 (Figure 2.34). However, in 1999, four Member States were more than 10 index points above their target path. Only two Member States, Germany and the UK, were more than 10 index points below their linear path to the NECD target and five were more than 10 points above. In total, there were nine Member States who were above their linear target path. The European Union as a whole was 2 index points below the target path because of the importance of emissions in Germany and the UK.

The per capita and per GDP national emissions of NO_x, as shown in Figure 2.35, vary over a factor of 2 to 3 between the EU Member States.

Contrary to the case of sulphur dioxide, the NO_x emissions per capita and per GDP for the Netherlands, Austria and Sweden are comparable to other EU Member States. This confirms the observation that the relatively low sulphur dioxide emission for these countries are largely due to the particular fuel mix. The per capita emissions in Denmark and Finland were high relative to countries like Belgium, Ireland, Italy, the Netherlands and the United Kingdom. This difference is not observed for the per GDP emissions in these countries, due to their relatively high GDP per capita. Generally, both per capita and per GDP emissions are

Figure 2.35 **Per GDP (top; Gg/billion EUR) and per capita (bottom; kg/capita) emissions of NO_x in EU Member States**

Source: GDP and population: Eurostat.



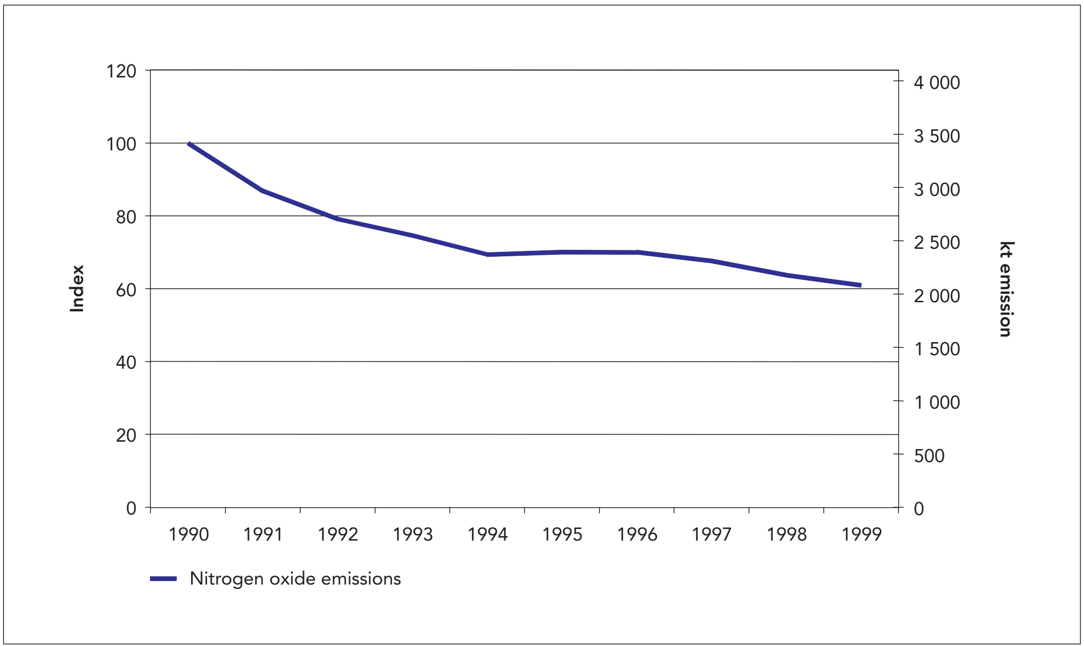
decreasing, the exception is Portugal where the per capita emissions increased.

2.3.2. Accession countries

Since 1990 NO_x emissions in accession countries have been reduced by 39 % (Figure 2.36). NO_x emissions in 1999 were dominated by energy industries and road transport — 49 % and 37 % of total emissions respectively (Figure 2.37).

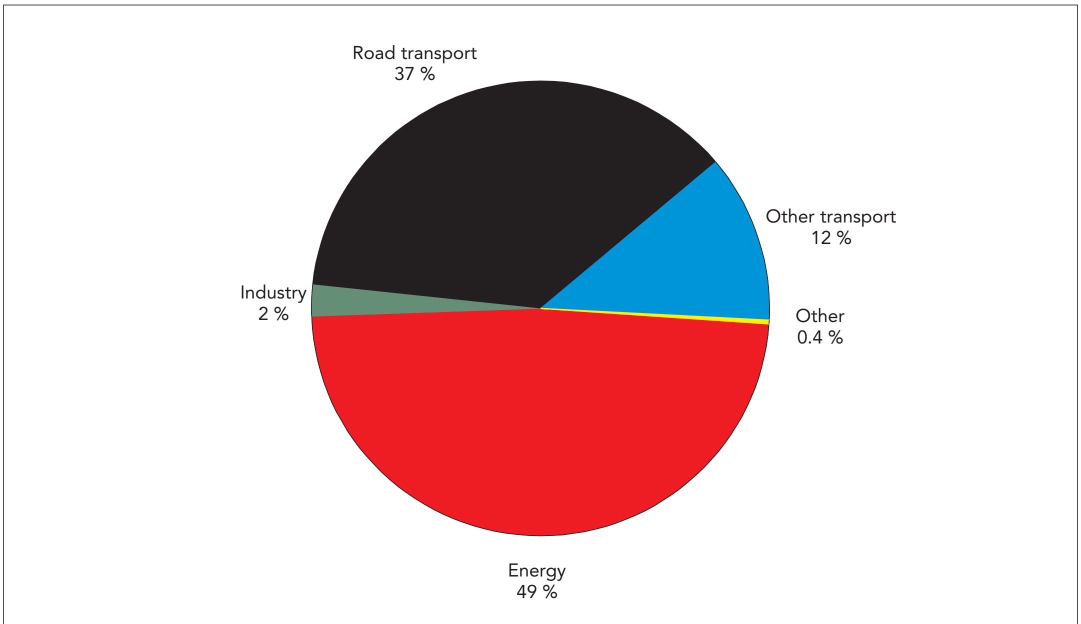
Most main sectors reduced NO_x emission substantially between 1990 and 1999 (Figure 2.38). The most important contributions to change in NO_x emissions between 1990–99 come from energy (– 77 %) and road transport (– 21 %) (Figure 2.39).

AC-9 NO_x emissions (Romania excluded) Figure 2.36



Source: EEA ETC/ACC based on data reported to the UNECE/CLRTAP/EMEP.

Sector split of AC-9 NO_x emissions in 1999 (%) Figure 2.37



Change in NO_x emissions for each sector 1990–99 in AC-9 (%) Figure 2.38

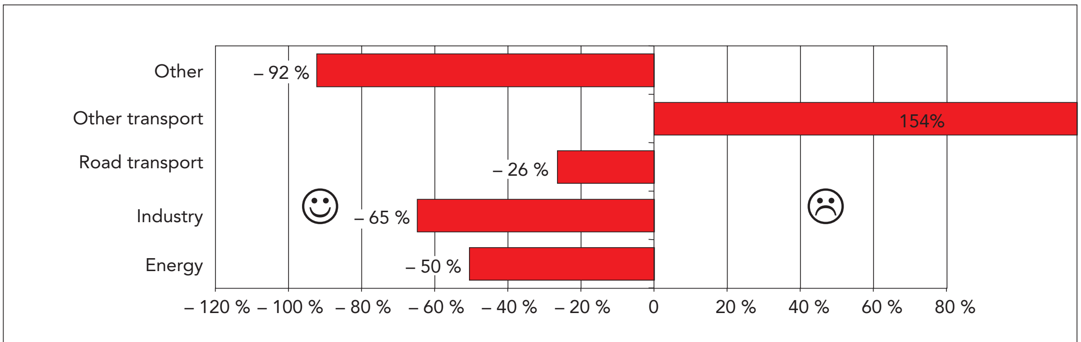


Figure 2.39 Contribution to change in NO_x emissions for each sector 1990–99, AC-9 (%)

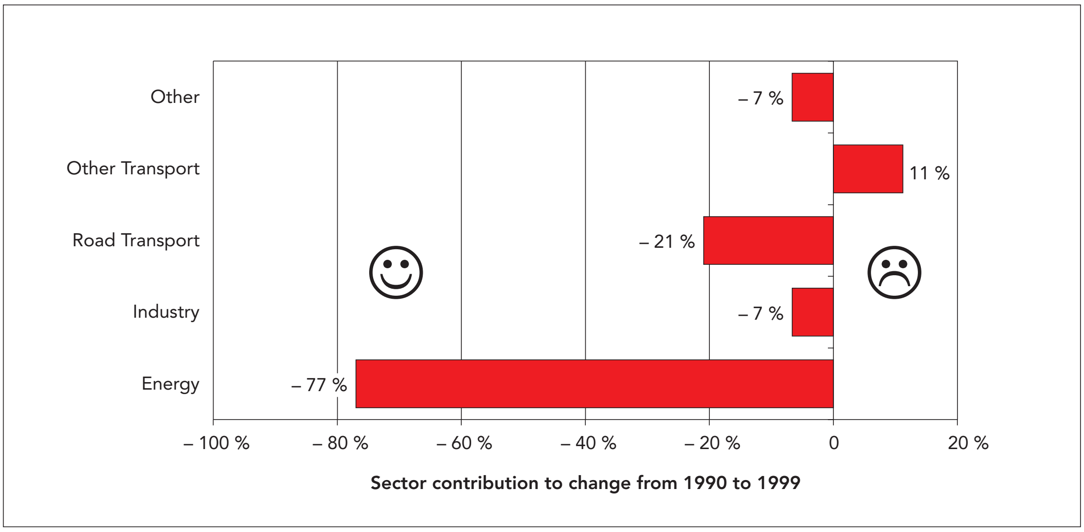
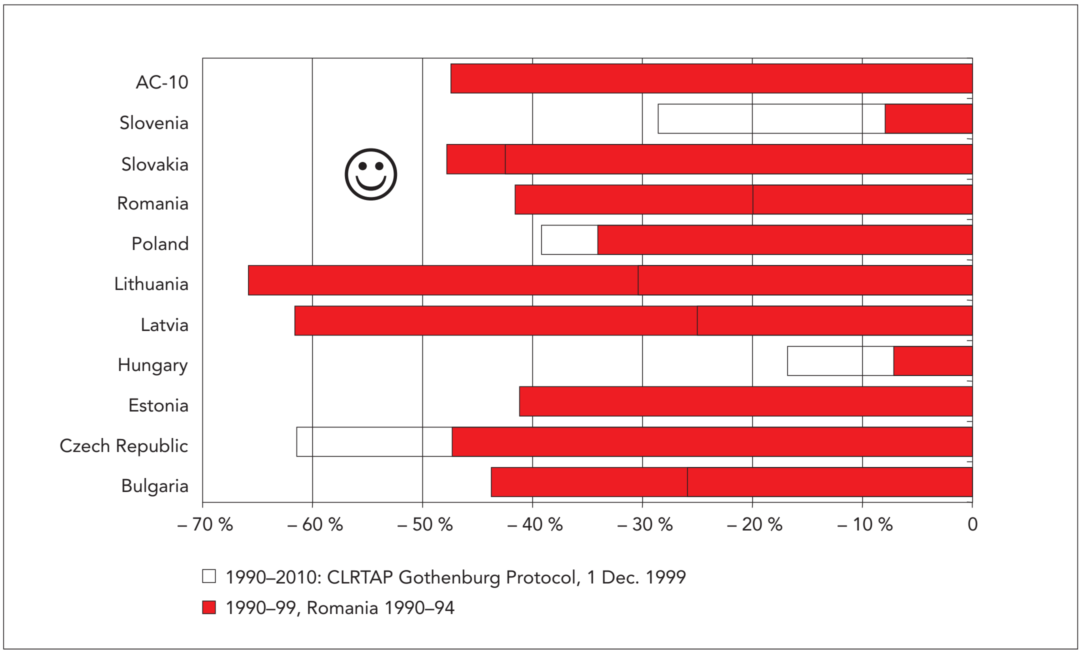


Figure 2.40 AC-10 percentage change in national NO_x emissions since 1990 compared with the 2010 targets

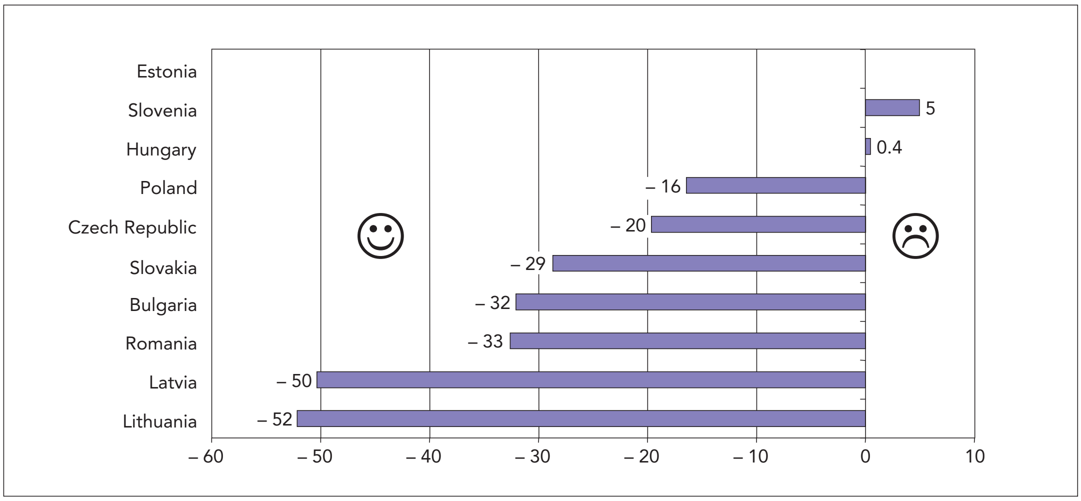


A comparison of the change in national NO_x emissions between 1990 and 1999 and the 2010 CLRTAP targets of the Gothenburg Protocol — expressed as a percentage change of the 1990 emissions — shows that NO_x emissions in many accession countries already have been reduced in line with their 2010 emission targets (Figure 2.40). For the Czech Republic, Hungary, Poland and Slovenia additional measures will be required to achieve the 2010 targets. The transport sector might be a particularly problematic sector for the Czech Republic, Hungary, and Poland.

The distance-to-target indicators (DTI) (Figure 2.41) also show that accession countries have made significant progress towards the 2010 targets. Seven countries were below their linear path to the 2010 target in 1999; only Slovenia and Hungary were 5 and 0.4 points above.

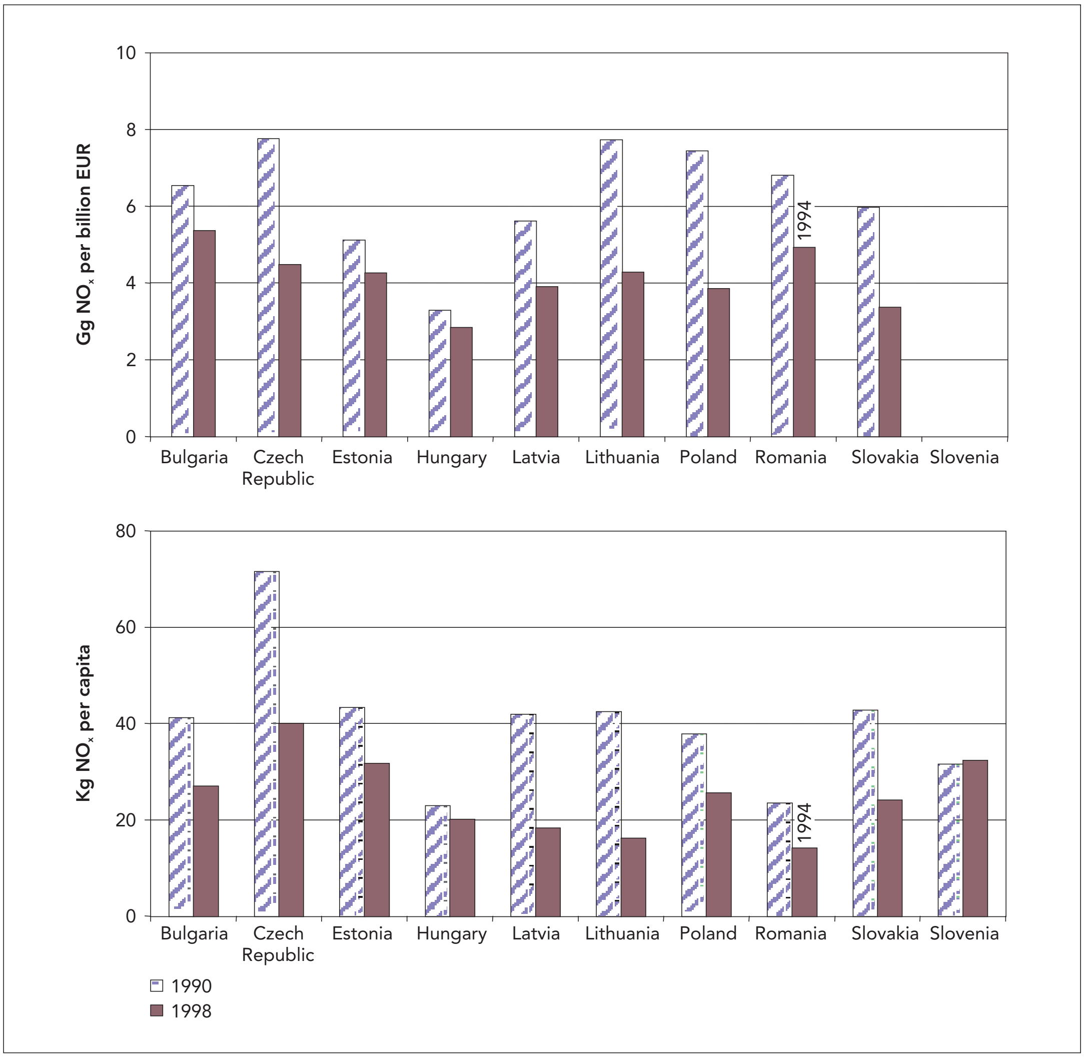
Figure 2.42 shows the per GDP (Gg/billion EUR) and per capita (kg/capita) emissions of NO_x in the 10 accession countries. The emissions per capita and per GDP decreased in all countries except Slovenia.

Distance-to-target indicators (in index points) for the 2010 targets — Figure 2.41



Note: The 2010 targets — CLRTAP Gothenburg Protocol, (1 Dec. 1999). Estonia is not a signatory of the Gothenburg Protocol. The distance-to-target indicator is a measure of the deviation of actual emissions in 1999 (Romania 1994) from the (hypothetical) linear path to the target set in the Gothenburg Protocol.

Per GDP (Gg/billion EUR) and per capita (kg/capita) emissions of NO_x in the 10 accession countries — Figure 2.42



Note: GDP (1990 billion EUR using PPPs) and population data source IAE Statistics. GDP data for Slovenia were not available.

2.4. Ammonia (NH_3)

Key messages — EU-15

☺ Ammonia emissions of EU-15 have been reduced by 6 % since 1990. This is mainly due to a reduction in livestock numbers.

☹ The EU-15 ammonia emissions are slightly above the linear target path towards the 2010 target of the national emissions ceilings directive.

☺ Seven Member States have made significant progress towards the 2010 target of the national emissions ceilings directive. In particular Spain, Ireland, Belgium and Portugal need substantial emissions reductions to reach their linear target path and the 2010 target of the national emissions ceilings directive.

☹ Substantial emission reductions are required to reach the 2010 targets of the national emissions ceilings directive.

Key messages — Accession countries

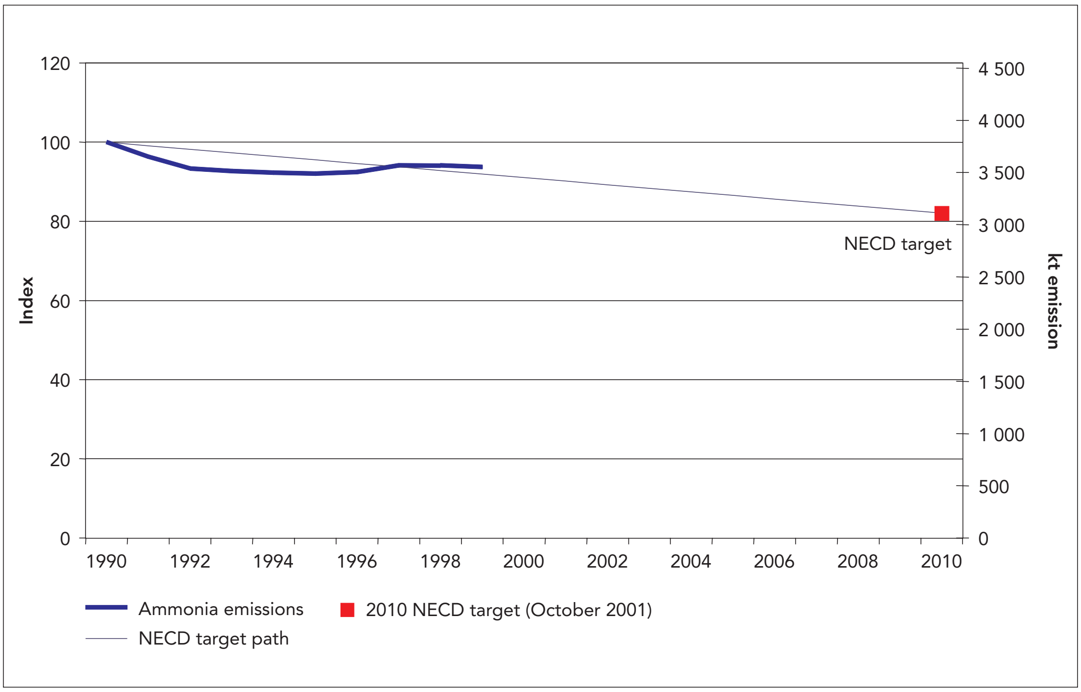
☺ Ammonia emissions in the accession countries have been reduced by 40 % since 1990. This is mainly due to a reduction in livestock numbers.

☺ All accession countries except Romania have reached their 2010 emission targets of the CLRTAP Gothenburg Protocol.

2.4.1. EU-15

Figure 2.43 **EU-15 ammonia emissions 1990–99 compared with 2010 NECD targets**

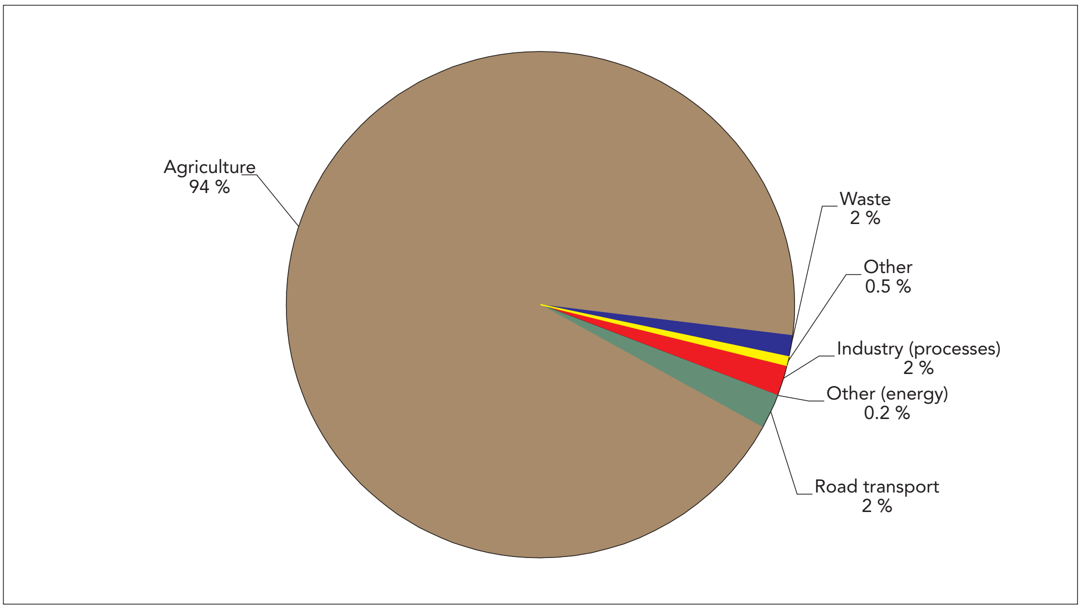
Source: EEA ETC/ACC based on data reported to the UNECE/CLRTAP/EMEP.



