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Analysis of greenhouse gas emission trends and projections in Europe 2003

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Acknowledgements

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Summary

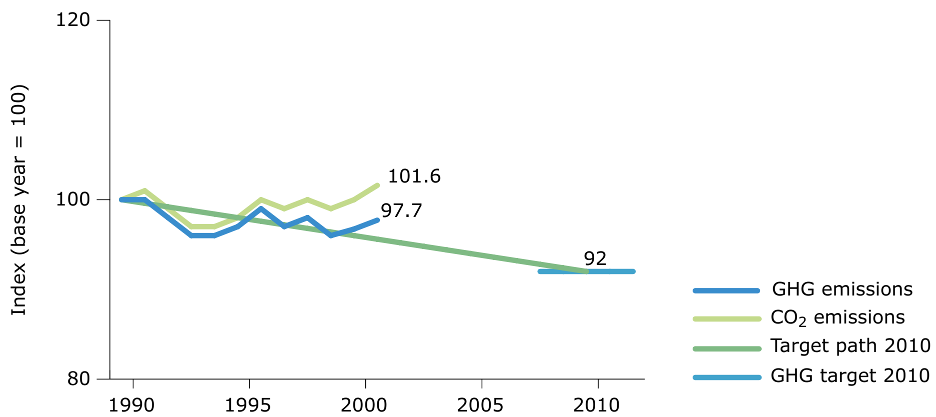
The purpose of this technical report is to analyse and present the progress of the European Union (EU) as a whole towards fulfilling its greenhouse gas (GHG) emission commitments under the United Nations Framework Convention on Climate Change (UNFCCC) and the Kyoto Protocol, and the contribution of each Member State (MS) towards achieving their 'burden sharing' targets. In addition, it provides a more limited analysis of the progress of 11 acceding and candidate countries towards their Kyoto Protocol targets.

The report, prepared by the European Environment Agency (EEA) and its European Topic Centre on Air and Climate Change (ETC/ACC), presents information on actual and projected progress, and therefore includes an analysis of past emission trends (1990–2001) as well as emission projections for 2010. It provides detailed background data and indicators to the EEA environmental issue report entitled 'Greenhouse gas emission trends and projections in Europe'. Both EEA reports are inputs to the annual evaluation report of the European Commission under the EU greenhouse gas monitoring mechanism. Some main explanations for the EU and MS emission trends and projections are provided in terms of either socioeconomic developments or specific climate change policies and measures. Similar but less detailed information is provided for 11 acceding and candidate countries.

GHG emission trends, 1990–2001, in the EU

In the European Union, GHG emissions increased in 2001 compared with 2000. In 2001, total EU GHG emissions were 4 108 Mt (CO_2 equivalents), which was 1.0 % above 2000 but 2.3 % below base-year levels (Figure A). The most important reason for emission increases

Figure A **EU greenhouse gas emissions compared with the Kyoto target for 2010 (excluding land-use change and forestry)**



Note (1): The target path is used to analyse how close 2001 emissions were to a linear path of emission reductions or allowed increases from the base year to the Kyoto Protocol target, assuming domestic measures are used (including emissions trading within the EU).

Note (2): GHG emission data for the EU as a whole do not include emissions and removals from land-use change and forestry (LUCF). In addition, no adjustments for temperature variations or electricity trade are considered.

Note (3): For fluorinated gases, most Member States selected 1995 as the base year, as allowed for under the Kyoto Protocol. Therefore, for the purpose of this analysis of EU GHG emission trends, 1995 is used as the base year for fluorinated gases for all Member States.

Note (4): The index on the *y* axis refers to the base year (1995 for fluorinated gases, 1990 for other gases). This means that the value for 1990 does not need to be exactly 100.

Source: Inventory submissions by the EU Member States (common reporting format (CRF) tables), EEA (2003a).

in 2001 compared with 2000 was a colder winter in most EU countries that led households to burn more heating fuel. Increased heating needs meant that CO_2 emissions from households and services jumped 6.0 % in 2001 from a year earlier, contributing substantially to the increase in overall GHG emissions. In addition, emissions increased from growing transport demand and greater use of carbon-intensive fuels in electricity and heat production.

Emissions of CO_2 account for 82 % of total GHG emissions. In 2001, CO_2 emissions increased mainly because of increases in households and services, but over the period 1990–2001, the main reason for increases was growing transport demand. The 20 % increase in transport-related CO_2 emissions between 1990 and 2001 was partly offset by reductions in energy-related emissions from manufacturing industries and from electricity and heat production.

Emissions of CH_4 account for 8 % of total EU GHG emissions and decreased by 21 % between 1990 and 2001. Also in 2001, emissions decreased compared with 2000. The main reasons for decreasing CH_4 emissions were the decline of coal mining, reductions in solid waste disposal on land and falling cattle population.

Emissions of N_2O are responsible for 8 % of total GHG emissions and decreased by 16 %. The main reason for large N_2O emission cuts was reduction measures in the chemical industry (adipic acid production).

Despite a sharp increase of fluorinated gas emissions between 1992 and 1998, they still account for only 1 % of total GHG emissions. The three fluorinated gases show opposing trends: hydrofluorocarbon (HFC) emissions increased by 11 % between 1995 and 2001, whereas polychlorinated fluorocarbon (PFC) emissions declined by 28 %. Emissions of SF_6 were 25 % below 1995 levels in 2001. The main reason for growing HFC emissions in the EU is the phase-out of ozone-depleting substances such as chlorofluorocarbons (CFCs) under the Montreal Protocol and the replacement of these substances with HFCs (mainly in refrigeration, air conditioning, foam production and as aerosol propellants). All fluorinated gases together decreased by 2 % between 1995 and 2001.

Contribution of Member States to the EU greenhouse gas targets

Table A shows large variations in GHG emission trends between Member States. Compared with 2000, only Spain reduced its emissions in 2001. Five Member States were below base-year levels in 2001, but 10 Member States were above the base-year level. The percentage change between 1990 and 2001 of GHG emissions ranged from – 44.2 % (Luxembourg) to + 36.4 % (Portugal).

The overall EU GHG emission trend is dominated by the two largest emitters, Germany and the United Kingdom, accounting for 40 % of EU GHG emissions. These two Member States achieved total GHG emission reductions of 313 million tonnes compared with the base year ([1]).

The main reasons for the favourable trend in Germany are increasing efficiency in power and heating plants and the economic restructuring of the five new *Länder* after German reunification. The reduction of GHG emissions in the United Kingdom was primarily the result of liberalising the energy market and the subsequent fuel switches from oil and coal to gas in electricity production and N_2O emission reduction measures in the chemical industry. From 2000 to 2001, both Germany's and the United Kingdom's total GHG emissions increased. In Germany, emissions from households and services increased mainly due to

([1]) The EU as a whole needs total GHG emission reductions of 8 %, i.e. 336 million tonnes according to the EEA (2003a) in order to meet the Kyoto target.

Table A **Greenhouse gas emissions in CO_2 equivalents (excluding LUCF) and Kyoto Protocol targets for 2008–12**

Member State	Base year [1] (million tonnes)	2001 (million tonnes)	Change 2000–2001 (%)	Change base year–2001 (%)	Targets 2008–12 under Kyoto Protocol and 'EU burden sharing' (%)	Distance-to-target indicator (DTI) (index points)	Evaluation of progress in 2001 [3]
Austria	78.3	85.9	4.8	9.6	– 13.0	16.8	☹
Belgium	141.2	150.2	0.2	6.3	– 7.5	10.5	☹
Denmark [2]	69.5	69.4	1.8	– 0.2 (– 9.0)	– 21.0	11.4 (2.6)	☹
Finland	77.2	80.9	7.3	4.7	0.0	4.7	☹
France	558.4	560.8	0.5	0.4	0.0	0.4	☹
Germany	1 216.2	993.5	1.2	– 18.3	– 21.0	– 6.8	☺
Greece	107.0	132.2	1.9	23.5	25.0	9.8	☹
Ireland	53.4	70.0	2.7	31.1	13.0	23.9	☹
Italy	509.3	545.4	0.3	7.1	– 6.5	10.7	☹
Luxembourg	10.9	6.1	1.3	– 44.2	– 28.0	– 28.8	☺
Netherlands	211.1	219.7	1.3	4.1	– 6.0	7.4	☹
Portugal	61.4	83.8	1.9	36.4	27.0	21.6	☹
Spain	289.9	382.8	– 1.1	32.1	15.0	23.8	☹
Sweden	72.9	70.5	2.2	– 3.3	4.0	– 5.5	☺
United Kingdom	747.2	657.2	1.3	– 12.0	– 12.5	– 5.2	☺
EU-15	**4 204.0**	**4 108.3**	**1.0**	**– 2.3**	**– 8.0**	**2.1**	☹

(1) Base year for CO_2, CH_4 and N_2O is 1990; for the fluorinated gases most Member States selected 1995 as base year, as allowed for under the Protocol. Therefore, for the purpose of this analysis of the EU GHG emission trends, 1995 is used as the base year for fluorinated gases for all Member States.
(2) For Denmark, data that reflect adjustments for electricity trade (import and export), in 1990, are presented in parentheses. This method is used by Denmark to monitor progress towards its national target under the EU 'burden sharing' agreement. For the EU emissions, total non-adjusted Danish data have been used.
(3) The EEA's evaluation of progress to 2001 awards 'smileys' according to the distance-to-target indicator (DTI) in 2000 (for more details see Section 1.2). The following rating system is used:
☺ positive contribution to EU trend: the negative distance-to-target indicator means that the Member State is below its linear target path;
☹ negative contribution to EU trend: the positive distance-to-target indicator means that the Member State is above its linear target path.

Source: Inventory submissions by the EU Member States (CRF tables), EEA (2003a).

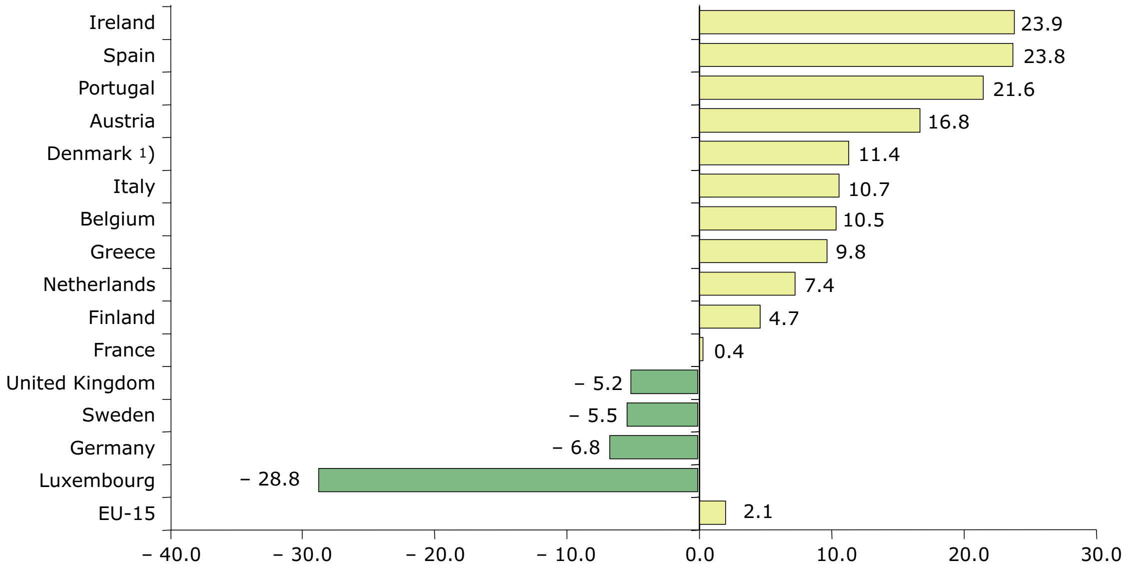
the cold winter. The largest increases in the United Kingdom occurred from electricity and heat production.

Actual progress of the Member States
If GHG emissions of the Member States are compared with their linear target path for 2008–12, the following conclusions with regard to actual progress of Member States can be drawn (Figure B).

- The EU as a whole was 2.1 index points above its linear target path in 2001, thus leaving the track to Kyoto to a certain extent.
- Five Member States (United Kingdom, Sweden, Germany, Luxembourg and France) were near or below their Kyoto target paths, thus fully on track towards fulfilling their Kyoto targets.
- Ten Member States were well above their Kyoto target paths (Ireland, Spain, Portugal, Austria, Denmark, Italy and Belgium by more than 10 index points). The Danish distance-to-target indicator (DTI) is 11.4 index points for non-adjusted data, and 2.6 index points if Danish GHG emissions are adjusted for electricity trade and temperature in 1990.

In order to analyse the sectoral GHG trends in greater detail, the most important GHG source categories (key sources) have been identified. A key source category is defined as an emission source that has a significant

Figure B **Distance-to-target indicators (in index points) for the Kyoto Protocol and EU burden sharing targets of EU Member States**



([1]) The Danish DTI is + 2.6 index points if Danish GHG emissions are adjusted for electricity trade in 1990.

Note: The DTI measures the deviation of actual emissions in 2001 from the (hypothetical) linear target path between base year and 2010. The DTI gives an indication on progress towards the Kyoto and Member State shared targets. It assumes that the Member States meet their target entirely on the basis of domestic measures. See Section 1.2 for an explanation of the DTI.

Source: Inventory submissions by the EU Member States (CRF tables), EEA (2003a).

influence on a country's GHG inventory in terms of the absolute level of emissions, the trend in emissions, or both. In total, the EEA (2003a) identifies 28 key source categories for the EU (out of 68 source categories), covering 98 % of total EU GHG emissions in 2001 (Table B).

The emission trends of the key source categories vary widely. Figure C shows the ranking of key source categories according to absolute and relative changes between the base year and 2001. The changes of the eight most important key sources, covering approximately 90 % of all GHG emissions, are described below.

Energy industries (CO_2)
- Share in total GHG emissions in 2001: 27 %
- Change, 1990–2001: – 2 %
- Main driving force: production and consumption of electricity
- CO_2 emissions from energy industries decoupled considerably from electricity consumption. This was mainly due to fuel shifts in power production from coal to natural gas, and larger shares of electricity generation from renewable energy sources and nuclear power, as well as efficiency improvements. In 2001, CO_2 emissions from energy industries increased by 2 % compared with 2000, which was mainly due to increased use of fossil fuels for power production.

Transport (CO_2)
- Share in total GHG emissions in 2001: 20 %
- Change, 1990–2001: + 20 %
- Main driving force: transport volumes on road (passenger and freight transport)
- Passenger transport in cars increased by 17 % between 1990 and 1999 (almost in line with total CO_2 emissions from transport). Freight transport grew by 42 %, i.e. much faster than CO_2 from transport between 1990 and 2001.

Table B EU greenhouse gas source categories identified as key sources (emissions in Gg of CO_2 equivalents)

Greenhouse gas source categories	Gas	Base year	2001	Cumulative share (%)
		(Gg)		
1.A.1. Energy industries	CO_2	1 144 434	1 119 301	27.2
1.A.3. Transport	CO_2	695 003	833 925	47.5
1.A.4. Other sectors	CO_2	635 096	655 763	63.5
1.A.2. Manufacturing industries and construction	CO_2	642 348	585 160	77.8
4.D. Agricultural soils	N_2O	214 489	196 818	82.5
4.A. Enteric fermentation	CH_4	144 091	131 631	85.7
2.A. Mineral products	CO_2	106 934	105 952	88.3
6.A. Solid waste disposal on land	CH_4	110 982	80 295	90.3
2.B. Chemical industry	N_2O	106 096	49 167	91.5
4.B. Manure management	CH_4	45 172	45 268	92.6
2 F Consumption of halocarbons and SF_6	HFC	6 167	31 383	93.3
1.B.2. Oil and natural gas	CH_4	32 969	28 338	94.0
1.A.3. Transport	N_2O	11 660	26 361	94.7
2.C. Metal production	CO_2	25 702	23 856	95.3
4.B. Manure management	N_2O	23 495	21 562	95.8
1.B.2. Oil and natural gas	CO_2	17 247	16 377	96.2
1.B.1. Solid fuels	CH_4	48 510	15 277	96.5
2 E Production of halocarbons and SF_6	HFC	32 373	11 957	96.8
2.B. Chemical industry	CO_2	12 884	10 769	97.1
1.B.1. Solid fuels	CO_2	9 283	8 081	97.3
1.A.4. Other sectors	CH_4	10 453	7 739	97.5
1.A.5. Other	CO_2	20 076	7 307	97.7
2 F Consumption of halocarbons and SF_6	SF_6	9 617	6 543	97.8
6.B. Waste-water handling	N_2O	6 492	5 579	98.0
2 C Metal production	PFC	5 637	3 100	98.0
4.D. Agricultural soils	CO_2	3 208	1 946	98.1
2.G. Other	CO_2	1 111	1 295	98.1
6.D. Other	CO_2	881	420	98.1

Source: EEA (2003a).

Other sectors (CO_2) (households and services)

- Share in total GHG emissions in 2001: 16 %
- Change, 1990–2001: + 3 %
- Main driving forces: outdoor temperature, number and size of dwellings, building codes, age distribution of the existing building stock, fuel split for heating and warm water
- The pattern of CO_2 emissions from households and services follows very closely the pattern of heating degree days: the coldest years in the decade had the highest CO_2 emissions from households and services.

Manufacturing industries and construction (CO_2)

- Share in total GHG emissions in 2001: 14 %
- Change, 1990–2001: – 9 %
- Main driving force: energy use in industry
- The largest part of the emission reductions were already achieved before 1994, which was mainly due to efficiency improvements and structural change in Germany after reunification and low economic activity in the EU. Between 1990 and 2000, industrial output in terms of gross value added increased by 13 % (no value for 2001 available). Therefore, CO_2 emissions from manufacturing industries decoupled from gross value added.

Figure C **Absolute and relative change base year to 2001, of EU key source emissions (in million tonnes of CO_2 equivalents and percent)**

Source: Inventory submissions by the EU Member States (CRF tables), EEA (2003a).

Agricultural soil (N_2O)

- Share in total GHG emissions in 2001: 5 %
- Change, 1990–2001: – 8 %
- Main driving force: fertiliser and manure use
- Use of fertilisers decreased by 13 % between 1990 and 2001, which was partly due to the effects of the 1992 reform of the common agricultural policy and the resulting shift from production-based support mechanisms to direct area payments in arable production.

Enteric fermentation (CH_4)

- Share in total GHG emissions in 2001: 3 %
- Change, 1990–2001: – 9 %
- Main driving force: number of cattle
- CH_4 emissions from enteric fermentation declined almost parallel with the number of cattle.

Table C Data and base year of the acceding and candidate countries

Country	Base year	Emissions of CO_2, CH_4, N_2O	Emissions of fluorinated gases
Bulgaria	1988	1988, 1990–99	1998–99
Czech Republic	1990	1990, 1994, 1996–2001	1995–2001
Estonia	1990	1990–2001	NA
Hungary	average 1985–87	average 1985–87, 1990–2000	1998–2000
Latvia	1990	1990–2001	1995–2001
Lithuania	1990	1990, 1998	NA
Poland	1988	1988, 1990–2001	1995–2001
Romania	1989	1989,1990–2001	1992–2001
Slovakia	1990	1990–2001	1990–2001
Slovenia	1986	1986, 1990–96	1990–96
Cyprus	—	NA	NA
Malta	—	1990–2000	NA
Turkey	—	NA	NA

Note: NA — data are not available from any of these sources.

Source: Submissions in 2002 (Hungary CRF 2000, Bulgaria CRF 1999) and 2003 (the Czech Republic, Estonia, Latvia, Poland, Romania, Slovakia, all countries provided the CRF 2001) Slovenia (IPCC Tables 7A 1990–96 provided by the country, Malta IPCC tables downloaded from the address provided by the country (http://www.phys.um.edu.mt/climate/downloads/ghg/ghg_inventory.zip), UNFCCC database (Lithuania, 2002 submission, years 1990–98).

Mineral products (CO_2)

- Share in total GHG emissions in 2001: 3 %
- Change, 1990–2001: – 1 %
- Main driving force: cement production
- Emissions declined in the early 1990s, but increased again in recent years. Cement production was 2 % above 1990 levels in 1999 (no values for 2000–01 were available).

Solid waste disposal on land (CH_4)

- Share in total GHG emissions in 2001: 2 %
- Change, 1990–2001: – 28 %
- Main driving force: amount of biodegradable waste going to landfills and CH_4 recovery
- The reductions were mainly achieved by reducing solid waste disposal on land and by recovering CH_4 from landfills. The emission reductions are also partly due to the implementation of the landfill waste directive or similar legislation of the Member States.

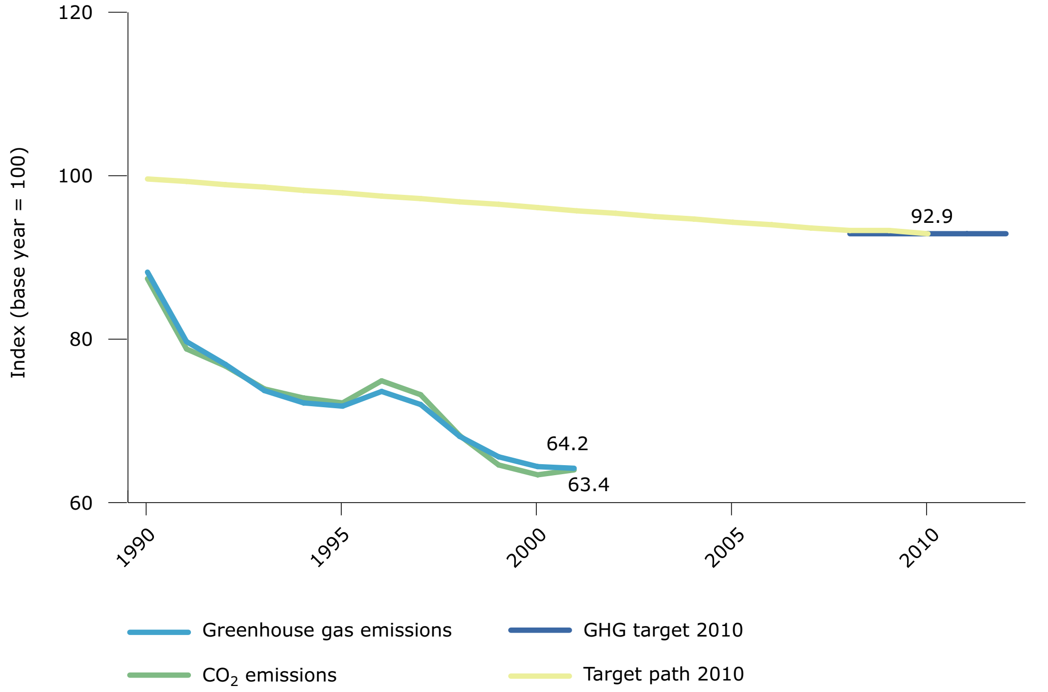
Greenhouse gas emission trends, 1990–2001, in the acceding and candidate countries

The report also includes a preliminary assessment of GHG emission trends in the acceding countries (AC), the Czech Republic, Estonia, Hungary, Latvia, Lithuania, Poland, Slovakia, Slovenia and Malta; and in the candidate countries (CC), Bulgaria and Romania.

The main sources of this report are data supplied by the AC and CC under the UNFCCC, data reported under the European environment information and observation network (Eionet), and data (CRF tables) submitted voluntarily under Council Decision 1999/296/EC by May 2003. Background data were obtained from the International Energy Agency (IEA) and Eurostat. No emission data are available for Cyprus and Turkey.

The completeness of the data sets differs between countries (Table C). Some countries reported emissions for the whole period 1990–2001, in consistent time series. Several countries still need to remove gaps and inconsistencies

Figure D **AC/CC-10 greenhouse gas emissions compared with Kyoto target for 2008–12 (excluding LUCF)**



Note (1): Bulgaria (last reported year 1999), Hungary (last reported year 2000), Lithuania (last reported year 1998), Slovenia (last reported year 1996) did not report complete time series. For missing years a gap-filling procedure was applied**.** Malta is not included as it has no base year nor a Kyoto target.

Note (2): The index on the *y* axis refers to the base year. As the acceding and candidate countries use different base years (see Table C), the value for 1990 is not 100.

Source: Submissions by acceding and candidate countries (CRF tables, IPCC tables), UNFCCC database.

both in estimation methods and sectoral emissions.

As transition economies, the AC and CC can apply certain flexibility in the implementation of their commitments. Therefore, some AC and CC use a base year other than 1990.

In the Kyoto Protocol eight AC and CC agreed to reduce their GHG emissions by 8 % by 2008–12, from base-year levels. Hungary and Poland agreed to reduce their emissions by 6 % from base-year levels. All countries have to reach their targets individually as defined in the Kyoto Protocol, and all AC and CC aimed to stabilise emissions in line with Article 4.2 of the UNFCCC.

In the whole region of the AC/CC10 (i.e. the 10 AC and CC with a Kyoto target), the total GHG emissions declined by 35.8 % between the base year and 2001.

The base year for AC/CC10 is assumed to be the sum of the base years of the individual AC and CC (Table D). In 2001, the distance-to-target indicator for the whole region was – 31.7 index points in this year. This means that the AC/CC10 was far below its hypothetical Kyoto target path in 2001. The performance of the AC/CC10, however, varied considerably (Figure D). Nine countries were below their Kyoto target path, with distance-to-target indicators ranging from — 14.4 index points in Hungary to — 56.4 index points in Latvia. Only Slovenia was above its target path, with + 6 index points.

All AC and CC except Malta and Slovenia achieved substantial GHG emission cuts between 1990 and 2001. In the Czech Republic, Slovakia and Latvia, emissions increased between 2000 and 2001 (Table D). Most of the AC and CC have already achieved or will achieve

Table D Greenhouse gas emissions in CO_2 equivalents (excluding LUCF) and Kyoto Protocol targets for 2008–12

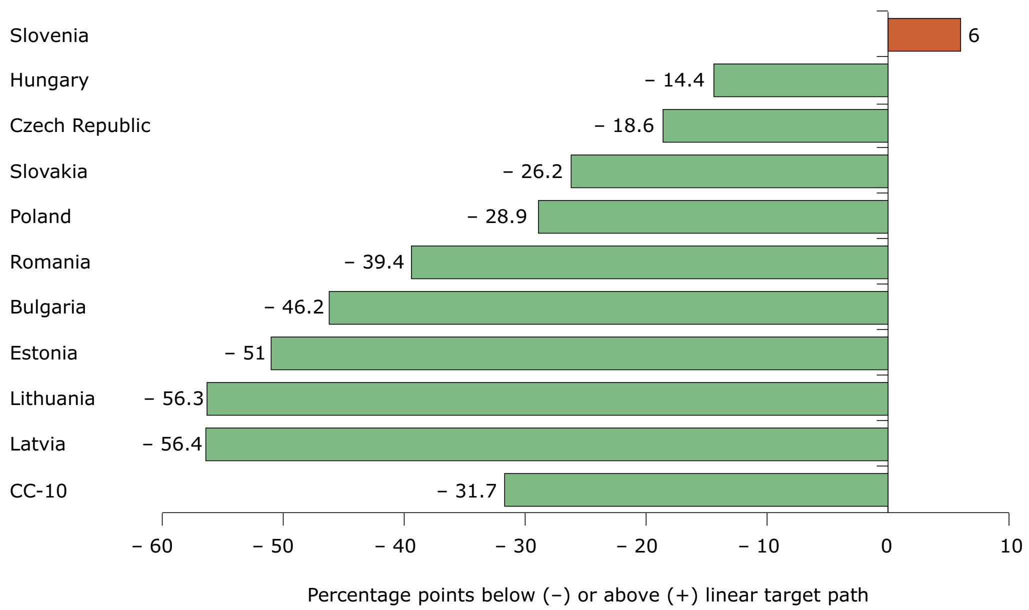
Country	Base year (million tonnes)	1990 (million tonnes)	2001 (million tonnes)	Change 1999–2000 (%)	Change 2000–2001 (%)	Change base year –2001 (%)	Targets 2008–12 under Kyoto Protocol (%)	Distance-to-target indicator (DTI) (index points)	Evaluation of progress in 2001
Bulgaria	157.7	137.7	77.7	-	-	– 50.7	– 8	– 46.2	☺
Czech Rep.	192.1	192.0	148.0	5.2	0.3	– 23.0	– 8	– 18.6	☺
Estonia	43.5	43.5	19.4	0.4	– 1.7	– 55.4	– 8	– 51.0	☺
Hungary	102.6	86.6	84.3	– 2.6	–	– 17.8	– 6	– 14.4	☺
Latvia	29.0	29.0	11.4	– 6.2	16.9	– 60.8	– 8	– 56.4	☺
Lithuania	51.5	51.5	20.2	– 7.0	–	– 60.7	– 8	– 56.3	☺
Poland	565.3	458.9	382.8	– 3.8	– 0.9	– 32.3	– 6	– 28.9	☺
Romania	264.8	228.5	148.3	0.5	– 4.9	– 44.0	– 8	– 39.4	☺
Slovakia	72.2	72.2	50.1	– 4.9	4.7	– 30.6	– 8	– 26.2	☺
Slovenia	19.9	18.3	20.2	– 0.8	-	1.4	– 8	6.0	☹
AC/CC-10	**1 498.7**	**1 318.3**	**962.4**	**– 1.6**	**– 0.9**	**– 35.8**	**– 7.1**	**– 31.7**	☺
Malta	-	2.2	2.8	2.4	-	-	-	-	-

Note: 2001 refers to the last reported year, as many countries did not provide complete time series: Bulgaria (last reported year 1999), Hungary (last reported year 2000), Lithuania (last reported year 1998), Slovenia (last reported year 1996). For missing years, a gap-filling procedure was used. Malta is not included, as it has no Kyoto target.