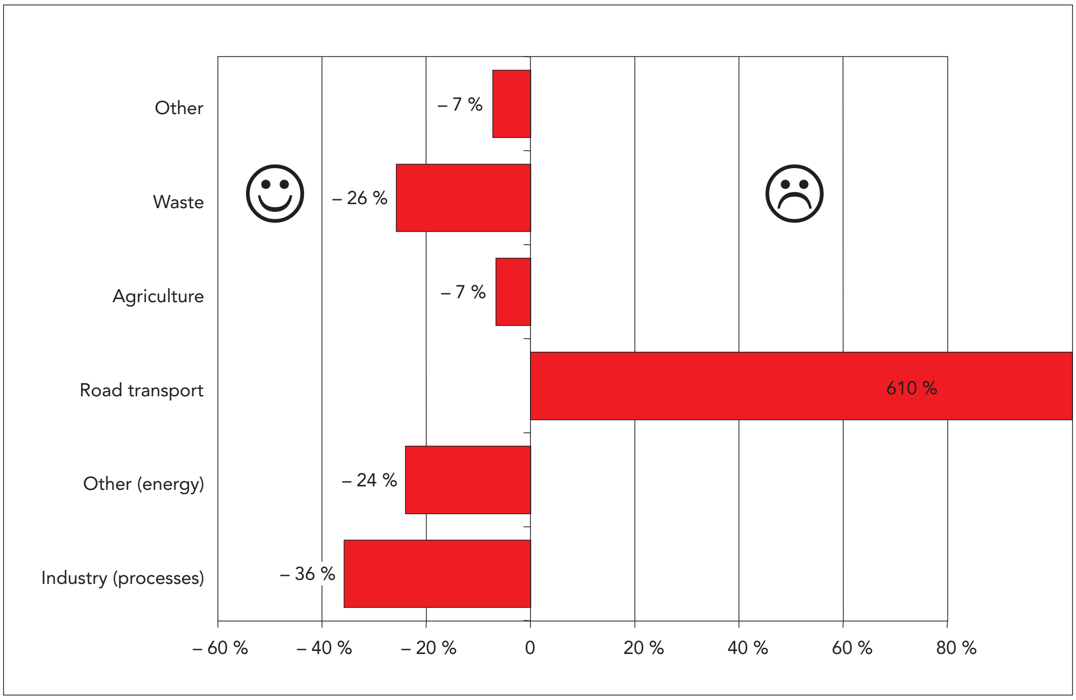
Note: Emission targets are set through the national emissions ceilings directive — NECD (October 2001). The NECD specifies individual targets for Member States and EU-15 — for SO_2, NO_x, VOC and NH_3 respectively. Weighting factors are used to derive tropospheric ozone forming potentials (TOFP) so that emissions can be combined in terms of their contribution to tropospheric ozone: nitrogen oxides 1.22, non-methane volatile organic compounds 1.0, carbon monoxide 0.11 and methane 0.014.
The factors used to aggregate pollutants and present a single figure for a particular issue are currently under development. They represent an over-simplified approach to a very complex process of chemical interactivity. In many cases an average effect has been taken. However, depending on atmospheric conditions and concentration loadings of different pollutants these factors could vary considerably.

Between 1990 and 1999, a 6 % decrease in emissions took place as a result of a reduction in livestock numbers, particularly for pigs and cattle, and improved manure management measures. These reductions were driven by a few Member States (Netherlands, Germany, and Austria). Ammonia emissions are stabilising although agriculture emissions, the major source (94 % of 1999 EU Member States totals as seen in Figure 2.44), are very uncertain and difficult to control.

Sector split of EU-15 NH_3 emissions in 1999 (%) Figure 2.44



Change in NH_3 emissions for each sector 1990–99, EU-15 (%) Figure 2.45



Note: Emission targets for ammonia are set through the national emissions ceilings directive — NECD. The NECD specifies individual targets for Member States- and EU-15- for sulphur dioxide, nitrogen oxide and ammonia respectively.

The most important sources in agriculture from manure management in livestock and enteric fermentation. Particularly large emissions are from pigs, cattle and poultry rearing. Changes in agricultural practice through better manure management, such as ploughing in manure spread onto fields, and reductions in livestock numbers is expected to help reduce ammonia emissions. Reaching the NECD targets for 2010 will require substantial further emission reductions particularly from agriculture.

All sectors except road transport have reduced NH_3 substantially since 1990 (Figure 2.45). The most important contribution to the overall reduction of NH_3 emissions between 1990–99 comes from the agriculture sector (– 100 %).

Figure 2.46 **Contribution to change in NH_3 emissions for each sector 1990–99, EU-15 (%)**

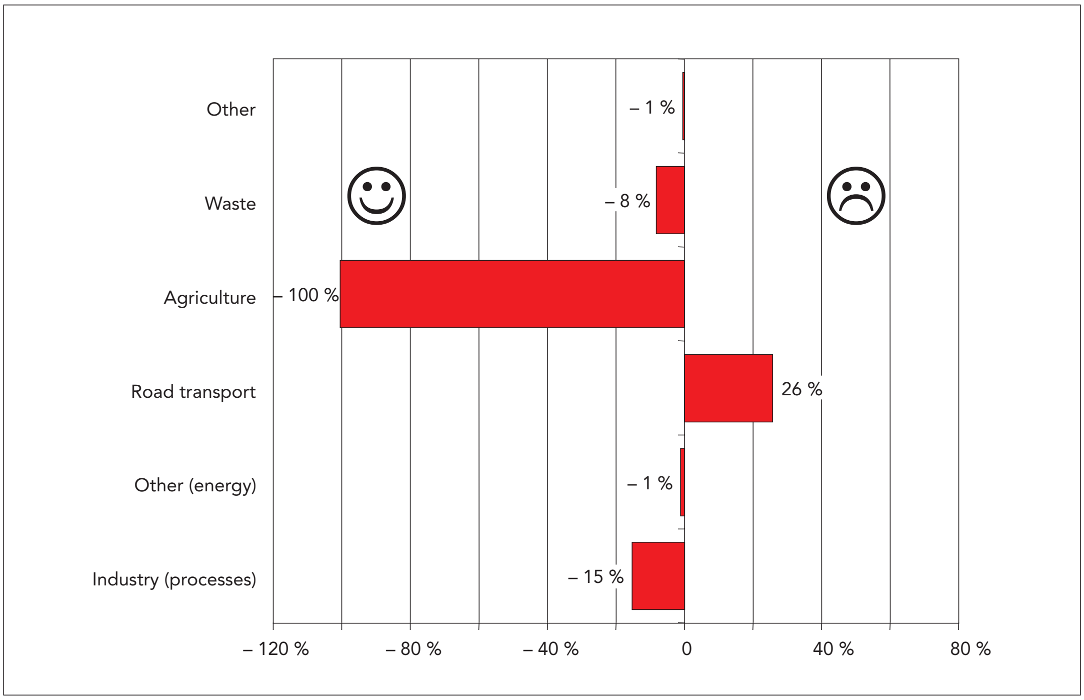
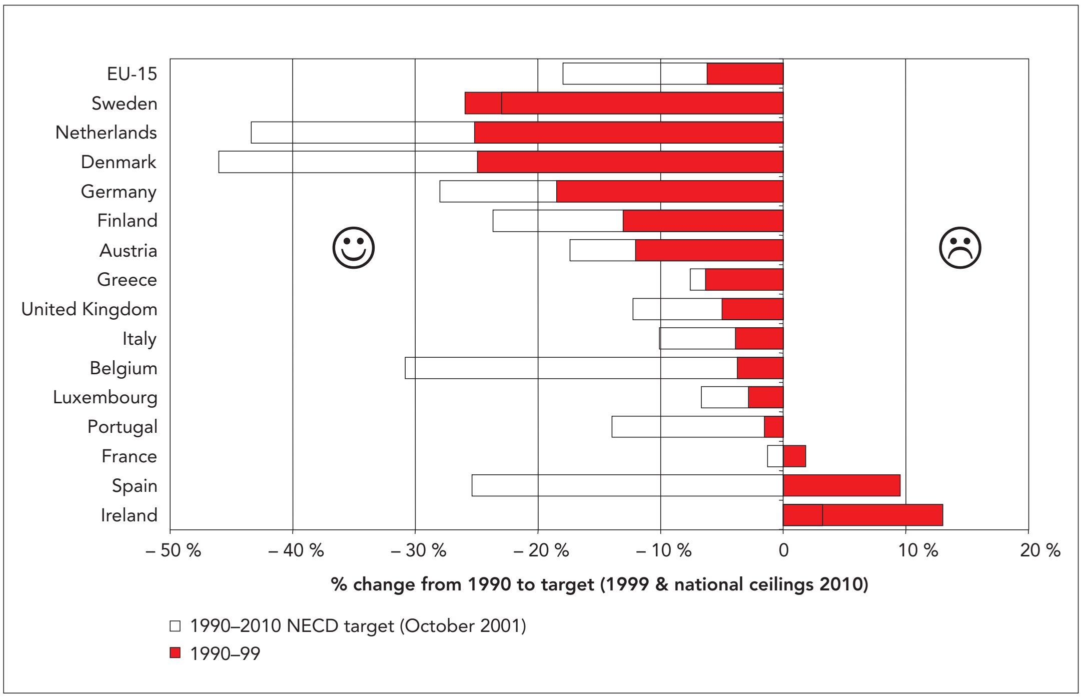


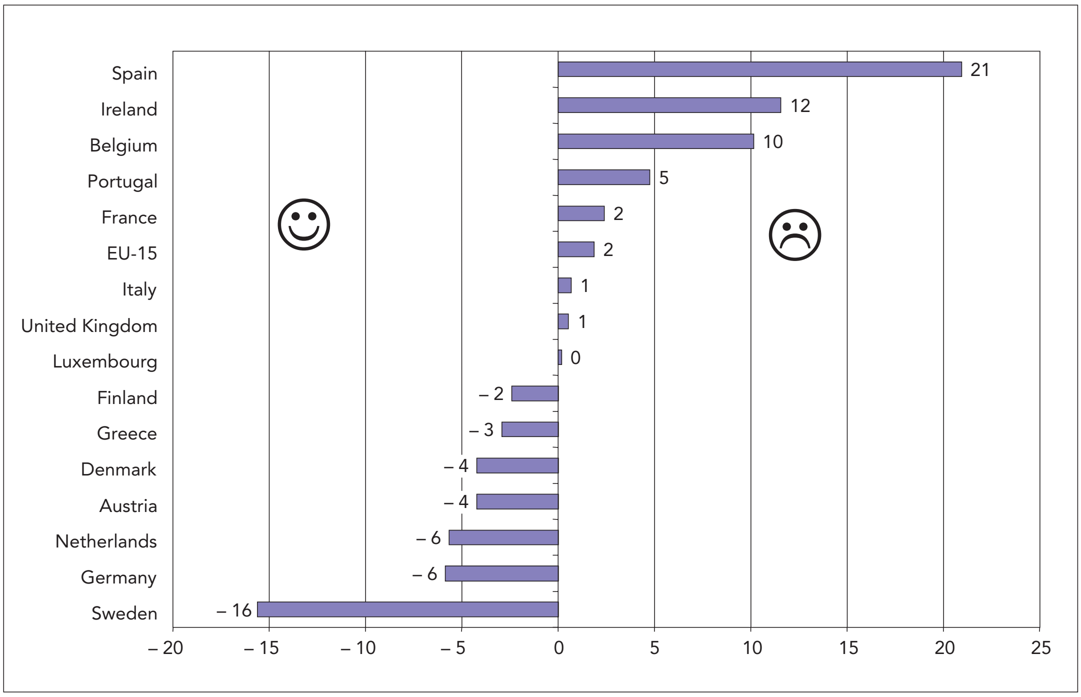
Figure 2.47 **Change in national NH_3 emissions since 1990 compared with the 2010 NECD targets (%)**



Note: The targets for 2010 are the NECD targets (June 2000) which specify country and EU Member States targets for ammonia.

The change in national ammonia emissions (1990–99) is compared with the 2010 NECD targets — expressed as percentage change from 1990 emissions (Figure 2.47). Seven Member States are more than half way to the 2010 targets of the national emissions ceilings directive (NECD). The largest percentage reductions have taken place in Germany, Denmark and the Netherlands with Sweden the only country to reach the 2010 target of the NECD. Three Member States — Ireland, Spain and France have increased their emissions since 1990. Substantial reductions will therefore be required to meet the NECD targets for 2010 and additional measures will be needed. If

Distance-to-target indicators (in index points) for the NECD targets Figure 2.48



Note: The distance-to-target indicator is a measure of the deviation of actual emissions in 1999 from the (hypothetical) linear path to the target set in the NECD.

Other EEA-18 countries:
Norway shows a 16 % increase in emissions of ammonia between 1990 and 1999. A reduction of 14 % is needed for Norway to meet its 2010 Gothenburg Protocol emission targets of 23 000 tonnes. Liechtenstein has not reported emissions of ammonia but has a target of 150 tonnes in 2010.

livestock rearing becomes less intensive, or livestock numbers fall with any reform of the common agricultural policy then emissions may decrease.

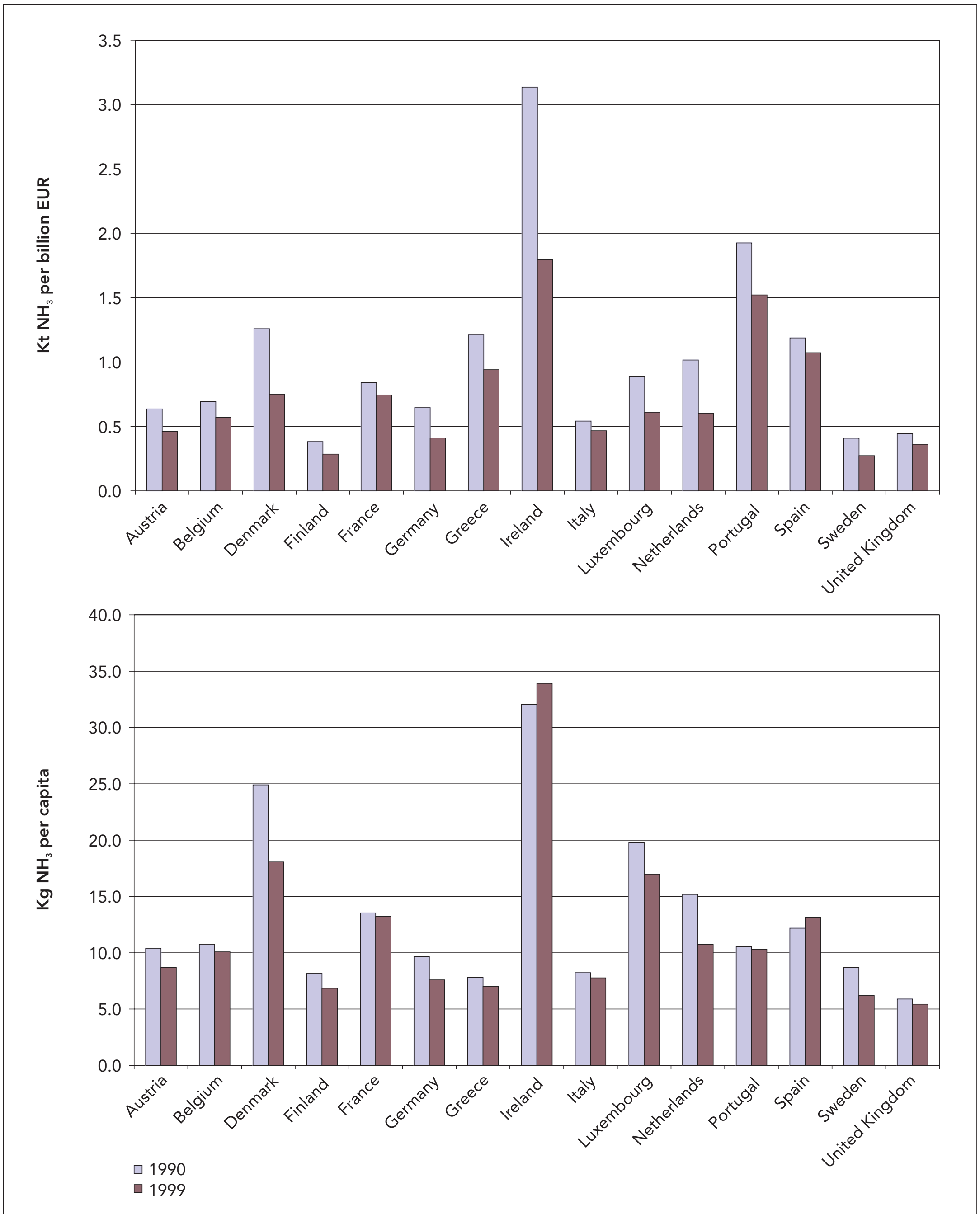
The distance-to-target indicator (DTI) (Figure 2.48) shows that EU NH_3 emissions are slightly above the linear target path towards the 2010 NECD targets. Seven Member States have emission above the linear target path and seven have emissions below. In particular Spain, Ireland, Belgium need substantial emissions reductions to reach their linear target path and the 2010 target of the national emissions ceilings directive.

The per capita and per GDP emissions of ammonia (Figure 2.49) show considerable variation amongst the EU Member States. The per capita emissions in Ireland, Denmark and Luxembourg are relatively high. The importance of agriculture in the Irish and Portuguese economies is reflected in a relatively high emission of ammonia per GDP ratio, while this is not reflected in the emissions per capita. For Ireland this is showing the decrease in the relative importance of agriculture to the Irish economy. The decrease in emissions per GDP and per capita in Denmark and the Netherlands is also substantial.

Figure 2.49

Per GDP (top; Gg/billion EUR) and per capita (bottom; kg/capita) emissions of ammonia in EU Member States

Source: GDP and population: Eurostat.

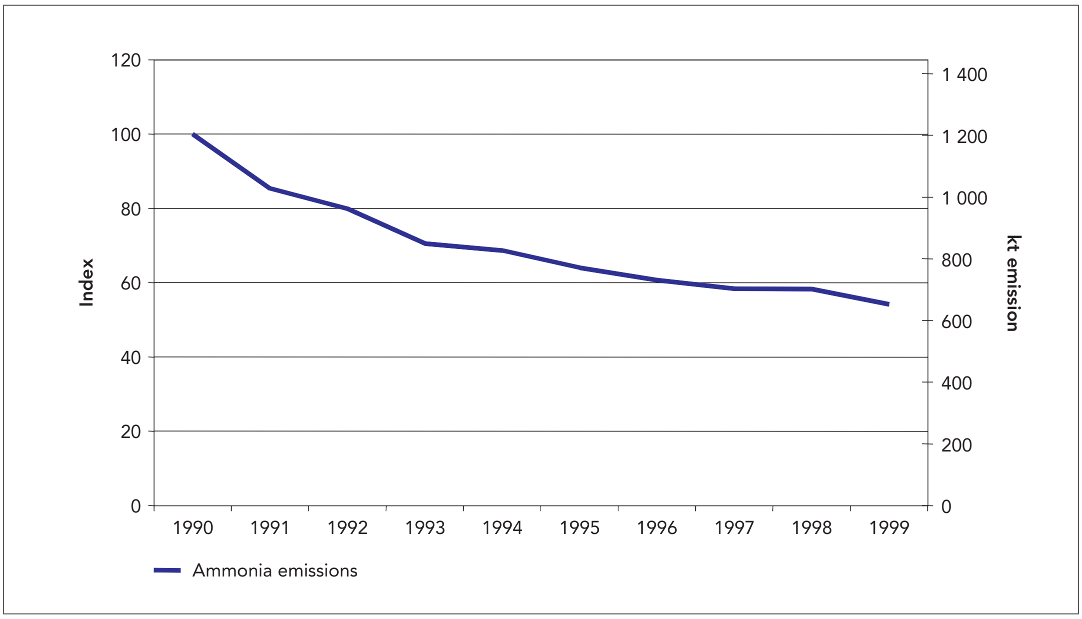


2.4.2. Accession countries

In accession countries, ammonia emission have been reduced by almost 42 % since 1990 as result of a reduction in livestock numbers, particularly for cattle and dairy cattle and reductions in fertiliser consumption — per hectare of arable land (Figure 2.50).

As for EU Member States, the dominating source of ammonia emissions is agriculture through manure management which constituted 94 % of total emission in 1999 (Figure 2.51). All main sectors have reduced ammonia emission since 1990 (Figure 2.52) but the reductions in the agriculture is by far the largest contributor to the overall emission reduction (Figure 2.53).

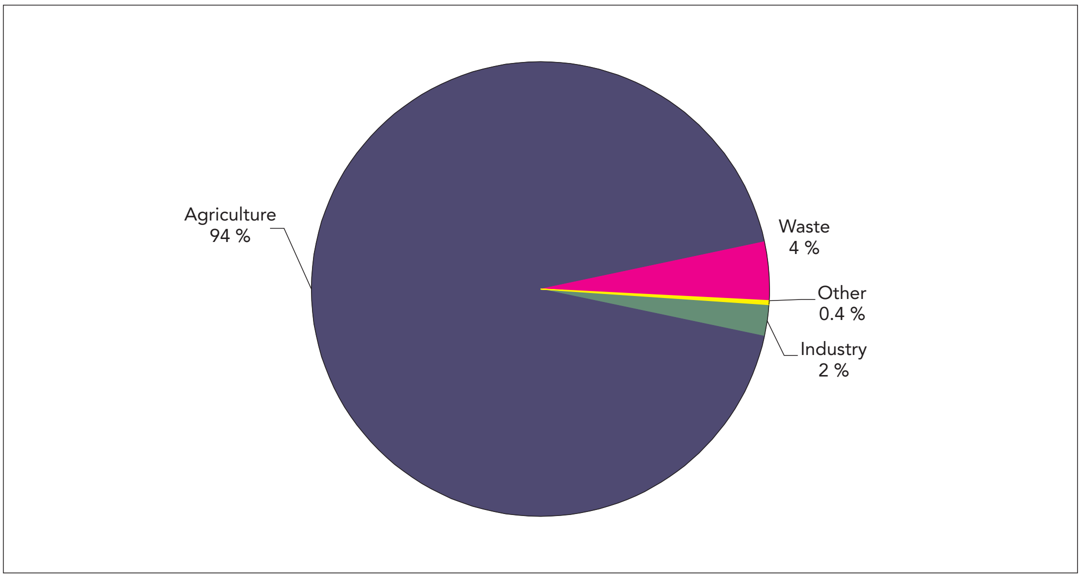
AC-9 ammonia emissions (Romania not included) Figure 2.50



Source: EEA ETC/ACC based on data reported to the UNECE/CLRTAP/EMEP.

Note: For Poland 1991 NH_3 emissions were used for 1992.

Sector split of AC-9 ammonia emissions in 1999 in (%) Figure 2.51



Change in AC-9 ammonia emission per sector 1990 to 1999 (%) Figure 2.52

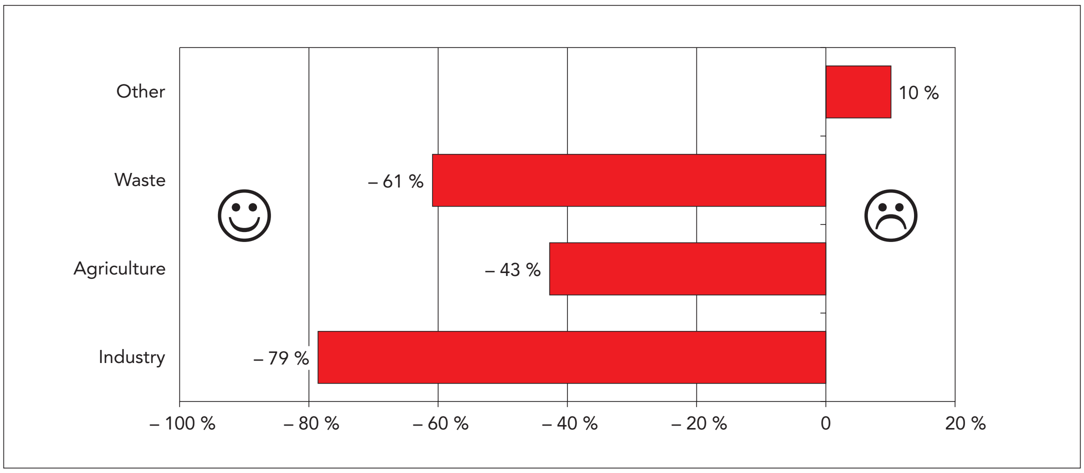


Figure 2.53 **Contribution to change in NH_3 emissions for each sector 1990–99, AC-9 (%)**

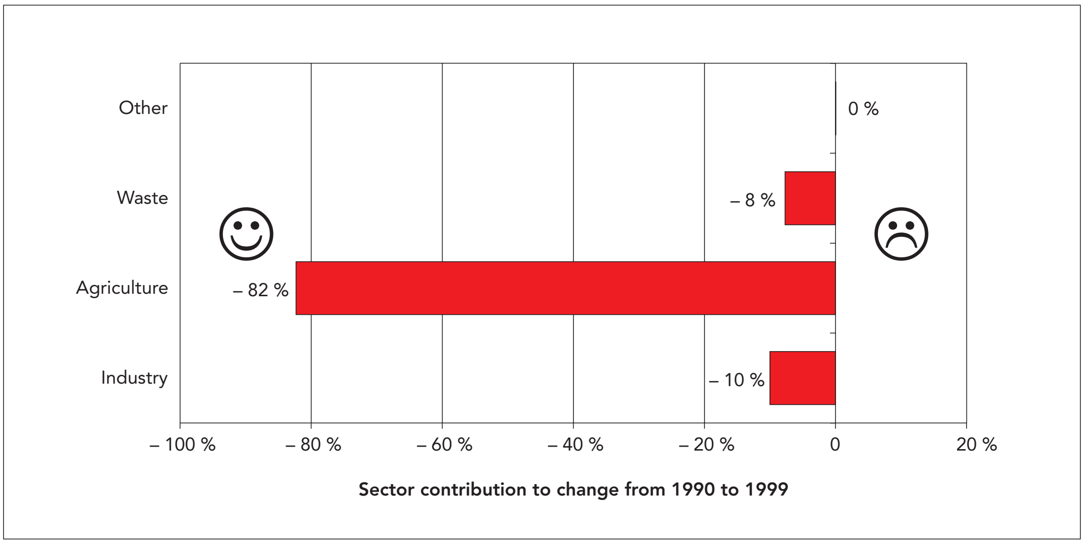
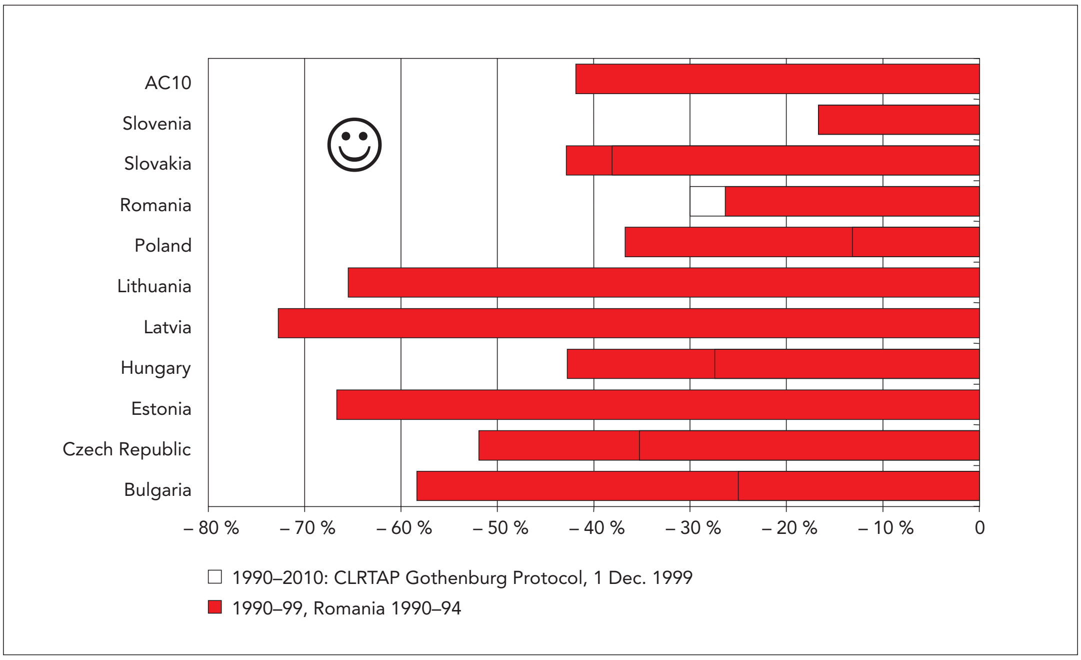


Figure 2.54 **AC-10 percentage change in national ammonia emissions since 1990 compared with the 2010 targets**

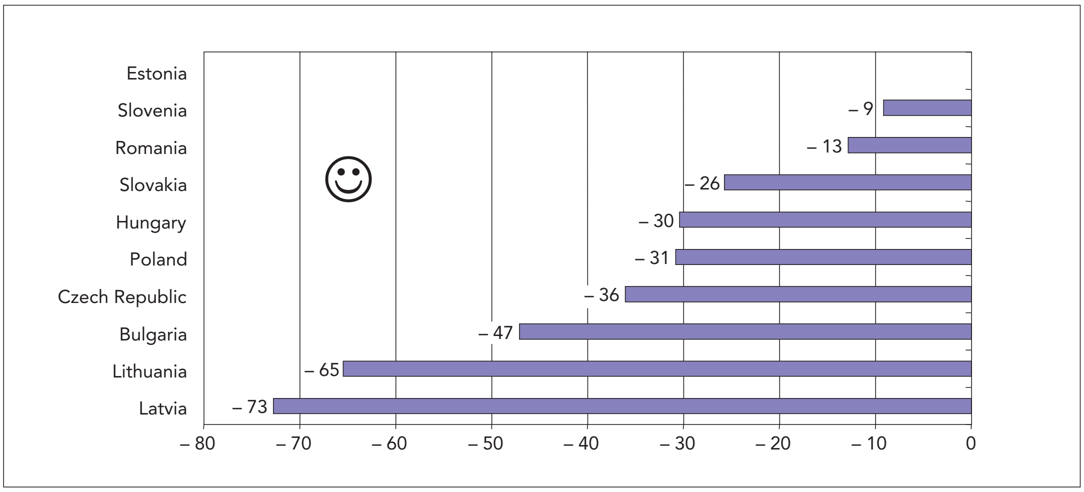


The change in national ammonia emissions (1990–99) is compared with the 2010 targets of the CLRTAP Gothenburg Protocol — expressed as a percentage change from 1990 emissions (Figure 2.54). By 1999 all accession countries, except Romania, had already reached their individual Gothenburg Protocol targets for ammonia emissions. However further development of emissions in agriculture sector will depend on the subsidy policy in Europe. As a result, this positive trend might change.

The distance-to-target indicators (DTI) (Figure 2.55) shows that NH_3 emissions in accession countries are above the linear target path towards the 2010 Gothenburg Protocol targets.

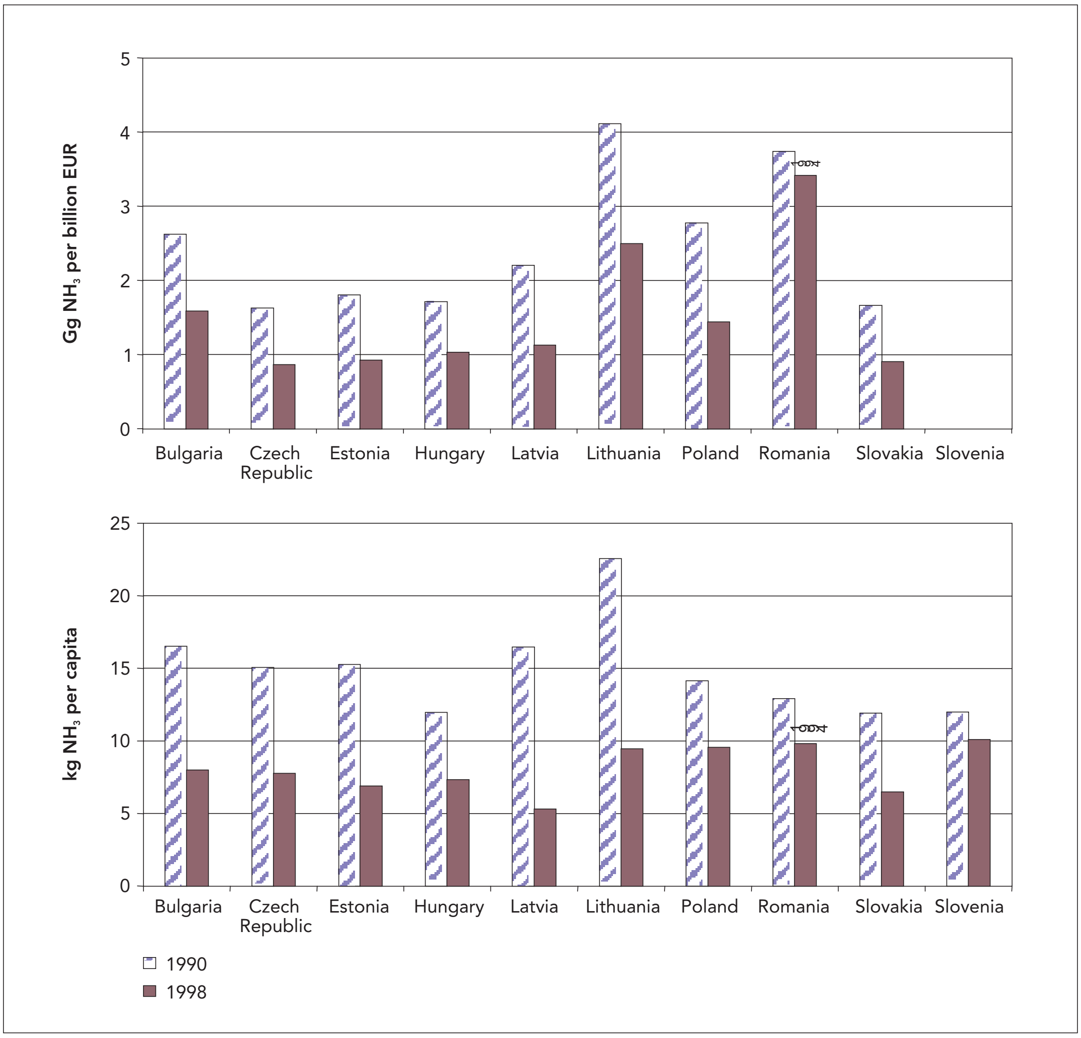
Both the per GDP and per capita emissions have been substantially reduced between 1990 and 1999 (Figure 2.56). The relative importance of agriculture in the Romanian and Lithuanian economies is reflected in a relatively high per GDP emission of ammonia.

Distance-to-target indicators (in index points) for the 2010 targets Figure 2.55



Note: The distance-to-target indicator is a measure of the deviation of actual emissions in 1999 (Romania 1994) from the (hypothetical) linear path to the target set in the Gothenburg Protocol. Estonia is not a signatory of the CLRTAP Gothenburg Protocol.

Emission of ammonia per GDP (Gg/billion USD) and per capita (kg/capita) in AC-10 Figure 2.56



Note: GDP (1990 billion USD using PPPs) and population data source IEA Statistics. GDP data for Slovenia were not available.

3. Emissions of tropospheric ozone precursors

3.1. Total ozone precursor gases

Key messages — EU-15

☺ Emissions of ozone forming gases (ground level ozone precursors) have been reduced by 27 % between 1990 and 1999. The emission reductions are mainly due to introduction of catalysts on new cars.

☺ The emissions of EU-15 and most Member States are below their linear target paths to the 2010 targets of the EU national emissions ceilings directive.

☹ Substantial reductions of emissions of ozone precursors are still required to reach 2010 targets of the EU national emissions ceilings directive.

Key messages — Accession countries

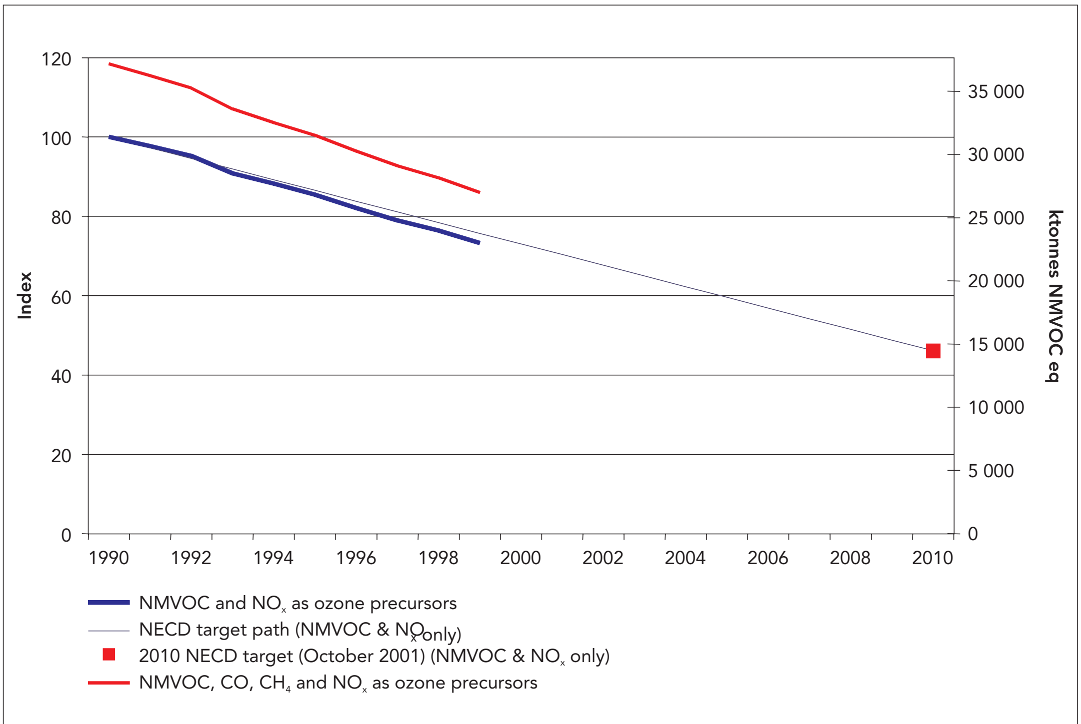
☺ Emissions of ozone forming gases (ground level ozone precursors) have been reduced by 35 % between 1990 and 1999. The emission reductions are mainly due to decrease in energy production and introduction of catalysts on new cars.

☺ All accession countries except Hungary and the Czech Republic have reached their 2010 emission targets of the CLRTAP Gothenburg Protocol.

3.1.1. EU-15

Figure 3.1 **Changes in EU-15 emission of ozone precursors between 1990 and 1999 and the NECD target for 2010 (kt NMVOC equiv.)**

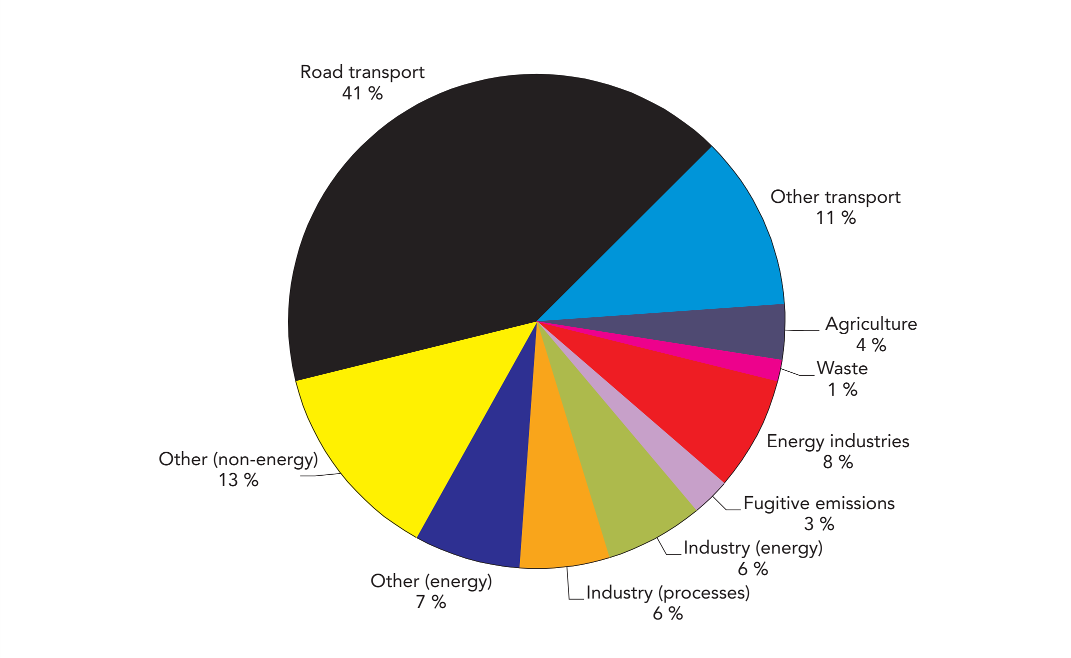
Source: EEA ETC/ACC based on data reported to the UNECE/CLRTAP/EMEP.



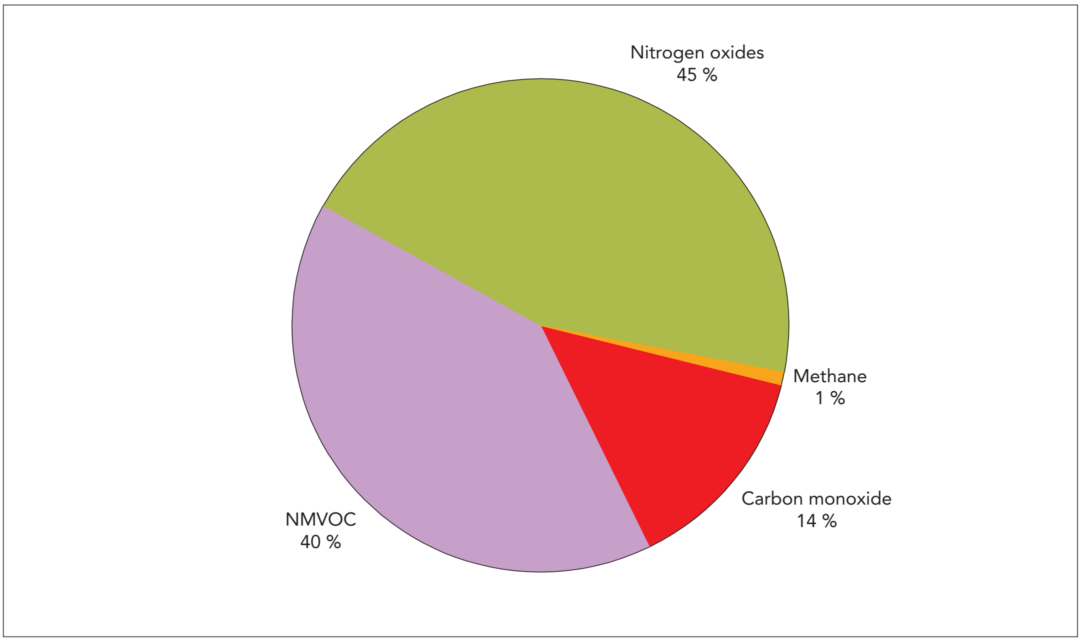
Note: Emission targets are set through the national emissions ceilings directive — NECD (October 2001). The NECD specifies individual targets for Member States and EU-15 — for SO_2, NO_x, VOC and NH_3 respectively. Carbon monoxide and methane contributions to ground level ozone formation have been included for 1990–99.

Total EU emissions of ozone precursor have been reduced by 27 % between 1990 and 1999 (Figure 3.1). The decrease between 1998 and 1999 was 4 %. Road transport is the dominant source of ozone precursors and contributes to 41 % of total emissions in 1999 (Figure 3.2). Other sources, including commercial and domestic combustion and use of solvents in paint, glue and printing, which contributed 20 % to the emissions in 1999. Emissions of non-methane volatile organic compounds (40 % of total) and

Sector split of EU-15 emissions of ozone precursors in 1999 (%) Figure 3.2



Pollutant split of EU-15 emissions of ozone precursors in 1999 (%) Figure 3.3



nitrogen oxides (45 % of total) are the most significant pollutants contributing to the formation of tropospheric ozone in 1999.

Emissions from all sectors and all pollutants have been reduced between 1990 and 1999 (Figure 3.4). The most important contribution to change in ozone precursors emissions between 1990–99 for EU-15 is in road transport (– 58 %) through increased penetration of diesel and of catalytic converters for road vehicles (Figure 3.5). In terms of pollutants, NMVOC and nitrogen oxides are the two pollutants which contributed the most to change in ozone precursors emissions 1990 to 1999 (– 42 % and – 40 % respectively).

Figure 3.4 **Change in EU-15 emissions of ozone precursors for each sector and pollutant 1990–99 (%)**

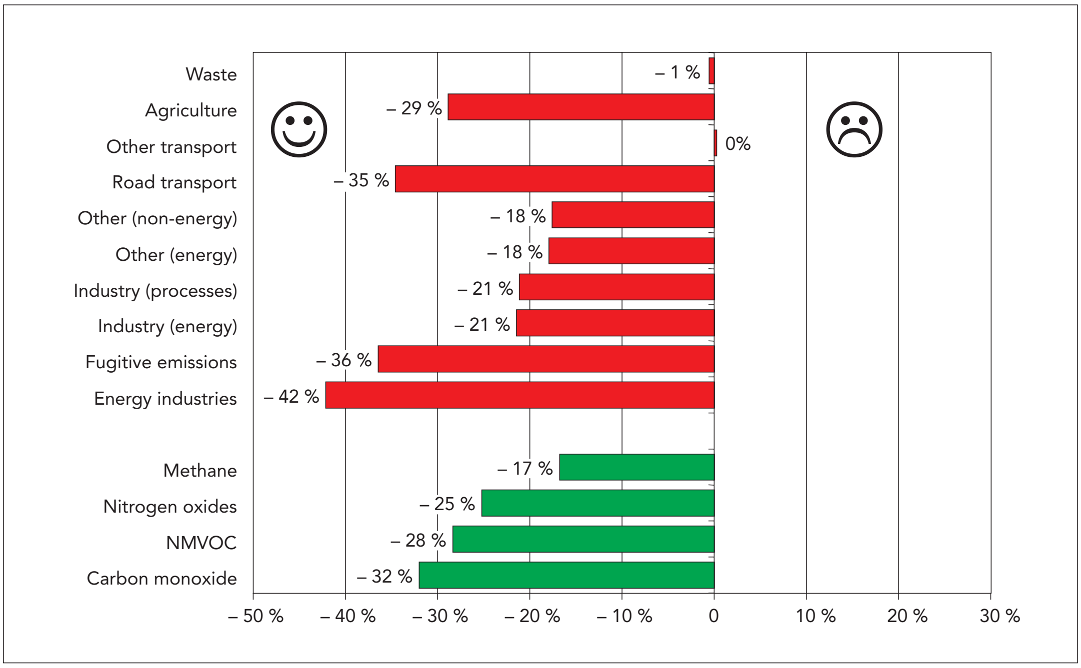
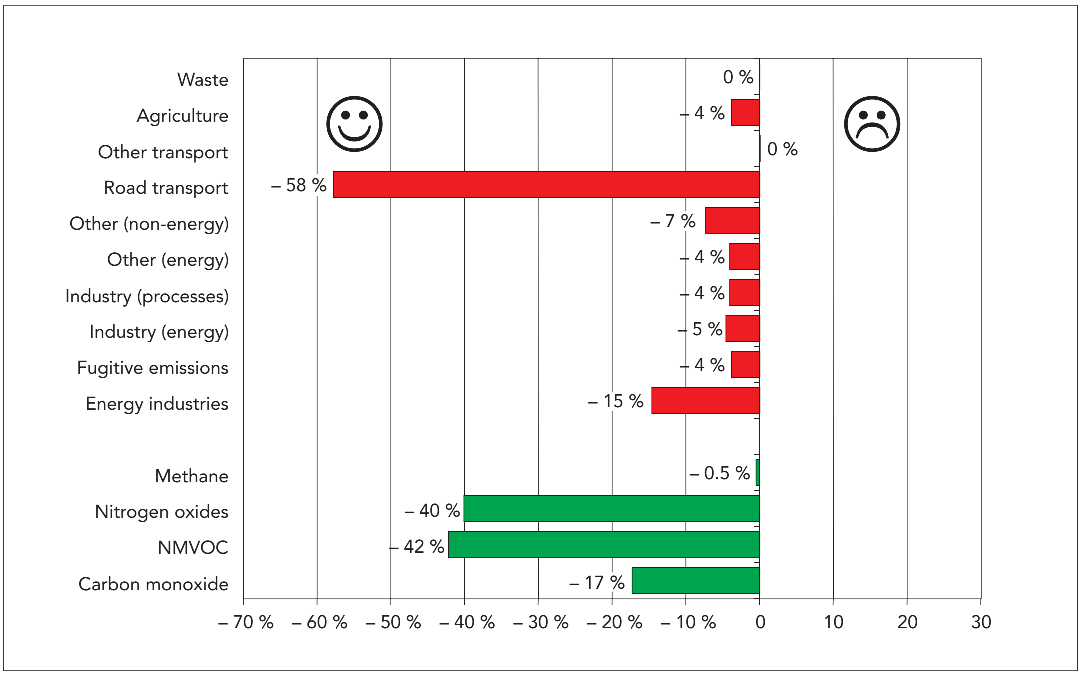


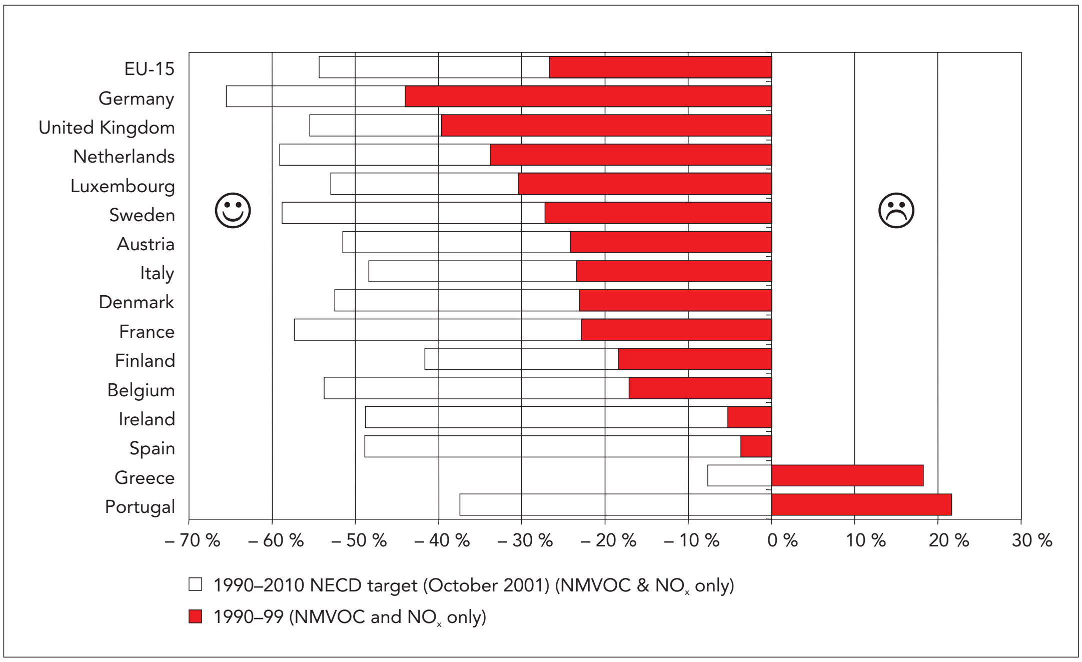
Figure 3.5 **Contribution to change in ozone precursors emissions for each sector 1990–99, EU-15 (%)**



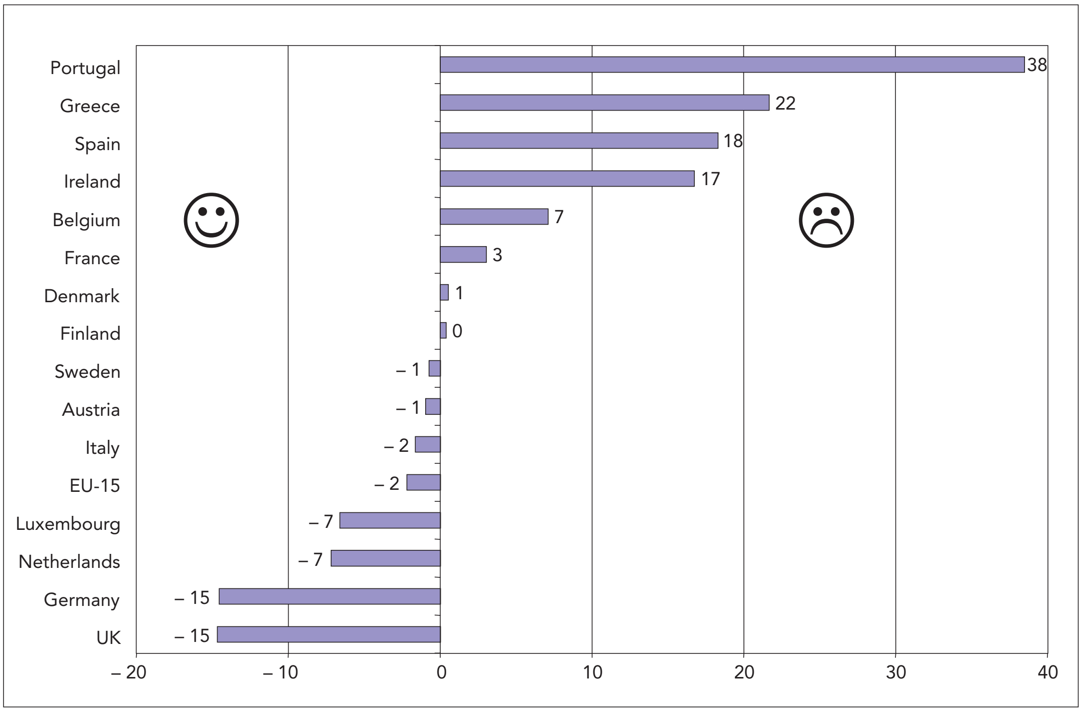
Eight Member States and the EU as a whole are more than half way towards the NECD targets for 2010 (Figure 3.6). The largest emission (percentage) reductions have taken place in Germany, Luxembourg and the United Kingdom. Emissions in Portugal and Greece have increased since 1990.