Source: Submissions by CC (CRF tables, IPCC tables), UNFCCC database.

Note: The common target under the Kyoto Protocol for all CC was calculated for the presentation of the development in the CC10 region as a whole for this report only, and does not have any legally binding implication.

Figure E Distance-to-target indicators (in index points) for the Kyoto Protocol of CC



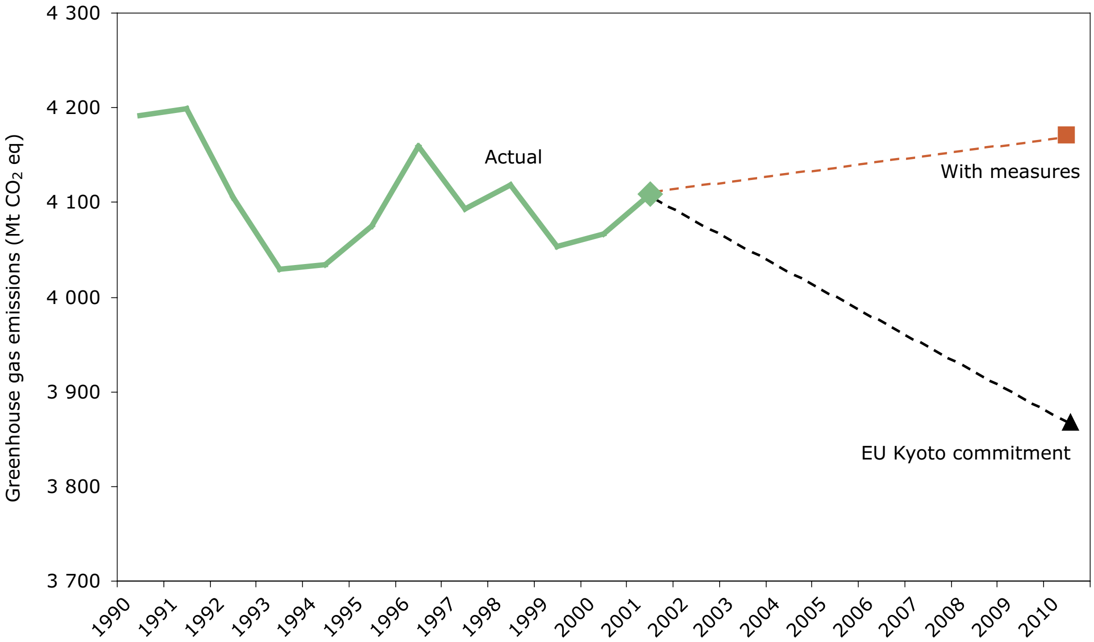
Note: The distance-to-target indicator refers to 2001 for all CC, except for Bulgaria (1999), Hungary (2000), Lithuania (1998) and Slovenia (1996).

the aim of the UNFCCC to keep GHG emissions below 1990 levels by 2000.

In 2001, total GHG emissions were 35.8 % below the base-year levels and 0.9 % below 2000 emissions ([2]). Change

([2]) Note that the percentage change between 2000 and 2001 does not include data from Bulgaria, Hungary, Lithuania and Slovenia.

Figure F Actual and projected progress for the EU based on Member State projections



in emissions between 1999 and 2000 was – 1.6 %. In most AC and CC, the CO_2 emissions decreased more than the total GHG emissions. However, in 2001, CO_2 emissions increased compared with 2000 partly due to cold outdoor temperatures during the heating season.

Summary on GHG emission projections for 2010

Figure F shows the actual progress of the EU between 1990 and 2001 and the projected progress with existing domestic measures by 2010. Aggregate with existing domestic measures projections for the EU show total greenhouse gas emissions decreasing by 0.5 % between 1990 and 2010. This leaves a gap of 7.5 % to reach the EU's Kyoto target of an 8 % reduction in emissions. However, this relies on over-delivery by some Member States (Sweden and the United Kingdom) compared with their burden sharing targets.

Savings from additional domestic measures being planned by Member States would result in further emissions reductions sufficient to almost meet the Kyoto target, leaving just a 0.8 % gap. However, this relies on over-delivery by some Member States (United Kingdom, Sweden, France, Finland and Ireland) compared with their burden sharing agreements.

If no over-delivery by Member States is considered, the EU as a whole achieves a 0.2 % greenhouse gas reduction with existing domestic policies and measures and a 5.1 % reduction with additional domestic policies and measures. This leads to a shortfall of 7.8 % and 2.9 % respectively in 2010, taking into account domestic policies and measures only.

Eight Member States intend to use carbon sinks options under the Kyoto Protocol. CO_2 sequestration of 10 and 3 Mt CO_2 equivalents has been quantified so far according to Articles 3.3 and 3.4 of the Kyoto Protocol. These savings represent about 4 % of the total required emission reduction of the EU.

The use of flexible mechanisms for achieving the EU Kyoto target is so far limited to about 21 Mt CO_2 equivalents per year in the commitment period. This represents about 6.3 % of the total required emission reduction of the EU. Only a few countries have allocated resources (Austria, Finland, Sweden, Netherlands). The Netherlands project to achieve their target by a combination of domestic policies and measures and the use of Kyoto mechanisms.

The majority of savings from both domestically implemented and planned policies and measures in EU Member States are in the energy sector, with savings in energy supply being greater than those from the manufacturing sector or other end-use sectors.

Six key EU policies have been identified (renewable energy, CHP, energy efficient appliances, building standards, the agreement with car manufacturers and the landfill directive), which have widespread implementation across the EU and are expected to result in significant savings. Of these the promotion of renewable energy has the greatest impact on emissions in most EU Member States for both implemented and planned policies, with the landfill directive being next most important. The agreement with the car manufacturers is an important contributor in the growing transport sector.

EU greenhouse gas emissions from the energy sector (excluding domestic transport) are projected to remain constant between 1990 and 2010 under the 'with existing domestic measures' scenario.

EU domestic transport-related greenhouse gas emissions are projected to increase by 34 %, if no additional policies and measures are introduced.

EU agricultural (– 11 %), process (– 2 %) and waste emissions (– 51 %) are all projected to decline between 1990 and 2010 under the 'with existing domestic measures' scenario.

EU methane and nitrous oxide emissions are expected to decrease between 1990 and 2010. EU carbon dioxide emissions are projected to increase by 4 % under the 'with existing domestic measures' scenario, while methane and nitrous oxide are expected to fall by 32 % and 12 % respectively. EU fluorinated gas emissions are forecast to increase by 98 %, although their total contribution to total EU emissions will remain small.

An analysis of the types of domestic policies and measures being used by EU Member States shows that, across all sectors, regulatory and fiscal policies and measures are the most popular and are projected to generate the largest proportion of greenhouse gas reductions. Education, research and information appear to be used very little apart from in the transport sector where education and information are significant.

EU-wide projections of CO_2 emissions (estimated with the Primes model, to be published by the Commission in 2003) show an increase of 4 % between 1990 and 2010, which is in line with the aggregated Member State projections. However, there are significant differences in the two sets of projections for individual Member States and for specific sectors.

Detailed analysis of the differences has been hampered by a lack of consistency between the sectoral coverage and disaggregation of the EU-wide projections and those from Member States. The most significant differences (more than 8 %) are observed for Luxembourg, Spain and Italy, where the EU-wide projections are higher than those projected by Member States and also for Denmark, Finland, and Belgium where the Member States project a greater increase in CO_2 emissions.

There are a number of reasons why the projections do not agree, including differences in sector coverage, base-year data, emission factors, types of models used and key assumptions such as GDP and population changes.

The European climate change programme has identified savings totalling 578–696 Mt CO_2 equivalents in the EU. This is around twice the emissions reductions required for the first commitment period. In addition, a potential 93–103 Mt CO_2 equivalents could theoretically be sequestered through the enhancement of sinks activities (which is substantially higher than the estimate based on the Member

States projections of approxately 13 Mt CO_2 equivalents).

The legislative measures currently in force or already proposed represent a potential 276–316 Mt CO_2 equivalents. Key measures include the directive on electricity from renewable energy sources, the directive on the energy performance of buildings, the landfill directive, proposals for a directive on bio-fuels and combined heat and power generation (CHP). However, the savings that could be realised, in practice, may be much less. The effectiveness of these measures that have been adopted or are now being implemented, therefore, needs to be closely monitored, and their implementation reviewed, if necessary.

Seven acceding and candidate countries have submitted third national communications to the UNFCCC, and Slovenia provided its first national communication. Greenhouse gas emissions in seven acceding and candidate countries are projected to decrease in the 'with existing domestic measures' projections, enabling these countries to meet their Kyoto target. Slovenia, however, is expecting emissions to increase.

Policies and measures aimed at most sectors and gases are in place and additional policies and measures are identified in many EU Member States. Most acceding and candidate countries have identified measures.

The quality and transparency of reporting for some Member States and acceding and candidate countries have improved again, but are still facing some challenges. Disaggregation of the projections by gas and sector is more detailed and consequently more analysis has been possible than in previous years. Reporting of underlying parameters has also been more extensive although there is still a limited number that can be compared between Member States. Reporting of policies and measures is more comprehensive, including more consistent data on the type of measure and status of implementation. However, quantification of the effectiveness of individual policies and measures in terms of GHG emission reduction potential for some Member States is still not available.

Austria, Belgium, Finland, the United Kingdom and the Czech Republic all provided sensitivity analyses in their UNFCCC third national communications. However, there is no common framework guiding the type of analysis undertaken and therefore these analyses cannot easily be compared.

In February 2003, a workshop on ammonia and GHG emissions and projections from agriculture was held at the EEA in Copenhagen with the aims of improving transparency and completeness of reporting of inventories and projections in agriculture and reducing uncertainty in inventories and projections. A number of recommendations were prepared.

1. Introduction

1.1. Purpose and outline of the report

This report is an indicator-based assessment of greenhouse gas emissions trends and projections in Europe. It is based on information provided by the countries (EU Member States and the acceding and candidate countries) under the EU GHG monitoring mechanism ([3]). For the acceding and candidate countries, information from national communications submitted to the UNFCCC secretariat is also taken. In addition, Eurostat emissions estimates for CO_2 (used for the indicators) and background data and the latest EU-wide projections of GHG emissions were used. The report is an updated version of similar reports published in 2001 and 2002 (see EEA, 2001, 2002a, 2002b, 2003c).

The purpose of this report is:

- to present and analyse actual and projected progress of the EU as a whole, of each EU Member State and of the AC and CC towards fulfilling their GHG emission commitments under the UNFCCC and the Kyoto Protocol. For the purpose of actual progress assessment, for the EU, the Member States and the AC and CC, distance-to-target indicators (DTI) are calculated as a measure of the deviation of actual emissions in 2001 from the linear target path 1990 to 2010. For the purpose of projected assessment, the gaps between emission projections and Kyoto targets are identified;
- to present and analyse GHG emission trends and projections in the EU, its Member States and in the AC and CC by gas and by sector (sectoral assessment). Sectoral indicators, for socioeconomic driving forces behind GHG emissions, are identified and presented by using data from Eurostat or from Member States' detailed inventories;
- to try to analyse to what extent national and EU common and coordinated climate change policies and measures, in addition to socioeconomic developments, can explain decreasing or less increasing emission trends and projections for the EU and its Member States (policy-effectiveness assessment).

The legal basis of this report is Council Decision 1993/389/EEC as amended by Decision 1999/296/EC for a monitoring mechanism of Community CO_2 and other GHG emissions ([3]). This decision establishes a mechanism for: (1) monitoring, in the Member States, all anthropogenic GHG emissions not controlled by the Montreal Protocol (CO_2, carbon dioxide; CH_4, methane; N_2O, nitrous oxide; HFCs, PFCs and SF_6, industrial fluorinated gases); (2) evaluating actual and projected progress towards meeting commitments in respect of these emissions.

According to Article 6 of Council Decision 1999/296/EC, the Commission shall assess annually whether the actual and projected progress of Member States is sufficient to ensure fulfilment of the EU commitments under the UNFCCC and the Kyoto Protocol and shall report to the European Parliament and the Council. The annual evaluation report of the Commission has to be forwarded to the European Parliament and the Council by October each year. The last annual Commission progress report under the decision was published in December 2002 (EC, 2002b).

Progress is evaluated by the Commission, in consultation with the Member States, and is based on national programmes and updates

([3]) OJ L 117, 5.5.1999, p. 35.

supplied by the Member States as described in Article 2(2) of Council Decision 1999/296/EC and other relevant information. These national programmes should include information on (a) GHG inventories, (b) policies and measures, and (c) GHG projections.

Member States are required by 31 December each year to submit inventory data for the two previous years ([4]) and any updates of previous years (including the base year 1990 ([5])) and their most recent projected emissions for the years 2005, 2010, 2015 and 2020 ([6]). Any updates to the national programmes, for example, new policy measures, should also be reported to the Commission by 31 December. If no change has occurred, this should be formally indicated to the Commission.

For the purpose of facilitation and harmonisation of collection, reporting and evaluation of data, the monitoring committee, established under Council Decision 1999/296/EC, set up two working groups. These working groups developed a set of guidelines ([7]) covering both the collection and evaluation of emission inventories and national programmes.

This report, prepared by the EEA and its ETC/ACC, is a basis for the EEA report on 'Greenhouse gas emission trends and projections in Europe'. Both reports serve as an input to the annual evaluation report of the European Commission.

1.2. Targets and progress evaluation

The Kyoto Protocol and EU burden sharing

In the Kyoto Protocol (December 1997), the European Community agreed to reduce its GHG emissions by 8 % below base-year levels by 2008–12. According to Council Decision 2002/358/EC ([8]), the European Community and its Member States notified the United Nations of their joint fulfilment of commitments under the Kyoto Protocol. This means that not all Member States will have to reduce their GHG emissions by 8 % as long as the EU as a whole meets the target.

In June 1998, the Council of Ministers agreed on different emission limitation and/or reduction targets for each Member State basically according to economic circumstances, called the 'burden sharing' agreement. These targets were reaffirmed in Council Decision 2002/358/EC. Figure 1 summarises all Member State targets. It shows that eight Member States agreed to reduction targets by 2008–12 (Austria, Belgium, Denmark, Germany, Italy, Luxembourg, the Netherlands, the United Kingdom). Two Member States (Finland, France) agreed to stabilise GHG emissions by 2008–12, whereas five Member States (Greece, Ireland, Portugal, Spain, Sweden) agreed to limit their increases by 2008–12. These differences take account of the particular circumstances of each Member State and in all cases imply a reduction against the business-as-usual trend in emissions.

([4]) Member States have to report annually their inventories to the Commission by 31 December year *n*: anthropogenic CO_2 emissions and CO_2 removals by sinks for year *n*–1; emissions by source and removals by sinks of the other greenhouse gases; final data for year *n*–2 and provisional data for year *n*–1.

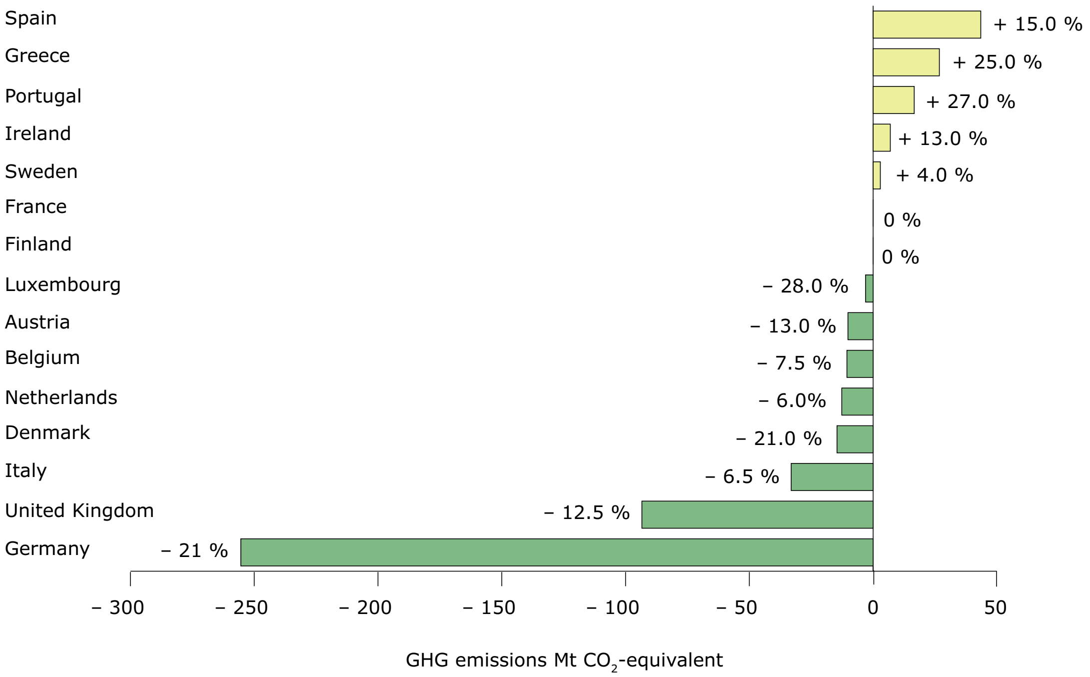
([5]) The base year is 1990, except for HFC, PFC, SF_6 for which the base year can be selected by the party to be either 1990 or 1995.

([6]) Decision 1999/296/EC requires reporting of projected emissions and removals for the period 2008 to 2012 and as far as possible, for 2005. However, in addition the monitoring mechanism, 'Guidelines for the methodology of the evaluation of progress towards the KP targets and for reporting of national programmes' requires the projected emissions and removals also for the year 2015 and 2020.

([7]) Guidelines: Part 1: Guidelines for Member States and EU annual inventories; Part 2: Methodology for the evaluation of progress and for the contents of national programmes, Brussels, 1 September 2000.

([8]) OJ L 130, 15.5.2002, p. 1.

Figure 1 **Member States' emission limitation or reduction commitments in accordance with Article 4 of the Kyoto Protocol (9)**



Source: Council Decision 2002/358/EC.

Progress evaluation

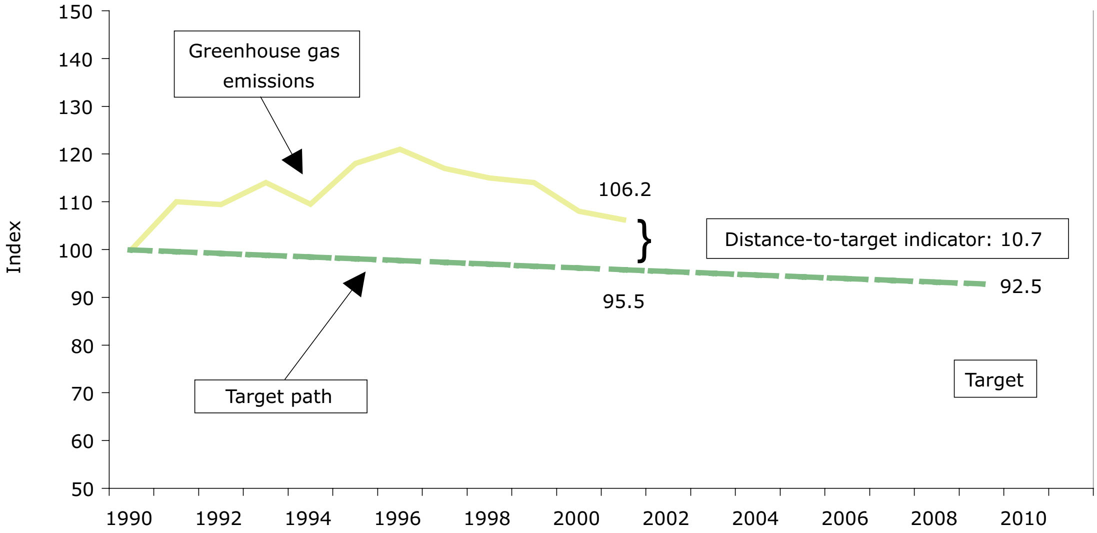
This report evaluates actual and projected progress of the European Union towards fulfilling its GHG emission targets.

Actual progress is evaluated by comparing past (actual) emissions with the GHG emission target path in 2001. As a measure for actual progress, the deviation of actual emissions in 2001 from the (hypothetical) linear target path between 1990 and 2010 (i.e. the mid-point of the Kyoto range 2008–12) is provided (distance-to-target indicator — DTI). See Figure 2 for a theoretical example of a country's actual progress. Projected progress is evaluated by identifying the gap (over-delivery or shortfall) between emission projections and the Kyoto targets. Two types of projections are considered: with (existing) measures projections and with additional domestic measures projections.

Note: This report does not aim at evaluating compliance of Member States with targets. Instead, the report aims at evaluating the Member States' contribution to the actual and projected EU GHG emissions in 2001 and in 2010. For actual progress this is done by comparing actual values in 2001 with hypothetical values for 2001 on the linear burden sharing (for EU MS) and Kyoto (for AC and CC) target paths. These linear target paths are used in this report in order to perform a consistent and comparable assessment of the contribution of the Member States to the progress of the European Union as a whole within the period 1990 to 2001 and for assessing progress of AC and CC regarding their Kyoto targets. For projected progress assessment, GHG emission projections with (existing) measures and with additional domestic measures are compared with the EU MS burden sharing and AC and CC Kyoto targets. Both actual and projected progress assessment assumes that Member States meet their target entirely on the basis of domestic measures (including emissions trading within the EU). At the UNFCCC conference in Marrakesh, countries agreed to the rules for the use of the flexible mechanisms (joint implementation, clean development mechanism, international emissions trading) and carbon sinks for meeting the Kyoto targets. After entry into force of the Kyoto Protocol, countries could therefore also use these options to meet their targets. Therefore, this report includes in addition to the analyses mentioned above also a first initial analysis of the projected use of flexible mechanisms and carbon sinks by EU MS to achieve their burden sharing targets.

(9) In the Council decision on the approval by the EU of the Kyoto Protocol, the different commitments of the Member States are expressed as percentage change from the base year. In 2006, the respective emission levels shall be expressed in terms of tonnes of carbon dioxide equivalents. In this connection, the Council of environment ministers and the Commission have in a joint statement agreed to take into account, *inter alia*, the assumptions in Denmark's statement to the Council conclusions on 16 and 17 June 1998 relating to base-year emissions.

Figure 2 Distance-to-target assessment of actual progress (theoretical example)



Note: The distance-to-target assessment of actual progress consists of the four steps.

1. Plotting the index of actual performance (i.e. 1990–2001 index of GHG emissions) against the index of the Kyoto target path (hypothetical line between 1990 and 2010).
2. Calculating the hypothetical, interpolated, value on the target path in 2001 (in this example: 95.5).
3. Calculating the deviation of the emission index value in 2001 (in this example: 106.2) from the value on the target path. In the example, the deviation is 10.7 index points, i.e. the distance-to-target indicator (DTI) is 10.7 index points.
4. Awarding smileys according to the achievements with the following ratings:
   - ☺ positive contribution to EU trend: the negative distance-to-target indicator means that the Member State is below its linear target path;
   - ☹ negative contribution to EU trend: the positive distance-to-target indicator means that the Member State is above its linear target path.

The performance of the country in this example would be evaluated with ☹, since the trend is not following the hypothetical linear path towards the Kyoto target.

The assessment of actual and projected progress is made for each Member State in order to evaluate their contribution to the fulfilment of the targets by the European Union.

1.3. Data sources

The main sources of this report are data supplied by the EU Member States under the EU GHG monitoring mechanism (for GHG emissions and projections, sectoral background data, policies and measures), data from Eurostat's New Cronos database (main and sectoral driving force data and emission estimates for CO_2), national communications submitted to the UNFCCC by the AC and CC, and the results of the latest EU-wide projections of greenhouse gas emissions from energy (performed for the Commission).

Greenhouse gas emissions and main and sectoral driving force data

For the preparation of this report, EU GHG inventories as compiled under the EU monitoring mechanism (by the EEA ETC/ACC) and submitted by the European Commission to the UNFCCC (April 2003) have been used. The data are presented in EEA publications (2003a) and are also available on the EEA website (http://www.eea.eu.int/). In addition, Annex 2 includes the main data. The EU inventory contains data submitted by the Member States to the

Greenhouse gas data restrictions: GHG emission data, as referred to in this report, do not include emissions and removals from land-use change and forestry (LUCF) (CRF Category 5) for two reasons: (1) inconsistent calculation methods of Member States; (2) Member States decided not to update their LUCF data before the IPCC good practice guidance for the LUCF sector has become available. Therefore, data on carbon sinks in line with the conference of the parties (COP) 7 decisions were not available for this report. In addition, no adjustments for temperature variations or electricity trade are made for the EU as a whole. However, for Denmark, additional emission data adjusted for temperature variations and electricity trade are presented separately (as the Danish target refers to adjusted data and data were submitted).

European Commission before 5 April 2003. All Member States provided data for the most recent years. A data gap-filling procedure was applied in accordance with the guidelines of the monitoring mechanism for Luxembourg (CO_2, CH_4, N_2O for 1991–93 and fluorinated gases for 1990–2000) and Belgium and Ireland (fluorinated gases for 1990–94). See EEA (2003a) for more details.

For sectoral background data there are two main data sources.

(1) The data as supplied by the Member States under the monitoring mechanism in the CRF tables before April 2003. For 14 Member States, sectoral background data were available. Twelve Member States provided time series from 1990 to 2001.
(2) Data downloaded from Eurostat's New Cronos database; this database was also used to derive the main driving force data. In addition, the data used for the calculation of some CO_2 indicators were provided by Eurostat (both emission and driving force data).

The geographical coverage of emission statistics and other statistics is not fully consistent (i.e. inclusion of overseas territories in emission data). However, this is not expected to distort overall trends and main conclusions.

The data availability (time series) of GHG emissions and of sectoral background data can be seen in Annex 1 for each Member State and the EU as a whole.

Overview of new information on projections and policies and measures
The information presented in this report on projections and policies and measures is based on the latest information submitted by Member States under the EU GHG monitoring mechanism, together with additional material on the AC and CC taken from their national communications and the results of the latest EU-wide projections of greenhouse gas emissions. The most significant new information available for this year's report, compared with the 2002 report, is:

- new projections and updated information on policies and measures for Greece and Italy based on their third national communications;
- new greenhouse gas projections from Denmark and Germany;
- updated information on policies and measures for Finland and Sweden;
- information for the first time on projections and policies and measures for Bulgaria and Slovenia based on their national communications;
- information on the proposed use of sinks and/or flexible mechanisms from Austria, Belgium, Finland, the Netherlands, Portugal, Spain, Sweden and the United Kingdom.

2. Greenhouse gas emission trends in Europe

2.1. Distance-to-target assessment of the EU

This section is evaluating progress of the European Union as a whole towards fulfilling its GHG emission targets. Section 2.1.1 evaluates actual progress of the EU by presenting distance-to-target indicators (DTI). The DTIs are based on a comparison of 2001 GHG emission data with the target path in 2001 for total GHG emissions (2008–12). Section 2.1.2 presents overall GHG emission trends and the contribution of major driving forces to energy-related CO_2 emissions. Section 2.1.3 evaluates the contribution of the Member States to the fulfilment of the EU GHG targets.

2.1.1. Distance-to-target indicator

In the European Union, GHG emissions increased in 2001 compared with 2000. In 2001, total EU GHG emissions were 4.108 Mt (CO_2 equivalents), which was 1.0 % above 2000 but 2.3 % below base-year levels. The most important reason for emission increases in 2001 compared with 2000 was a colder winter in most EU countries that led households to burn more heating fuel. Increased heating needs meant that CO_2 emissions from households and services jumped 6.0 % in 2001 from a year earlier, contributing substantially to the increase in overall GHG emissions. In addition, emissions increased from growing transport demand and greater use of fossil fuels in electricity and heat production.

In the Kyoto Protocol, the EU agreed to reduce its GHG emissions by 8 % by 2008–12, from base-year levels. The base year is 1990 for CO_2, CH_4 and N_2O. For fluorinated gases most Member States have indicated to select 1995 as base year, as allowed for under the Kyoto Protocol. Therefore, for the purpose of this analysis of the EU GHG emission trends, 1995 is used as the base year for fluorinated gases for all Member States. Assuming a linear target path from the base year to 2010, total EU GHG emissions were 2.1 index points above this target path in 2001 (Figure 3), in other words, the DTI is + 2.1.

By far the most important GHG is CO_2, accounting for 82 % of total EU emissions in 2001. In 2001, EU CO_2 emissions (excluding LUCF) were 3.384 Mt, up 1.6 % from 2000, and also from 1990 levels ([10]) (Figure 3).

2.1.2. EU greenhouse gas emission trends and main driving forces

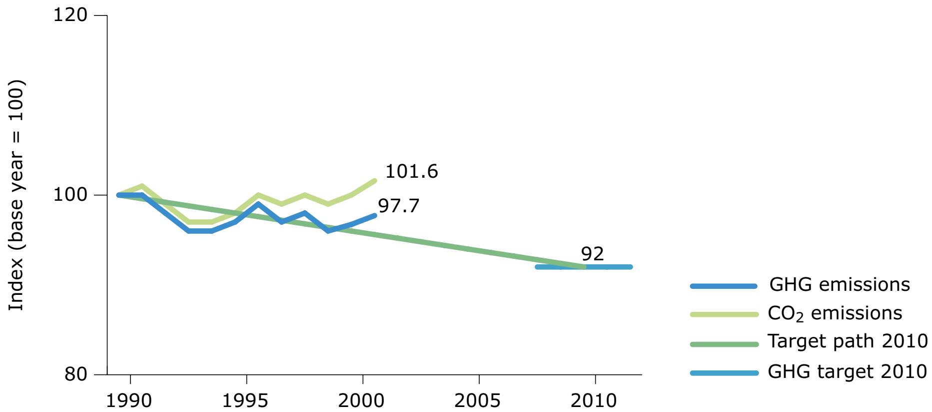
Greenhouse gas emission trends: Total GHG emissions decreased by 2.3 % between the base year and 2001, but trends of the different gases varied considerably. Figure 4 shows that the CO_2 emissions increased by 2 % whereas all other GHG decreased.

Emissions of CO_2 account for 82 % of total GHG emissions. In 2001, CO_2 emissions increased mainly because of increases in households and services, but over the period 1990–2001 the main reason for increases is growing transport demand. The 20 % increase in transport-related CO_2 emissions between 1990 and 2001 was partly offset by reductions in energy-related emissions from manufacturing industries and from electricity and heat production.

Emissions of CH_4 account for 8 % of total EU GHG emissions and decreased by 21 % between 1990 and 2001. Also in 2001, emissions decreased compared with 2000. The main reasons for declining CH_4 emissions were the decline of coal mining, reductions in solid waste disposal on land and falling cattle population.

([10]) The EU CO_2 emissions including LUCF were also above the 1990 levels.

Figure 3 EU greenhouse gas emissions compared with the Kyoto target for 2010 (excluding LUCF)



Note (1): The target path is used to analyse how close 2001 emissions were to a hypothetical linear path of emission reductions or allowed increases from the base year to the Kyoto Protocol target, assuming domestic measures are used (including emissions trading within the EU).
Note (2): GHG emission data for the EU as a whole do not include emissions and removals from LUCF. In addition, no adjustments for temperature variations or electricity trade are considered. See Section 1.3 for details.
Note (3): For the fluorinated gases most Member States have selected 1995 as base year, as allowed for under the Kyoto Protocol. Therefore, for the purpose of this analysis of the EU GHG emission trends, 1995 is used as the base year for fluorinated gases for all Member States.
Note (4): The index on the *y* axis refers to the base year (1995 for fluorinated gases, 1990 for other gases). This means that the value for 1990 does not need to be exactly 100.

Source: Inventory submissions by the EU Member States (CRF tables), EEA (2003a).

Emissions of N_2O are responsible for 8 % of total GHG emissions and decreased by 16 %. The main reason for large N_2O emission cuts was reduction measures in the chemical industry (adipic acid production).

Despite a sharp increase of fluorinated gas emissions between 1992 and 1998, they still account for only 1 % of total GHG emissions ([11]). The three fluorinated gases show opposing trends: HFC emissions increased by 11 % between 1995 and 2001, whereas PFC emissions declined by 28 %. Emissions of SF_6 were 25 % below 1995 levels in 2001. The main reason for growing HFC emissions in the EU is the phase-out of ozone-depleting substances such as chlorofluorocarbons under the Montreal Protocol and the replacement of these substances with HFCs (mainly in refrigeration, air conditioning, foam production and as aerosol propellants). All fluorinated gases together decreased by 2 % between 1995 and 2001.

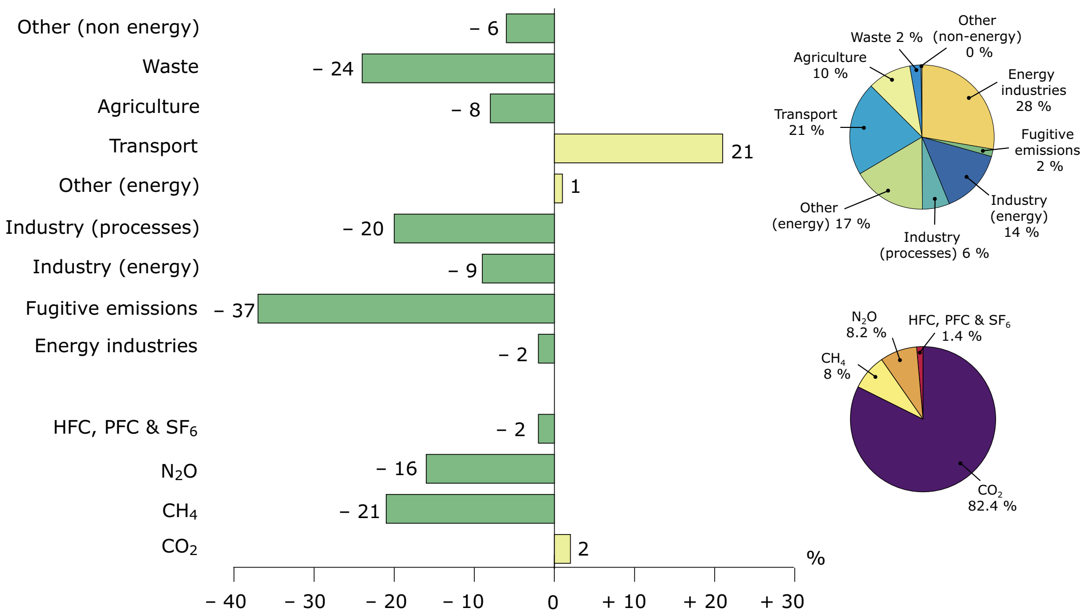
Energy industries are the largest sector accounting for 28 % of total EU GHG emissions. The sector includes emissions from electricity and heat production, oil refineries and manufacturing of solid fuels. The 2 % decline of the sector is largely due to efficiency improvements in German coal fired power plants and to fuel switch in the UK power industry.

Transport is the second largest sector accounting for 21 % of total EU GHG emissions. With a 20 % increase it is also the fastest growing sector in the EU. This is mainly due to fast growing road transport in almost all EU Member States.

Other (Energy) is the third largest sector accounting for 17 % of total EU GHG emissions. This sector includes mainly emissions from households and services. Emissions were 1 % above 1990 levels in 2001, but fluctuate to a certain extent according to annual changes in outdoor temperature.

([11]) In the EU, emissions from fluorinated gases based on Member States' estimates were 59.7 Tg CO_2 equivalents in 1995. Independent studies summarised by the EU (2001c) estimate total EU emissions of fluorinated gases to be 65.2 Tg CO_2 equivalents, which shows a good correspondence with Member States' emission estimates.

Figure 4 **Change, base year to 2001 for EU-15 greenhouse gas emissions by sector and gas and their share in 2001**



Note: The left side of the figure shows the percentage change between 1990 and 2001 of GHG emissions by sector and gas; the right side of the figure shows the share by sector and gas in total EU–15 GHG emissions in 2001.

Source: Inventory submissions by the EU Member States (CRF tables), EEA (2003a).

Industry (Energy) is the fourth largest sector accounting for 14 % of total EU GHG emissions. Emissions decreased by 9 % largely due to the restructuring of the German industry and efficiency improvements after German reunification.

Agriculture accounts for 10 % of total EU GHG emissions. Emissions decreased by 8 % mainly due to a decline in the use of nitrogenous fertiliser and manure and a decline in cattle population.

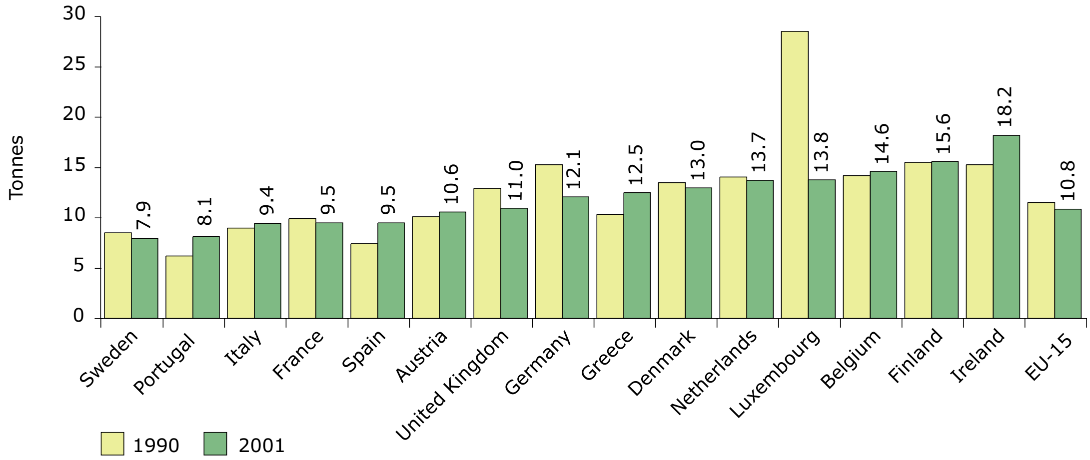
Industry (Processes) accounts for 6 % of total EU GHG emissions. Emissions decreased by 20 % mainly due to N_2O emission reduction measures in the adipic acid production.

The largest emission decreases between 1990 and 2001 occurred from fossil fuel-related fugitive emissions, but they account only for 2 % of the total EU emissions.

Figure 5 shows the development of GHG emissions per capita in the EU and by Member States between 1990 and 2001. In the EU, GHG emissions per capita decreased by 6 % from 11.5 tonnes in 1990 to 10.8 tonnes in 2001. This reduction is largely due to decreases in Germany (– 21 %) and the United Kingdom (– 15 %). There were also decreases in Denmark, France, the Netherlands, Luxembourg and Sweden. In eight Member States, per capita emissions increased between 1990 and 2001, with Greece, Portugal and Spain showing percentage increases of more than 20 %. Ireland had the highest per capita emissions in 2001 (18.2 tonnes), and Sweden had the lowest (7.9 tonnes).

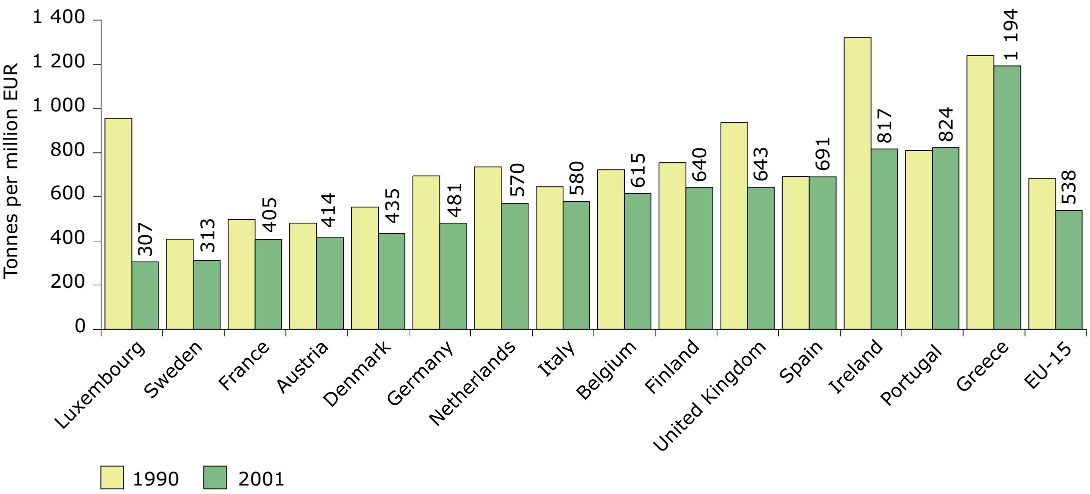
Figure 5 shows the development of GHG emissions per GDP in the EU and by Member State between 1990 and 2001. In the EU, GHG emissions per GDP decreased by 21 % from 684 tonnes per million euro in 1990 to 538 tonnes in 2001. In most Member States, the emissions per GDP decreased between 1990 and 2001, the only exception being Portugal. Greece had the highest GDP emissions in 2001 (1 194 tonnes per million Euro), and Luxembourg had the lowest (307 tonnes).

Figure 5 EU Member State greenhouse gas emissions per capita, 1990–2001



Source: Inventory submissions by the EU Member States (CRF tables), EEA (2003a) and Eurostat for population.

Figure 6 EU Member State greenhouse gas emissions per GDP, 1990–2001



Source: Inventory submissions by the EU Member States (CRF tables), EEA (2003a) and Eurostat for GDP.

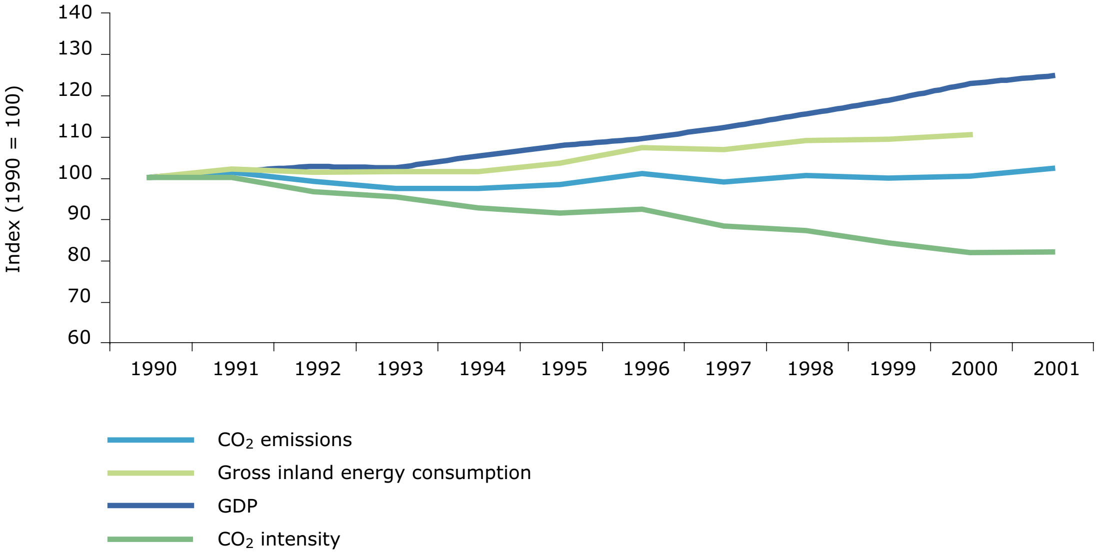
Main driving forces of CO_2 emissions from fossil fuels: CO_2 emissions from fossil fuel combustion account for 78 % of total EU GHG emissions. Figure 7 shows the development of main driving forces of CO_2 emissions from fossil fuel combustion: real GDP grew by 25 % between 1990 and 2001, energy consumption decoupled from GDP, but increased by 10 % between 1990 and 2000 (no 2001 value available). Emissions of CO_2 from fossil fuels were slightly above 1990 levels in 2001. Therefore, CO_2 emissions decoupled from both GDP and energy consumption; CO_2 intensity of GDP decreased by 18 %.

2.1.3. *Contribution of Member States to the EU greenhouse gas trends*

Table 1 shows large variations in GHG emission trends between Member States. Compared with 2000, only Spain reduced its emissions in 2001. Five Member States were below base-year levels in 2001, but 10 Member States were above the base-year level. The percentage changes from the base year to 2001 of GHG emissions ranges from – 44.2 % (Luxembourg) to + 36.4 % (Portugal).

The overall EU GHG emission trend is dominated by the two largest emitters,

Figure 7 **GDP, gross inland energy consumption, CO_2 emissions from fossil fuel combustion and CO_2 intensity of GDP (as an index)**



Source: Eurostat, inventory submissions by the EU Member States (CRF tables), EEA (2003a).

Table 1 **Greenhouse gas emissions in CO_2 equivalents (excluding LUCF) and Kyoto Protocol targets for 2008–12**

Member State	Base year [1]) (million tonnes)	2001 (million tonnes)	Change 2000–2001 (%)	Change base year–2001 (%)	Targets 2008–12 under Kyoto Protocol and 'EU burden sharing' (%)	Distance-to-target indicator (DTI) (index points)	Evaluation of progress in 2001 [3])
Austria	78.3	85.9	4.8	9.6	– 13.0	16.8	☹
Belgium	141.2	150.2	0.2	6.3	– 7.5	10.5	☹
Denmark [2])	69.5	69.4	1.8	– 0.2 (– 9.0)	– 21.0	11.4 (2.6)	☹
Finland	77.2	80.9	7.3	4.7	0.0	4.7	☹
France	558.4	560.8	0.5	0.4	0.0	0.4	☹
Germany	1 216.2	993.5	1.2	– 18.3	– 21.0	– 6.8	☺
Greece	107.0	132.2	1.9	23.5	25.0	9.8	☹
Ireland	53.4	70.0	2.7	31.1	13.0	23.9	☹
Italy	509.3	545.4	0.3	7.1	– 6.5	10.7	☹
Luxembourg	10.9	6.1	1.3	– 44.2	– 28.0	– 28.8	☺
Netherlands	211.1	219.7	1.3	4.1	– 6.0	7.4	☹
Portugal	61.4	83.8	1.9	36.4	27.0	21.6	☹
Spain	289.9	382.8	-1.1	32.1	15.0	23.8	☹
Sweden	72.9	70.5	2.2	– 3.3	4.0	– 5.5	☺
United Kingdom	747.2	657.2	1.3	– 12.0	– 12.5	– 5.2	☺
EU-15	**4 204.0**	**4 108.3**	**1.0**	**– 2.3**	**– 8.0**	**2.1**	☹

(1) Base year for CO_2, CH_4 and N_2O is 1990; for the fluorinated gases most Member States selected 1995 as base year, as allowed for under the Protocol. Therefore, for the purpose of this analysis of the EU GHG emission trends, 1995 is used as the base year for fluorinated gases for all Member States.
(2) For Denmark, data that reflect adjustments for electricity trade (import and export), in 1990, are presented in parentheses. This method is used by Denmark to monitor progress towards its national target under the EU 'burden sharing' agreement. For the EU emissions, total non-adjusted Danish data have been used.
(3) The EEA's evaluation of progress to 2001 awards 'smileys' according to the distance-to-target indicator (DTI) in 2000 (for more details see Section 1.2). The following rating system is used:
☺ positive contribution to EU trend: the negative distance-to-target indicator means that the Member State is below its linear target path;
☹ negative contribution to EU trend: the positive distance-to-target indicator means that the Member State is above its linear target path.

Source: Inventory submissions by the EU Member States (CRF tables), EEA (2003a).

Germany and the United Kingdom, accounting for 40 % of EU GHG emissions. These two Member States achieved total GHG emission reductions of 313 million tonnes compared with the base year ([12]).

The main reasons for the favourable trend in Germany are increasing efficiency in power and heating plants and the economic restructuring of the five new *Länder* after German reunification. The reduction of GHG emissions in the United Kingdom was primarily the result of liberalising the energy market and the subsequent fuel switches from oil and coal to gas in electricity production and N_2O emission reduction measures in the chemical industry. In 2000 and 2001, both Germany's and the United Kingdom's total GHG emissions increased. In Germany, emissions from households and services increased mainly due to the cold winter. The largest increases in the United Kingdom occurred from electricity and heat production.

France and Italy are the third and fourth largest emitters with a share of 14 and 13 %, respectively. France's emissions increased by 0.5 % in 2001, compared with 2000, and were 0.4 % above base-year levels in 2001. In France, large reductions were achieved in N_2O emissions from the chemical industry, but CO_2 emissions from transport and from households and services increased considerably between 1990 and 2001. Italy's GHG emissions were 0.3 % above 2000 and 7.1 % above base-year levels in 2001. Italian GHG emissions increased between base year and 2001 primarily from transport and from electricity and heat production.

Spain, as the fifth largest emitter in the EU, accounts for 9 % of total EU GHG emissions and increased emissions by 32.1 % between base year and 2001. This was largely due to emission increases from transport, from electricity and heat production and from manufacturing industries. In 2001, GHG emissions were – 1.1 % lower than in 2000, largely due to increases in hydropower production and HFC reductions from production of halocarbons.

Progress of the Member States: If GHG emissions of the Member States are compared with their linear target path for 2008–12, the following conclusions with regard to progress of Member States can be drawn (Figure 8) ([13]).

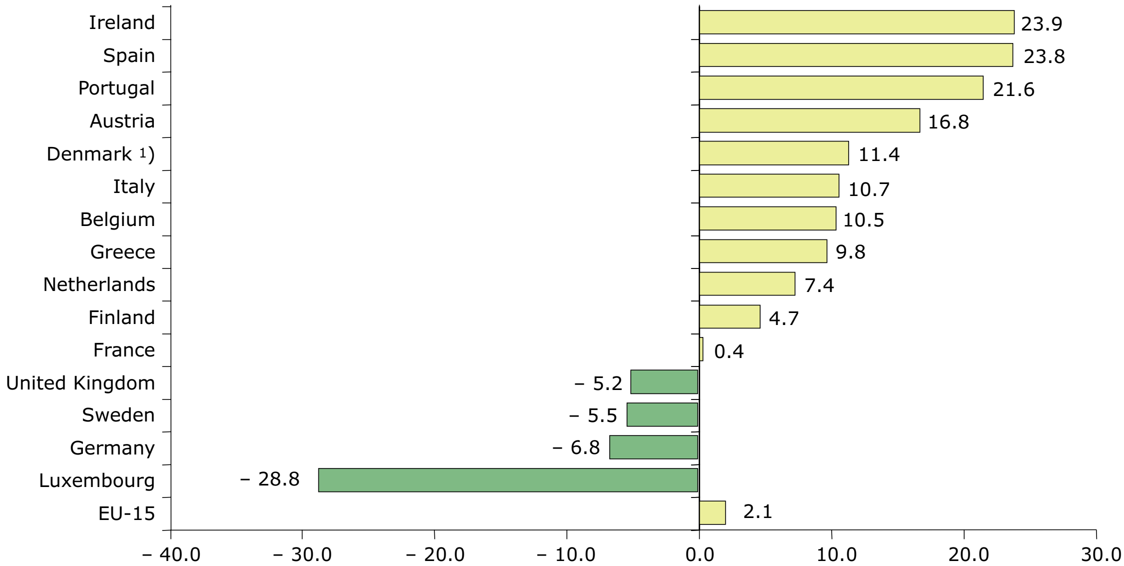
- The EU as a whole was 2.1 index points above its linear target path in 2001, thus leaving the track towards Kyoto to a certain extent.
- Five Member States (United Kingdom, Sweden, Germany, Luxembourg and France) were near or below their burden sharing target paths, thus fully on track towards fulfilling their Kyoto targets with domestic policies and measures.
- Ten Member States were well above their burden sharing target paths (Ireland, Spain, Portugal, Austria, Denmark, Italy and Belgium by more than 10 index points), and therefore are not on track towards their target with domestic policies and measures. The Danish distance-to-target indicator is 11.4 index points for non-adjusted data and 0.9 index points, if Danish GHG emissions are adjusted for electricity trade and temperature variation in 1990.

Table 2 indicates the change in DTI (as index points) for each Member State between 2000 and 2001.

- Sweden was the only EU country that moved further below the hypothetical Kyoto target path in 2001. Spain was the only country that reduced its distance-to-target path.
- France and Finland were both below their target paths in 2000, but one year later they were above their paths.

([12]) The EU as a whole needs emission reductions of total GHG to be 8 %, i.e. 336 million tonnes on the basis of the EEA (2003a) in order to meet the Kyoto target.
([13]) In some Member States, activities have already started to put Kyoto mechanisms in place, but the effects of these do not appear in the Member State GHG inventories and are thus not analysed here. A preliminary analysis of the projected use of Kyoto mechanisms is presented in Chapter 3.

Figure 8 Distance-to-target indicators (in index points) for the Kyoto Protocol and EU burden sharing targets of EU Member States



([1]) The Danish DTI is + 2.6 index points, if Danish GHG emissions are adjusted for electricity trade in 1990.

Note: The DTI measures the deviation of actual emissions in 2001 from the (hypothetical) linear target path between base year and the burden sharing target (in 2010). The DTI gives an indication on progress towards the Kyoto and Member States' shared targets. It assumes that the Member States meet their targets entirely on the basis of domestic measures. See Section 1.2 for an explanation of the DTI.

Source: Inventory submissions by the EU Member States (CRF tables), EEA (2003a).

Table 2 Distance-to-target indicators and their change in each Member State between 2000 and 2001

Member State	Distance-to-target indicator (DTI) 2000 (index points)	Distance-to-target indicator (DTI) 2001 (index points)	Change in DTI between 2000–2001 (index points)
Spain	26.2	23.8	– 2.4
Sweden	– 3.9	– 5.5	– 1.6
Belgium	10.0	10.5	0.4
Greece	8.7	9.8	1.1
United Kingdom	– 6.7	– 5.2	1.5
Netherlands	5.6	7.4	1.8
Germany	– 8.6	– 6.8	1.8
France	– 1.7	0.4	2.1
Luxembourg	– 31.1	– 28.8	2.3
Denmark ([1])	8.8	11.4	2.6
Italy	7.2	10.7	3.5
Portugal	16.6	21.6	5.0
Ireland	17.5	23.9	6.4
Austria	9.2	16.8	7.6
Finland	– 4.1	4.7	8.8
EU-15	**0.5**	**2.1**	**1.6**

([1]) Denmark's DTIs are based on non-adjusted data.

- The United Kingdom, Germany and Luxembourg increased their emissions and reduced, thereby, their DTI, in 2001.
- Belgium, Greece, the Netherlands, Denmark, Italy, Portugal, Ireland and Austria were above their target paths in 2000 and they moved further away from their target paths in 2001.

A more detailed analysis of the progress of each Member State is given in Annex 1.

2.2. Sectoral assessment of the EU

This section analyses the sectoral performance of the EU as a whole, and of its Member States. First, the selection of the EU key sources for the presentation in this report is described. Then, the trends of emissions and driving forces are analysed for each key source selected with the following elements: (1) presentation of emission trends and sectoral driving force at EU level; (2) an overview of trends of emissions and sectoral driving forces at Member State level; (3) the contribution of each Member State to the key source, in order to identify decreasing or less increasing emission trends in the Member State. Moreover, for some key sources, additional indicators are given.

The key sources are presented according to their contribution to total EU GHG emissions. Information on methodologies and emission factors used by the Member States is included for each key source in the EU inventory report, 2003 (EEA, 2003a). Sectoral driving force indicators are presented based on data submitted by the Member States (FCCC common reporting format or CRF tables) and additional data from Eurostat. The data basis for the additional CO_2 indicators is primarily Eurostat.