Figure 3.7) shows that the emissions of most EU Member States and the EU were below the linear path to the target. Two of these, UK and Germany, were more than 10 points below the linear path. The emissions for four countries: Portugal, Greece, Spain and Ireland were substantially above their linear target paths. Substantial further reductions of emissions of ozone precursor pollutants are required to achieve the 2010 targets of the NECD.

Change in emissions of ozone precursors (NMVOC and NO_x only) since 1990 compared with the 2010 NECD targets (%) Figure 3.6



Distance-to-target indicators (in index points) to the 2010 targets of NECD Figure 3.7



Source: EEA ETC/ACC based on data reported to the UNECE/CLRTAP/ EMEP.

Note: Emission targets are set through the national emissions ceilings directive — NECD (October 2001). The NECD specifies individual targets for Member States and EU-15 — for SO_2, NO_x, VOC and NH_3 respectively. Carbon monoxide and methane have been excluded, as there are no explicit targets for these pollutants.

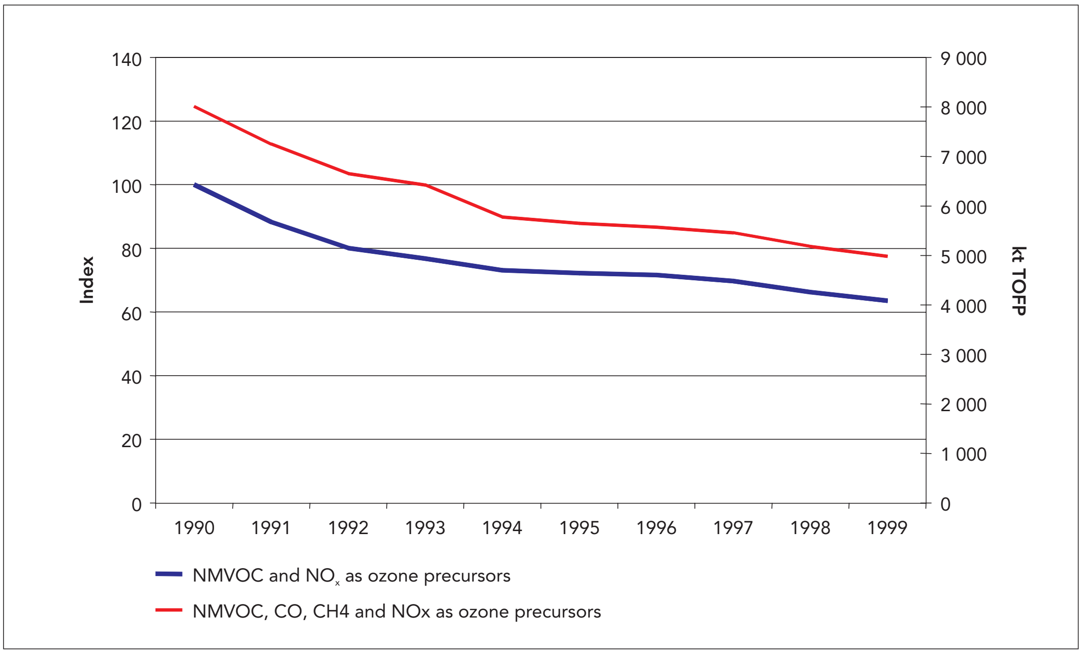
The distance-to-target indicator is a measure of the how close the current emissions (1999) are to a linear path of emissions reductions from 1990 to the target set in the NECD for 2001.

3.1.2. Accession countries

Emissions of ozone precursors that are addressed by the CLRTAP Gothenburg Protocol (NMVOC and NO_x) have been reduced by approximately 35 % in accession countries (Figure 3.8).

Figure 3.8 **AC-9 emissions of ozone precursor gases (Romania excluded) (kt NMVOC equivalents)**

Source: EEA ETC/ACC based on data reported to the UNECE/CLRTAP/EMEP.



Note: For Poland 1994 CO emissions were used instead of missing emissions data from 1990 to 1993.

Figure 3.9 **Pollutant split of AC-9 emissions of ozone precursors in 1999 (%)**

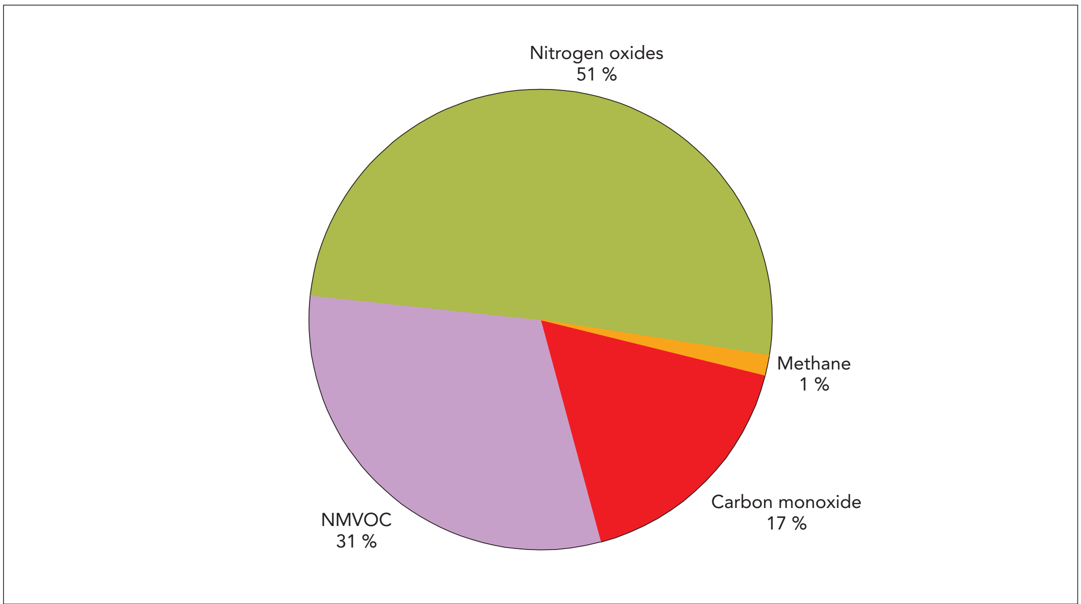
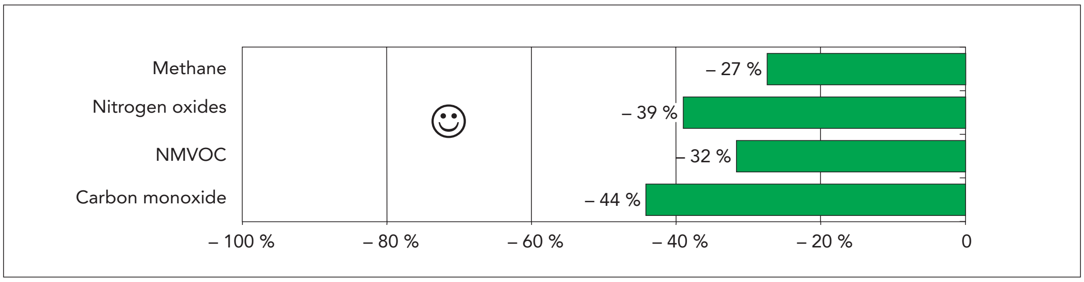
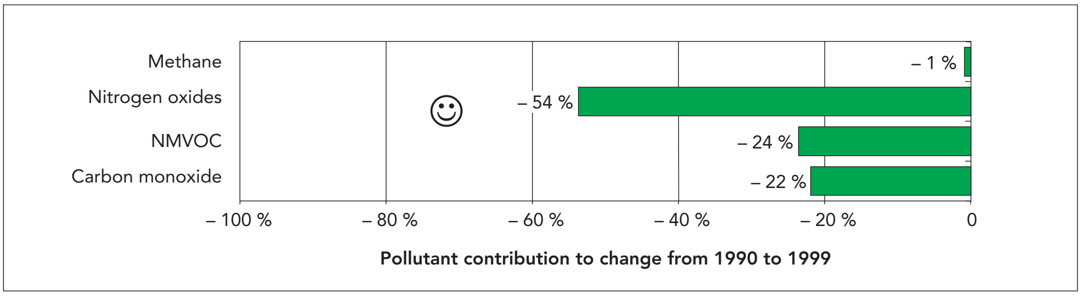


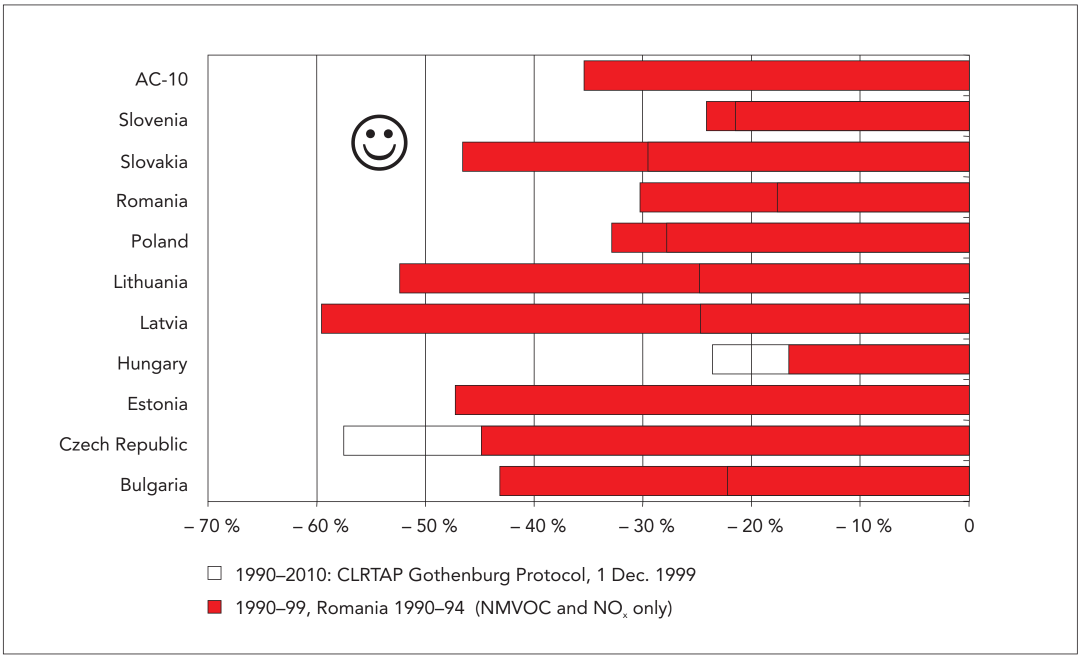
Figure 3.10 **Change in AC-9 emissions of ozone precursors for each pollutant 1990–99 (%)**



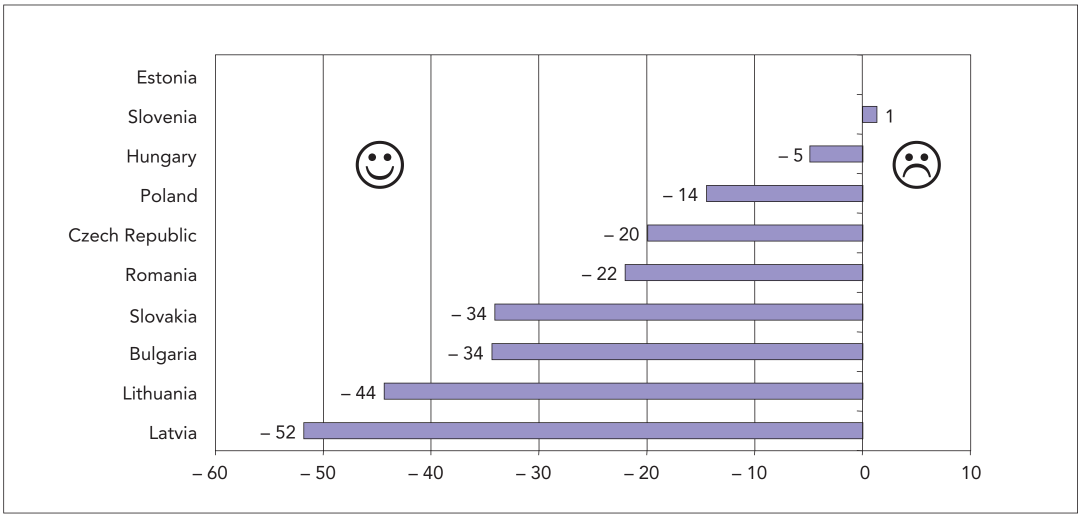
Contribution to change in ozone precursors emissions for each pollutant 1990–99, AC-9 (%) Figure 3.11



AC-10 percentage change in national emissions of ozone precursors (NMVOC and NO_x only) since 1990 compared with the 2010 targets (%) Figure 3.12



Distance-to-target indicators (in index points) to the 2010 targets Figure 3.13



Note: The targets for 2010 are set out in the CLRTAP Gothenburg Protocol (1 Dec. 1999) for non-methane volatile organic compounds and nitrogen oxides. Carbon monoxide and methane have been excluded, as there are no explicit targets for these pollutants.

The distance-to-target indicator is a measure of the deviation of actual emissions in 1999 (Romania 1994) from the (hypothetical) linear path to the target set in the Gothenburg Protocol. Estonia is not a signatory of the Gothenburg Protocol.

3.2. Non-methane volatile organic compounds (NMVOC)

Key messages — EU-15

☺ EU-15 emissions of NMVOC have been reduced by 28 % since 1990. This is mainly due to the introduction of the exhaust catalyst on new cars.

☺ EU-15 and most Member States have emissions below their linear target path and are about half way, or more, to their 2010 targets of the national emissions ceilings directive.

☹ Three Member States (Portugal, Greece and Spain) are significantly above their linear paths towards the 2010 targets for the national emissions ceilings directive.

☹ Substantial emission reductions are needed to reach the 2010 targets of the national emissions ceilings directive.

Key messages — Accession countries

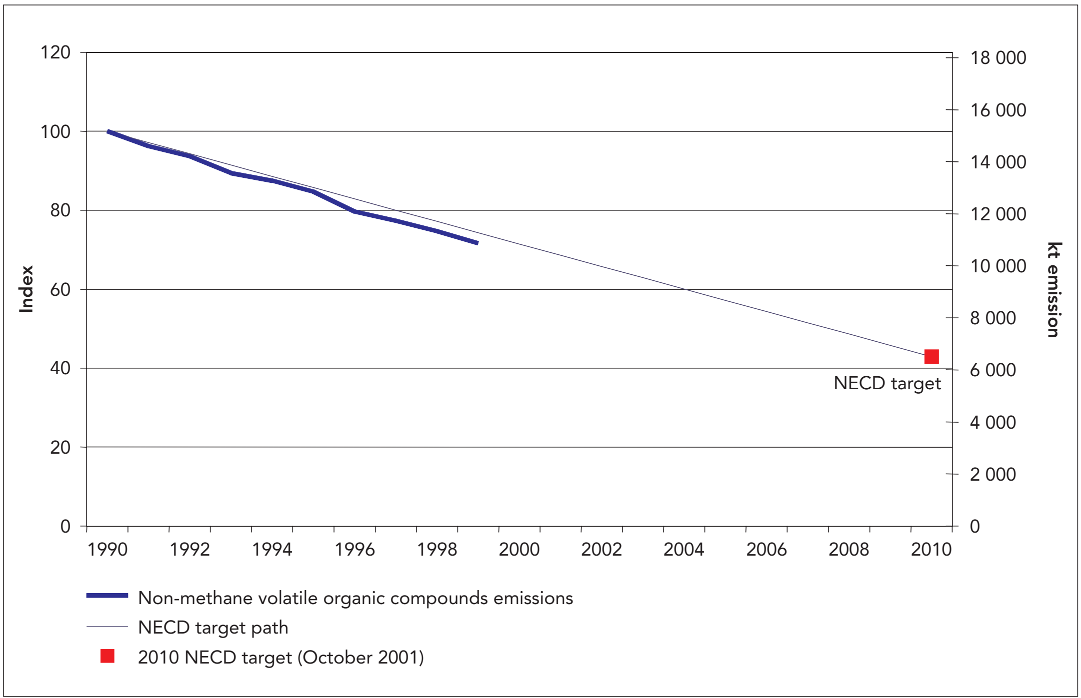
☺ Emissions of NMVOC have been reduced by approximately 30 % between 1990 and 1999.

☺ All accession countries except Hungary and the Czech Republic have reached their 2010 emission targets of the CLRTAP Gothenburg Protocol.

3.2.1. EU-15

Figure 3.14 **EU-15 emissions of NMVOC (kt)**

Source: EEA ETC/ACC based on data reported to the UNECE/CLRTAP/EMEP and/or also UNFCCC.

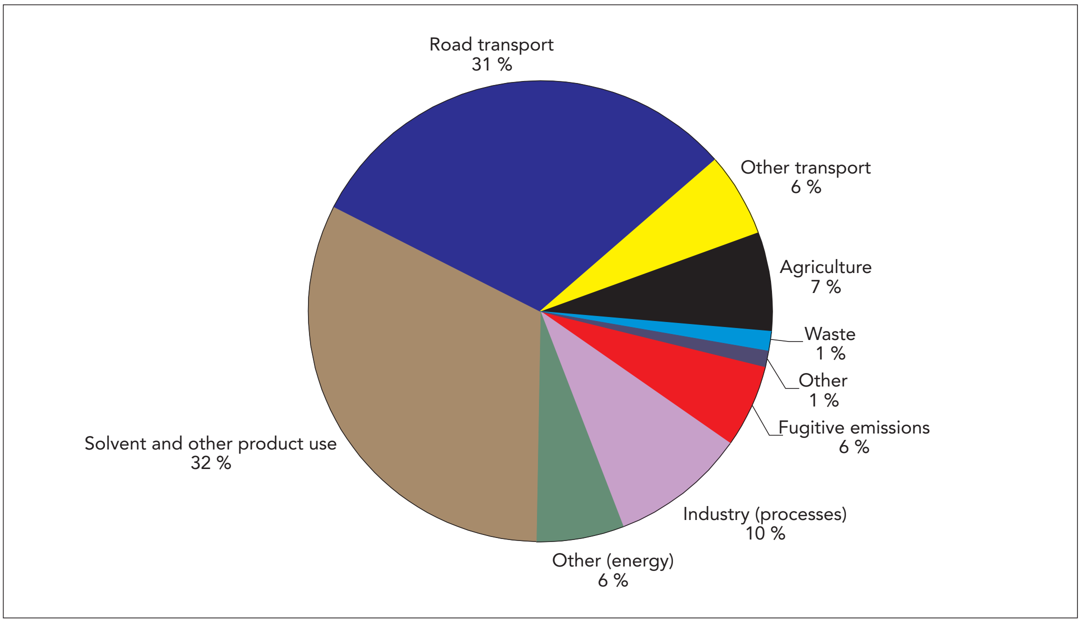


Note: Emission targets are set through the national emissions ceilings directive — NECD (October 2001). The NECD specifies individual targets for Member States and EU-15 — for SO_2, NO_x, NMVOC and NH_3 respectively.

In the EU Member States there has been an overall decrease in emissions of NMVOC of 28 % from 1990 to 1999 (Figure 3.14). This is close to the target of 30 % from the NMVOC protocol.

Significant emissions arise from road transport (31 % in 1999) from combustion and petrol evaporation (Figure 3.15). Other sources (38 % in 1999) include domestic and commercial combustion, solvent use in paints, glues and other products as well as printing and vehicle spraying. Fugitive sources such as petroleum transportation and storage, manufacturing industry and agricultural sources contribute 6 %, 10 % and 7 % respectively to the total NMVOC emissions in 1999.

Sector split of EU-15 emissions of non-methane volatile organic compounds (NMVOC) in 1999 (%) — Figure 3.15



NMVOC emissions have been reduced from most sectors (Figure 3.16). Emission reductions in the transport sector have been reduced by 42 % since 1990 primarily due to the introduction of the exhaust catalyst on cars. Since the implementation of the VOC protocol and through the solvents directive, efforts have been made to reduce emissions from the use of solvents and manufacturing processes through best practice schemes, substitution with water-based products and abatement technology. The emissions from industry processes have been reduced by 19 % between 1990 and 1999.

Emission reduction in the transport sector contributed substantially to the overall emission reduction between 1990 and 1999. Reduction from fugitive emission and agriculture have also been significantly reduced (37 and 33 % respectively). Other sector contribution to change in NMVOC emissions are shown in Figure 3.17.

Change in EU-15 emissions of NMVOC for each sector 1990–99 (%) — Figure 3.16

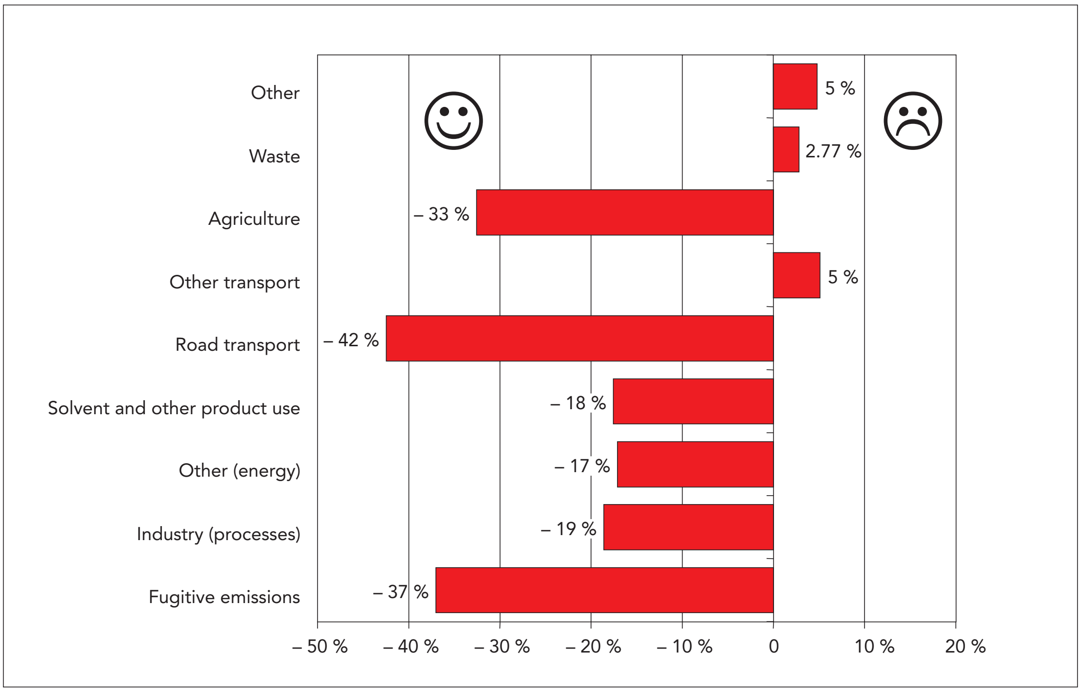


Figure 3.17 **Contribution to change in NMVOC emissions for each sector 1990–99, EU-15 (%)**