Note that the comparisons of key source indicators refer to the trend from 1990 to 2001 in the Member States. The different national circumstances in the Member States are not taken into account. This might give a misleading picture for Member States that already implemented emission reduction measures or fuel shifts before 1990. Also for Member States with lower-than-EC-average economic welfare in 1990, but which had a higher-than-EC-average economic growth, emission reductions or limited growth may have been difficult to achieve.

2.2.1. The selection of key source categories

In order to analyse the sectoral GHG trends in greater detail this report focuses on the most important key sources. The selection of the most important key sources takes as a starting point the key source analysis provided in the EU inventory report, 2003 (EEA, 2003a), which is based on the methodology (tier 1) described in the IPCC good practice guidance report (IPCC, 2000). A key source category is defined as an emission source that has a significant influence on a country's GHG inventory in terms of the absolute level of emissions, the trend in emissions, or both. In total, the EEA (2003a) identifies 28 key source categories for the EU (out of 68 source categories), covering 98 % of total EU GHG emissions in 2001 (Table 3). Last year, 22 key sources were identified for 2000. New key sources for 2001 are oil and natural gas (CO_2), chemical industry (CO_2), solid fuels (CO_2), consumption of halocarbons and SF_6 (SF_6), waste water handling (N_2O), agricultural soil (CO_2), and two sources for other (CO_2) (EEA 2002). Other sectors (N_2O) and chemical industry (HFC) are no longer key sources in the 2001 inventory.

The analysis in this report focuses on the eight largest key sources covering 90 % of total EU GHG emissions. Each of the eight large key sources is dealt with in a separate section; for some of them additional indicators are presented. In the final section, overview information on four additional source categories is presented. The criteria for choosing these four source categories are either percentage contribution to total EU GHG emissions of more than 1 %, or a large increase in absolute terms between the base year and 2001.

Therefore, the following eight key sources (covering 80 % of total EU GHG emissions) are dealt with in more detail:

- energy industries (CO_2)
- transport (CO_2)
- other sectors (CO_2) (households and services)

Table 3 EU greenhouse gas source categories identified as key sources (emissions in Gg of CO_2 equivalents)

Greenhouse gas source categories		Gas	Base year (Gg)	2001 (Gg)	Absolute change	% change	Share (%)	Cumulative share (%)
1.A.1.	Energy industries	CO_2	1 144 434	1 119 301	– 25 133	– 2	27.2	27.2
1.A.3.	Transport	CO_2	695 003	833 925	138 922	20	20.3	47.5
1.A.4.	Other sectors	CO_2	635 096	655 763	20 667	3	16.0	63.5
1.A.2.	Manufacturing industries and construction	CO_2	642 348	585 160	– 57 189	– 9	14.2	77.8
4.D.	Agricultural soils	N_2O	214 489	196 818	– 17 670	– 8	4.8	82.5
4.A.	Enteric fermentation	CH_4	144 091	131 631	– 12 460	– 9	3.2	85.7
2.A.	Mineral products	CO_2	106 934	105 952	– 982	– 1	2.6	88.3
6.A.	Solid waste disposal on land	CH_4	110 982	80 295	– 30 687	– 28	2.0	90.3
2.B.	Chemical industry	N_2O	106 096	49 167	– 56 929	– 54	1.2	91.5
4.B.	Manure management	CH_4	45 172	45 268	97	0	1.1	92.6
2 F	Consumption of halocarbons and SF_6	HFC	6 167	31 383	25 216	409	0.8	93.3
1.B.2.	Oil and natural gas	CH_4	32 969	28 338	– 4 631	– 14	0.7	94.0
1.A.3.	Transport	N_2O	11 660	26 361	14 701	126	0.6	94.7
2.C.	Metal production	CO_2	25 702	23 856	– 1 847	– 7	0.6	95.3
4.B.	Manure management	N_2O	23 495	21 562	– 1 933	– 8	0.5	95.8
1.B.2.	Oil and natural gas	CO_2	17 247	16 377	– 870	– 5	0.4	96.2
1.B.1.	Solid fuels	CH_4	48 510	15 277	– 33 233	– 69	0.4	96.5
2 E	Production of halocarbons and SF_6	HFC	32 373	11 957	– 20 416	– 63	0.3	96.8
2.B.	Chemical industry	CO_2	12 884	10 769	– 2 116	– 16	0.3	97.1
1.B.1.	Solid fuels	CO_2	9 283	8 081	– 1 202	– 13	0.2	97.3
1.A.4.	Other sectors	CH_4	10 453	7 739	– 2 713	– 26	0.2	97.5
1.A.5.	Other	CO_2	20 076	7 307	– 12 770	– 64	0.2	97.7
2 F	Consumption of halocarbons and SF_6	SF_6	9 617	6 543	– 3 074	– 32	0.2	97.8
6.B.	Waste-water handling	N_2O	6 492	5 579	– 913	– 14	0.1	98.0
2 C	Metal production	PFC	5 637	3 100	– 2 537	– 45	0.1	98.0
4.D.	Agricultural soils	CO_2	3 208	1 946	– 1 262	– 39	0.0	98.1
2.G.	Other	CO_2	1 111	1 295	184	17	0.0	98.1
6.D.	Other	CO_2	881	420	– 461	– 52	0.0	98.1

Source: EEA (2003a).

- manufacturing industries and construction (CO_2)
- agricultural soil (N_2O)
- enteric fermentation (CH_4)
- mineral products (CO_2)
- solid waste disposal on land (CH_4).

In addition, overview information is provided for:

- chemical industry (N_2O)
- manure management (CH_4)
- consumption of halocarbons and SF_6 (HFC)
- transport (N_2O).

The largest changes of EU key sources between the base year and 2001
Figure 9 shows the absolute and relative change of key source categories between the base year and 2001. The thick dark bar indicates absolute change against the bottom of the figure. The thin white bar indicates percentage changes against the top of the figure.

Sectors with large increase in emissions: Emissions from transport have risen rapidly since 1990 (mainly CO_2, but also N_2O emissions). Emissions of CO_2 increased by 139 million tonnes or 20 %. This is mainly due to rapid growth of road transport in almost all Member States. Increases in N_2O

Figure 9 **Absolute and relative change, base year to 2001, of EU key source emissions (in million tonnes of CO_2 equivalents and percentage)**

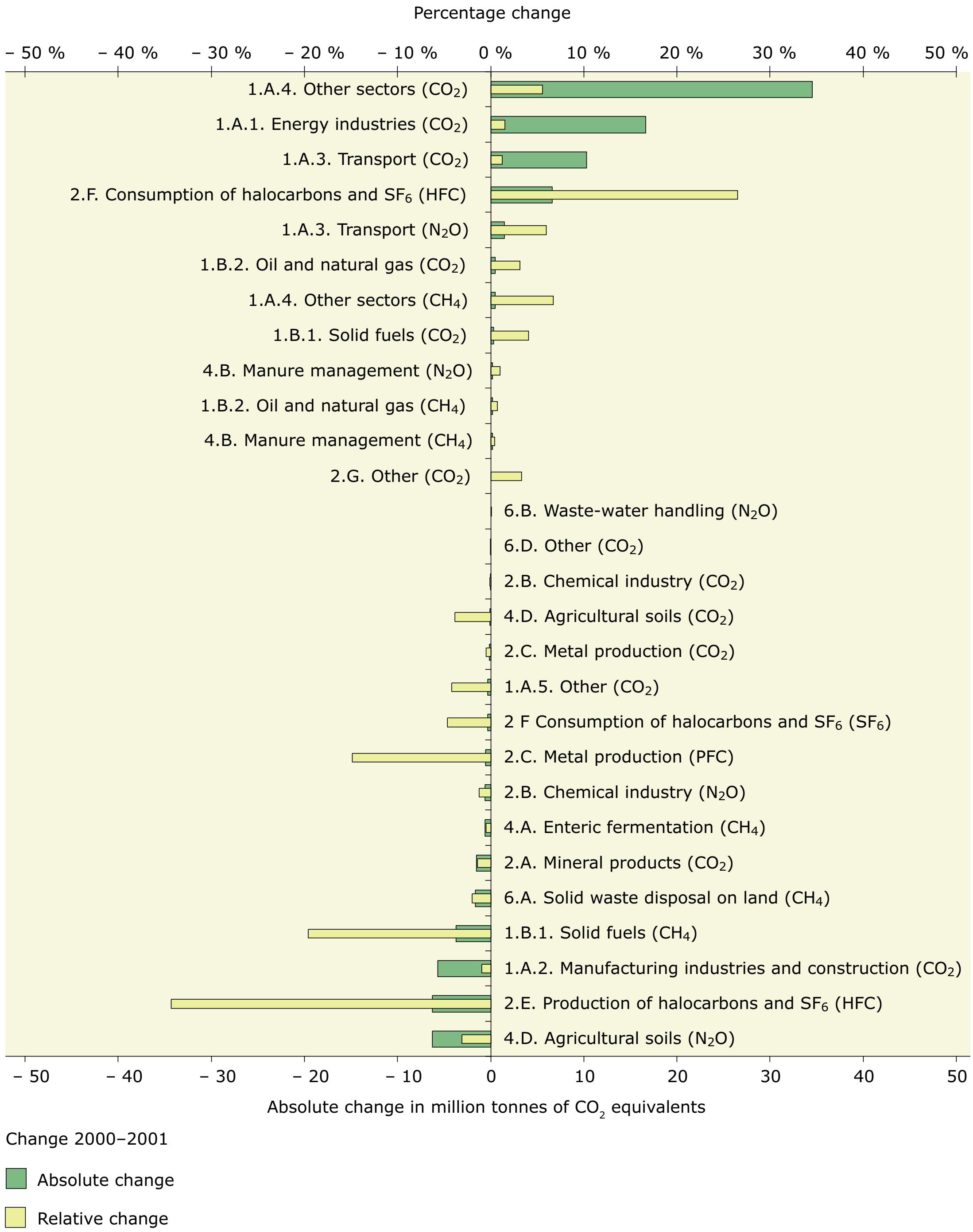
Source: Inventory submissions by EU Member States (CRF tables), EEA (2003a).

emissions from transport are mainly due to the increased use of catalytic converters, which reduce emissions of air pollutants, but produce N_2O as a by-product.

A third key source category with substantial increases is HFC emissions from consumption of halocarbons and SF_6. Emissions increased by 409 % between 1995 and 2001. This is mainly due to the use of some HFCs as substitutes for ozone-depleting CFCs, which were gradually phased out in the 1990s. However, the share of this source category in the total emissions is only 0.8 %.

A fourth key source is other sectors (households and services). Low temperature in the winter of 2001, compared with 2000, and the growing number of dwellings contribute to emission increases in this sector.

Figure 10 Absolute and relative change, between 2000 and 2001, of EU key source emissions (in million tonnes of CO_2 equivalents and percentage)



Source: Inventory submissions by the EU Member States (CRF tables), EEA (2003a).

Sectors with reductions in emissions: The largest reductions in absolute terms were achieved in CO_2 emissions from fossil fuel combustion in the manufacturing industries mainly due to economic restructuring and efficiency improvements in the German manufacturing industry after German reunification. Emissions decreased by 57 million tonnes or 9 %.

Emissions of N_2O from the chemical industry decreased by 57 million tonnes or 54 % mainly due to specific measures in the adipic acid production in the United Kingdom, Germany and France.

Large reductions were achieved for CH_4 emissions from solid fuels (33 million tonnes or 69 %) and from solid waste disposal on land (31 million tonnes or 28 %). These reductions are mainly due to the decline of coal mining after cuts in coal subsidies mainly in the United Kingdom, Germany and France and due to measures related to the implementation of the European landfill waste directive.

The largest changes of EU key sources between 2000 and 2001

Figure 9 shows the absolute and relative change of key source categories between 2000 and 2001.

Sectors with large increase in emissions: The largest emission increases in absolute terms (35 million tonnes) occurred in other sectors (households and services) mainly due to comparatively low temperature in most EU Member States in 2001.

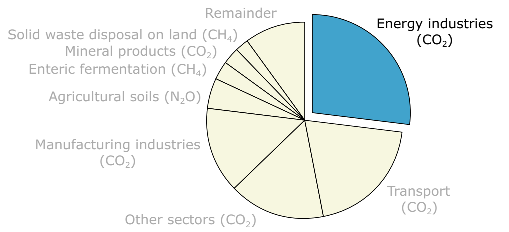
In addition, emissions increased from energy industries (17 million tonnes). The most important reason for this is the increase of carbon-intensive fuel use in power and heat production in several Member States. The largest increases occurred in the United Kingdom, Finland and Germany. In the United Kingdom, CO_2 emissions from the use of solid fuels in power and heat production increased by 10 million tonnes, in Germany by 3 million tonnes, and in Finland by 2 million tonnes. In addition, in Finland CO_2 emissions from the use of other carbon-intensive fuels increased by 3 million tonnes.

Emissions from transport increased by 10 million tonnes and emissions from HFCs from consumption of halocarbons by 7 million tonnes.

Sectors with reductions in emissions: The emission increases were partly offset by reductions in N_2O from agricultural soil, HFCs from production of halocarbons and CO_2 from manufacturing industries (– 6 million tonnes each).

2.2.2. *Energy industries (CO_2)*

Share in total EU greenhouse gases:	27 %
1990:	1 144 Mt
2001:	1 119 Mt
Change, 1990–2001:	– 25 Mt – 2 %
Change, 2000–01:	17 Mt 2 %

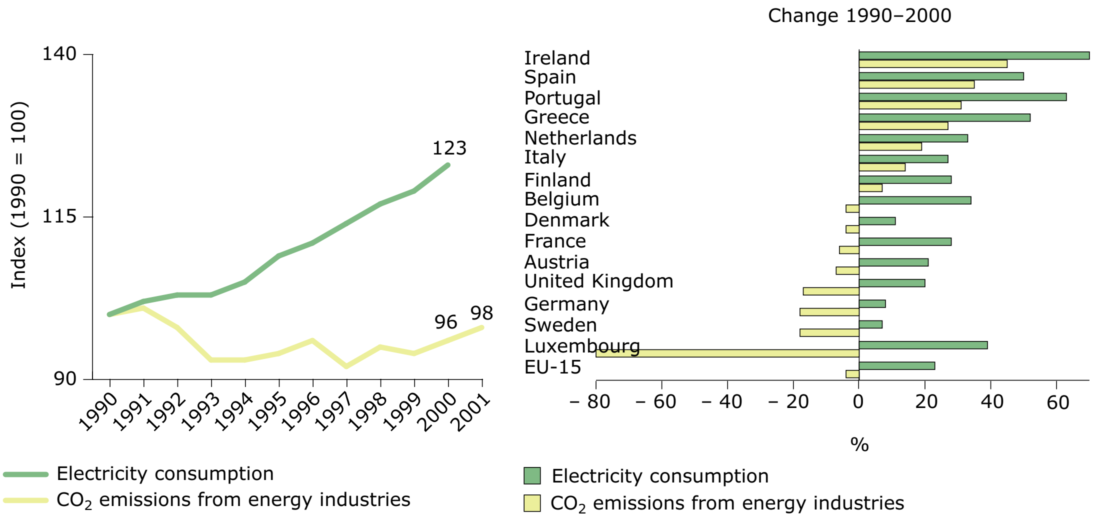


Emissions of CO_2 from energy industries are the largest single source of GHG emissions in the EU accounting for 27 % of total GHG emissions in 2001. They include emissions from fossil fuel combustion in public electricity and heat production, petroleum refining, and the manufacture of solid fuels and other energy industries. Public electricity and heat production accounts for about 85 % of the emissions in this key source, petroleum refining for about 11 %.

Between 1990 and 2001, CO_2 emissions from energy industries declined by 2 % in the EU. The main driving force of CO_2 emissions from energy industries is consumption and production of electricity and heat. Final electricity consumption increased by 23 % between 1990 and 2001. Figure 11 shows that CO_2 emissions from energy industries decoupled ([14]) considerably from electricity consumption. This was mainly due to fuel shifts in power production from coal to natural gas, and larger shares of electricity generation from renewable energy sources and nuclear power, as well as efficiency improvements. In 2001, CO_2 emissions from energy industries increased by 2 % compared with 2000, which was mainly due to increased use of carbon-intensive fuels for power production.

Figure 11 also shows that CO_2 emissions from energy industries declined in several Member States. However, electricity consumption increased in all Member States. Only Sweden, Denmark

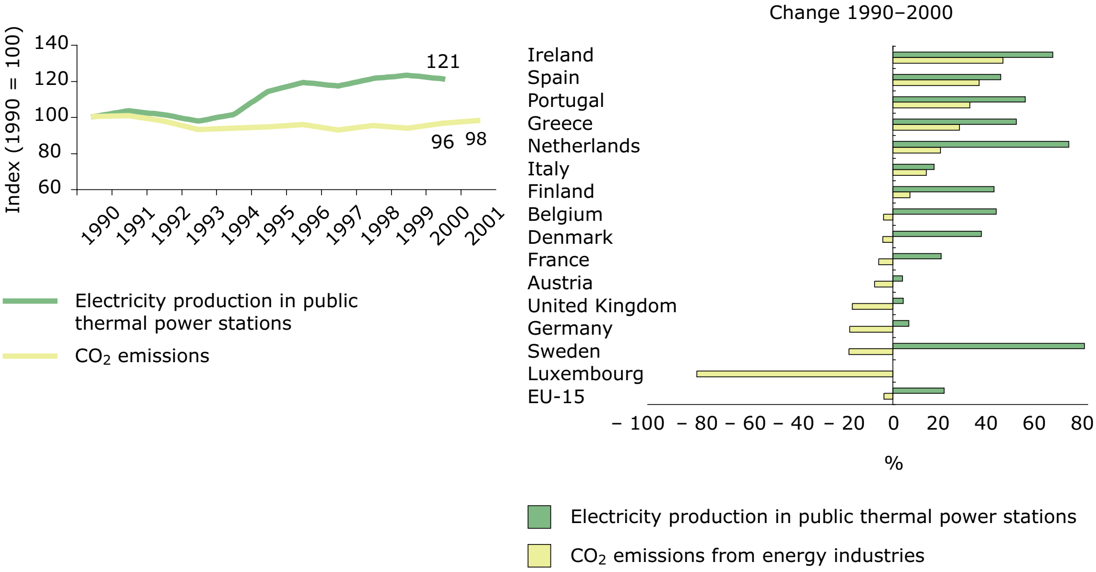
Figure 11 Emissions of CO_2 from energy industries and development of electricity consumption for the EU (left, as index with 1990 = 100) and the Member States (right, as percentage change from 1990)



Source: Eurostat and inventory submissions by the EU Member States (CRF tables), EEA (2003a).

([14]) In this report the term 'decoupling' is used for any deviation of emissions from underlying activity where: (1) emissions do not grow as rapidly as the activity; (2) emissions decrease and activity increases; (3) emissions decrease more rapidly than activity. The degree of the decoupling can be measured by the deviation in terms of index points.

Figure 12 **Emissions of CO_2 from energy industries and development of electricity production in public thermal power plants for the EU (left, as index with 1990 = 100) and the Member States (right, as percentage change from 1990)**



Source: Eurostat and inventory submissions by the EU Member States (CRF tables), EEA (2003a).

Note: In this report, decoupling means that emissions do not grow as rapidly as the activity.

and Germany achieved to limit growth in power consumption below 10 %.

Figure 12 shows that CO_2 emissions from energy industries decoupled also from electricity production in public thermal power plants. The main reasons were fuel shifts in power production from coal to natural gas and efficiency improvements. Most Member States achieved decoupling between electricity production and emissions from energy industries. Sweden's remarkable performance is mainly due to a shift from coal to biomass: biomass increased its share in power and heat production from 13 % in 1990 to 49 % in 2001, whereas the share of coal declined in the same period from 47 to 19 %.

Table 4 shows the contribution of the EU Member States to the level and trend of total EU CO_2 emissions from energy industries. Germany is the largest emitter in the EU accounting for 31 % of total EU CO_2 emissions from energy industries, followed by the United Kingdom (18 %) and Italy (14 %).

In 2001, the United Kingdom and Finland compared with 2000, had the largest emission increases in absolute terms. In the United Kingdom, coal consumption for electricity and heat production increased substantially for the second consecutive year. The main reason for the Finnish increases was a substantial growth of thermal power production, partly due to declines in hydropower production and a decline in electricity imports. Also Germany, the Netherlands and Austria had large emission increases in absolute terms, whereas Spain and Italy showed substantial emission decreases. The main reason for the Spanish decline was a substantial decline in thermal power production and a substantial increase in hydropower production.

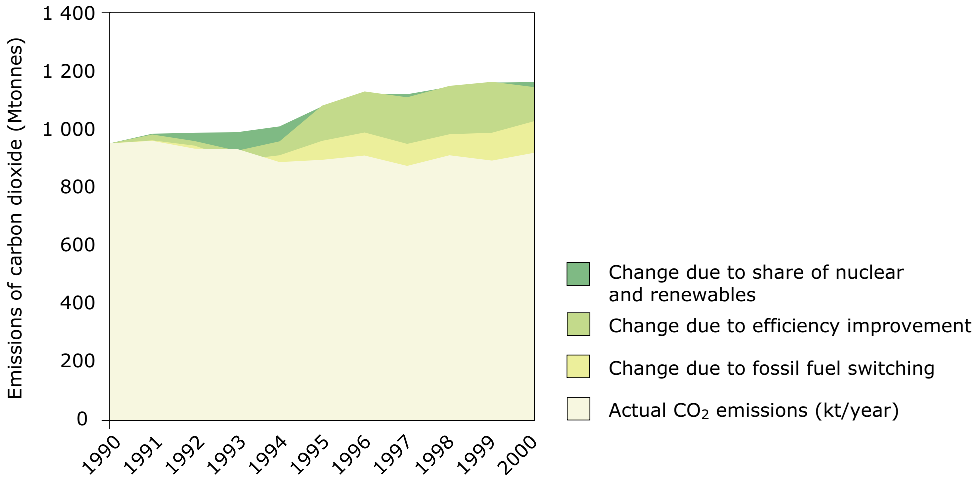
Between 1990 and 2001, Germany and the United Kingdom had large emission decreases in absolute and relative terms, whereas emissions increased considerably in Spain. The most important reason for German CO_2 reductions from energy industries was efficiency improvements in coal-fired power plants. In the United Kingdom, the most important factor for emission reductions was the fuel switch from coal to gas in power production. The

Table 4 Member States' contributions to CO_2 emissions from energy industries

Member State	Greenhouse gas emissions ($Gg\ CO_2$ equivalents)			Share in EU-15 emissions in 2001 (%)	Change 2000–2001		Change 1990–2001	
	1990	2000	2001		($Gg\ CO_2$ equivalents)	(%)	($Gg\ CO_2$ equivalents)	(%)
Germany	412 896	340 043	345 293	30.8	5 250	2	– 67 603	– 16
United Kingdom	228 090	190 184	199 229	17.8	9 045	5	– 28 860	– 13
Italy	138 957	157 835	155 279	13.9	– 2 556	– 2	16 322	12
Spain	77 030	104 082	98 417	8.8	– 5 666	– 5	21 387	28
Netherlands	51 305	61 222	64 776	5.8	3 553	6	13 471	26
France	67 636	63 694	57 487	5.1	– 6 207	– 10	– 10 149	– 15
Greece	43 302	55 058	55 579	5.0	521	1	12 277	28
Finland	18 517	19 815	26 762	2.4	6 946	35	8 244	45
Belgium	28 572	27 482	26 669	2.4	– 813	– 3	– 1 904	– 7
Denmark	26 202	25 121	26 375	2.4	1 254	5	173	1
Portugal	16 199	21 280	21 953	2.0	672	3	5 754	36
Ireland	11 057	16 016	17 145	1.5	1 128	7	6 087	55
Austria	13 225	12 236	14 375	1.3	2 139	17	1 150	9
Sweden	10 169	8 336	9 697	0.9	1 361	16	– 473	– 5
Luxembourg	1 277	255	266	0.0	11	4	– 1 011	– 79
EU-15	**1 144 434**	**1 102 660**	**1 119 301**	**100.0**	**16 641**	**2**	**– 25 133**	**– 2**

Source: Inventory submissions by the EU Member States (CRF tables), EEA (2003a).

Figure 13 Explanations for the reduction of emissions of CO_2 in the EU public power production



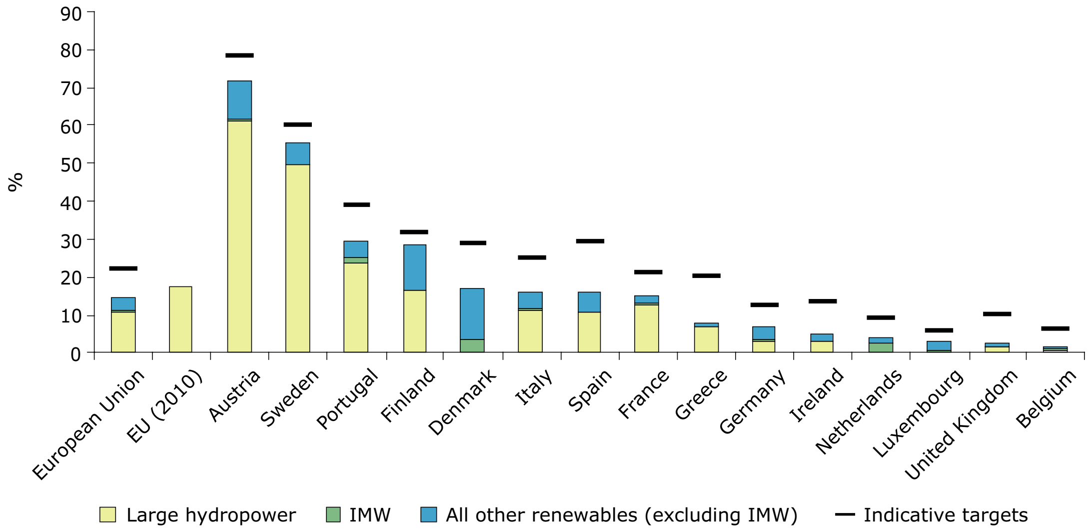
Note: Data and analysis presented here are preliminary results of ongoing work to refine and improve associated statistics and methodology.

Source: EEA (2003b).

main reasons for the 79 % decrease of Luxembourg's CO_2 emissions from energy industries were reductions in thermal power production and increases in electricity imports and hydropower production.

Figure 13 shows that if the structure of electricity production had remained unchanged from 1990, then by 2000 emissions of CO_2 would have increased in line with electricity output. In fact, over this period there have been a number of changes in the electricity industry in the EU that caused emission reductions of CO_2. Changes in the fossil fuel mix from coal and lignite to natural gas accounts for 45 % of this reduction. A further 48 % came from an increase in the efficiency of electricity production

Figure 14 Renewable electricity as a percentage of gross electricity consumption, 2000



Note: Industrial and municipal waste (IMW) includes electricity from both biodegradable and non-biodegradable energy sources, as there are no separate data available for the biodegradable part. The EU 22.1 % indicative target for the contribution of renewable electricity to gross electricity consumption by 2010 only classifies biodegradable waste as renewable. The share of renewable electricity in gross electricity consumption is therefore overestimated by an amount equivalent to the electricity produced from non-biodegradable IMW. National indicative targets shown here are reference values that Member States agreed to take into account when setting their indicative targets by October 2002, according to the EU renewable electricity directive.

Source: Eurostat, EEA (2003b).

from fossil fuels and much of this is also linked to the switch to high-efficiency combined-cycle gas technology. The remaining 7 % of the reduction is attributable to the increased share of nuclear power and renewable energy sources (EEA, 2003b).

Renewable energy: The share of renewable energy in the EU's electricity consumption grew slightly from 13.4 % in 1990 to 14.7 % in 2000. This was achieved through an average annual growth in output of 3.3 % per year over the 1990–2000 period (EEA, 2003b). Substantial additional growth is required to meet the EU renewable electricity indicative target of 22.1 % by 2010 (Figure 14).