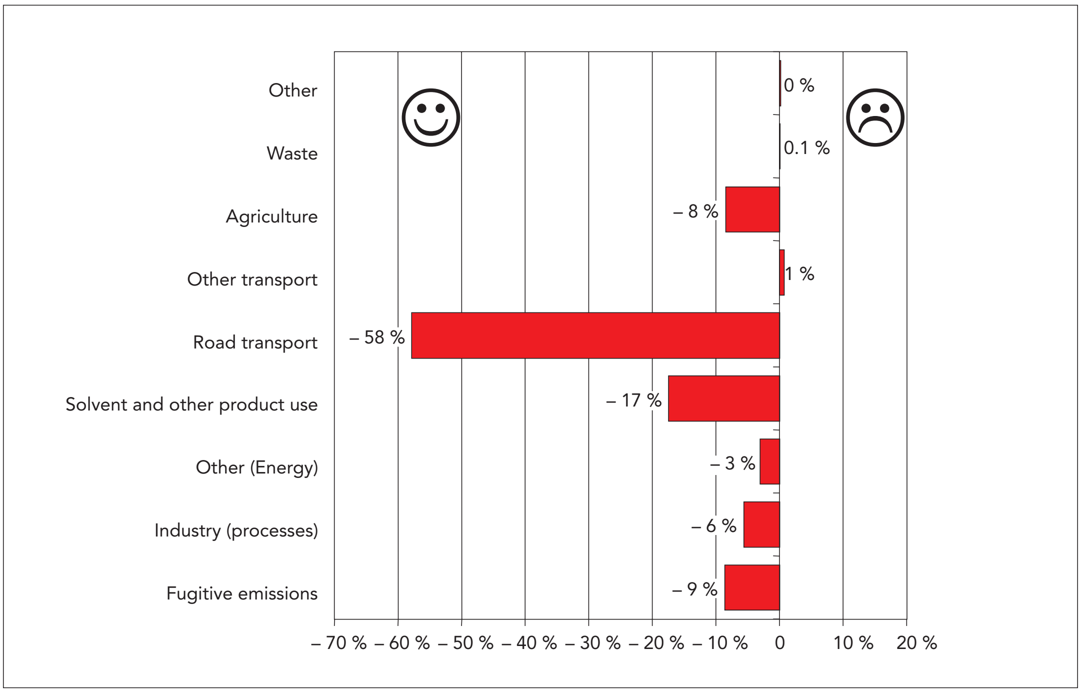
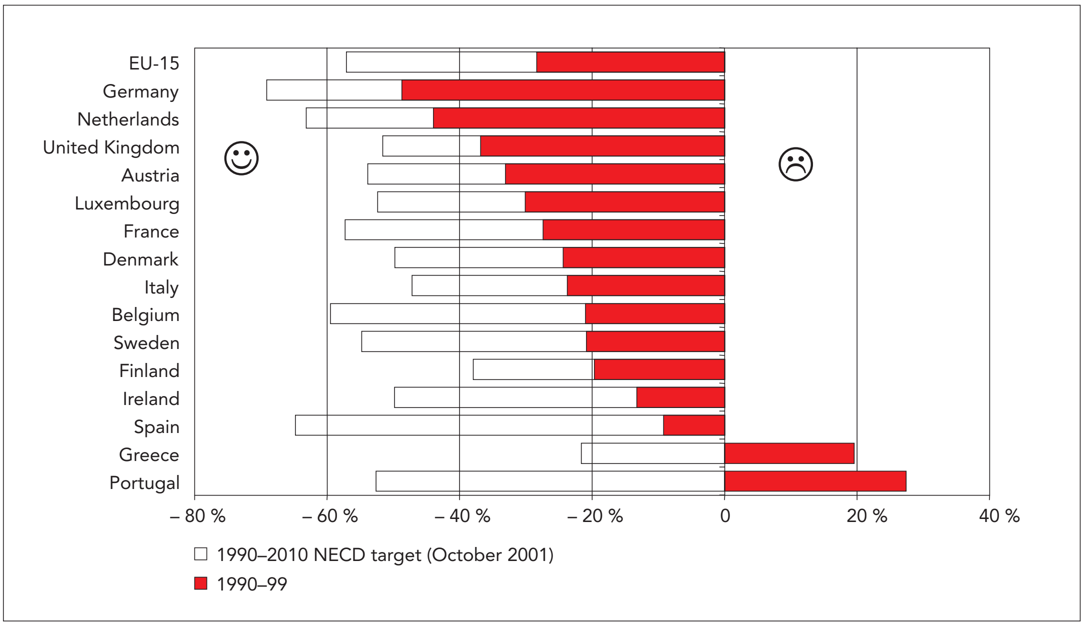


Figure 3.18 **Change in emissions of NMVOC since 1990 compared with the 2010 NECD targets (%)**

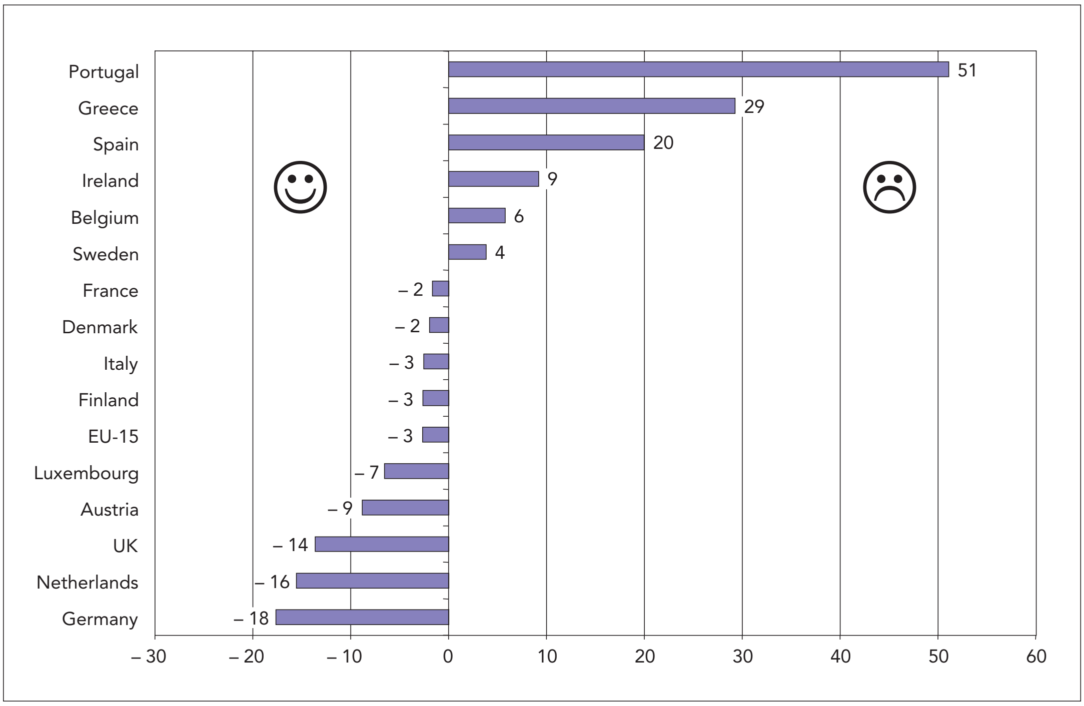


The EU and most Member States are about half way, or more, to their 2010 targets of the national emissions ceilings directive (Figure 3.18). Germany, the Netherlands and the UK have been particularly successful in reducing their emissions. Greece and Portugal are the only Member States which have increased their emission since 1990. Substantial emission reductions are needed from most Member States to reach the 2010 targets of the NECD.

Emissions of NMVOC are significantly higher than the 2010 targets of the NECD and exceedances of critical levels (ecosystems) and concentration thresholds (human health) still exist. Substantial emission reductions are required to reach the 2010 targets of the national emissions ceilings directive.

Nine Member States and the European Union as a whole were below their linear

Distance-to-target indicators (in index points) to the 2010 NECD targets — Figure 3.19



Source: EEA ETC/ACC based on data reported to the UNECE/CLRTAP/ EMEP and/or also UNFCCC.

Note: The targets for 2010 emissions are set out in the national emissions ceilings directive, NECD. The NECD specifies Member State and EU-15 targets for non-methane volatile organic compounds and nitrogen oxides.

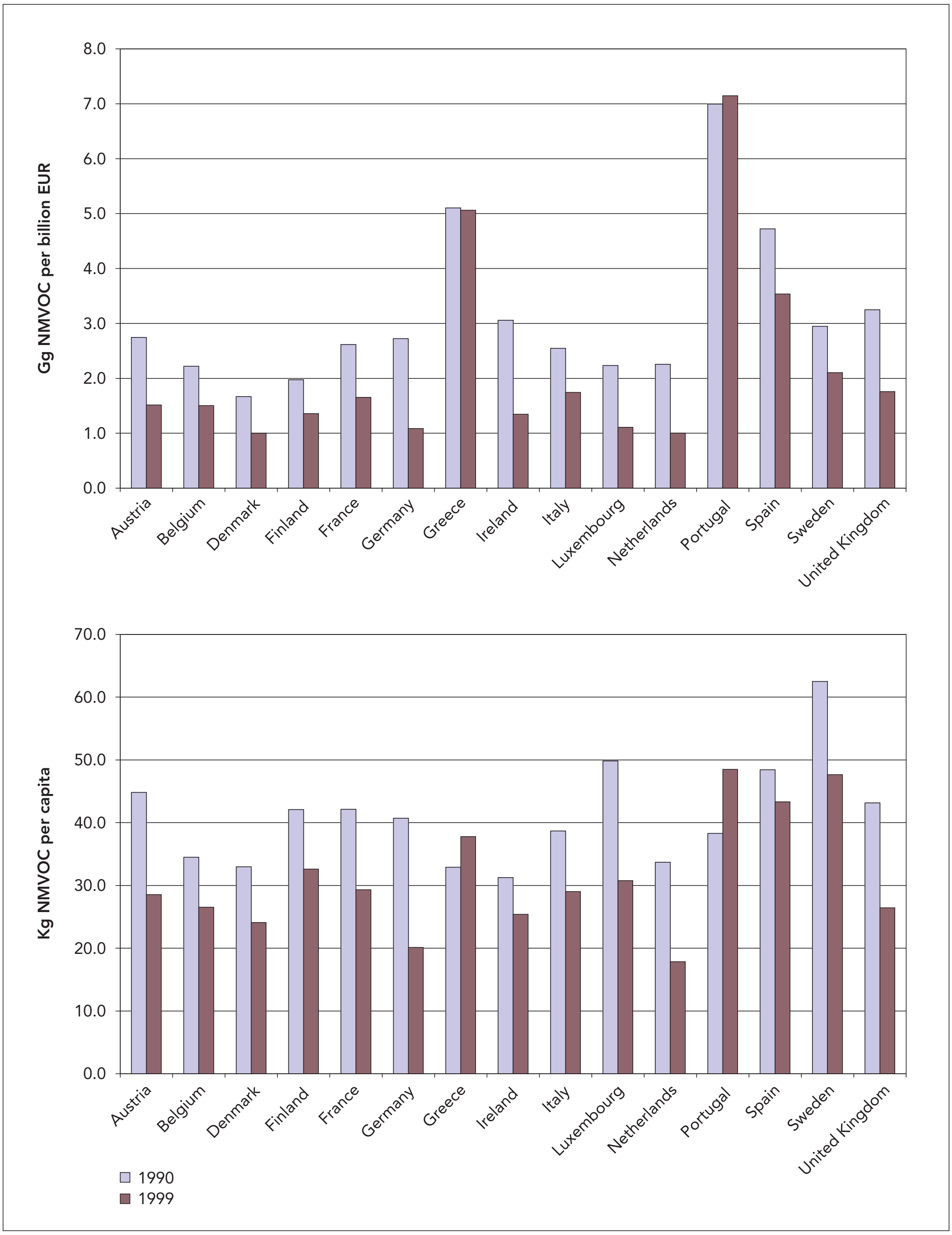
Other EEA-18 countries:
Norway shows a 16 % increase in emissions of ammonia between 1990 and 1999. A reduction of 44 % is needed for Norway to meet its 2010 Gothenburg Protocol emission targets of 195 000 tonnes. Liechtenstein has reduced emissions by 19 % between 1990 and 1999. A further 57 % reduction is necessary for Liechtenstein to meet its Gothenburg Protocol targets of 860 tonnes in 2010.

target path for NMVOCs in 1999 (Figure 3.19). The European Union as a whole was 2 index points below the linear target path in 1999 mainly due to emission reductions in three countries: UK, Netherlands and Germany. These three countries were more than 10 index points below their linear path. Two countries, Greece and Portugal were significantly above their target path but their emissions are relatively small and they have only a small effect on the overall EU trend.

Emissions of NMVOC per capita are high across most of the EU Member States (Figure 3.20). Emissions per capita for the Netherlands and Germany have fallen significantly due to strict controls on emissions from vehicles and industrial processes. Emissions per GDP are high for Portugal and Greece where GDP per capita is relatively low. Emissions per capita have increased in Greece and Portugal, where emissions per GDP have also increased.

Figure 3.20 | EU Member State emissions of NMVOC per GDP (top; Gg/billion EUR) and per capita (bottom kg/capita)

Source: GDP and population: Eurostat.

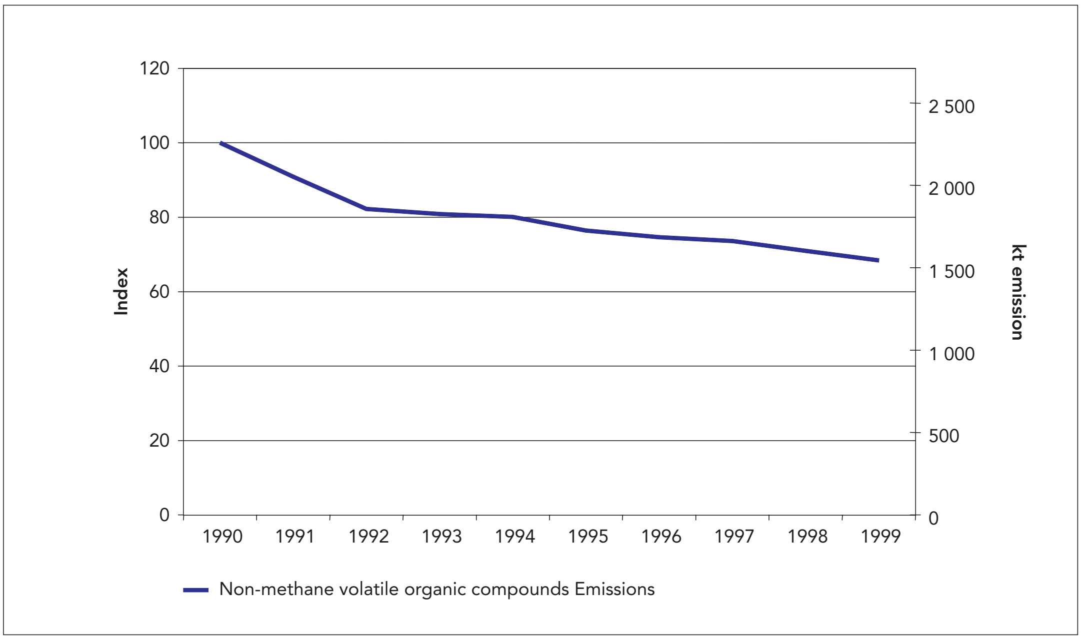


3.2.2. Accession countries

The emissions of NMVOC in accession countries have been reduced by approximately 30 % since 1990.

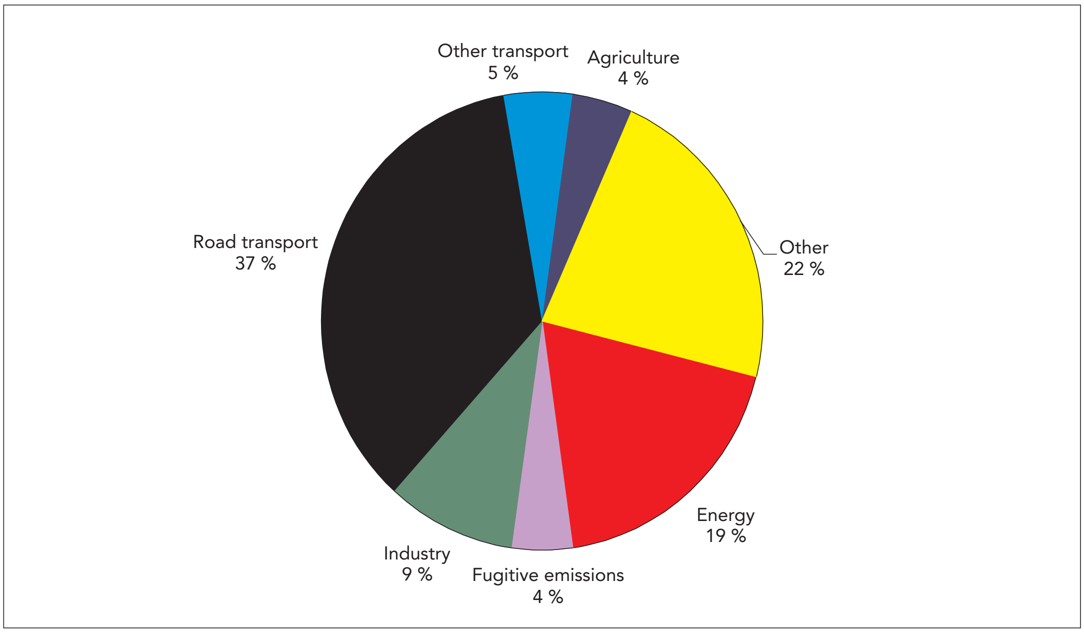
Emissions of NMVOCs in the accession countries (Figure 3.21), occur mainly from incomplete combustion, in gasoline-powered road vehicles and from solvent production and use. NMVOC emissions have been reduced in accession countries since 1990 by between 9 % and 64 %. The reduction in some accession countries is as a result of measures implemented following the introduction of the VOC protocol, in others probably, the reduction is due to the process of economic restructuring. Most of the accession countries have achieved a sufficient decrease to meet emission targets for 2010. The Czech Republic and Hungary need to achieve further emission reductions to meet the 2010 targets. These further reductions are likely to require additional measures.

AC-9 NMVOC emissions (Romania not included) Figure 3.21



Source: EEA ETC/ACC based on data reported to the UNECE/CLRTAP/EMEP and/or also UNFCCC.

Sector split of AC-9 NMVOC emissions in 1999 in (%) Figure 3.22



Change in AC-9 (Romania excluded) emissions of NMVOC per sector 1990 to 1999 (%) Figure 3.23

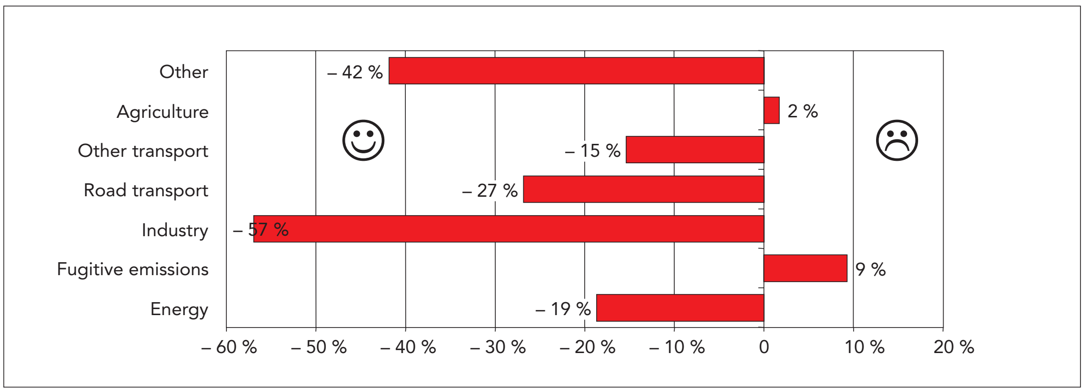


Figure 3.24 **Contribution to change in non-methane volatile organic compounds emissions for each sector 1990–99, AC-9 (Romania excluded) (%)**

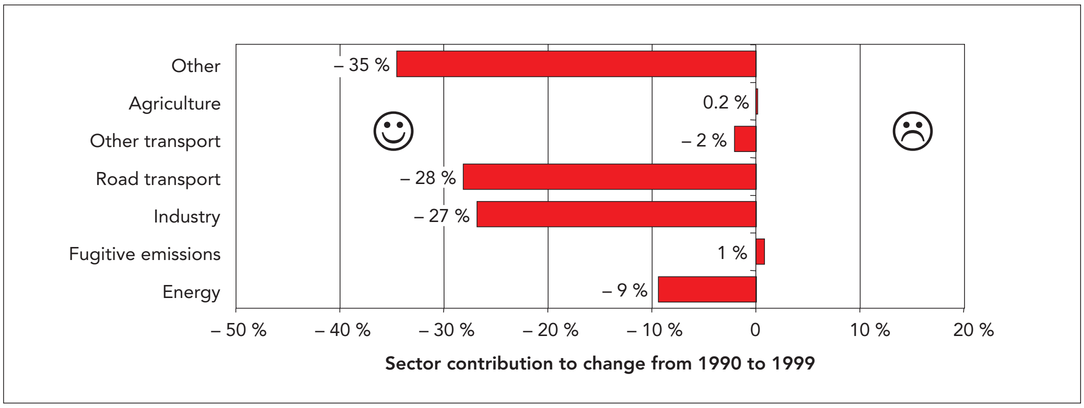


Figure 3.25 **AC-10 percentage change in NMVOC emissions since 1990 compared with the 2010 targets**

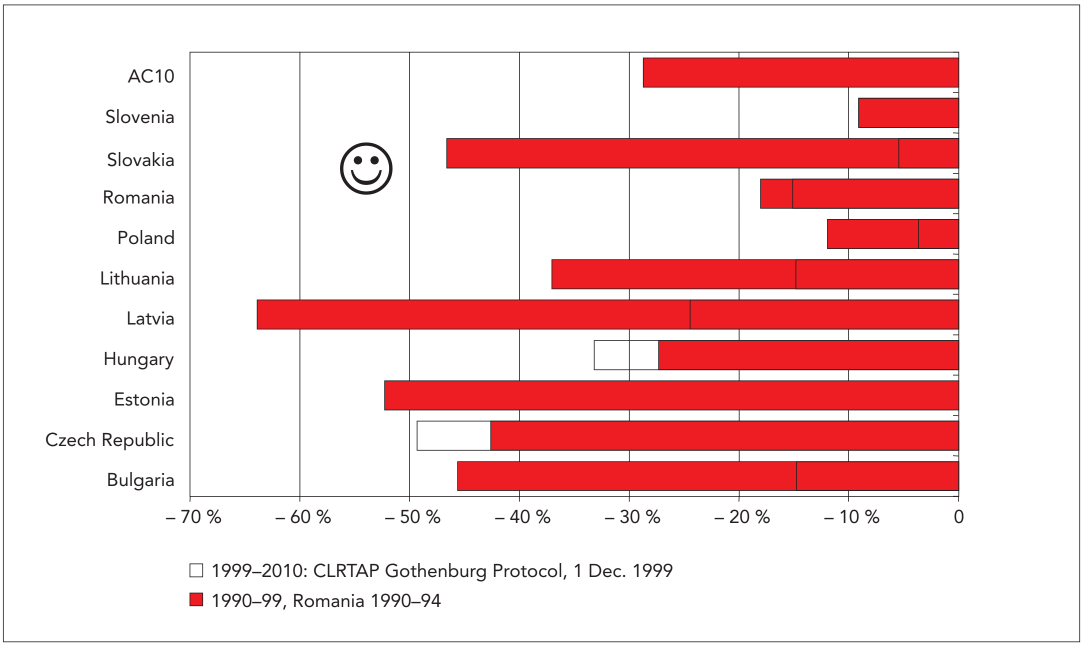
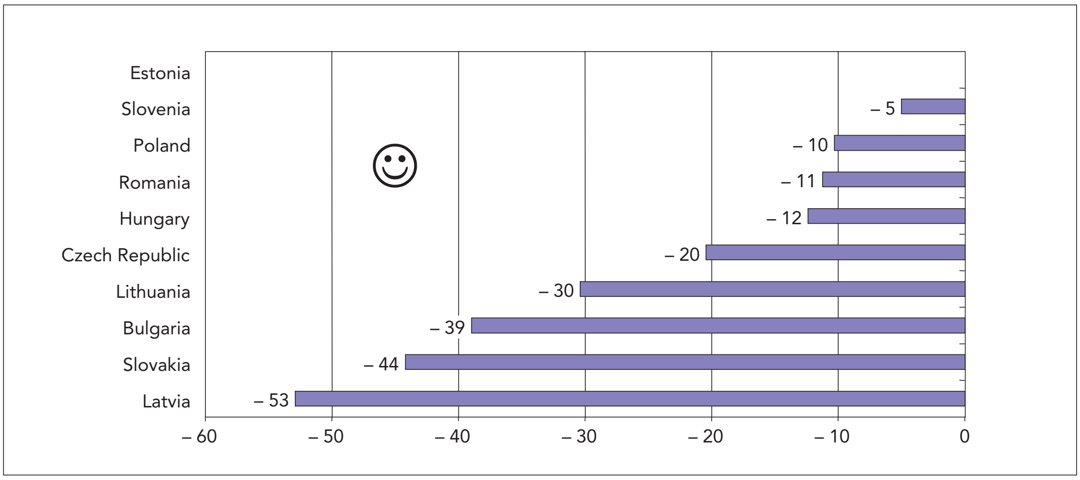


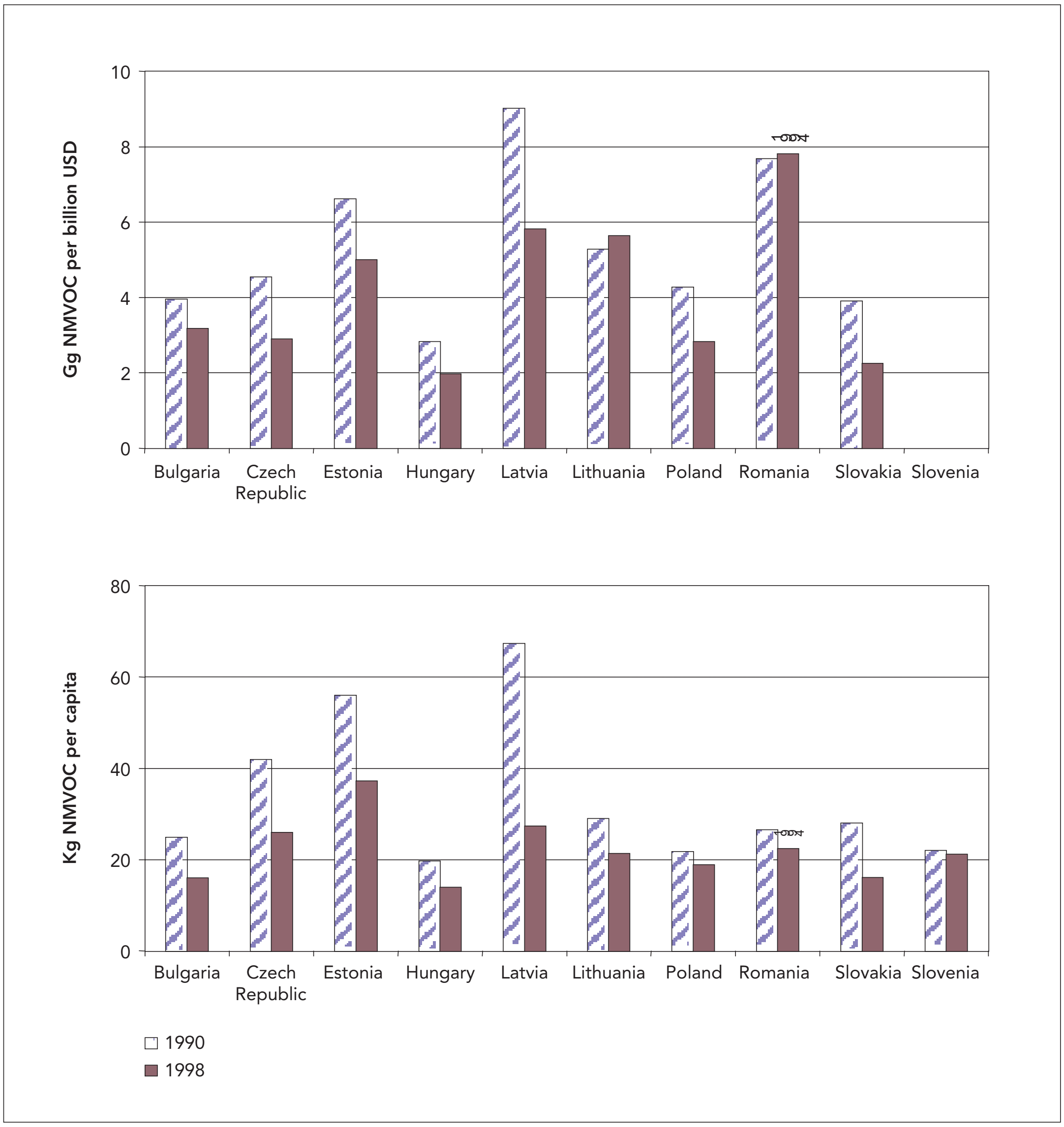
Figure 3.26 **Distance-to-target indicators (in index points) for the 2010 targets**



Note: The 2010 targets — CLRTAP Gothenburg Protocol, (1 Dec. 1999). Estonia is not a signatory of the Gothenburg Protocol.