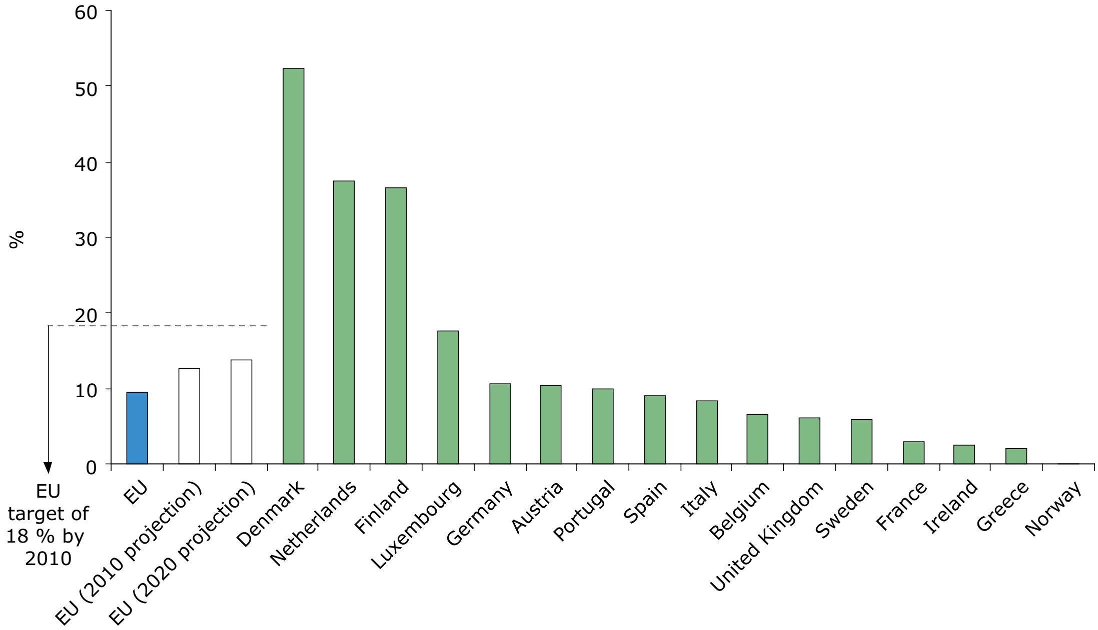
Renewable electricity was dominated by large hydropower, which had an 83 % share of output in 2000, followed by biomass/waste (10 %) and wind power (6 %). Large hydro is an established technology, but its capacity is not expected to increase substantially because of concerns linked to its impacts on the environment through the loss of land and the resultant destruction of natural habitats and ecosystems. Growth in renewable electricity will therefore have to come from renewable energy sources such as wind energy, solar power, biomass and small hydro (EEA, 2003b).

Combined heat and power: Combined heat and power (CHP) technology uses fossil fuels, biomass or waste to generate a mix of heat and electricity. In so doing it avoids much of the waste heat losses associated with normal electricity production: CHP utilises over 85 % of the energy in the fuel rather than the average of about 35 to 45 % in current plants producing only electricity (EEA, 2003b). In the EU, the share of CHP was 10 % in 2000. The EU's target is a share of 18 % by 2010 (Figure 15) ([15]).

Growth in use of CHP was highest in Member States that have programmes and targets for the technology such

([15]) The Commission's cogeneration strategy sets an overall indicative Union target of doubling the share of electricity production from cogeneration in total EU electricity production from 9 % in 1994 to 18 % by 2010 (COM(97) 514 final).

Figure 15 Share of gross electricity production from combined heat and power plants, 2000



Note: Eurostat has adopted a new methodology designed to better identify electricity production from combined heat and power. This revision has resulted in different (lower) figures for some countries. The 18 % target for 2010 (which was set on the basis of the old methodology) may therefore not be directly comparable with the new methodology used to calculate the share of CHP in gross electricity production for 2000. The data include combined heat and power production from public electricity and heat producers, and from auto producers (at specific industrial sites).

Source: Eurostat, EEA (2003b).

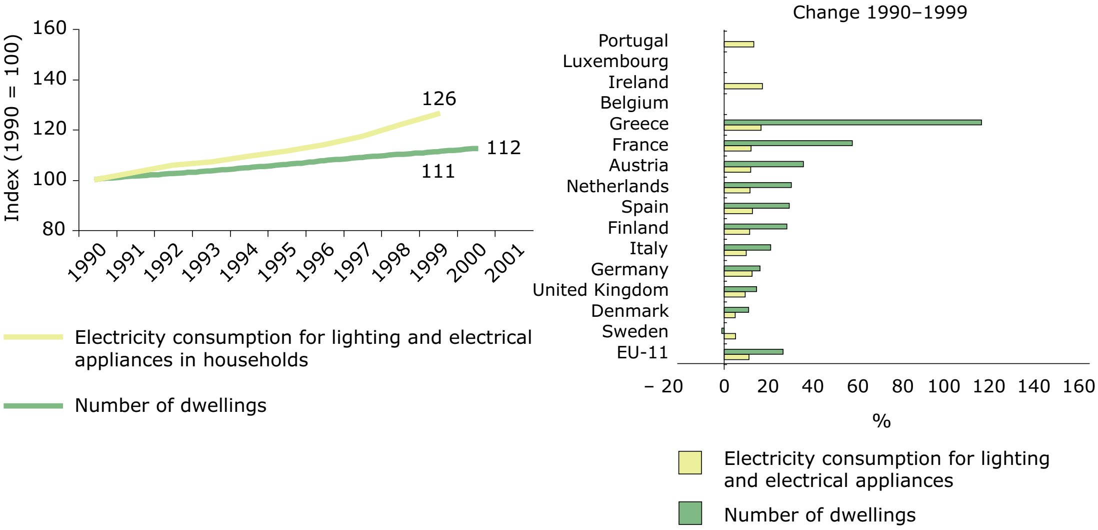
as Finland, Denmark, Italy, the Netherlands and Spain. However, progress in other countries with ambitious targets, such as Germany or the United Kingdom was slower. CHP production has declined since 1998. This reverse is spread across the EU, but most severe indications were noted in Germany, the Netherlands and the United Kingdom. This decline has been caused by a combination of factors (EEA, 2003b):

- reduction of cost-competitiveness caused by:
  - increasing natural gas prices (gas is the preferred fuel for new CHP); and
  - falling electricity prices, resulting from market liberalisation and increased competition;
- uncertainty over the evolution of electricity markets as liberalisation is progressively extended is making companies reluctant to invest in CHP;
- aggressive pricing has been used by electricity utilities to protect their market.

Electricity consumption: Figure 11 showed that final electricity consumption increased by 23 % between 1990 and 2000. Increases in electricity consumption are a main driver of CO_2 emissions. Households and services account for more than half of final electricity consumption. Figure 16 shows that electricity consumption from lighting and electrical appliances in households increased by 26 % between 1990 and 1999 (no data for 2000 and 2001 available), whereas the number of dwellings increased by only 11 %. The figure also shows that, except for Sweden, in all Member States, electricity consumption for lighting and electrical appliances increased.

Figure 17 shows that electricity consumption in services increased by 32 % between 1990 and 2000, which

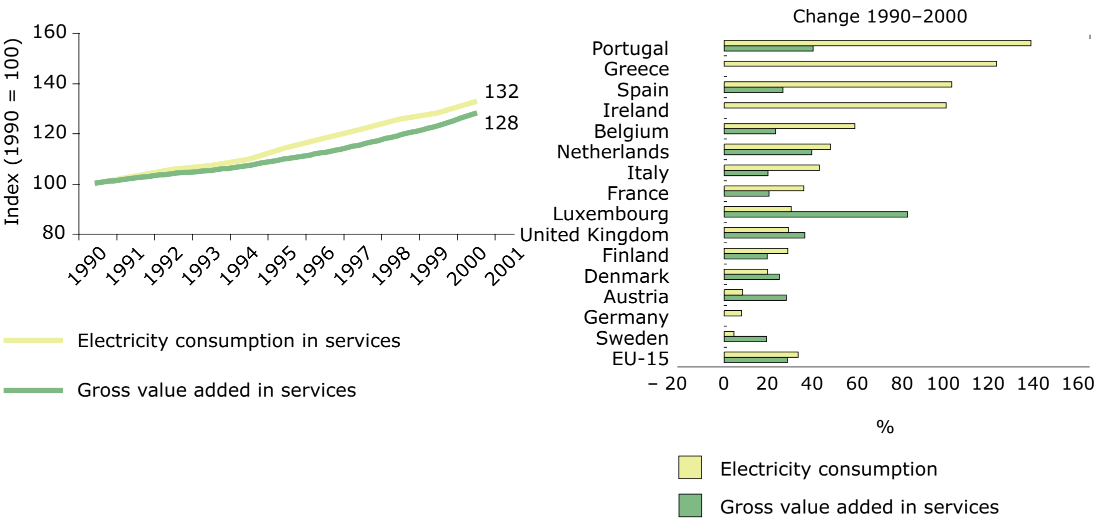
Figure 16 **Electricity consumption for lighting and electrical appliances in households and number of dwellings for the EU (left, as index with 1990 = 100) and the Member States (right, as percentage change from 1990)**



Note: Does not include Belgium, Ireland, Luxembourg, Portugal.

Source: Eurostat.

Figure 17 **Electricity consumption and gross value added in services for the EU (left, as index with 1990 = 100) and the Member States (right, as percentage change from 1990)**



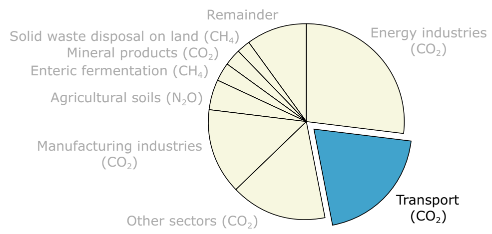
Note: Gross value added estimated for EU-15.

Source: Eurostat.

was a slightly higher increase than gross value added (+ 28 %). All Member States increased electricity consumption from services but a few Member States achieved decoupling of electricity consumption and gross value added (Austria, Luxembourg, Denmark, Sweden, the United Kingdom).

2.2.3. Transport (CO_2)

Share in total EU greenhouse gases:	20 %
1990: 2001:	695 Mt 834 Mt
Change, 1990–2001:	139 Mt 20 %
Change, 2000–01:	10 Mt 1 %



Transport includes emissions from fossil fuel combustion in road transportation, national civil aviation, railways, national navigation, and other transportation ([16]). Road transport is by far the largest emission source from transport accounting for 92 % of total transport-related CO_2 emissions. Emissions of CO_2 from transport are the second largest single source of GHG emissions in the EU accounting for 20 % of total GHG emissions in 2001.

Between 1990 and 2001, CO_2 emissions from transport increased by 20 % in the EU (Figure 18). The main driving forces of CO_2 emissions from transport are transport volumes on roads (passenger and freight transport). Passenger transport in cars increased by 18 % between 1990 and 2000 (almost in line with total CO_2 emissions from transport).

All Member States increased emissions from transport between 1990 and 2000. The countries with the lowest increases were Finland, the United Kingdom and Sweden. Sweden is also the only Member State to have reduced passenger transport volumes in cars between 1990 and 2000.

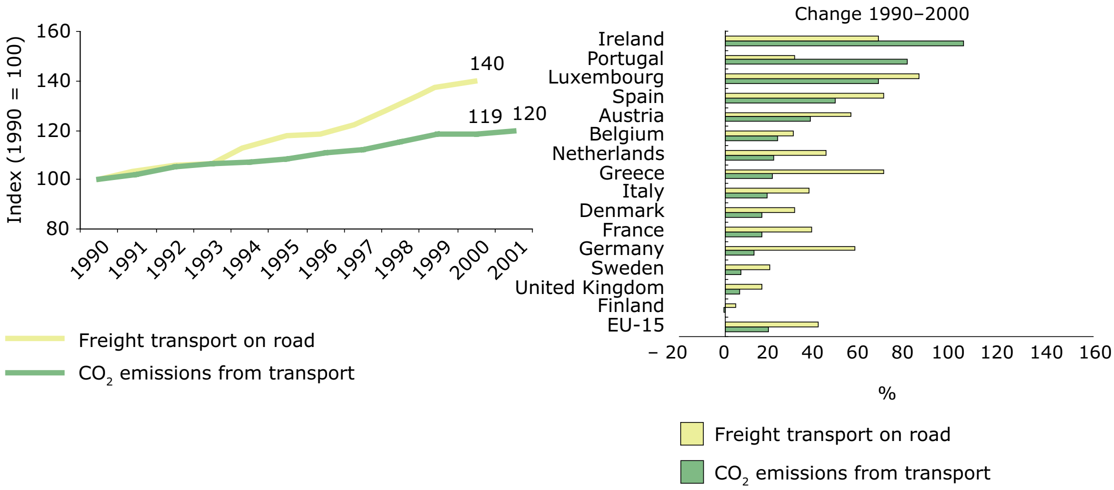
Freight transport grew by 40 % between 1990 and 2000 which is much faster than CO_2 emissions from transport (Figure 19). In all Member States, freight transport on roads increased, but Finland achieved to limit the growth below 10 %.

Figure 18 Emissions of CO_2 from transport and development of volumes of passenger transport in cars (passenger kilometres) for the EU (left, as index with 1990 = 100) and the Member States (right, as percentage change from 1990)

Source: Eurostat, inventory submissions by the EU Member States (CRF tables), EEA (2003a).

([16]) Note that, in accordance with UNFCCC guidelines, these emissions do not include CO_2 emissions from international aviation and navigation, which were 236 Mt in 2001 or 6 % of total EU greenhouse gas emissions. Total EU CO_2 emissions from international aviation and navigation grew by 44 % between 1990 and 2001.

Figure 19 **Emissions of CO_2 from transport and development of transport volumes of freight transport on roads (tonne kilometres) for the EU (left, as index with 1990=100) and the Member States (right, as percentage change from 1990)**



Source: Eurostat, inventory submissions by the EU Member States (CRF tables), EEA (2003a).

Table 5 shows the contribution of the EU Member States to absolute EU CO_2 emissions from transport (in 2001) and to its development (1990–2001). The largest emitter is Germany accounting for 21 % of total EU CO_2 emissions from transport, followed by France (17 %), Italy (15 %), the United Kingdom (15 %), and Spain (11 %).

The increase of CO_2 emissions from transport between 2000 and 2001 was mainly due to absolute emission increases in Italy, Spain, France and Austria. Ireland had a large increase in relative terms. In contrast to this, Germany reduced CO_2 emissions from transport by more than 4 million tonnes, and the United Kingdom by 1 million tonnes.

Between 1990 and 2001, CO_2 emissions from transport increased in all Member States. The largest increases in absolute terms occurred in Spain, Italy, France and Germany. Also all other Member States had increases of more than 1 million tonne, except Finland and Luxembourg. Finland, the United Kingdom and Sweden had increases of less than 10 %. Ireland more than doubled its CO_2 emissions from transport, and also Luxembourg, Portugal and Spain increased their emissions by more than 50 %. The main reasons for the large increases in Ireland are growth in vehicle fleets, road transport and fuel tourism (EPA, 2003).

Explanations for the low growth rates and/or emission reductions of Finland, Sweden and the United Kingdom might be high emission levels (these Member States had the highest per capita CO_2 emissions from transport in 1990) and high and/or rapidly growing road fuel prices. For the cohesion countries, the opposite is true: low starting points in terms of per capita emissions and low road fuel prices. They also have a strong growth in transport demand, particularly road, driven by economic growth and therefore also strong increases in CO_2 (see 2.3.4).

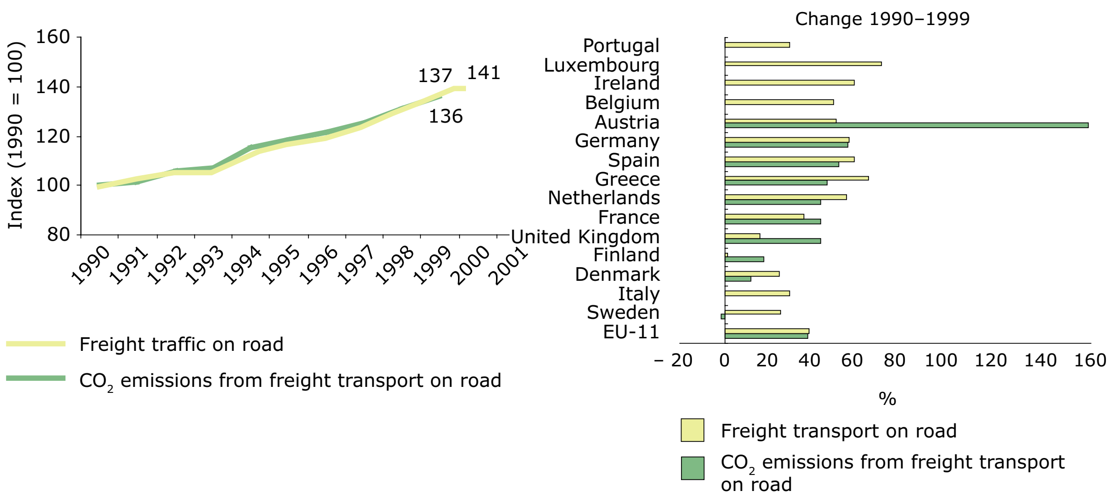
Figure 20 shows CO_2 emissions from freight transport and freight traffic volumes on roads (tonne kilometres). Emissions of CO_2 increased by 36 % between 1990 and 1999, whereas transport volumes on roads grew by 37 % (no emissions data for 2000 and 2001 available). This means that there was no decoupling between CO_2 emissions and freight traffic volumes. All Member States except Sweden and Italy increased CO_2 emissions from freight transport on roads. Austria's large emission increase might be partly due to low diesel prices and subsequent

Table 5 Member States' contribution to CO_2 emissions from transport

Member State	Greenhouse gas emissions ($Gg\ CO_2$ equivalents)			Share in EU-15 emissions in 2001 (%)	Change 2000–2001		Change 1990–2001	
	1990	2000	2001		($Gg\ CO_2$ equivalents)	(%)	($Gg\ CO_2$ equivalents)	(%)
Germany	162 281	182 697	178 313	21.4	– 4 384	– 2	16 032	10
France	119 135	137 738	140 670	16.9	2 932	2	21 536	18
Italy	102 023	120 571	125 191	15.0	4 621	4	23 168	23
United Kingdom	116 753	124 218	123 165	14.8	– 1 053	– 1	6 413	5
Spain	57 497	85 108	89 341	10.7	4 233	5	31 845	55
Netherlands	29 122	35 212	35 608	4.3	396	1	6 487	22
Belgium	19 610	24 048	24 162	2.9	114	0	4 552	23
Greece	18 039	21 678	22 448	2.7	770	4	4 409	24
Sweden	18 337	19 582	19 848	2.4	266	1	1 512	8
Portugal	10 701	19 185	19 077	2.3	– 108	– 1	8 376	78
Austria	12 739	17 481	18 887	2.3	1 406	8	6 148	48
Finland	12 475	12 379	12 569	1.5	190	2	94	1
Denmark	10 404	12 046	12 077	1.4	31	0	1 673	16
Ireland	5 020	10 211	11 063	1.3	852	8	6 043	120
Luxembourg	870	1 451	1 504	0.2	54	4	634	73
EU-15	**695 003**	**823 606**	**833 925**	**100.0**	**10 319**	**1**	**138 922**	**20**

Source: Inventory submissions by the EU Member States (CRF tables), EEA (2003a).

Figure 20 Emissions of CO_2 from diesel consumption of freight transport and development of freight traffic on roads (tkm) for the EU (left, as index with 1990 = 100) and the Member States (right, as percentage change from 1990)



Note: Does not include Belgium, Ireland, Luxembourg, Portugal.

Source: Eurostat.

large increases in diesel sold at transit routes. All Member States except Finland increased freight transport volumes on roads.

As regards passenger cars, the EU aims at reducing the average specific CO_2 emissions of new cars to 120 g CO_2/km by 2005, and 2010 at the latest. In order to meet these targets, voluntary agreements between the EU and the European, Japanese and Korean automobile manufacturers' associations (ACEA, JAMA, KAMA [17]))

[17] ACEA: European automobile manufacturers' association; JAMA: Japanese automobile manufacturers' association; KAMA: Korean automobile manufacturers association.

have been concluded. In these voluntary agreements, the automobile industry commits itself to aim at average specific CO_2 emissions of 140 g CO_2/km for new passenger cars by 2008 (ACEA) and 2009 (JAMA and KAMA).

According to the third annual report on the effectiveness of the strategy to reduce CO_2 emissions from cars (EC, 2002a), the average specific CO_2 emissions of new passenger cars was reduced by 9.7 % from 186 g CO_2/km in 1995 to 168 g CO_2/km in 2001 (Figure 21). In 2001, all associations reduced the average specific CO_2 emissions of their cars sold on the EU market (ACEA by about 2.5 %, JAMA by about 2.2 % and KAMA by about 2.6 %). However, in order to meet the final target of 140 g/km, additional efforts are necessary as the average annual reduction rate of all three associations needs to be increased.

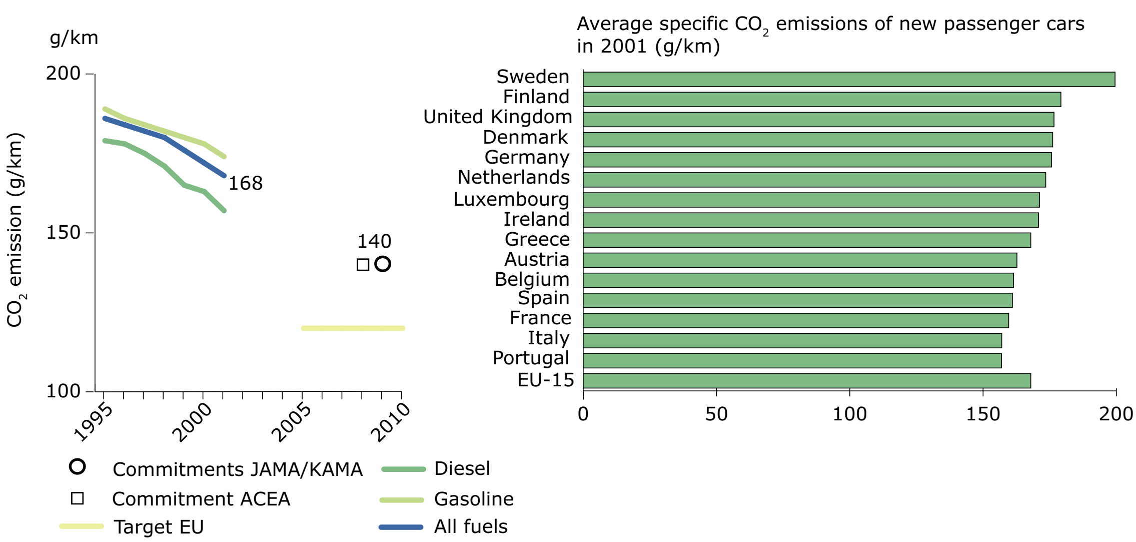
The reduction of average specific CO_2 emissions from new cars is the result of:

- reductions of specific CO_2 emissions in both, diesel and gasoline cars. However, due to the technological development in diesel cars, their fuel efficiency is significantly better than for gasoline vehicles: specific CO_2 emissions from new diesel cars decreased by 12.3 %, whereas emissions from gasoline cars by 7.9 % (Figure 21);
- a shift in the fleet composition from petrol to diesel passenger cars. All associations increased the diesel share of their fleets. In 2001, more than one third of cars sold in the EU were diesel cars.

However, it should also be noted that the total number of passenger cars sold increased by 24.3 % between 1995 and 2001.

Figure 21 also shows considerable differences in 2001 between average specific CO_2 emissions of new cars within the EU Member States ranging from 157 g CO_2/km (Portugal, Italy) to 200 g (Sweden). One reason for the high specific emissions for Sweden is the very low share of new diesel cars.

Figure 21 Average specific CO_2 emissions of new passenger cars per fuel type for the EU (left) and the Member States (right)

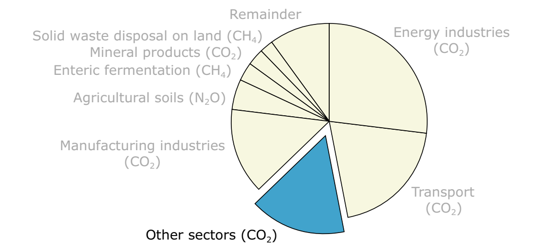


Note: Data provided by the car manufacturer associations, ACEA, JAMA, and KAMA.

Source: EC (2002a).

2.2.4. *Other sectors (CO_2) (households and services)*

Share in total EU greenhouse gases:	16 %
1990:	635 Mt
2001:	656 Mt
Change, 1990–2001:	21 Mt 3 %
Change, 2000–01:	35 Mt 6 %

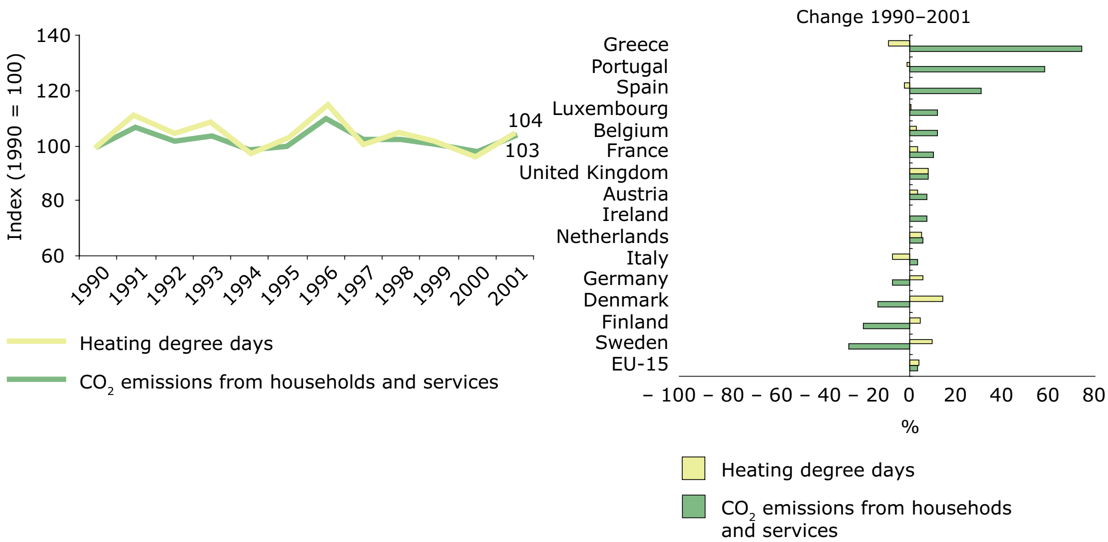


Emissions of CO_2 from households and services are the third largest source of GHG emissions in the EU and accounted for 16 % of total GHG emissions in 2001. This category includes fossil fuel combustion from households, services (private and public), other small businesses (as opposed to industry), and agricultural businesses (including agricultural off-road transport). Household's account for 67 % of emissions of this key source, services and other small businesses for about 25 %.

Between 1990 and 2001, CO_2 emissions from households and services increased by 3 % in the EU (Figure 22). Main factors influencing CO_2 emissions from this category are (1) outdoor temperature, (2) number and size of dwellings, (3) building codes, (4) age distribution of the existing building stock, and (5) fuel split for heating and warm water.

Figure 22 shows that the CO_2 emissions from households and services follow closely the heating degree days ([18]). The figure also shows that the Nordic countries and Germany decoupled substantially from the heating degree days. One reason for the performance of the Nordic countries seems to be increased use of district heating. As district heating replaces heating boilers in households, an increase in the share of district heating reduces

Figure 22 Emissions of CO_2 from households and services and development of heating degree days for the EU (left, as index with 1990 = 100) and the Member States (right, as percentage change from 1990)



Source: Eurostat, inventory submissions by the EU Member States (CRF tables), EEA (2003a).

(18) Heating degree days are a measure for the need for heating due to cold temperatures. They are the sum of temperature differences between a certain constant indoor temperature and the daily average of outdoor temperature. Therefore, high heating degree days indicate low average temperatures and increased need for heating.

Table 6 Member States' contributions to CO_2 emissions from households and services

Member State	Greenhouse gas emissions (Gg CO_2 equivalents)			Share in EU-15 emissions in 2001 (%)	Change 2000–2001		Change 1990–2001	
	1990	2000	2001		(Gg CO_2 equivalents)	(%)	(Gg CO_2 equivalents)	(%)
Germany	203 439	170 467	187 893	28.7	17 426	10	– 15 546	– 8
United Kingdom	112 538	117 812	121 109	18.5	3 297	3	8 571	8
France	94 381	96 807	103 859	15.8	7 052	7	9 478	10
Italy	75 664	77 240	78 120	11.9	880	1	2 456	3
Netherlands	34 185	34 550	36 134	5.5	1 584	5	1 950	6
Spain	25 953	34 041	33 928	5.2	– 113	0	7 976	31
Belgium	27 630	29 269	30 817	4.7	1 548	5	3 187	12
Austria	13 638	13 368	14 658	2.2	1 290	10	1 020	7
Ireland	9 726	10 364	10 414	1.6	50	0	688	7
Greece	5 341	8 530	9 300	1.4	770	9	3 959	74
Sweden	10 597	7 682	7 757	1.2	76	1	– 2 840	– 27
Denmark	8 959	7 505	7 688	1.2	183	2	– 1 271	– 14
Portugal	4 197	6 539	6 637	1.0	99	2	2 440	58
Finland	7 571	5 796	6 022	0.9	227	4	– 1 548	– 20
Luxembourg	1 277	1 268	1 426	0.2	158	12	148	12
EU-15	**635 096**	**621 237**	**655 763**	**100.0**	**34 526**	**6**	**20 667**	**3**

Source: Inventory submissions by the EU Member States (CRF tables), EEA (2003a).

CO_2 emissions from households (but increases emissions from energy industries if fossil fuels are used). In Germany, efficiency improvements and fuel switch in east German households are one reason for the emission reductions.

Greece, Portugal and Spain increased their emissions by more than 30 %. Heating degree days do not play a significant role for the emission variations in these Member States. In all three Member States emissions from services and small businesses grew at a faster rate than emissions from households.

Table 6 shows the contribution of the EU Member States to the level and trend of total EU CO_2 emissions from households and services. The largest emitter is Germany accounting for 29 % of total EU CO_2 emissions from households and services, followed by the United Kingdom (19 %), France (16 %) and Italy (12 %).

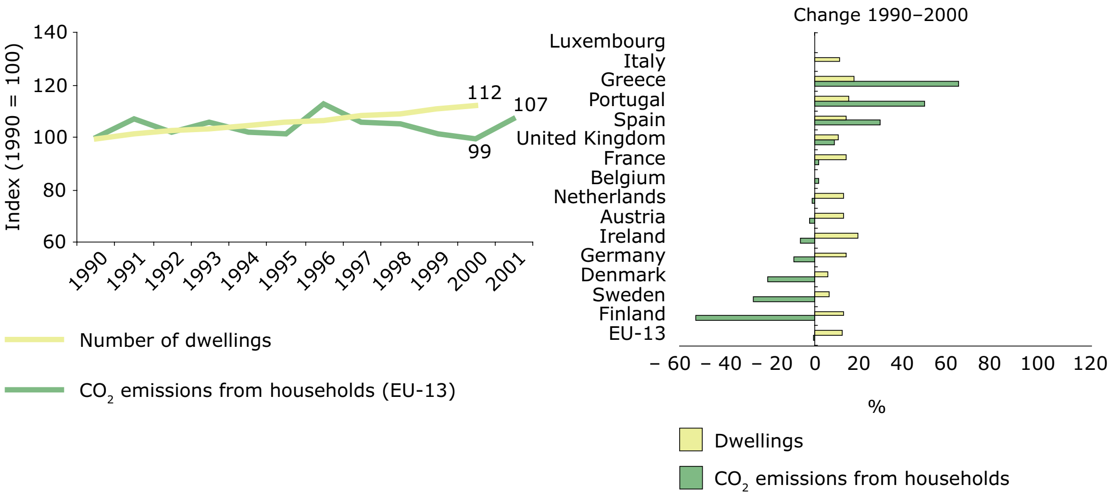
In 2001, emissions increased by 6 % compared with 2000. Only Ireland and Spain stabilised their emissions. All other Member States increased their emission from households and services, which corresponds to the fact that the heating degree days increased in most Member States.

Between 1990 and 2001, the largest reduction in absolute terms was reported by Germany, reducing emissions by 16 million tonnes. Also, the Nordic countries show emission reductions of more than 1 million tonnes. France, the United Kingdom and Spain had the largest emission increases in absolute terms.

The emissions of households account for about two thirds of CO_2 emissions for this key source. Figure 23 shows the CO_2 emissions from households against the number of dwellings: the stock of permanently occupied dwellings increased by 12 % between 1990 and 2000 while the emissions were 1 % below 1990 levels in 2000 (no data on number of dwellings for 2001 available).

The emissions of services account for about 25 % of CO_2 emissions for this key source. Figure 24 shows the CO_2 emissions from services against gross value added: gross value added in services increased by 29 % between 1990

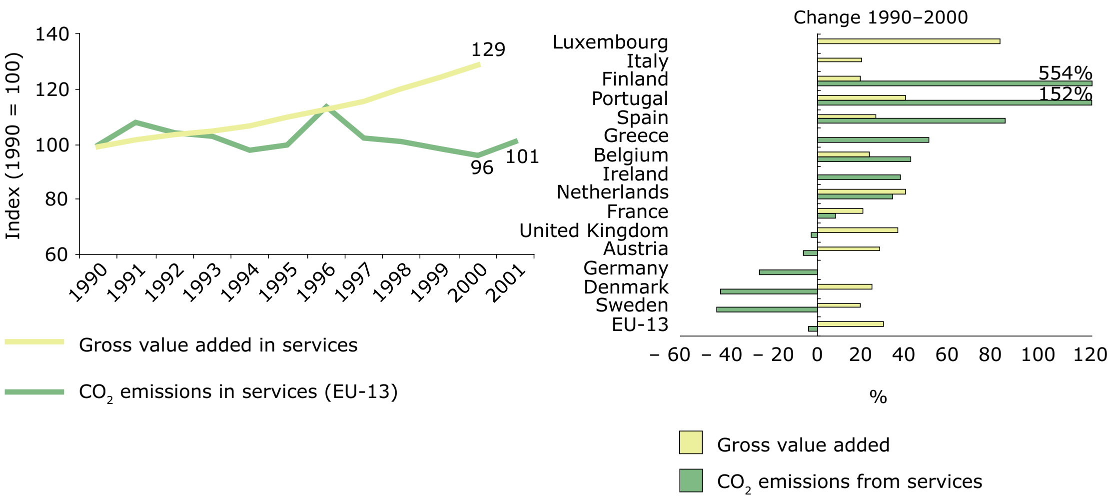
Figure 23 **Emissions of CO_2 from households and number of permanently occupied dwellings for the EU (left, as index with 1990 = 100) and the Member States (right, as percentage change from 1990)**



Note: Emissions and number of dwellings refer to EU-13, because emission data are not available for Italy and Luxembourg. The index of permanently occupied dwellings for EU-13 includes estimates for Belgium.

Source: Eurostat, inventory submissions by the EU Member States (CRF tables), EEA (2003a).

Figure 24 **Emissions of CO_2 from services and gross value added for the EU (left, as index with 1990 = 100) and the Member States (right, as percentage change from 1990)**



Note: Emissions and gross value added refer to EU-13, because emission data were not available for Italy or Luxembourg. The index of gross value added for EU-13 is partly based on estimates.

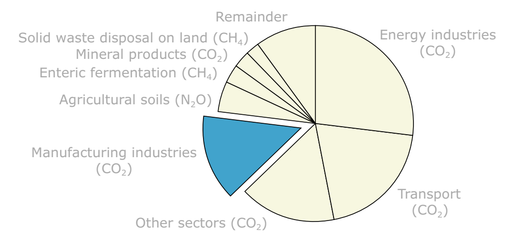
Source: Eurostat, inventory submissions by the EU Member States (CRF tables), EEA (2003a).

and 2000 whereas emissions were 4 % below 1990 levels in 2000 (no data on gross value added for 2001 available). This means that emissions decoupled considerably from gross value added.

Also, in most Member States emissions decoupled from gross value added. Only in Belgium, Finland, Portugal and Spain emissions increased faster than gross value added.

2.2.5. Manufacturing industries and construction (CO_2)

Share in total EU greenhouse gases:	14 %
1990:	642 Mt
2001:	585 Mt
Change, 1990–2001:	— 57 Mt — 9 %
Change, 2000–01:	— 6 Mt — 1 %

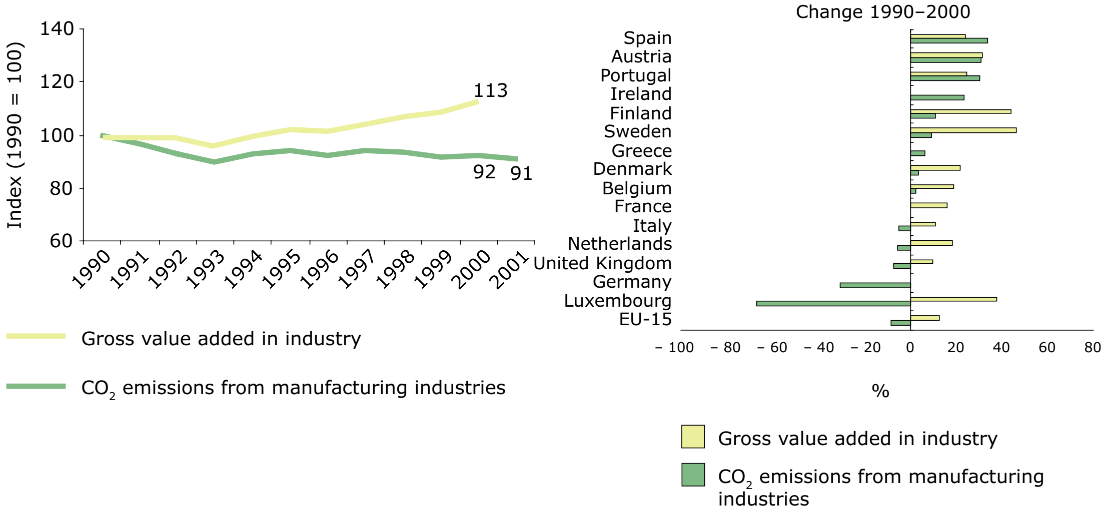


Emissions of CO_2 from fossil fuel use in manufacturing industries is the fourth largest source of GHG emissions in the EU accounting for 14 % of total GHG emissions in 2001. Fossil fuels are used for combustion in the manufacturing industries or as a feedstock in the chemical industry ([19]).

Between 1990 and 2001, CO_2 emissions from manufacturing industries declined by 9 % in the EU, of which most was achieved already in 1993 (Figure 25). This was mainly due to efficiency improvements and structural change in Germany after the reunification and low economic activity in the EU. In 2001, CO_2 emissions from manufacturing industries decreased by 1 %, compared with 2000. The main driving force of CO_2 emissions from manufacturing industries is production output of industry. Between 1990 and 2000, industrial output in terms of gross value added increased by 13 % (no value for 2001 available). Therefore, CO_2 emissions from manufacturing industries decoupled from gross value added.

Figure 25 also shows that most Member States achieved decoupling of CO_2 emissions and gross value added in industry. Only in Portugal and Spain did CO_2 emissions increase more than gross value added. For three Member States no data on gross value added are available. The main reason for the substantial cut in German CO_2 emissions from manufacturing industries was the

Figure 25 Emissions of CO_2 from energy use in manufacturing industries and gross value added of industry for the EU (left, as index with 1990 = 100) and the Member States (right, as percentage change from 1990)



Source: Eurostat and inventory submissions by the EU Member States (CRF tables), EEA (2003a).

([19]) All fossil fuels are used as feedstocks for non-energy purposes to some degree (e.g. natural gas is used for ammonia production). Emissions of CO_2 from feedstocks may be a substantial fraction of total CO_2 emissions from manufacturing industries, e.g. in the Netherlands they account for about 25 % of total industry emissions.

Table 7 Member States' contributions to CO_2 emissions from manufacturing industries

Member State	Greenhouse gas emissions ($Gg\ CO_2$ equivalents)			Share in EU-15 emissions in 2001 (%)	Change 2000–2001		Change 1990–2001	
	1990	2000	2001		($Gg\ CO_2$ equivalents)	(%)	($Gg\ CO_2$ equivalents)	(%)
Germany	196 457	136 199	132 536	22.6	– 3 662	– 3	– 63 920	– 33
United Kingdom	94 132	87 428	90 144	15.4	2 716	3	– 3 988	– 4
France	82 620	82 691	83 514	14.3	823	1	894	1
Italy	84 033	80 103	77 095	13.2	– 3 008	– 4	– 6 938	– 8
Spain	44 532	59 717	59 781	10.2	64	0	15 250	34
Netherlands	41 888	39 677	40 197	6.9	520	1	– 1 691	– 4
Belgium	33 181	34 001	33 589	5.7	– 412	– 1	409	1
Finland	14 358	15 956	13 855	2.4	– 2 101	– 13	– 503	– 4
Sweden	11 567	12 652	12 695	2.2	43	0	1 128	10
Portugal	8 166	10 651	11 324	1.9	673	6	3 158	39
Greece	9 792	10 415	10 390	1.8	– 25	0	598	6
Austria	6 927	9 061	7 752	1.3	– 1 309	– 14	826	12
Denmark	5 605	5 823	5 909	1.0	86	1	304	5
Ireland	3 833	4 743	4 726	0.8	– 17	0	893	23
Luxembourg	5 258	1 734	1 651	0.3	– 83	– 5	– 3 607	– 69
EU-15	**642 348**	**590 851**	**585 160**	**100.0**	**– 5 691**	**– 1**	**– 57 189**	**– 9**

Source: Inventory submissions by the EU Member States (CRF tables), EEA (2003a).

restructuring of the German industry and efficiency improvements after German reunification. The decrease of Luxembourg's CO_2 emissions was mainly due to a sharp decline in coke consumption after the conversion of the steel industry to electric arc furnaces.

Germany is the largest emitter accounting for about 23 % of EU emissions, followed by the United Kingdom (15 %), France (14 %) and Italy (13 %) (Table 7).

Large emission decreases in absolute terms were reported for Germany, Italy, Finland and Austria in 2001, compared with 2000, whereas in the United Kingdom emissions from fossil fuel combustion increased considerably.

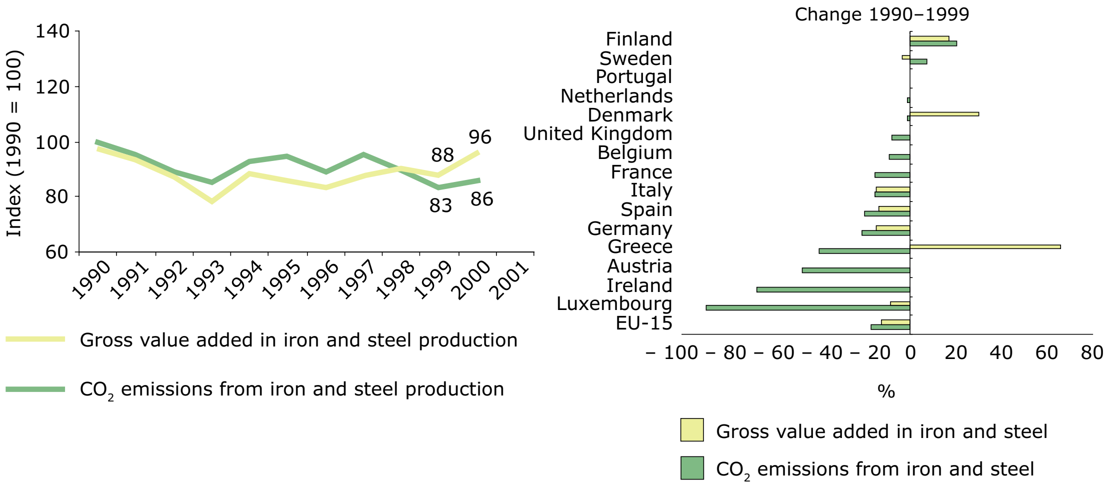
Between 1990 and 2001, Germany shows by far the largest emission reductions in absolute terms. Also Italy, the United Kingdom, Luxembourg and the Netherlands show emission reductions of more than 1 million tonnes, whereas large emission increases occurred in Spain, Portugal and Sweden.

CO_2 indicators by industrial branches: Figure 25 showed that CO_2 emissions from the energy use of manufacturing industries decoupled from gross value added. This means that overall CO_2 intensity of manufacturing industries decreased in the 1990s. The following figures show the development of the CO_2 emissions and activity (in terms of gross value added or tonnes produced) for the largest CO_2-emitting branches on the basis of Eurostat data.

The iron and steel industry is the largest CO_2 emitter within industry accounting for about 30 % of CO_2 emissions. Emissions of CO_2 from energy use in the iron and steel industry decreased by 17 % between 1990 and 1999 (Figure 26). Also gross value added of the branch was below 1990 levels in 1999 (– 12 %). This means that emissions slightly decoupled from gross value added. Almost all Member States achieved emission reductions from the iron and steel industry; exceptions are Finland and Sweden. For several Member States, data on gross value added are not available.

Whereas CO_2 intensity of iron and steel production (emission per gross value added) declined only slightly in the 1990s, CO_2 unit consumption (emissions

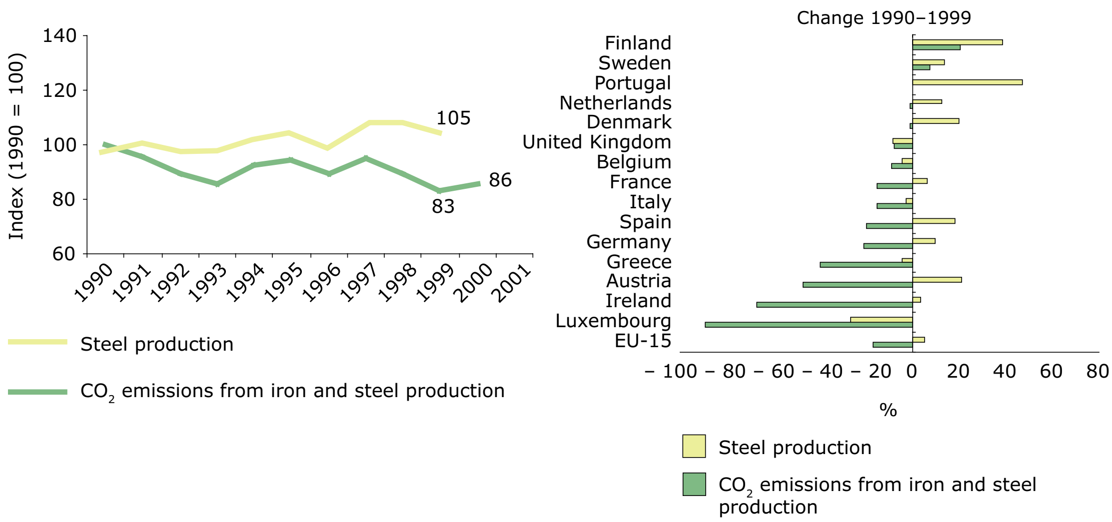
Figure 26 Emissions of CO_2 and gross value added in the iron and steel industry for the EU (left, as index with 1990 = 100) and the Member States (right, as percentage change from 1990)



Note: Eurostat estimates for gross value added for EU-15.

Source: Eurostat.

Figure 27 Emissions of CO_2 of the iron and steel industry and development of crude steel production for the EU (left, as index with 1990 = 100) and the Member States (right, as percentage change from 1990)

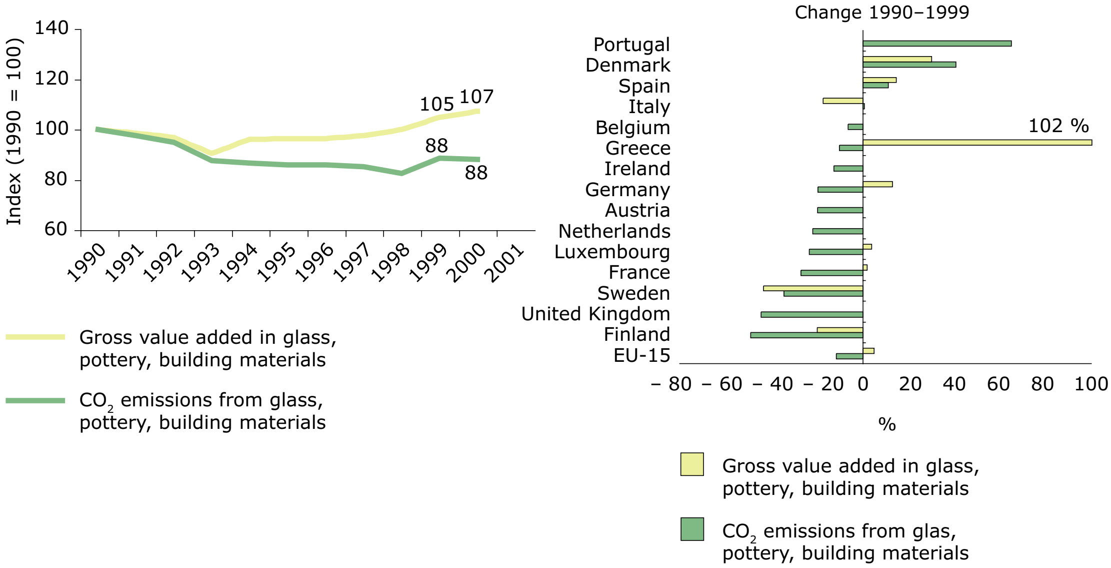


Source: Eurostat.

per tonne of steel produced) of the branch decreased more significantly. Figure 27 shows that crude steel production increased by 5 % between 1990 and 1999. Emissions of CO_2 of the branch decreased by 17 %. Therefore, CO_2 emissions decoupled by 22 percentage points.

The glass, pottery and building material industry is the second largest CO_2 emitter within industry accounting for about 17 % of CO_2 emissions. The most important building material in terms of CO_2 emissions is cement. Figure 28 shows that the CO_2 emissions were 12 % below 1990 levels in 1999. Gross value added of the branch was 5 % above 1990 levels. This means that CO_2 emissions decoupled by 17 percentage points from gross value added. Almost all Member States achieved emission reductions from glass, pottery and building materials; exceptions being Denmark, Portugal and Spain. For several Member States, data on gross value added are not available.

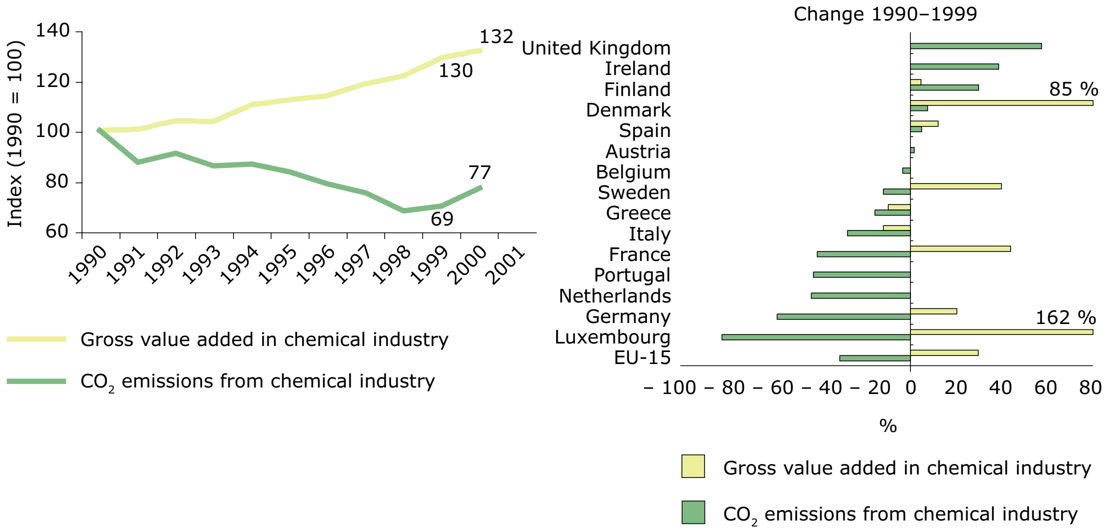
Figure 28 **Emissions of CO_2 and gross value added of the glass, pottery and building material industry for the EU (left, as index with 1990 = 100) and the Member States (right, as percentage change from 1990)**



Note: Eurostat estimates for gross value added for EU-15.

Source: Eurostat.

Figure 29 **Emissions of CO_2 and gross value added of the chemical industry for the EU (left, as index with 1990 = 100) and the Member States (right, as percentage change from 1990)**



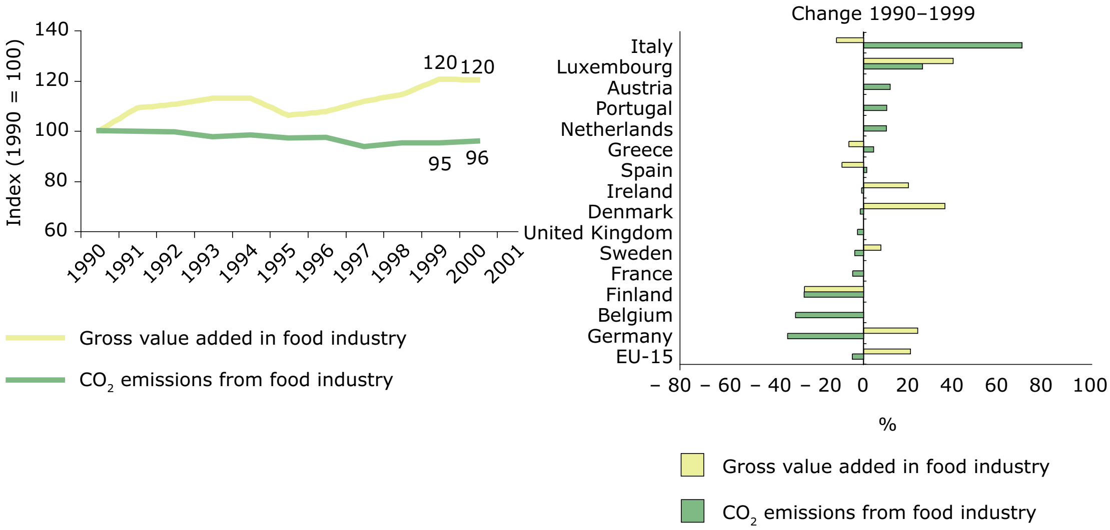
Note: Eurostat estimates for gross value added for EU-15.

Source: Eurostat.

The chemical industry is the third largest CO_2 emitter within industry. Emissions declined by 31 % between 1990 and 1999, whereas gross value added increased by 30 % in the branch (Figure 29). This means that CO_2 emissions decoupled by 61 percentage points. The figure also shows that all Member States for which data on gross value added are available decoupled emissions from gross value added except for Finland.

The chemical industry is a very heterogeneous branch consisting, for example, in the production of agrochemicals, petrochemicals, inorganic chemicals and pharmaceuticals. The most energy-intensive processes are the production of

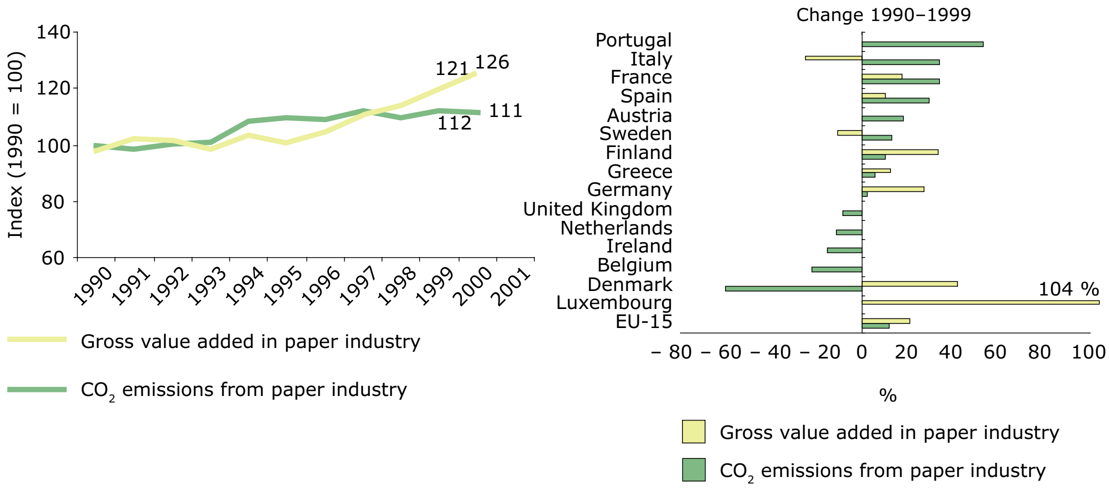
Figure 30 Emissions of CO_2 and gross value added of the food industry for the EU (left, as index with 1990 = 100) and the Member States (right, as percentage change from 1990)



Note: Eurostat estimates for gross value added for EU-15.

Source: Eurostat.

Figure 31 Emissions of CO_2 and gross value added of the paper and printing industry for the EU (left, as index with 1990 = 100) and the Member States (right, as percentage change from 1990)



Note: Eurostat estimates for gross value added for EU-15.