The distance-to-target indicator is a measure of the deviation of actual emissions in 1999 (Romania 1994) from the (hypothetical) linear path to the target set in the Gothenburg Protocol.

Emissions of NMVOC per GDP (top; Gg/USD) and per capita (bottom; kg/capita) in AC-10 Figure 3.27



Note: GDP (1990 billion USD) and population data source IAE Statistics. GDP data for Slovenia were not available.

The most important contribution to change in NMVOC emissions in the period 1990–99 in this region is solvent use (– 35 %), road transport (– 28 %), and industry (– 27 %). Other sector contribution to change in NMVOC emissions are shown in Figure 3.24.

Figure 3.26 shows that in 1999, all accession countries were below their linear target path for NMVOCs.

3.3. Carbon monoxide

Key message — EU-15

☺ EU-15 emissions of CO have been reduced by 32 % between 1990 and 1999 mainly as a result of controls on road vehicles and increases penetration of diesel vehicles.

Key message — Accession countries

☺ CO emissions in accession countries have been reduced by 44 % between 1990 and 1999 mainly as a result of controls on road vehicles, decreases in iron and steel industry and decrease in energy consumption.

Figure 3.28 **EU-15 emissions of carbon monoxide, CO, (kt)**

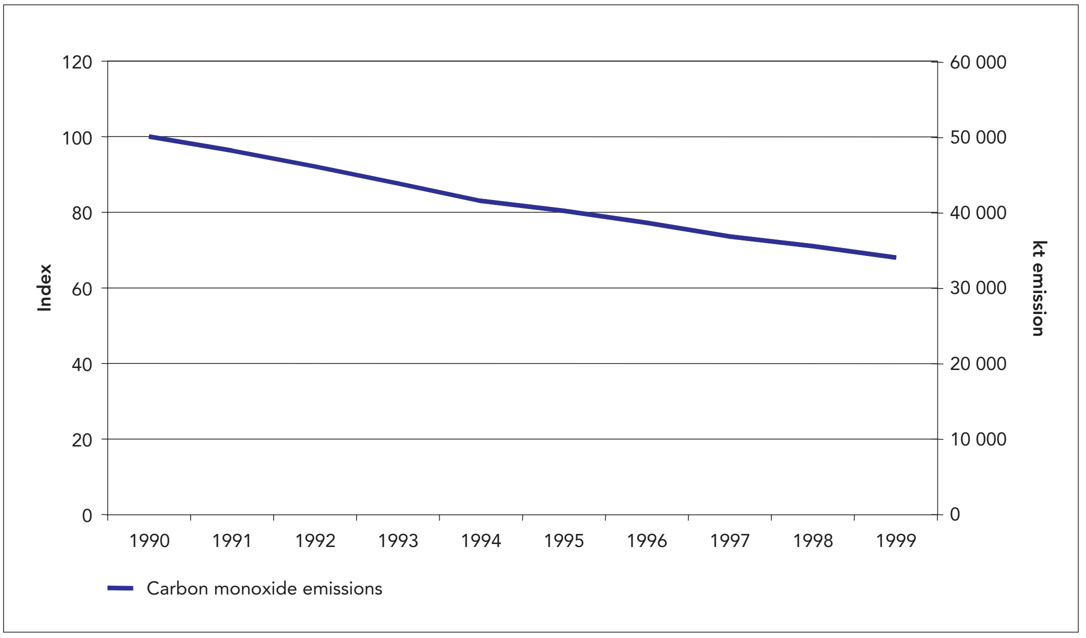
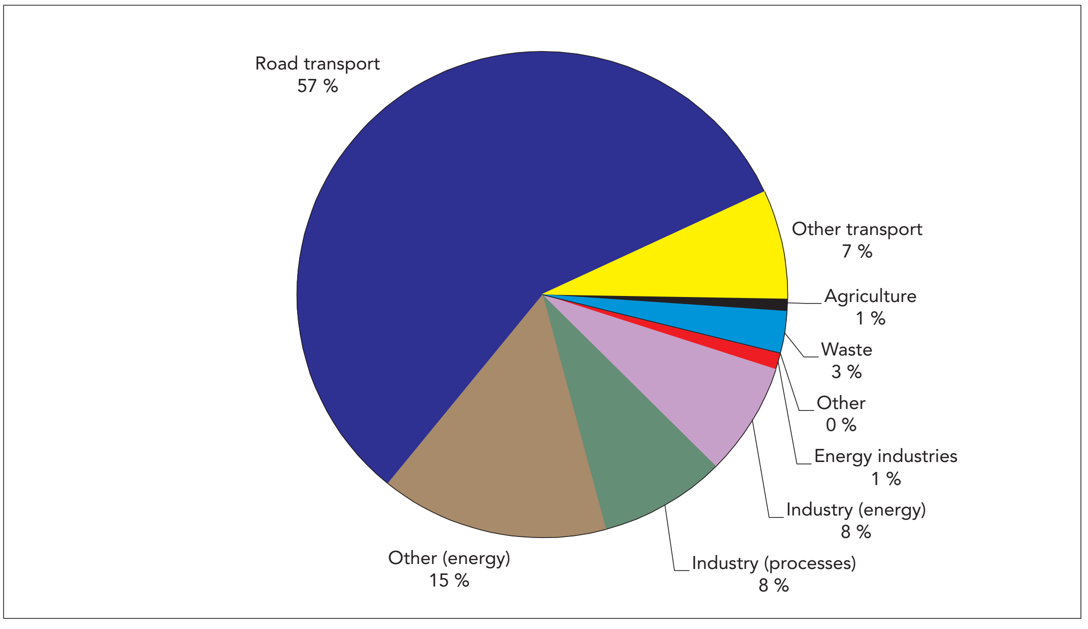
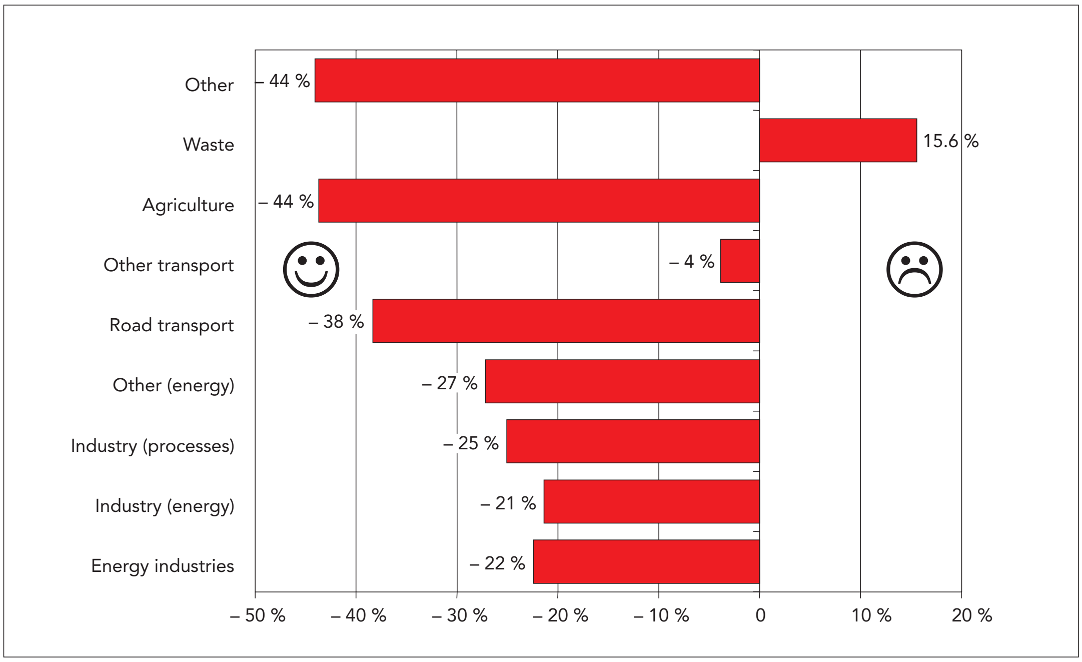


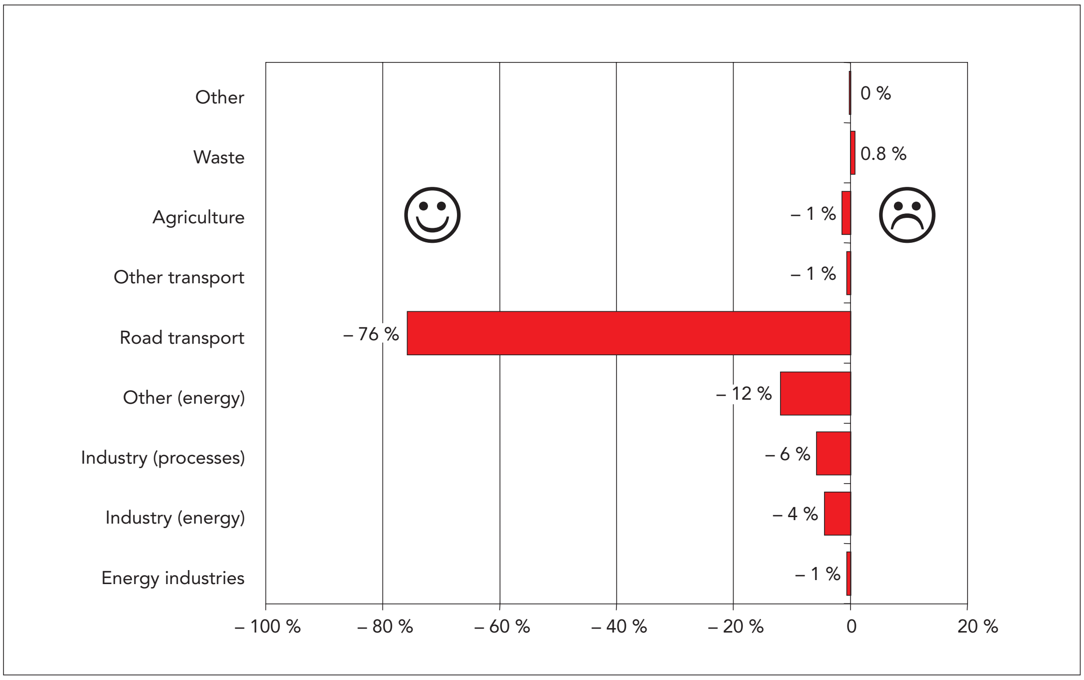
Figure 3.29 **Sector split of EU-15 CO emissions in 1999 (%)**



Change in CO emissions for each sector 1990–99, EU-15 (%) Figure 3.30



Contribution to change in CO emissions for each sector 1990–99, EU-15 (%) Figure 3.31



Source: EEA ETC/ACC based on data reported to the UNECE/CLRTAP/ EMEP and/or also UNFCCC.

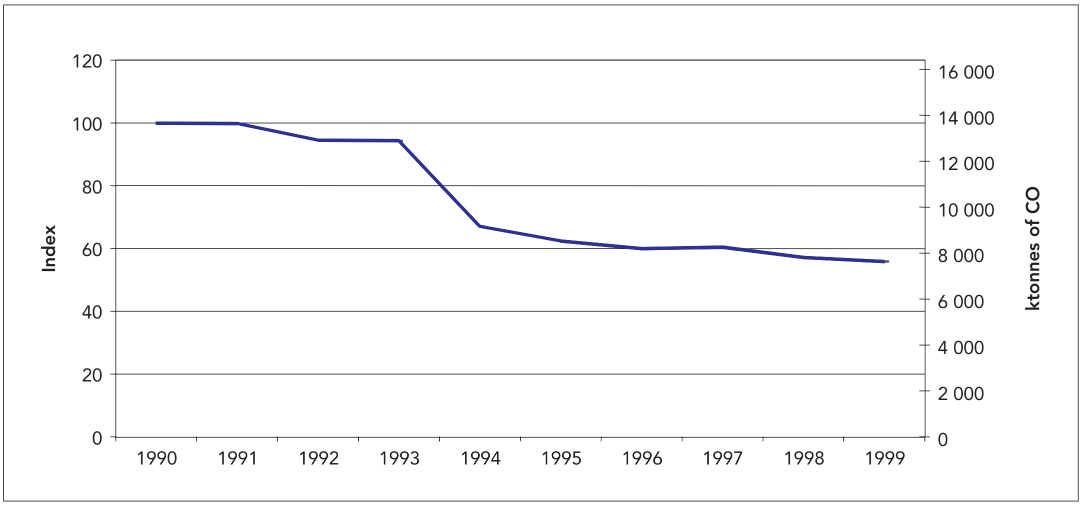
Note: There are no specific emission reduction targets for CO.

EU-15 emissions of CO have been reduced by 32 % between 1990 and 1999 (Figure 3.28). The decrease between 1998 and 1999 was 4 %. Carbon monoxide is mainly emitted due to incomplete combustion of fossil fuels.

Road transport (mostly petrol cars) is the most important source of CO (57 % in 1999). Industry contributed to 16 % of CO emissions in 1999 through combustion and certain industrial processes such as iron and steel production. Smaller emission in other sources (15 %) includes incomplete burning of fossil fuels in the domestic and commercial sectors.

Carbon monoxide (CO) is a toxic gas that in high concentrations can become a hazard to human health. There are no specific emission targets set for CO. However, there

Figure 3.32 **AC-9 emissions (Romania excluded) of carbon monoxide, CO, (kt)**



Note: Missing emissions data of Poland between 1991 and 1993 were substituted with 1990 value.
Sectoral CO emission data for accession countries were not available.
There are no specific emission reduction targets for CO.

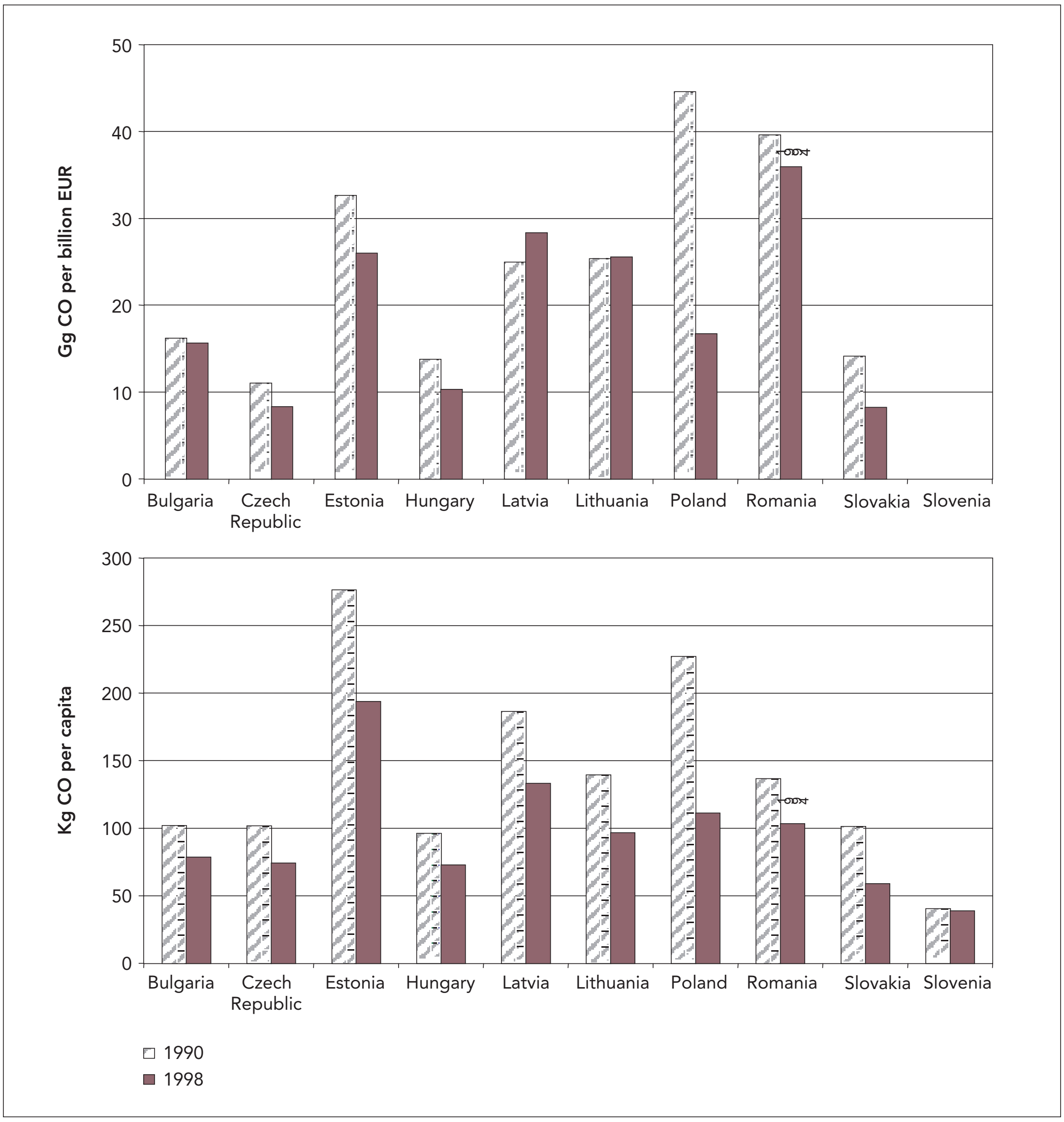
are directive and protocol that affect the emissions of CO. Carbon monoxide is covered by the second daughter directive under the air quality directive. This gives a limit of 10 mg m^{-3} for ambient air quality to be met by 2005. Carbon monoxide contributes to the formation of troposphere ozone, although it is less important in that respect than NO_x and NMVOC. The tropospheric ozone forming potentials (TOFP) for carbon monoxide is 0.11. NMVOC have a TOFP of 1.

Emission reduction of CO is mainly as a result of controls on road vehicles and increases penetration of diesel vehicles.

3.3.1. Accession countries

Accession countries emissions of CO have been reduced by more than 40 % between 1990 and 1999. The structure of sources is approximately the same as in the EU region, carbon monoxide is mainly emitted from incomplete combustion of fossil fuels.

Emissions of CO per GDP (top; Gg/USD) and per capita (bottom; kg/capita) Figure 3.33



4. Emissions of particulates — EU-15

Key messages — EU-15

☺ Total EU-15 emissions fine particulate have been reduced by 34 % between 1990 and 1999. This is mainly due to reduction in emissions of the secondary particulates precursors SO_2 and NO_x, but also to reductions of primary PM_{10} from energy industries.

☺ Nine Member States have reduced their total emissions of fine particulates more than 25 % since 1990.

☹ Substantial further reductions are needed to reach the limit values set in the first daughter directive to the EU framework directive on ambient air quality.

☹ Data on emissions of particulates are more uncertain than data for other air pollutants and further improvement of data quality is needed.

This chapter presents some data on emissions of particulate matter (PM_{10}), in Europe. High levels of particulate matter (PM_{10}) has been found to have a close correlation with instances of increased hospital admissions for breathing-related problems. Some of the compounds that make up particulate matter can also have a toxic or carcinogenic effects.

A large fraction of the urban population is exposed to levels of fine particulate matter in excess of limit values set for the protection of human health.

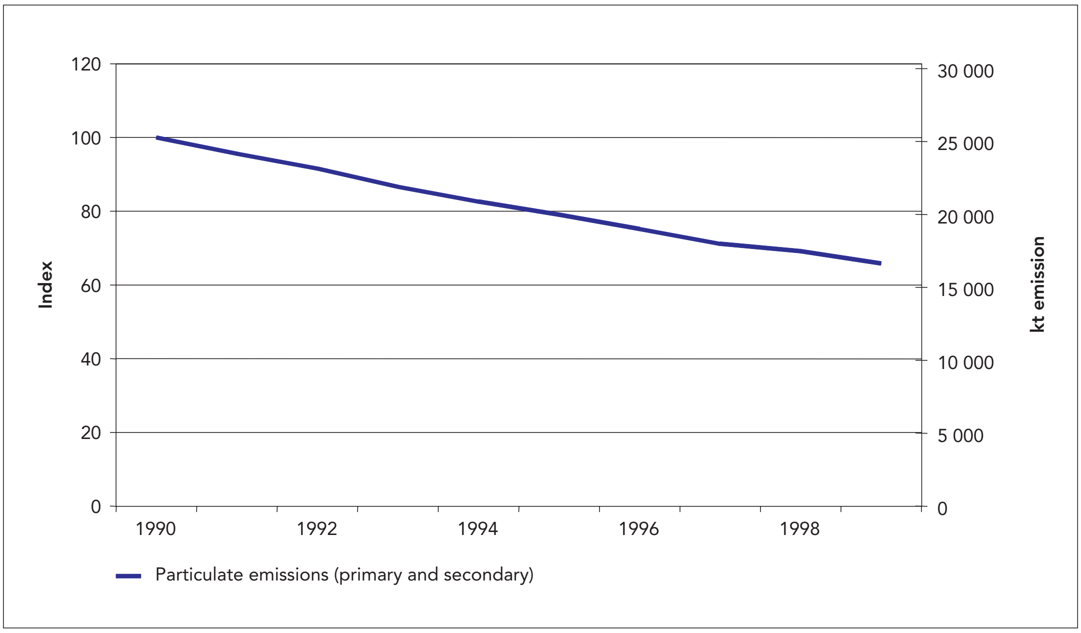
The emissions of PM_{10} as presented in this chapter are based on primary particulate estimates presented for Auto Oil II. Secondary particulate have been estimated using crude particulate forming potential factors applied to nationally reported estimates of NO_x, SO_2 and NH_3.

The coordinated European programme on particulate matter emission inventories, projections and guidance (CEPMEIP) has recently compiled particulate emissions data for 1995 as part of the activities aimed at supporting national experts in reporting particulate matter emission inventories to the EMEP programme under the UNECE Convention on Long-range Transboundary of Air Pollution (CLRTAP).

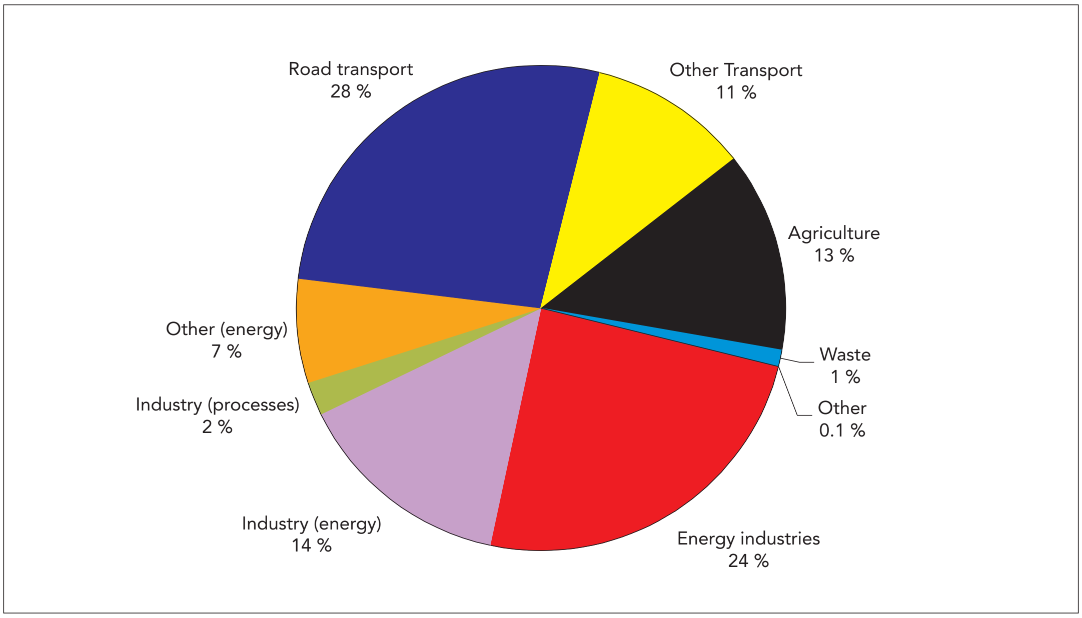
Submission of PM_{10} emission to the UNECE will be required from 2002.