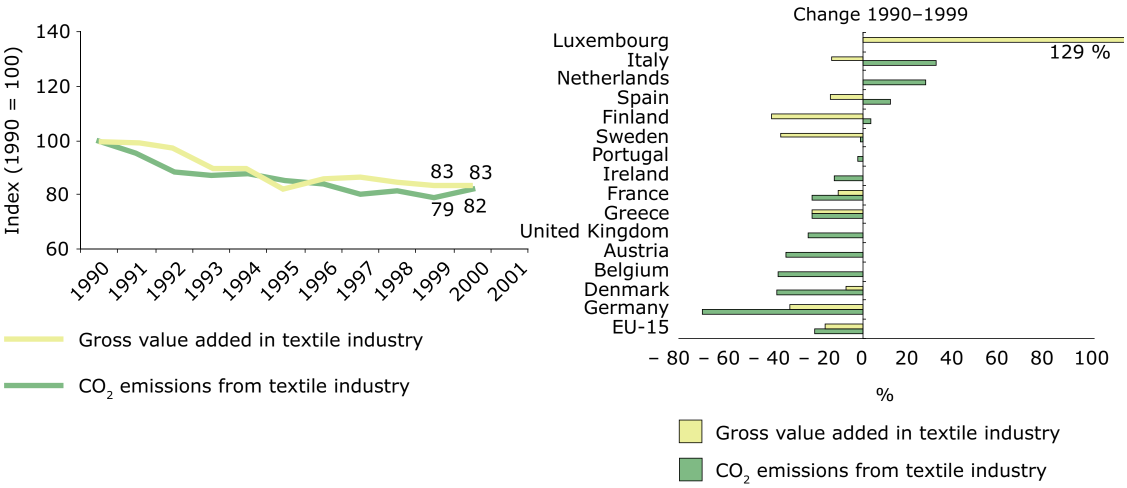
Source: Eurostat.

ammonia, which is the raw material for most fertilisers. Structural changes from energy-intensive chemical branches to less energy-intensive branches might be an important factor for overall reductions in CO_2 intensity of the branch. For this reason, a further split into energy-intensive and less energy-intensive chemical branches would be useful.

The food industry is the fourth largest CO_2 emitter within industry. Figure 30 shows that the CO_2 emissions declined by 5 % between 1990 and 1999, whereas gross value added increased by 20 % in the branch. This means that CO_2 emissions decoupled by 25 percentage points. The figure also shows that most Member States for which data on gross value added are available decoupled emissions from gross value added; exceptions being Greece, Italy and Spain.

The paper and printing industry is the fifth largest CO_2 emitter within

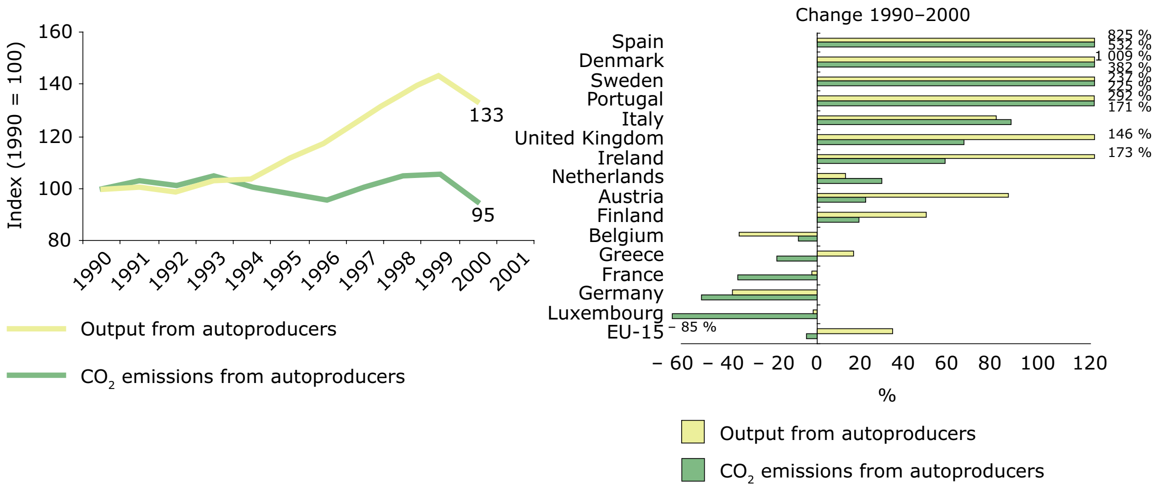
Figure 32 Emissions of CO_2 and gross value added of the textile industry for the EU (left, as index with 1990 = 100) and the Member States (right, as percentage change from 1990)



Note: Eurostat estimates for gross value added for EU-15.

Source: Eurostat.

Figure 33 Emissions of CO_2 of auto producer thermal power plants and development of power and heat production for the EU (left, as index with 1990 = 100) and the Member States (right, as percentage change from 1990)



Source: Eurostat.

industry. Figure 31 shows that the CO_2 emissions increased by 12 % between 1990 and 1999; gross value added was 21 % above 1990 levels. This means that CO_2 emissions decoupled by 9 percentage points. The figure also shows that most Member States increased emissions from the paper and printing industry. Some Member States decoupled emissions from gross value added; in some Member States emissions grew more rapidly than gross value added.

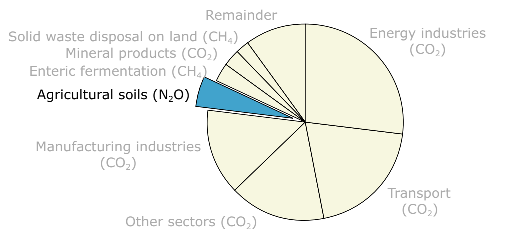
The textile industry is the sixth largest CO_2 emitter within industry. Figure 32 shows that the CO_2 emissions declined by 21 % between 1990 and 1999; gross value added was 17 % below 1990 levels. This means that CO_2 emissions decoupled only slightly (4 percentage points). In most Member States emissions were reduced.

Finally, Figure 33 shows CO_2 emissions of auto producer thermal power plants and power and heat production.

Emissions of CO_2 from auto producer power plants were 5 % below 1990 levels in 2000, whereas overall output (power and heat production) was 33 % above 1990 levels. Therefore, CO_2 emissions decoupled by 38 percentage points. Most Member States decoupled emissions from total output in auto producer power plants; exceptions being Belgium, Italy and the Netherlands.

2.2.6. *Agricultural soil (N_2O)*

Share in total EU greenhouse gases:	5 %
1990:	215 Mt
2001:	197 Mt
Change, 1990–2001:	– 18 Mt – 8 %
Change, 2000–01:	– 6 Mt – 3 %



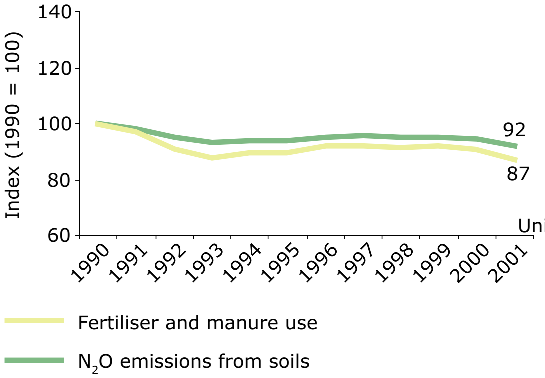
Emissions of N_2O from agricultural soil are the largest source category of N_2O emissions and account for 5 % of total EU GHG emissions in 2001. These emissions occur from the application of mineral nitrogen fertilisers and organic nitrogen from animal manure.

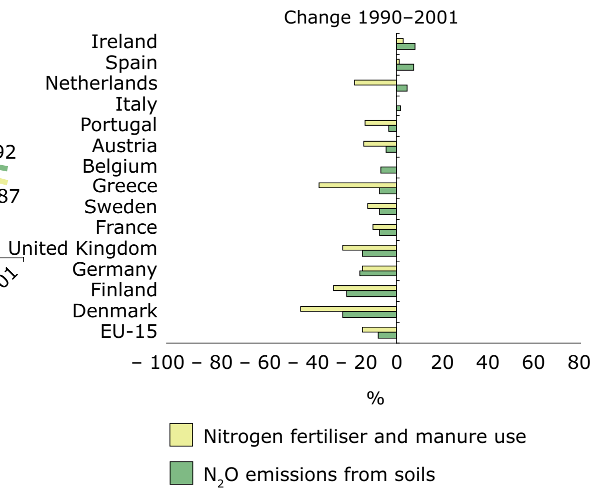
Between 1990 and 2001, emissions decreased by 8 %. The main driving force of N_2O emissions from agricultural soil is the use of nitrogen fertiliser and manure, which was 13 % below 1990 levels in 2001. Figure 34 shows the close relationship between N_2O emissions and fertiliser and manure use, both for the EU as a whole and for the Member States. Emissions of N_2O from agricultural land can be decreased by overall efficiency improvements of nitrogen uptake by crops, which should lead to lower fertiliser consumption on agricultural land.

The decrease of fertiliser use is partly due to the effects of the 1992 reform of the common agricultural policy and the resulting shift from production-based support mechanisms to direct area payments in arable production. This has tended to lead to an optimisation and overall reduction in fertiliser use. In addition, reduction in fertiliser use is also due to directives such as the nitrate directive and to the extensification measures included in the agro-environment programmes (EC, 2001b).

Figure 34 also shows that Denmark, Finland, Germany and the United Kingdom reduced emissions by more than 10 % between 1990 and 2001. The highest increases occurred in Spain and Ireland. The decoupling of the Dutch emissions from nitrogenous fertiliser and manure use is due to the phase-out of manure-spreading on the land and the incorporation of manure into

Figure 34 Emissions of N_2O from agricultural soil and development of fertiliser and manure use for the EU (left, as index with 1990 = 100) and the Member States (right, as percentage change from 1990)





Note: Luxembourg is not included in the table because data seem to be inconsistent.

Source: Inventory submissions by the EU Member States (CRF tables), EEA (2003a).

Table 8 Member States' contributions to N_2O emissions from agricultural soil

Member State	Greenhouse gas emissions (Gg CO_2 equivalents)			Share in EU-15 emissions in 2001 (%)	Change 2000–2001		Change 1990–2001	
	1990	2000	2001		(Gg CO_2 equivalents)	(%)	(Gg CO_2 equivalents)	(%)
France	55 802	52 928	51 611	26.2	– 1 318	– 2	– 4 192	– 8
Germany	39 800	34 451	33 386	17.0	– 1 065	– 3	– 6 414	– 16
United Kingdom	30 353	27 569	25 807	13.1	– 1 762	– 6	– 4 546	– 15
Italy	19 736	19 918	20 026	10.2	108	1	290	1
Spain	16 277	18 682	17 532	8.9	– 1 150	– 6	1 255	8
Denmark	9 797	7 853	7 477	3.8	– 376	– 5	– 2 320	– 24
Ireland	6 870	7 679	7 414	3.8	– 265	– 3	544	8
Netherlands	6 674	7 000	6 978	3.5	– 22	0	304	5
Greece	6 501	6 370	6 031	3.1	– 339	– 5	– 470	– 7
Sweden	5 428	5 001	5 027	2.6	26	1	– 401	– 7
Belgium	5 074	4 772	4 730	2.4	– 42	– 1	– 344	– 7
Portugal	4 791	4 634	4 634	2.4	0	0	– 158	– 3
Finland	4 269	3 382	3 336	1.7	– 46	– 1	– 934	– 22
Austria	2 970	2 862	2 831	1.4	– 31	– 1	– 139	– 5
Luxembourg	146	0	0	0.0	0	0	– 146	– 100
EU-15	**214 489**	**203 101**	**196 818**	**100.0**	**– 6 282**	**– 3**	**– 17 670**	**– 8**

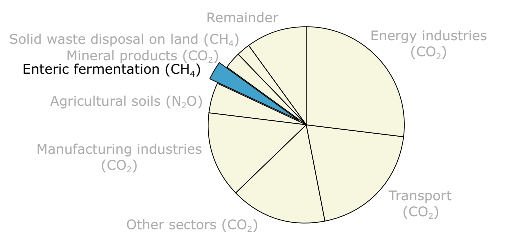
Source: Inventory submissions by the EU Member States (CRF tables), EEA (2003a).

the soil, which is a measure to reduce ammonia emissions from manure, but which increases N_2O emissions as a negative side-effect (Olivier et al., 2002). The largest emitter is France (26 % of total EU emissions), followed by Germany (17 %) and the United Kingdom (13 %).

In 2001, nearly all EU Member States reduced or stabilised their N_2O emissions compared with 2000 (Table 8). The largest absolute emission reductions occurred in the United Kingdom and France and the largest increase in Spain. In general, the N_2O trends should be interpreted with care, as methodological problems with estimating N_2O emissions from agricultural soil exist in a number of Member States.

2.2.7. *Enteric fermentation (CH_4)*

Share in total EU greenhouse gases:	3 %
1990:	144 Mt
2001:	132 Mt
Change, 1990–2001:	12 Mt – 9 %
Change, 2000–01:	– 1 Mt 0 %

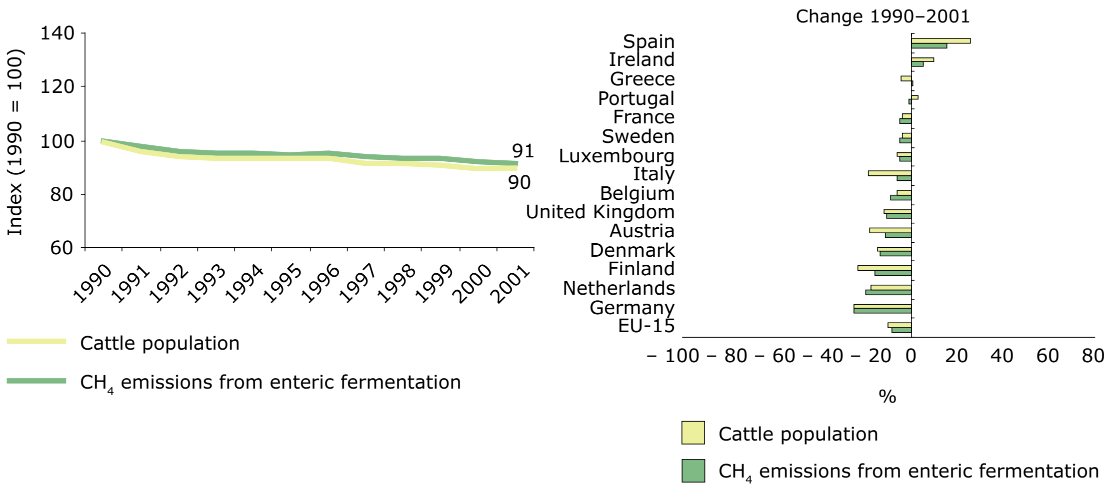


Enteric fermentation is the largest single source of CH_4 emissions in the EU accounting for 3 % of total GHG emissions in 2001. Between 1990 and 2001, emissions decreased by 9 %. Emissions of CH_4 from enteric fermentation result from anaerobic fermentation of polysaccharides and other components of animal feed in the stomachs of ruminant animals by micro-organisms.

The main driving force of CH_4 emissions from enteric fermentation is the number of cattle. Between 1990 and 2001, CH_4 emissions from enteric fermentation declined almost in parallel with the number of cattle (Figure 35). In 2001, the cattle population was 10 % below 1990 levels. All Member States except Spain, Ireland and Greece reduced CH_4 emissions from enteric fermentation.

France is the largest emitter of CH_4 from enteric fermentation accounting for 22 % of EU emissions, followed by Germany (16 %), the United Kingdom (13 %) and Spain (11 %). These Member States also account for more than 60 % of the EU cattle population. The United Kingdom and Spain have the largest sheep populations in the EU. Large emission reductions occurred in Germany, the United Kingdom, the Netherlands and France (Table 9).

Figure 35 **Emissions of CH_4 from enteric fermentation and development of cattle population for the EU (left, as index with 1990 = 100) and the Member States (right, as percentage change from 1990)**



Note: Includes Eurostat data for cattle population for Belgium, Italy and Luxembourg.

Source: FAO, Inventory submissions by the EU Member States (CRF tables), EEA (2003a), Eurostat.

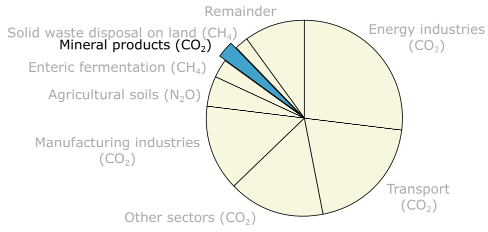
Table 9 Member States' contributions to CH_4 emissions from enteric fermentation

Member State	Greenhouse gas emissions (Gg CO_2 equivalents)			Share in EU-15 emissions in 2001 (%)	Change 2000–2001		Change 1990–2001	
	1990	2000	2001		(Gg CO_2 equivalents)	(%)	(Gg CO_2 equivalents)	(%)
France	30 854	29 230	29 324	22.3	93	0	– 1 530	– 5
Germany	28 037	20 893	20 952	15.9	59	0	– 7 085	– 25
United Kingdom	19 122	18 170	17 074	13.0	– 1 096	– 6	– 2 048	– 11
Spain	12 651	14 249	14 607	11.1	358	3	1 956	15
Italy	13 625	12 673	12 781	9.7	108	1	– 844	– 6
Ireland	9 180	9 925	9 677	7.4	– 248	– 2	497	5
Netherlands	8 439	6 708	6 766	5.1	58	1	– 1 673	– 20
Belgium	4 617	4 175	4 205	3.2	29	1	– 412	– 9
Austria	3 555	3 196	3 150	2.4	– 47	– 1	– 405	– 11
Greece	2 976	2 920	3 000	2.3	81	3	24	1
Sweden	3 027	2 902	2 875	2.2	– 27	– 1	– 152	– 5
Denmark	3 189	2 715	2 747	2.1	33	1	– 441	– 14
Portugal	2 606	2 581	2 581	2.0	0	0	– 24	– 1
Finland	1 868	1 581	1 565	1.2	– 16	– 1	– 304	– 16
Luxembourg	346	327	328	0.2	0	0	– 19	– 5
EU-15	**144 091**	**132 246**	**131 631**	**100.0**	**– 615**	**0**	**– 12 460**	**– 9**

Source: Inventory submissions by the EU Member States (CRF tables), EEA (2003a).

2.2.8. *Mineral products (CO_2)*

Share in total EU greenhouse gases:	3 %
1990:	107 Mt
2001:	106 Mt
Change, 1990–2001:	– 1 Mt – 1 %
Change, 2000–01:	– 2 Mt – 1 %

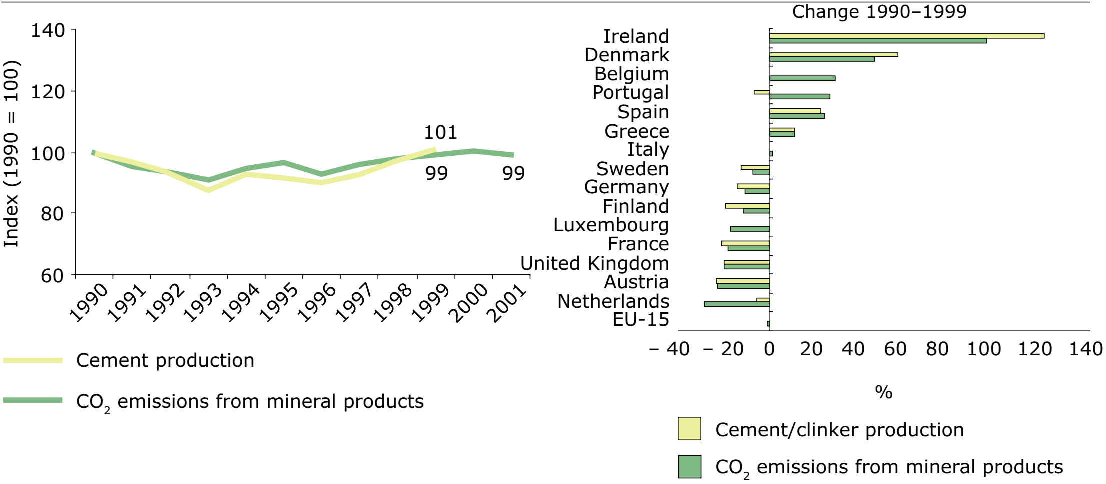


Emissions of CO_2 from industrial processes of mineral products accounted for 3 % of total EU GHG emissions in 2001. The main sectors in this category are cement production, lime production, limestone and dolomite use, soda ash production and use, asphalt roofing, and road paving with asphalt. Cement production is by far the largest source of CO_2 emissions.

In 2001, CO_2 emissions from mineral products were 1 % below 1990 levels in the EU. They declined in the early 1990s, but increased again in recent years. The main driving force of CO_2 emissions from mineral products is cement production. In 1999, cement production was 2 % above 1990 levels (for the EU, no values for 2000–01 were available).

Figure 36 shows the close relationship between cement production and CO_2 emissions from mineral products. It also shows that the United Kingdom, the Netherlands and Austria reduced emissions by 20 % or more, whereas Denmark and Ireland had emission increases of more than 40 %. Germany is the largest emitter (21 % of total EU emissions), followed by Italy and Spain (17 % each) (Table 10). These results should be interpreted with care as different criteria are used by Member States to decide whether particular emissions are allocated to fossil fuel combustion or to the relevant industrial process (e.g. cement production).

Figure 36 Emissions of CO_2 from mineral products and development of cement production for the EU (left, as index with 1990 = 100) and the Member States (right, as percentage change from 1990)



Source: Eurostat, inventory submissions by the EU Member States (CRF tables), EEA (2003a).

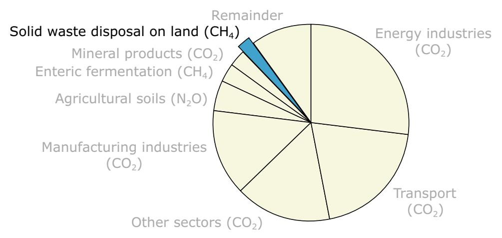
Table 10 Member States' contributions to CO_2 emissions from mineral products

Member State	Greenhouse gas emissions (Gg CO_2 equivalents)			Share in EU-15 emissions in 2001 (%)	Change 2000–2001		Change 1990–2001	
	1990	2000	2001		(Gg CO_2 equivalents)	(%)	(Gg CO_2 equivalents)	(%)
Germany	24 512	23 515	21 802	20.6	– 1 713	– 7	– 2 709	– 11
Italy	18 223	18 061	18 473	17.4	413	2	251	1
Spain	14 076	17 074	17 457	16.5	383	2	3 380	24
France	14 945	12 203	12 231	11.5	28	0	– 2 714	– 18
Greece	6 984	7 625	7 752	7.3	127	2	768	11
United Kingdom	9 629	8 500	7 702	7.3	– 798	– 9	– 1 927	– 20
Belgium	4 569	5 875	5 875	5.5	0	0	1 305	29
Portugal	3 426	4 349	4 330	4.1	– 19	0	904	26
Austria	3 975	3 060	3 074	2.9	14	0	– 901	– 23
Ireland	941	1 693	1 833	1.7	140	8	891	95
Sweden	1 765	1 592	1 630	1.5	38	2	– 135	– 8
Denmark	1 005	1 453	1 464	1.4	11	1	459	46
Finland	1 175	1 072	1 042	1.0	– 31	– 3	– 134	– 11
Netherlands	1 124	857	805	0.8	– 52	– 6	– 319	– 28
Luxembourg	585	547	483	0.5	– 64	– 12	– 102	– 17
EU-15	**106 934**	**107 476**	**105 952**	**100.0**	**– 1 524**	**– 1**	**– 982**	**– 1**

Source: Inventory submissions by the EU Member States (CRF tables), EEA (2003a).

2.2.9. *Solid waste disposal on land (CH_4)*

Share in total EU greenhouse gases:	2 %
1990:	111 Mt
2001:	80 Mt
Change, 1990–2001:	– 31 Mt – 28 %
Change, 2000–01:	– 2 Mt – 2 %



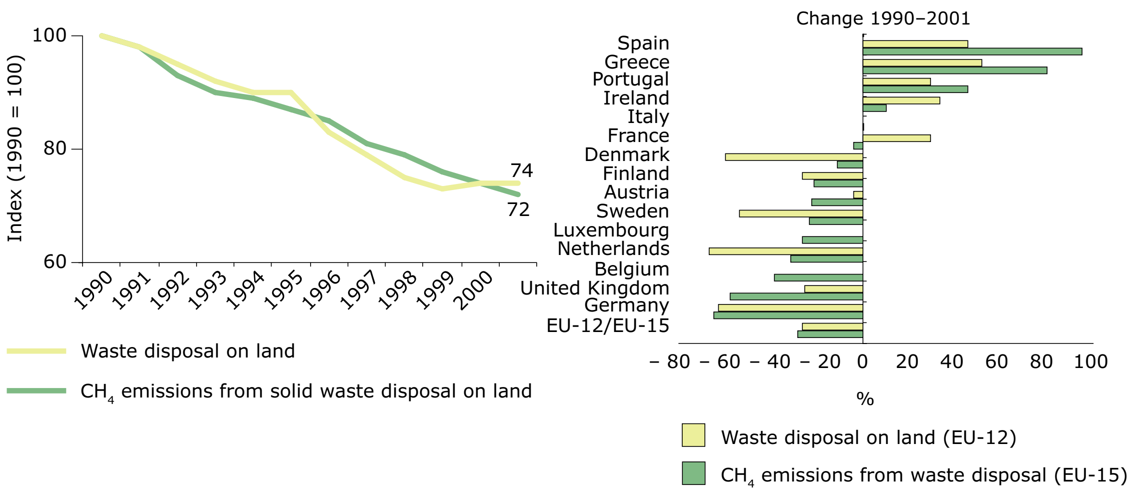
Emissions of CH_4 from solid waste disposal on land account for 2 % of total EU GHG emissions. They occur in landfills due to the breakdown of biodegradable carbon compounds by anaerobic methanogenic bacteria. The resulting landfill gas does not only contain methane but also CO_2, since aerobic processes occur in landfills as well.

Between 1990 and 2001, CH_4 emissions from landfills declined by 28 % in the EU (Figure 37). In 2001, CH_4 emissions from landfills decreased by 2 %. The main driving force of CH_4 emissions from solid waste disposal on land is the amount of biodegradable waste going to landfills. Waste disposal on land declined by 26 % between 1990 and 2001. In addition, CH_4 emissions from landfills are influenced by the amount of CH_4 recovered and utilised or flared.

The emission reductions are partly due to the (early) implementation of the landfill waste directive or similar legislation of the Member States. The landfill waste directive was adopted in 1999 and requires the Member States to reduce the amount of biodegradable waste disposed untreated to landfills and to install landfill gas recovery at all new sites. There are, however, large variations in CH_4 emission trends by Member State. Germany and the United Kingdom achieved emission reductions of about 40 %, whereas Portugal, Greece and Spain increased emissions by more than 40 % (Figure 37 and Table 11).

A major reason for declining emissions is CH_4 recovery (Figure 38). All Member States increased the share of recovery between 1990 and 2001 substantially. For some Member States no data are available.

Figure 37 Emissions of CH_4 from waste disposal on land and development of waste disposal on land for the EU (left, as index with 1990 = 100) and the Member States (right, as percentage change from 1990)



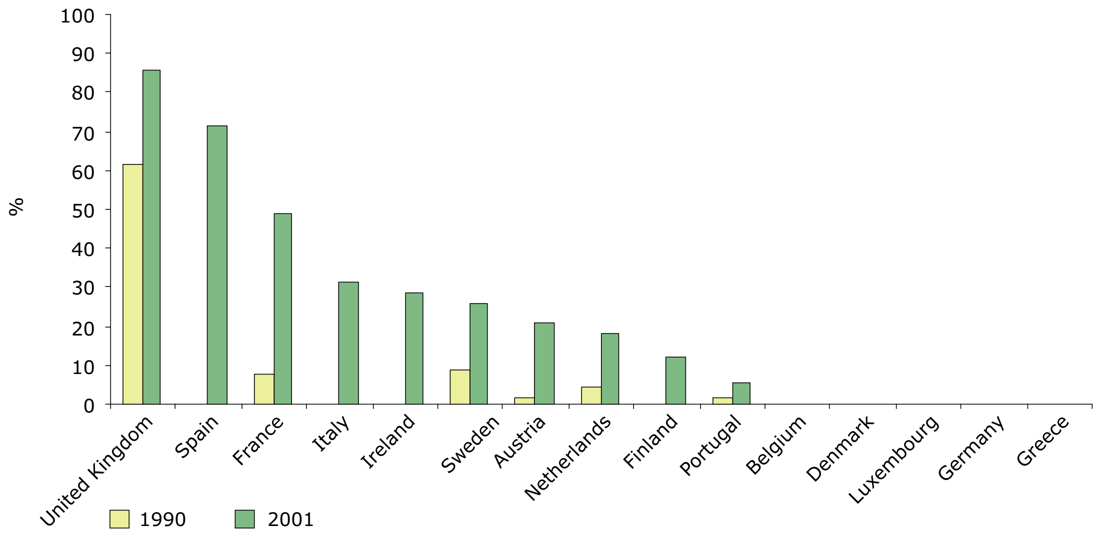
Source: Inventory submissions by the EU Member States (CRF tables), EEA (2003a).