Emissions of primary PM_{10}, and secondary PM_{10} precursors (NO_x, sulphur dioxide and ammonia) (Figure 4.1) contribute to elevated levels of fine particles in the atmosphere. Primary PM_{10} refers to fine

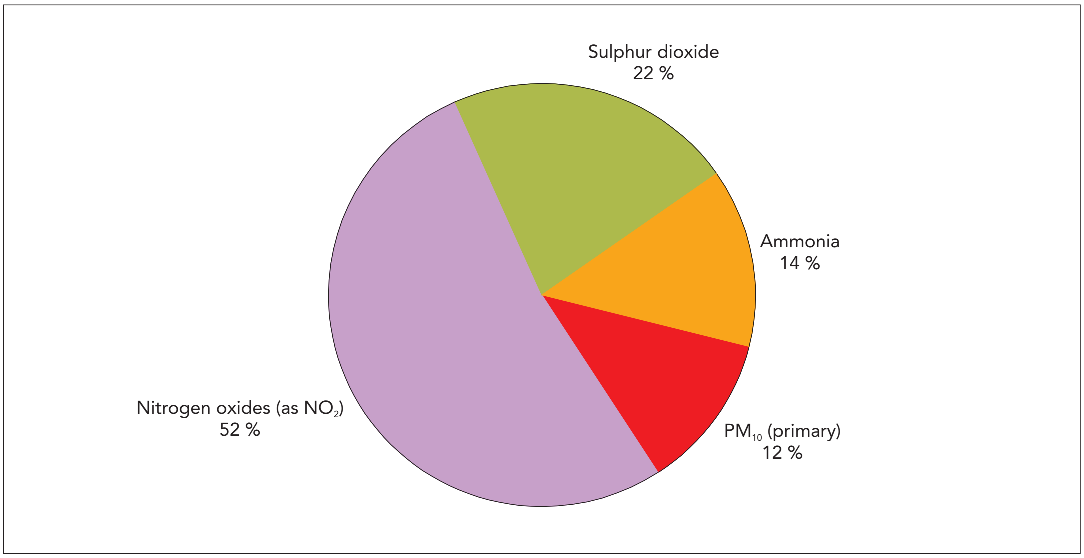
Figure 4.1 **Total EU-15 emissions of primary and secondary fine particulate (kt)**



Sector split of EU-15 emissions of primary and secondary fine particulates in 1999 (%) Figure 4.2



Pollutant split of EU-15 emissions of primary and secondary fine particulates in 1999 (%) Figure 4.3



particles directly emitted into the atmosphere from sources while the PM_{10} precursors emissions refer to emissions from pollutants, which are (partly) transformed to particles (the so-called secondary fraction) by photo-chemical reactions in the atmosphere. Estimates of primary PM_{10} are quite uncertain as the emission data for primary PM_{10} is not as robust as that for other pollutants. The factors used in the estimation of secondary PM_{10} emission are based on assumptions about the deposition and reactions of the precursor pollutants.

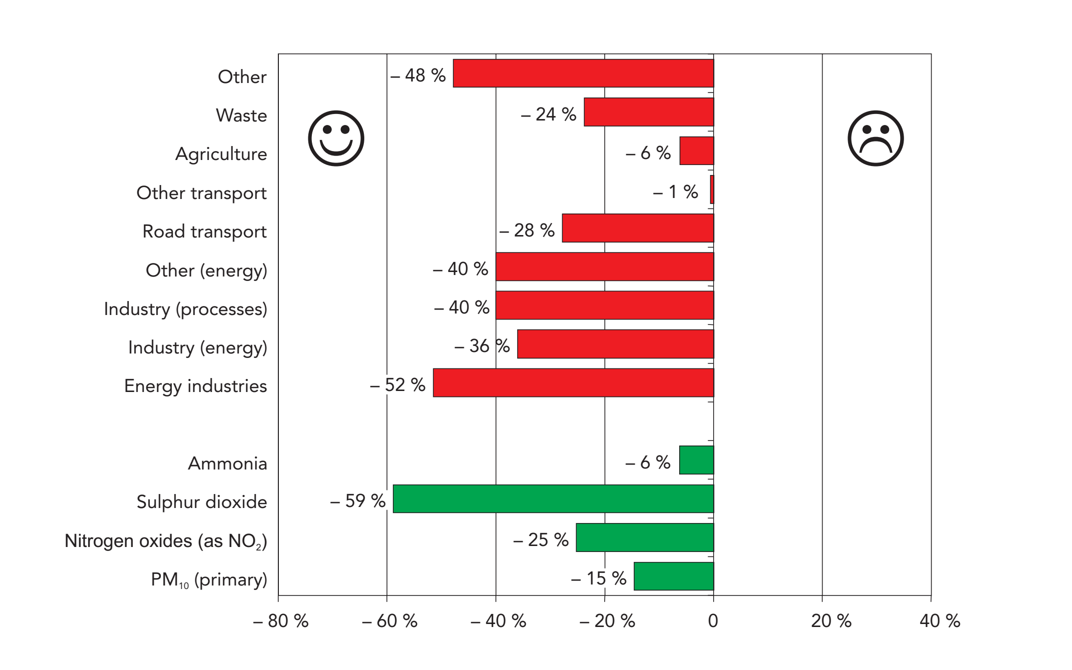
The transport and energy industry sector were the most important contributing sectors in 1999 28 and 24 % respectively (Figure 4.2). Emissions of the precursors NO_x (52 %) and sulphur dioxide (23 %) are the most significant pollutants contributing to atmospheric PM_{10} in 1999 (Figure 4.3). Primary PM_{10} and ammonia contribute 12 % and 13 % in 1999 respectively.

Between 1990 and 1999, especially energy industries, but also the road transport and industry sectors contributed strongly to the reduction of total PM_{10} (Figure 4.4 and Figure 4.5). Implemented measures includes fuel switching and the introduction of abatement technologies in the energy industries and industry and increased

Figure 4.4

Change in EU-15 emissions of primary and secondary fine particulates for each sector and pollutant 1990–99 (%)

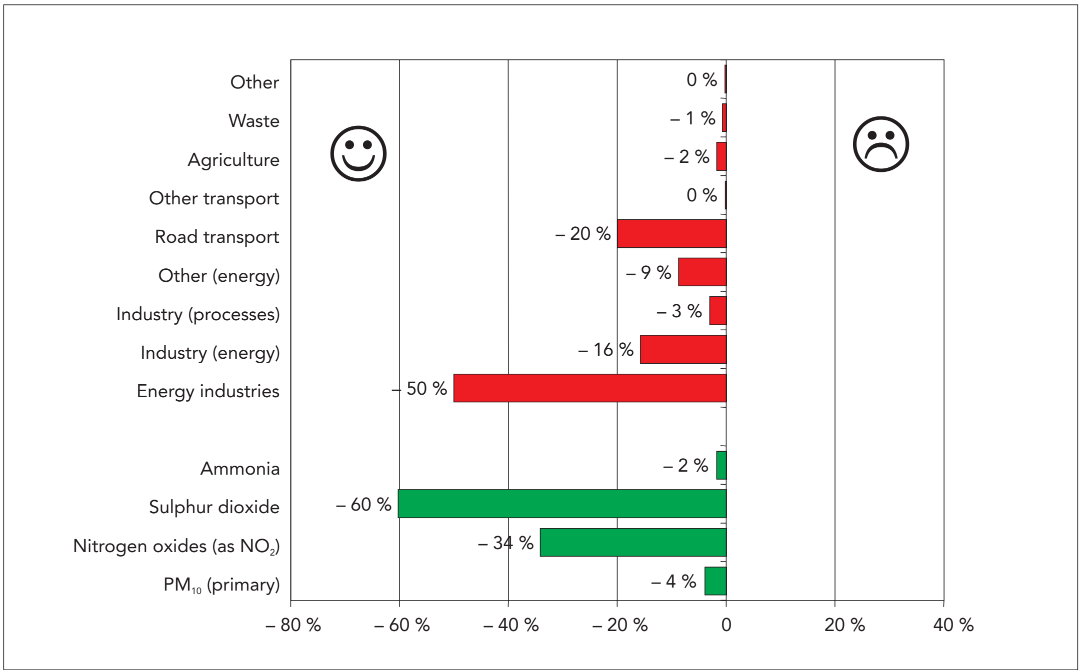
Source: EEA — ETC/ACC and UNECE/ CLRTAP/ EMEP.



Note: Emission trend of primary and secondary fine particulates. No emission target exists for emissions of primary particles.
Aerosol formation factors for SO_2, NO_x and NH_3 were used to assess the emissions of secondary particulates precursors: SO_2=0.54; NO_x=0.88 and NH_3=0.64.

Figure 4.5

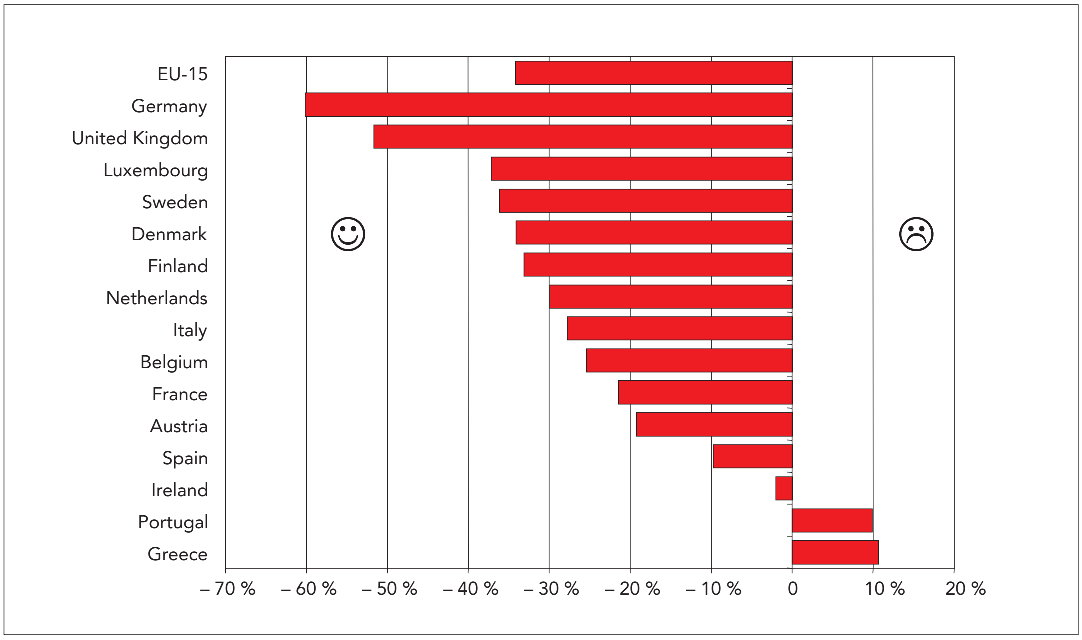
Contribution to change in primary and secondary fine particulate emissions for each sector and pollutant 1990–99, EU-15 (%)



penetration of catalytic converters for road vehicles.

Emissions of primary PM_{10} and secondary PM_{10} precursors are expected to be reduced in the future as improved vehicle engine technologies are adopted and stationary fuel combustion emissions are further controlled. Despite this, it is expected that in the near future, in the majority of the urban areas within EU-15 territory, PM_{10} concentrations will be well above the limit values.

Change in emission of primary and secondary fine particles since 1990 (%) Figure 4.6



Source: EEA — ETC/ACC and data reported to the UNECE/CLRTAP/EMEP.

Two countries, the United Kingdom and Germany have reduced emissions by more than 50 % since 1990 (Figure 4.6). Five other Member States have reduced emissions with more than 30 %. Overall this contributes to a 34 % reduction in the EU. Portugal and Greece are the only Member States that have increased emissions between 1990 and 1999.

Currently no emission ceilings or reduction targets exist for fine particulates within the EU or within the framework of UNECE/ CLRTAP.

5. Emissions by sectors — EU-15

This chapter addresses the emissions from some main sectors and pollutants/issues (see table below and sector table on page 8) and their contribution for the pollutants contributing to acidification, tropospheric ozone formation and emissions of fine particulates (Figure 5.1). Thus this chapter summarises the information presented in Figure 2.2, Figure 2.16, Figure 2.30, Figure 2.44, Figure 3.2, Figure 3.15 and Figure 4.2. In addition this chapter provides additional information.

Chapter	Corresponding UNECE/ EMEP/ Corinair sectors in 1999
5.1. Energy industries	1: Combustion in energy and transformation industries
5.2. Industry (process & energy	4: Production processes 3: Combustion in manufacturing industry
5.3. Transport (road and other)	7: Road transport 8: Other mobile sources and machinery
5.4. Agriculture	10: Agriculture

5.1. Energy industries

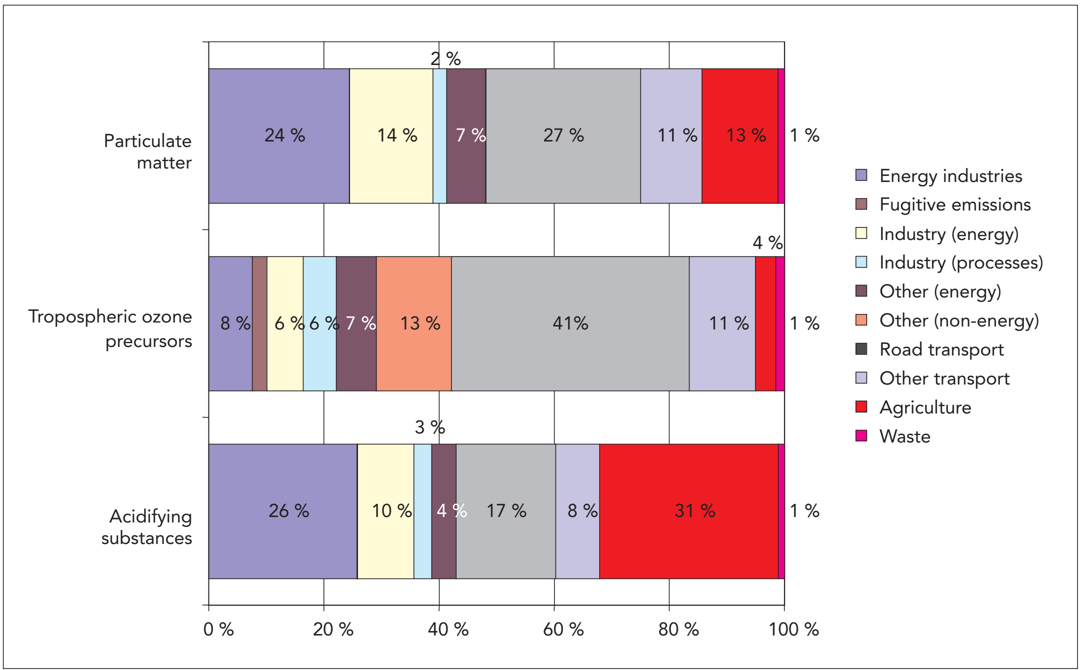
Key messages

☺ From 1990 to 1999, the emissions from energy industries of acidifying substances, tropospheric ozone precursors and particulate matter have decreased by 56 %, 42 % and 52 % respectively.

Total emissions of acidifying substances from the energy sector decreased by 56 % between 1990 and 1999, mainly through reductions of sulphur dioxide in the energy production and refining industries. Emissions of tropospheric ozone precursors (mainly NO_x) decreased less, but still by 42 %. These reductions are the result of controls (end-of-pipe technology) on emissions from coal combustion and a shift from solid and liquid fuel to natural gas.

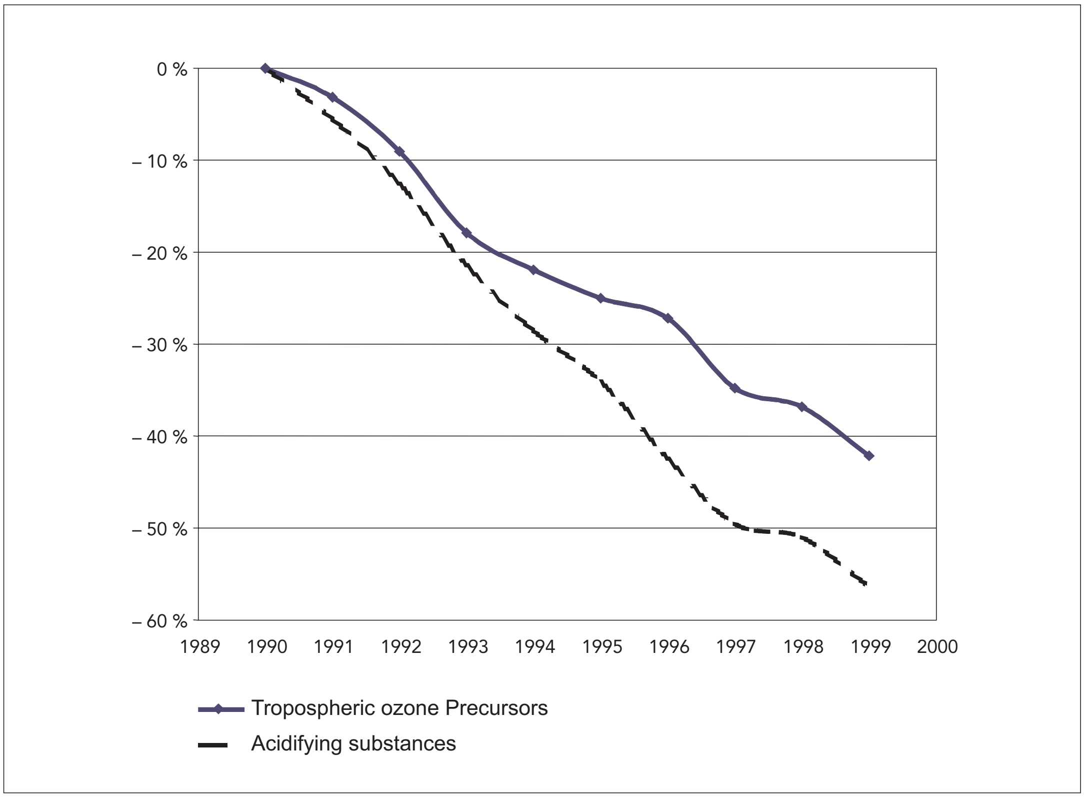
Figure 5.1 **Relative sector contributions to main air pollution issues in 1999 (%)**

Source: EEA — ETC/ACC and data reported to the UNECE/CLRTAP/EMEP.



Note: The factors used to aggregate pollutants and present a single figure for a particular issue are currently under development. They represent an over-simplified approach to a very complex process of chemical interactivity. In many cases an average effect has been taken. However, depending on atmospheric conditions and concentration loadings of different pollutants these factors could vary considerably.

Emission trend 1990–99 of tropospheric ozone precursors and acidifying substances from the energy sector (% of 1990 value) Figure 5.2



The energy sector's contribution in 1999 of total EU-15 emissions of individual air pollutants (%) Figure 5.3

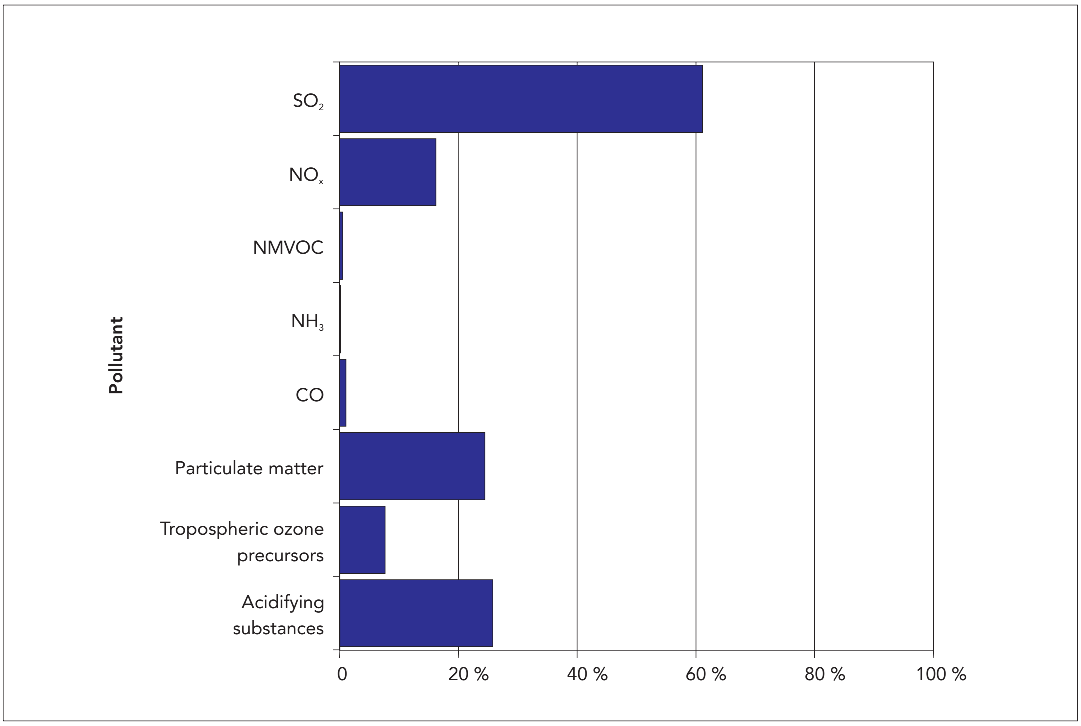
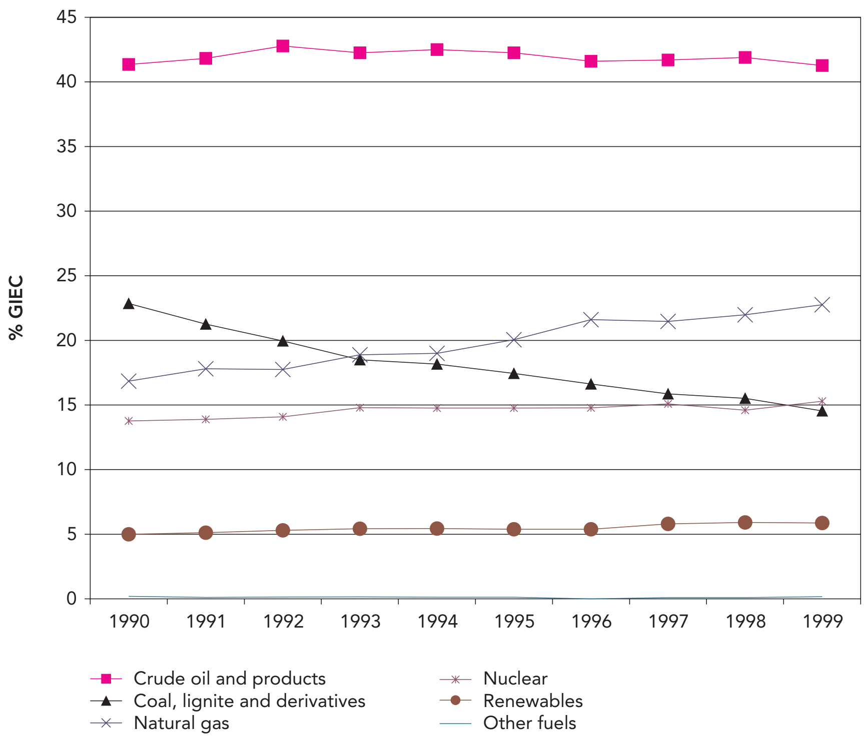


Figure 5.3, shows the energy sector's share of total European Union emissions of air pollutants.

Despite reductions in sulphur dioxide between 1990 and 1999 of nearly 60 %, the energy sector is still the most important

Figure 5.4 **Gross inland energy consumption in the EU Member States — Contribution of different fuels**



sector contributing to sulphur dioxide emissions (61 % of the European Union total emissions). The high share of sulphur emissions is also reflected in the significant contribution to the total emissions of particulate matter and acidifying substances. The relatively low contribution to the emission of tropospheric ozone precursors is a result of low result of high combustion efficiencies and therefore lower NMVOC and CO emissions.

The energy mix in the EU Member States has changed significantly during the period 1990 to 1999 (Figure 5.4). The use of coal lignite and derivatives has decreased from 23 % to less than 15 % during the period — natural gas has increased from about 17 % to almost 23 %.

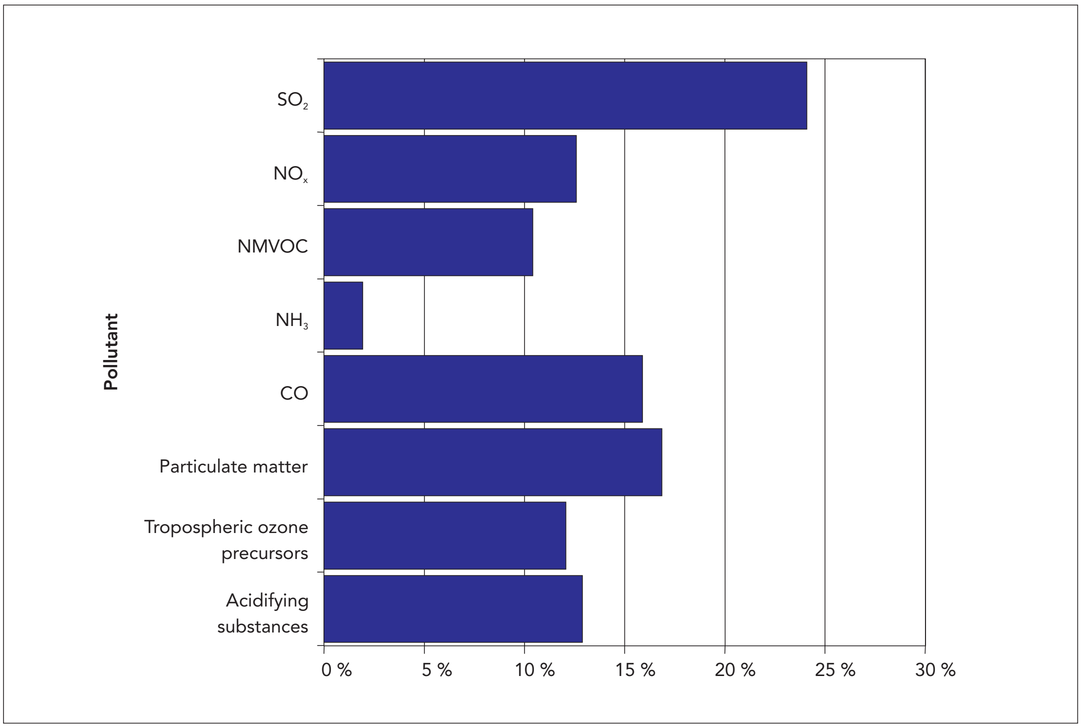
5.2. Industry (process and energy)

Key messages

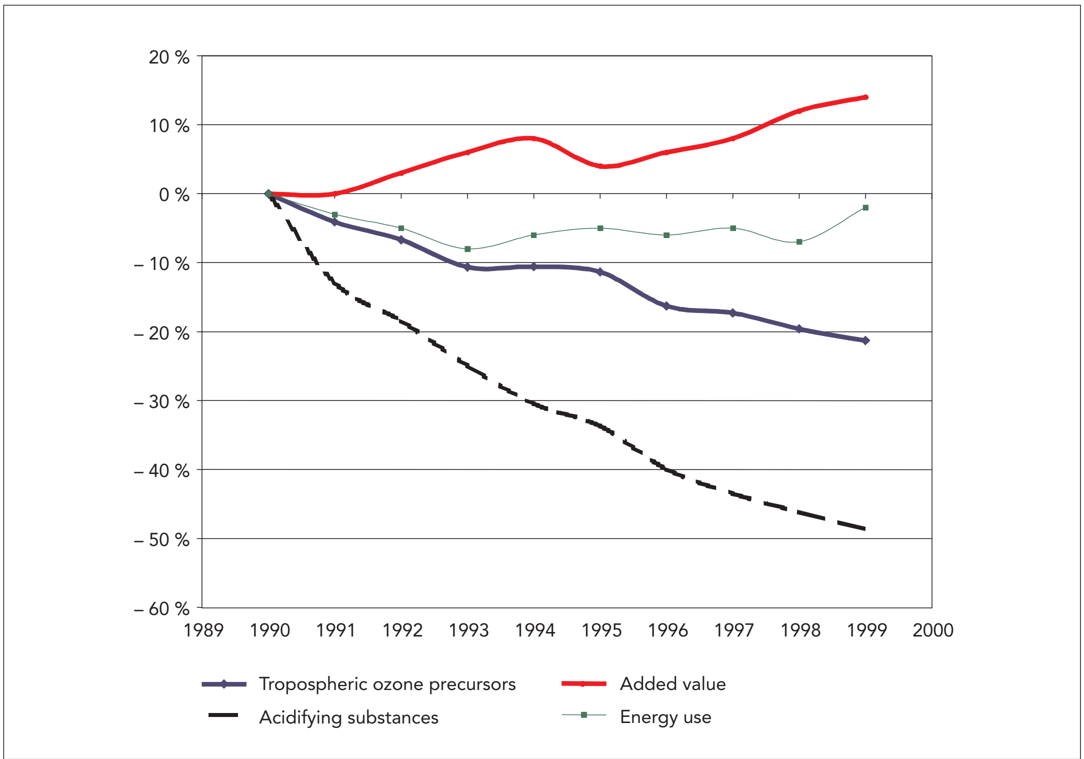
☺ Emissions of acidifying gases and tropospheric ozone precursors from the industry sector decreased between 1990 and 1999 by 50 % and 20 % respectively, while industrial energy use in 1999 were at 1990 levels and value added is above 1990 levels. This suggests decoupling of emissions from industry from energy use and economic developments.

Figure 5.5 shows the share of European Union emissions from industrial sources in 1999. The highest contribution to any pollutant or issue area covered here is that of sulphur dioxide at approximately 24 %. Emissions for other pollutants range from 3 to 20 %. However it should be noted that NMVOC emissions to a large extent fall within 'Other' emissions, as defined in Section 1.2. This includes all emissions from SNAP Sector 6 (Solvent and other product use), which is a combination of emissions from various industries and processes and from households. Therefore the share of NMVOC emissions from industry would in total be substantially higher than given in Figure 5. NMVOC emissions from industrial activities are quite diverse. Most industrial NMVOC emissions result from solvent use, which is associated with production activities like automobile and ship production, textile manufacture, paper coating and chemical product manufacture. However, domestic solvent use and road transport (see Section 5.3) are another important sources of NMVOC.

The industry sector's contribution to total EU-15 emissions of air pollutants (%) Figure 5.5



Change in energy use and emissions in the industry sector 1990–99 (% of 1990 values) Figure 5.6



Emissions of acidifying gases (weighted SO_2, NO_x and NH_3 emissions) from the industry sector decreased by nearly 50 % between 1990 and 1999, while tropospheric ozone precursors (NO_x, NMVOC) emissions decreased less, but still by 20 %. During the same period, 1990 to 1999, industrial energy use initially dropped, until 1993, but increased slowly to reach nearly the 1990 level by 1999. Over the same period, industrial value added increased steadily, except for 1995. This suggests a positive trend for emissions from industry. However there are different trends between Member

States and it should be noted that emissions from small and medium-sized enterprises (SMEs) are not well known and therefore trends in their emissions are uncertain.

The most striking emissions reductions is for sulphur dioxide (by 60 %) over the period 1990 to 1999. The smallest reductions were in CO_2 and CH_4, 8 % and 5 % respectively, the other gases reduced by about 20 %. The SO_2 and NO_x emission reductions are the result of reduced emissions from energy use, by means of abatement measures and end-of-pipe technology (flue gas desulphurisation, de-NO_x installations), increased energy efficiency and a trend from solid and liquid fuel to natural gas). Sulphur dioxide emissions from industrial manufacturing processes have also been reduced by measures in specific industries such as copper melting and fertiliser industries.

Emission reduction for NMVOC to date have been difficult but achieved to some extent through 'clean production' measures such as better production control and substance substitution and also by means of end of pipe abatement measures such as incineration and other technologies. Energy related emissions of NMVOC have increased by 9 % between 1990 and 1999.

The main Community level measures focused on industry are the large combustion plant (LCP) directive, the integrated pollution prevention and control (IPPC) directive and the 'solvents' directive (directive on the limitation of emissions of volatile organic compounds due to the use of organic solvents in certain activities and installations). These measures have contributed to the emission reductions and are expected to contribute to further future reductions for the industry sector.

5.3. Transport (road and other)

Key messages

☺ Emissions of acidifying substances have reduced by 22 % between 1990 and 1999, mainly as a result of NO_x emission reduction realised in road transport. Catalytic converters and reduced sulphur in fuels have contributed to this reduction. Further reduction of total acidifying substances is needed from all sectors to reach the 2010 targets.

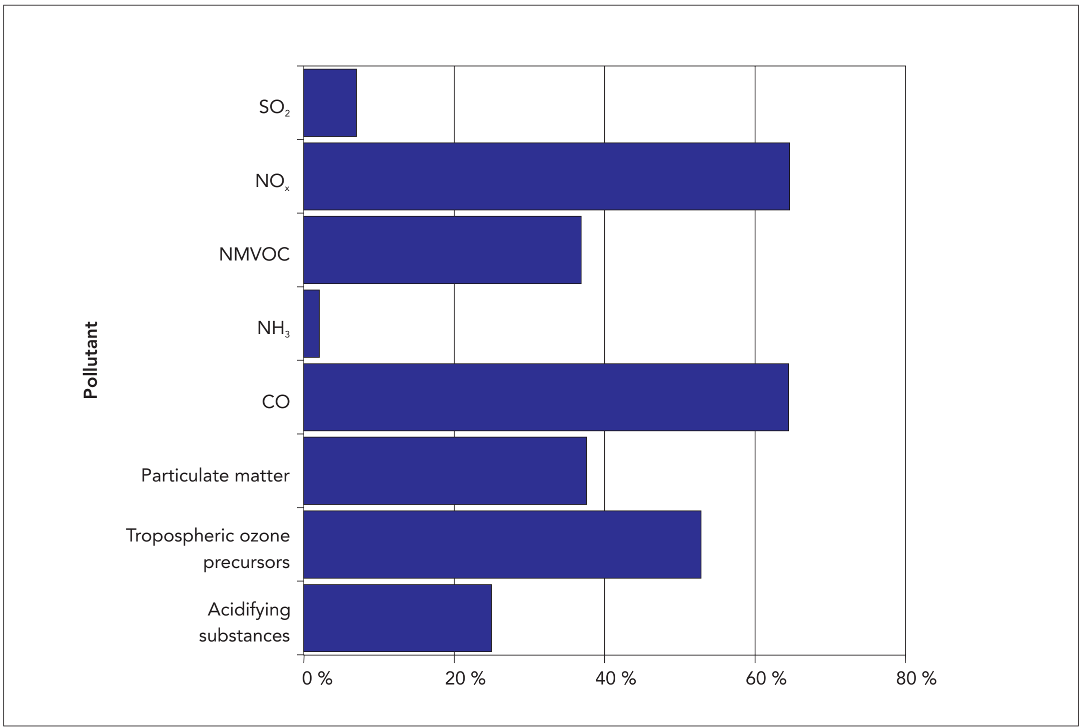
☺ Emissions of ozone precursors have reduced by 29 % over the same period. Road transport has contributed significantly (35 %) to a reduction of these emissions, mainly due to an increased penetration of diesel vehicles and of catalytic converters for petrol-engine vehicles. Further reduction of total ozone precursors is expected as improved vehicle engine technologies are adopted.

😐 Emissions of particulates have reduced by 22 % over the same period. This is due mainly to national and EU regulations aimed at automobile emission reductions (such as the catalytic converter), which have resulted in considerably lower emissions per vehicle. However, the continuous expansion of the vehicle fleet is partly offsetting these improvements. Future particulate emissions from road transport are likely to decrease by 2010. However, it is likely that concentrations of PM_{10} in some urban areas will continue to be above EU limits.

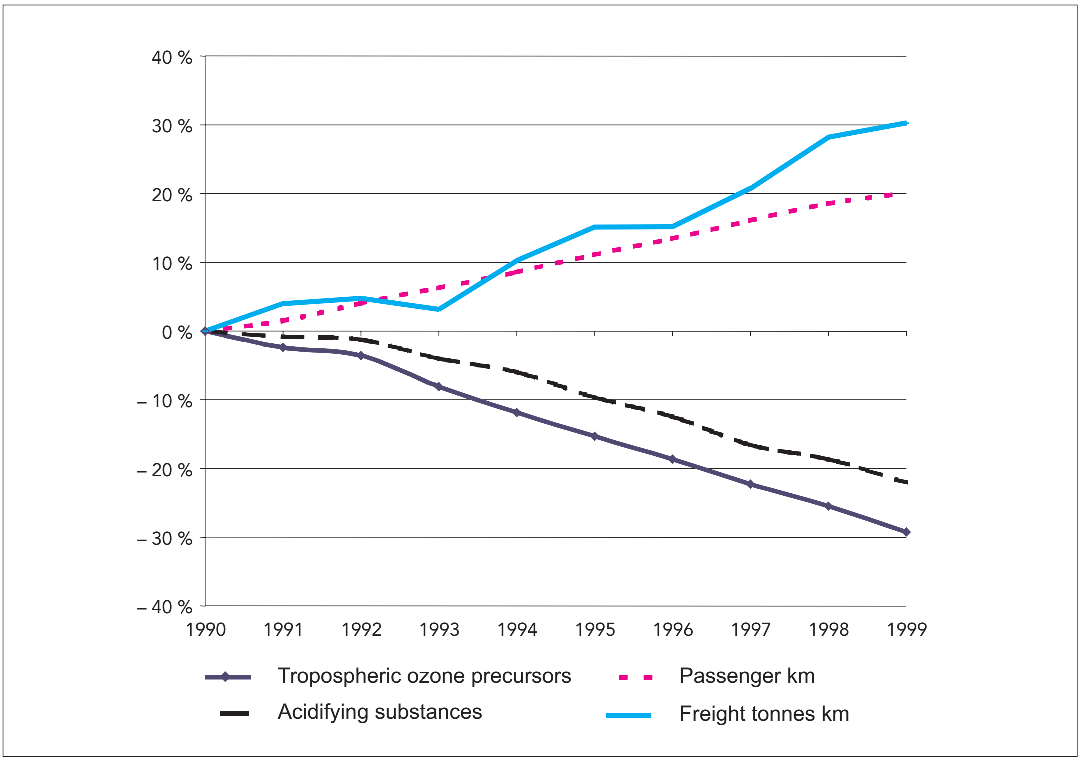
Figure 5.7 shows the share of European Union emissions from all means of transport. The transport sector is a major source of emissions of ozone precursors and to a lesser extent, but still substantial amount of acidifying pollutants.

The shares are the highest for nitrogen oxides (NO_x) (65 %) and carbon monoxide (CO) (64 %), followed by NMVOC (37 %) and carbon dioxide (CO_2) (25 %). As emissions from other sectors have decreased, the share of the transport sector in emissions is increasing for most air pollutants.

Transport sector share of total European Union emissions of air pollutants Figure 5.7



Transport volume and emission trends in the EU (% of 1990 values) Figure 5.8



Source: EEA-ETC/ACC and data reported to the UNECE/CLRTAP/EMEP and/or also UNFCCC. Data on passenger-km and tonne-km from Eurostat.

Figure 5.8 shows trends in emission from transport compared with trends in transport activity (passenger kilometres and freight tonne kilometres) and passenger cars with catalysts (as a percentage of the total number of passenger cars).

Emissions of ozone precursors from road transport have decreased by about 30 % between 1990 and 1999 due to the continued penetration of petrol vehicles fitted with catalytic converters and from an increase of diesel use in cars. However, the effects of these measures have been partially countered by increasing road vehicle use. NMVOCs (34 % reduction) and NO_x (21 % reduction) were the most significant reductions in ozone precursors from road transport. Particulate emissions from road transport fell by 22 % over the period 1990–99. This was largely as a result of the continued penetration of catalytic converters and other improvements to vehicle technology reducing the emissions of secondary particulate precursors (such as NO_x). However emission data of primary and secondary particulates are much less certain than data for other pollutants.

Current European legislation that should help reach the emission targets for acidifying substances and ozone precursors includes Directive 98/70/EC on the quality of petrol and diesel fuels, and the sulphur content of certain liquid fuels (in Directive 2001/81/EC). Also Directive 94/63/EC on the storage and distribution of petrol and solvents aims to limit emissions of volatile organic compounds.

Various measures have been proposed as a result of the auto oil programme (European Commission, 2000a). For instance, the European Commission wrote a proposal for a directive tightening the emission standards for two- and three-wheeled vehicles, which has been agreed upon early 2002 by the European Parliament. The Commission also proposed a directive concerning emissions from engines on recreational craft. Updates of directives concerning vehicles fuel quality (including sulphur levels) are also expected.

Actual energy efficiency of passenger transport (and consequently the specific CO_2 emissions) has improved only slightly in the 1990s, following technological improvements. Freight transport shows no improvement at all in energy efficiency, amongst others because of inefficient loading trends. The discrepancy between improvements in technology and actual energy efficiency is amongst others the result of the use of heavier and more powerful vehicles and lower occupancy rates and load factors (EEA, 2001b).

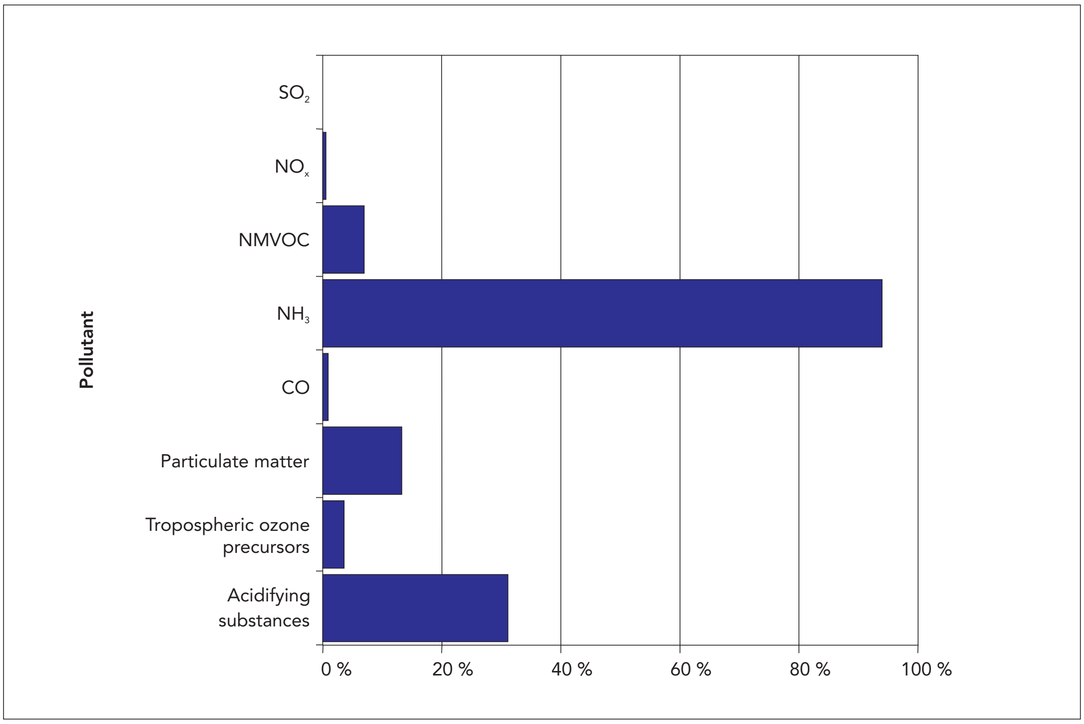
5.4. Agriculture

Key message

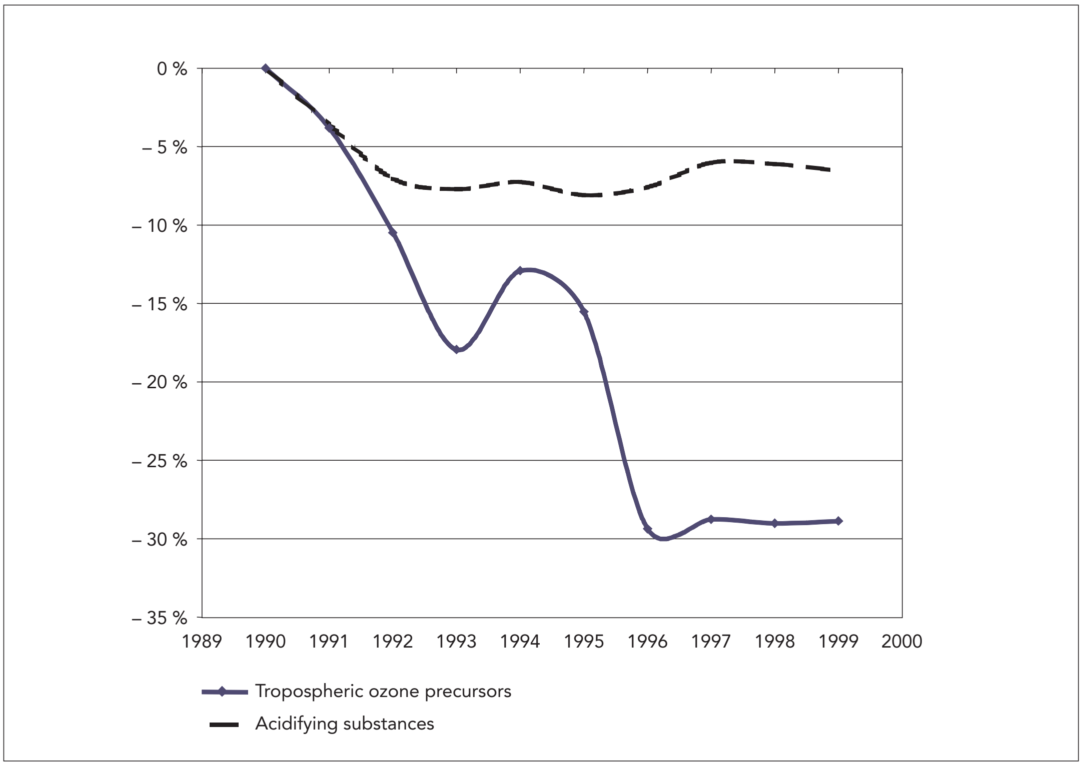
☹ Between 1990–99 ammonia emissions from agriculture have marginally decreased through reducing livestock numbers.

Figure 5.9 shows agricultural ammonia emissions to be 94 % of EU-15 emissions. These occur from manure and enteric fermentation in livestock. Some ammonia is also produced from agricultural soils through manure spreading. Emissions of ozone precursors and acidifying gases continue to fall (Figure 5.10).

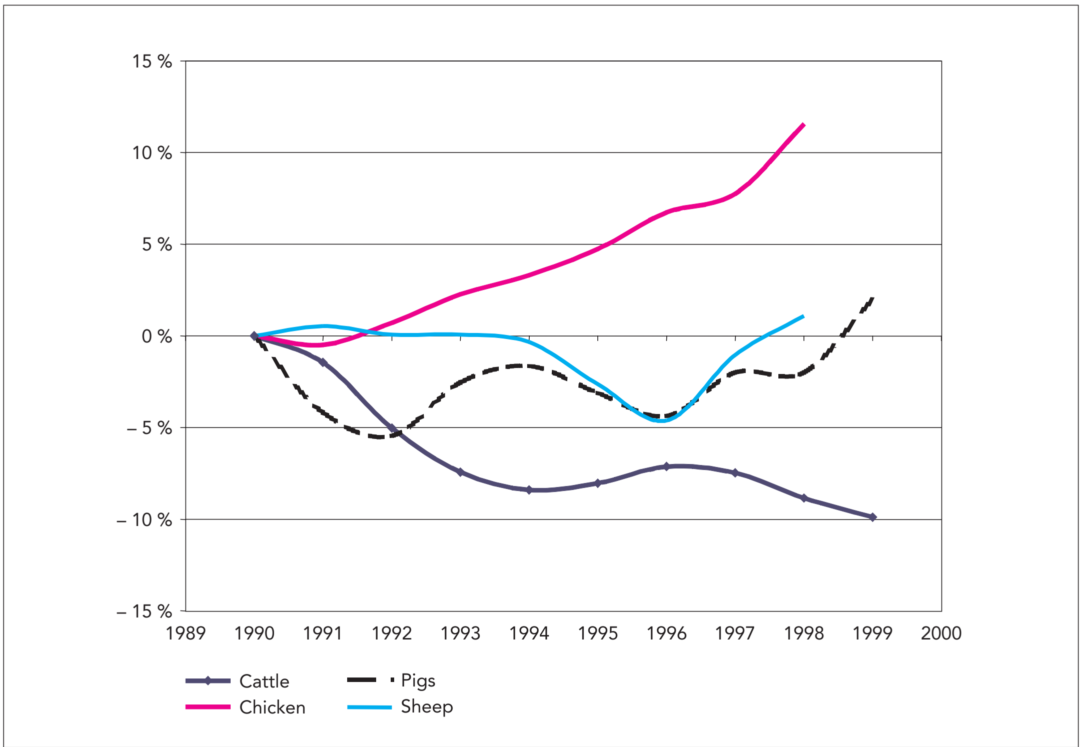
Figure 5.9 **Agriculture sector share of total European Union emissions of air pollutants**



Change in agriculture: emissions 1990–99 (% of 1990 values) Figure 5.10



Change in animal numbers in EU Member States 1990–99 (% of 1990 values) Figure 5.11



Note: 1999 Eurostat data for chicken and sheep numbers are not yet available.

Emissions of ammonia from agriculture have marginally decreased through reducing livestock numbers. From 1990 to 1999 the number of cattle decreased by about 10 % (Figure 5.11). Similarly agricultural methane emissions have decreased by about 5 %.

Ammonia emissions from intensive farming of chickens are significant and have continued to increase by more than 10 % since 1990. Cattle numbers have continued to decline by 10 % whereas pig numbers have increased by 2 %.

References

Relevant data and information available on the EEA web site:

All final EEA reports are available on the Internet, EEA web site: http://www.eea.eu.int/.

Some additional information is available on the ETC/ACC web site: http://air-climate.eionet.eu.int/

The following web sites contain some of the reports mentioned in this reference list or other data/information:

- Indicators and indicator factsheets underpinning site http://themes.eea.eu.int/all_indicators_box
- Detailed emission data, compiled is available on http://service.eea.eu.int/ and http://www.emep.int/index.html
- CEPMEIP
- UNECE/CLRTAP: http://www.unece.org/env/lrtap/
- European Commission, Environment DG: http://europa.eu.int/comm/environment/

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Annex 1: Emission data

Most emission data used and presented in this report, and in addition more detailed data, are available on the EEA Internet (web site) at: http://www.eea.eu.int/ http://service.eea.eu.int/

Go to:
Data service
Tropospheric ozone: trends in emissions of ozone precursors (CO, NMVOC)

Acidification: trends in emissions of acidifying pollutants (sulphur dioxide, NO_x, ammonia)

In all cases the user can make use of various applications by country and pollutant, which the user can select:

- view graphics;
- view tables;
- download tables (spreadsheets).

Examples from the EEA's public data service.

European Environment Agency

Emissions of atmospheric pollutants in Europe, 1990–99

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