Table 11 Member States' contributions to CH_4 emissions from landfills

Member State	Greenhouse gas emissions (Gg CO_2 equivalents)			Share in EU-15 emissions in 2001 (%)	Change 2000-2001		Change 1990-2001	
	1990	2000	2001		(Gg CO_2 equivalents)	(%)	(Gg CO_2 equivalents)	(%)
Spain	5 391	10 098	10 485	13.1	386	4	5 094	94
Germany	28 285	10 248	10 252	12.8	4	0	– 18 033	– 64
United Kingdom	23 760	11 597	10 231	12.7	– 1 366	– 12	– 13 528	– 57
France	10 461	10 511	10 067	12.5	– 444	– 4	– 395	– 4
Italy	9 526	9 434	9 556	11.9	121	1	29	0
Netherlands	11 802	8 480	8 181	10.2	– 299	– 4	– 3 621	– 31
Greece	2 811	4 767	5 039	6.3	272	6	2 229	79
Austria	4 929	3 884	3 842	4.8	– 41	– 1	– 1 086	– 22
Portugal	2 422	3 401	3 511	4.4	111	3	1 089	45
Finland	3 679	3 009	2 901	3.6	– 108	– 4	– 778	– 21
Sweden	2 554	2 034	1 972	2.5	– 63	– 3	– 582	– 23
Belgium	2 829	1 994	1 767	2.2	– 227	– 11	– 1 062	– 38
Ireland	1 158	1 220	1 276	1.6	56	5	118	10
Denmark	1 310	1 197	1 168	1.5	– 29	– 2	– 143	– 11
Luxembourg	64	56	48	0.1	– 8	– 14	– 17	– 26
EU-15	**110 982**	**81 929**	**80 295**	**100.0**	**– 1 634**	**– 2**	**– 30 687**	**– 28**

Source: Inventory submissions by the EU Member States (CRF tables), EEA (2003a).

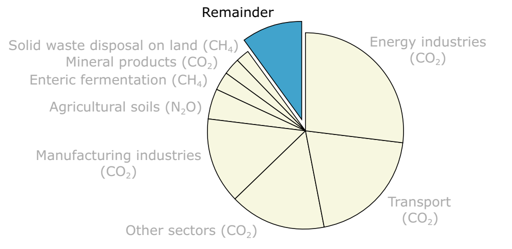
Figure 38 Share of CH_4 recovery in total CH_4 emissions for EU Member States, 1990 and 2001



Source: Inventory submissions by the EU Member States (CRF tables), EEA (2003a).

2.2.10. The remaining source categories

Share in total EU greenhouse gases:	10 %
1990: 2001:	509 Mt 399 Mt
Change, 1990–2001:	– 110 Mt – 22 %
Change, 2000–01:	4 Mt 1 %



The category 'Remainder' includes the remaining 60 source categories (including the remaining 20 key source categories). This section provides overview information on four of these remaining source categories. The criteria for choosing these four source categories are: (1) percentage contribution to total EU GHG emissions of more than 1 %, or (2) large increase in absolute terms between the base year and 2001.

Emissions of N_2O from the chemical industry

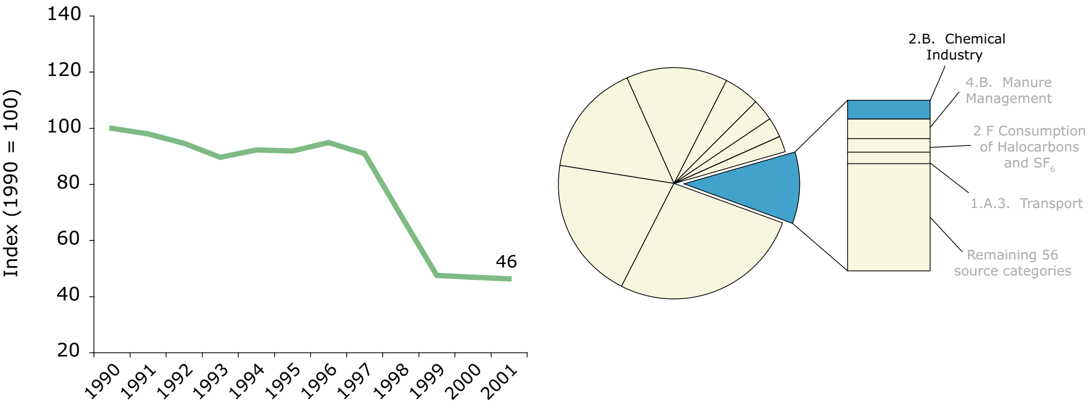
Emissions of N_2O from the chemical industry account for 1.2 % of total EU GHG emissions. Most N_2O emissions from the chemical industry occur in adipic and nitric acid production. Adipic acid is a raw material used mainly in the manufacture of 6,6 nylon, which is used in industrial carpets; some adipic acid is also used in the manufacture of engineering plastics and low temperature lubricants. Nitric acid is a raw material mainly used as a feedstock in fertiliser production, but also in the production of adipic acid and explosives. Within the EU about 80 % of nitric acid production is used for fertiliser production (EC, 2001a).

Between 1990 and 2001, N_2O emissions from the chemical industry dropped by 54 % in the EU. Most of the reductions were achieved between 1997 and 1999 due to emission reduction measures in German, French and UK adipic acid production (Figure 39). In 2001, N_2O emissions from the chemical industry decreased by 1.2 %, compared with 2000.

Emissions of CH_4 from manure management

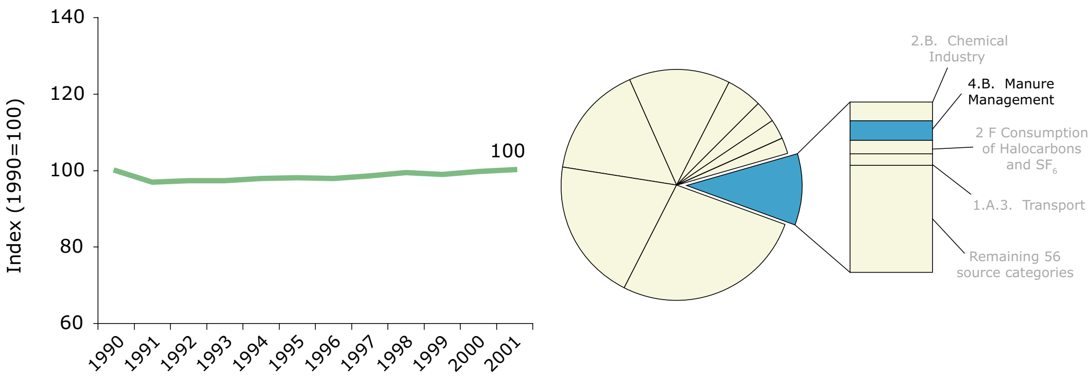
Emissions of CH_4 from manure management account for 1.1 % of total EU GHG emissions. These emissions are produced from the decomposition of manure under anaerobic conditions. These conditions often occur when large numbers of animals are managed in a confined area (e.g. dairy farms, beef feedlots, and swine and poultry farms), where manure is typically stored in large piles or disposed of in lagoons (IPCC, 1997).

Figure 39 Emissions of N_2O from the chemical industry



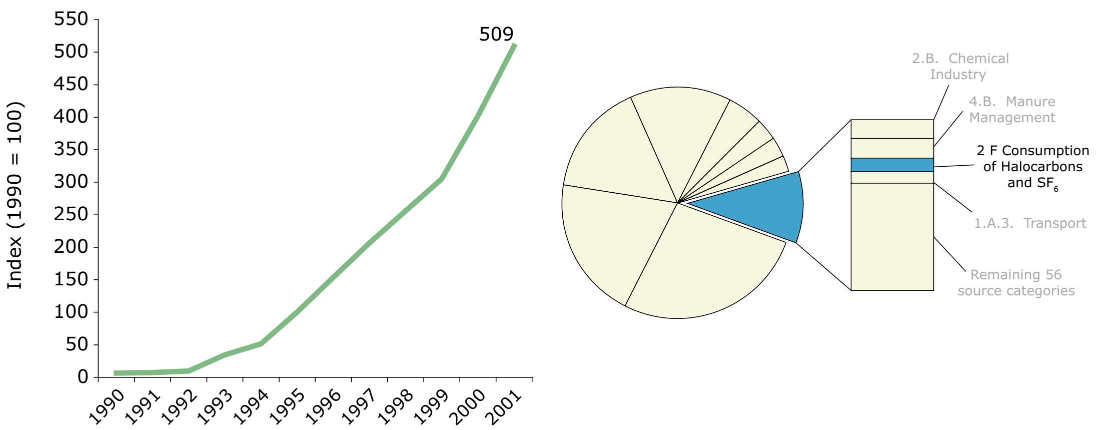
Source: Inventory submissions by the EU Member States (CRF tables), EEA (2003a).

Figure 40 Emissions of CH_4 from manure management



Source: Inventory submissions by the EU Member States (CRF tables), EEA (2003a).

Figure 41 Emissions of HFC from consumption of halocarbons and SF_6 (in CO_2 equivalents)



Source: Inventory submissions by the EU Member States (CRF tables), EEA (2003a).

Between 1990 and 2001, CH_4 emissions from manure management remained stable in the EU (Figure 40). In 2001, CH_4 emissions from manure management also remained stable compared with 2000.

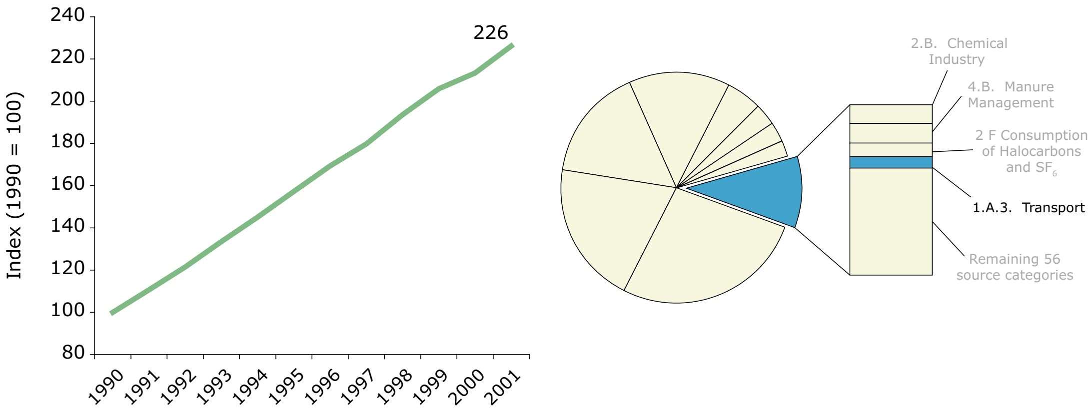
Emissions of HFC from consumption of halocarbons and SF_6

Emissions of HFC from consumption of halocarbons and SF_6 account for 0.8 % of total EU GHG emissions. The main driving force of HFC emissions is the phase-out of ozone-depleting chlorofluorocarbons (CFC). HFCs are replacing CFCs mainly in refrigeration and air conditioning, and as aerosol propellants and blowing agents for the production of thermal insulation foams. Figure 41 shows that between 1995 (the base year) and 2001, HFC emissions from consumption of halocarbons and SF_6 increased by about 400 % in the EU. This was the highest percentage increase of all EU key sources. However, this percentage increase slightly overestimates the increase as for Italy no detailed data for 1995 are available. The percentage increase excluding Italy would be + 365 %.

Emissions of N_2O from transport

Emissions of N_2O from transport account for 0.6 % of total EU GHG emissions. The most important source of N_2O from transport is petrol cars equipped with catalyst converters. Emissions of N_2O are mostly formed during the warm-up phase. If the catalyst degrades as it ages, then the length of the warm-up phase can be extended, and the period over which N_2O is emitted is also extended. Emissions measurements on petrol cars

Figure 42 Emissions of N_2O from transport



Source: Inventory submissions by the EU Member States (CRF tables), EEA (2003a).

equipped with 'first generation' three-way catalysts showed a substantial increase in N_2O emissions compared with vehicles without catalysts, but it now seems likely that the increase in emissions from more modern catalysts is substantially lower than this (EC, 2000).

Between 1990 and 2001, N_2O emissions from transport grew by 126 % in the EU, which was the second highest increase of all EU key sources. In 2001, they increased by 6 %, compared with 2000 (Figure 42).

2.3. Greenhouse gas emissions in the acceding and candidate countries

2.3.1. Introduction

This section and Annex 3 provide information on GHG emission reporting in 13 acceding and candidate countries: Bulgaria, the Czech Republic, Estonia, Cyprus, Hungary, Latvia, Malta, Lithuania, Poland, Romania, Slovakia, Slovenia and Turkey, and a trend assessment of GHG emissions in 11 AC and CC. The section is based on the data and information (CRF tables) provided by eight countries (Bulgaria, the Czech Republic, Estonia, Hungary, Latvia, Romania, Slovakia and Poland) under Council Decision 1999/296/EC and IPCC tables provided by Malta and Slovenia. The information for Lithuania was completed with the data from UNFCCC. Emission data for Cyprus and Turkey were not available.

The purpose of this section and Annex 3 is:

- to show data availability in the AC and CC to fulfil the reporting under Council Decision 1999/296/EC and under the UNFCCC;
- to illustrate GHG emission trends of the AC and CC and to identify progress towards fulfilling their commitments under the UNFCCC and the Kyoto Protocol;
- to identify gaps in emission reporting to assist parties in completing the required information;
- to identify indicators for main driving forces of GHG emissions in these countries.

The chapter starts with a section providing summary information on the status of reporting and data availability in the AC and CC. The next sections show distance-to-target indicators and emission trends for the AC/CC10 as a whole, and summary information for each country. Annex 3 presents a short analysis including the sectoral emission trends for each of the 11 AC and CC for which data are available.

2.3.2. *Acceding and candidate countries' targets and emission data availability*

The reporting under Council Decision 1993/389/EEC as amended by Decision 1999/296/EC for a monitoring mechanism of EU CO_2 and other greenhouse gas emissions ([20]) is not obligatory for the AC and CC yet, but should be implemented when joining the EU. The AC and CC are required to report GHG emissions under the UNFCCC and the Convention on Long-range Transboundary Air Pollution (CLRTAP). The AC and CC are Annex I parties to the UN Framework Convention on Climate Change and some of the AC and CC have already ratified the Kyoto Protocol (Table 12).

Under the UNFCCC, 10 AC and CC (Bulgaria, the Czech Republic, Estonia, Hungary, Latvia, Lithuania, Poland, Romania, Slovakia, Slovenia) belong to the group of countries undergoing the process of transition to a market economy. They can apply a certain degree of flexibility in the implementation of their commitments under Article 4.6 of the UNFCCC. The practical implication of this flexibility led to the declaration of base years other than 1990 in Bulgaria (1988) Hungary (average of the years 1985–1987), Poland (1988), Romania (1989) and Slovenia (1986).

The main source of this report is data supplied by the AC and CC under the UNFCCC (submission 2001 or 2002), data reported to the EEA under the Eionet, and data submitted under Council Decision 1999/296/EC by May 2003. Background data were obtained from Eurostat and the Energy Information Administration (EIA).

The completeness of the data sets reported under the UNFCCC, the Eionet and Council Decision 296/1999/EC differs between parties (Table 13). Most of the countries reported emissions for the whole period 1990–2001 in consistent time series. Several countries still need to remove gaps and inconsistencies in order to fulfil the requirements of the UNFCCC and the Kyoto Protocol ([21]). Ten countries reported data in CRF tables, Slovenia and Malta used

Table 12 Kyoto Protocol status of ratification in the acceding and candidate countries

Country	Signature	Ratification	Percentage of emissions (1)	Reduction commitment (1)
Bulgaria	18/09/98	18/08/02 (R)	0.6	92 %
Czech Republic	23/11/98	15/11/01 (Ap)	1.2	92 %
Cyprus (2)	—	16/07/99 (Ac)	—	not included in Annex B
Estonia	03/12/98	14/02/02 (R)	0.3	92 %
Hungary	—	21/08/02 (Ac)	0.5	94 %
Latvia	14/12/98	05/07/01 (R)	0.2	92 %
Lithuania	21/09/98	03/01/03 (R)	—	92 %
Malta (2)	17/04/98	11/11/01 (R)	—	not included in Annex B
Poland	15/07/98	13/12/02 (R)	3.0	94 %
Romania	05/01/99	19/03/01 (R)	1.2	92 %
Slovakia	26/02/99	31/05/02 (R)	0.4	92 %
Slovenia	21/10/98	02/08/02 (R)	—	92 %
Turkey (2)	—	—	—	not included in Annex B

Status on 19 May 2003 (R — Ratification, Ap — Approval, Ac — Accession).
(1) Percentage and reduction commitment (percentage of base year) as listed in Kyoto Protocol.
(2) Cyprus and Malta are not Annex I parties, Turkey is also Annex II party to the UNFCCC.

Source: UNFCCC.

([20]) OJ L 117, 5.5.1999, p. 35. For a brief description of this Council decision see Section 1.1 of this report.
([21]) For more detail, see country-related tables in Annex 3.

Table 13 Data and base year of the acceding and candidate countries

Country	Base year	Emissions of CO_2, CH_4, N_2O	Emissions of fluorinated gases
Bulgaria	1988	1988, 1990–99	1998–99
Czech Republic	1990	1990, 1994, 1996–2001	1995–2001
Estonia	1990	1990–2001	NA
Hungary	average 1985–87	average 1985–87, 1990–2000	1998–2000
Latvia	1990	1990–2001	1995–2001
Lithuania	1990	1990, 1998	NA
Poland	1988	1988, 1990–2001	1995–2001
Romania	1989	1989,1990–2001	1992–2001
Slovakia	1990	1990–2001	1990–2001
Slovenia	1986	1986, 1990–96	1990–96
Cyprus	—	NA	NA
Malta	—	1990–2000	NA
Turkey	—	NA	NA

Note: NA — data are not available from any of these sources.

Source: Submissions by the AC and CC in 2002 (Hungary CRF 2000, Bulgaria CRF 1999) and in 2003 (the Czech Republic, Estonia, Latvia, Poland, Romania, Slovakia, all countries provided the CRF 2001), Slovenia (IPCC tables 7A 1990–96 provided by the country), Malta (IPCC tables downloaded from the address provided by the country (http://www.phys.um.edu.mt/climate/downloads/ghg/ghg_inventory.zip), UNFCCC database (Lithuania, 2002 submission, years 1990–98).

IPCC tables. Data for Lithuania were extracted from the UNFCCC database. No emission data are available for Cyprus and Turkey. The timeliness, completeness and consistency of GHG emissions reported in 2003 improved significantly compared with the previous year, however there are still areas for improvement:

- fluorinated gases are not reported in complete time series, the base year for fluorinated gases is not always reported;
- estimation methods are not consistently applied for the whole period;
- emissions are not reported for all gases and years from 1990 to 2001;
- sector emissions are not reported consistently;
- 2001 year emissions are not reported in the last submission (2003).

For the preparation of this summary section and for the calculation of the indicators, a data gap filling procedure (interpolation, extrapolation) was applied. Emissions were interpolated for Lithuania (1991–97) and the Czech Republic (1991–93 and 1995). The last reported value was repeated:

- for all gases for Bulgaria (1999 for 2000 and 2001), Hungary (2000 for 2001);
- for all gases except CO_2 from fuel combustion for Lithuania (1998 for 1999–2001) and Slovenia (1996 for 1997–2001).

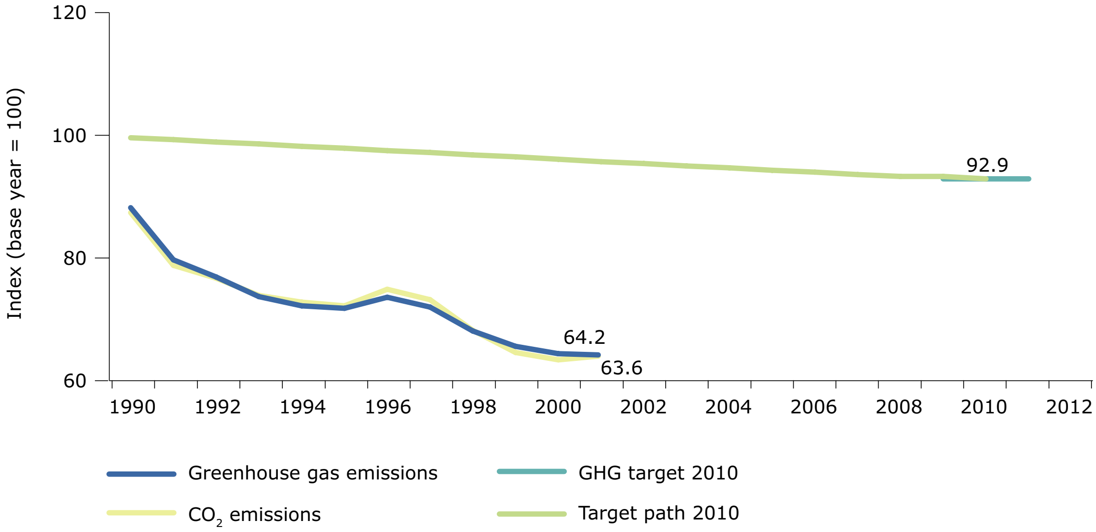
Emissions of CO_2 from fuel combustion for Slovenia (1997–2000) and Lithuania (1999–2000) were extrapolated by using percentage changes of the IEA (2002).

The data availability of fluorinated gas emissions was not complete, but this year also these emissions were included in total GHG emissions to assess development in this region.

2.3.3. *Distance-to-target assessment of acceding and candidate countries*

This section focuses on those 10 countries that have a Kyoto target, i.e. Bulgaria, the Czech Republic, Estonia, Hungary, Latvia, Lithuania, Poland, Romania, Slovakia, and Slovenia. According to Article 4.2 of the UNFCCC, parties shall aim at returning individually or jointly to their 1990 levels of anthropogenic emissions of carbon dioxide and other GHG not

Figure 43 **Acceding and candidate countries' (AC/CC-10) greenhouse gas emissions compared with Kyoto target for 2008–12 (excluding LUCF)**



Note (1): Bulgaria (last reported year 1999), Hungary (last reported year 2000), Lithuania (last reported year 1998), Slovenia (last reported year 1996) did not report complete time series. For missing years, a gap-filling procedure was applied**.** Malta is not included, as it has no Kyoto target.

Note (2): The index on the *y* axis refers to the base year. As the acceding and candidate countries use different base years (see Table 13), the value for 1990 is not 100.

Source: Submissions by the AC and CC (CRF tables, IPCC tables), UNFCCC database.

controlled by the Montreal Protocol. In the Kyoto Protocol eight AC and CC agreed to reduce their GHG emissions by 8 % by 2008–12, from the base-year levels. Hungary and Poland agreed to reduce their emissions by 6 % from the base-year levels (Table 12).

The AC and CC do not have a common target for emission reductions. All countries have to reach their targets individually as defined in the Kyoto Protocol, and all AC and CC aim at stabilising emissions in line with Article 4.2 of the UNFCCC. Nevertheless, an aggregate analysis is performed in this section for information purposes and in order to compare the overall trends in the AC and CC with the trends in the EC.

In the whole region of the AC/CC10, the total GHG emissions declined by 35.8 % between the base year and 2001 (Figure 43). The distance-to-target indicator for the whole region was — 31.7 index points in 2001 ([22]). In 2001, GHG emissions decreased by 0.9 % compared with 2000 ([23]). Change in emissions between 1999 and 2000 was — 1.6 %. Emissions of CO_2 decreased more than the total GHG emissions in AC/CC10. However, in 2001, CO_2 emissions increased compared with 2000 partly due to cold outdoor temperature.

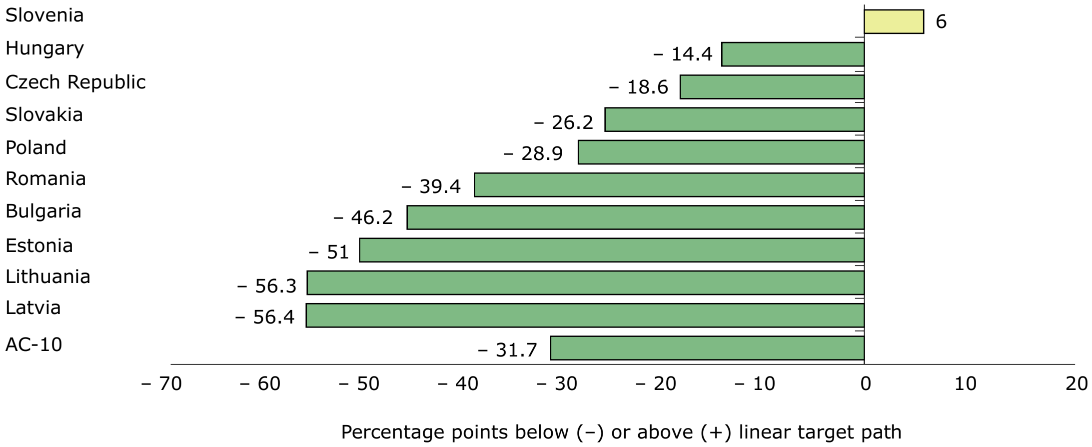
The performance of the AC and CC, however, varied considerably (Figure 44). Nine countries were below their Kyoto target path, with distance-to-target indicators ranging from – 14.4 index points in Hungary to – 56.4 index points in Latvia. Only Slovenia was above its target path, with + 6 index points.

Note: The common target under the Kyoto Protocol for all AC and CC was calculated for the presentation of the development in the AC/CC-10 region as a whole for this report only, and does not have any legally binding implication.

([22]) The calculated distance-to-target indicators for the whole region as well as for Slovenia and Lithuania are indicative, as these countries did not provide complete time series. In order to enable a preliminary assessment of the trends in all CC as a whole, a gap-filling procedure was applied. The base year for AC/CC-10 is assumed to be the sum of the base years of the individual AC and CC.

([23]) Note that the percentage change between 2000 and 2001 does not include data from Bulgaria, Hungary, Lithuania and Slovenia.

Figure 44 Distance-to-target indicators (in index points) for the Kyoto Protocol of the acceding and candidate countries, 2001



Source: Submissions by the AC and CC (CRF tables, IPCC tables), UNFCCC database.

Table 14 Greenhouse gas emissions in CO_2 equivalents (excluding LUCF) and Kyoto Protocol targets for 2008–12

Country	Base year (million tonnes)	1990 (million tonnes)	2001 (million tonnes)	Change 1999–2000 (%)	Change 2000–2001 (%)	Change base year –2001 (%)	Targets 2008–12 under Kyoto Protocol (%)	Distance-to-target indicator (DTI) (index points)	Evalua-tion of progress in 2001
Bulgaria	157.7	137.7	77.7	-	-	– 50.7	– 8	– 46.2	☺
Czech Rep.	192.1	192.0	148.0	5.2	0.3	– 23.0	– 8	– 18.6	☺
Estonia	43.5	43.5	19.4	0.4	– 1.7	– 55.4	– 8	– 51.0	☺
Hungary	102.6	86.6	84.3	– 2.6	–	– 17.8	– 6	– 14.4	☺
Latvia	29.0	29.0	11.4	– 6.2	16.9	– 60.8	– 8	– 56.4	☺
Lithuania	51.5	51.5	20.2	– 7.0	–	– 60.7	– 8	– 56.3	☺
Poland	565.3	458.9	382.8	– 3.8	– 0.9	– 32.3	– 6	– 28.9	☺
Romania	264.8	228.5	148.3	0.5	– 4.9	– 44.0	– 8	– 39.4	☺
Slovakia	72.2	72.2	50.1	– 4.9	4.7	– 30.6	– 8	– 26.2	☺
Slovenia	19.9	18.3	20.2	– 0.8	-	1.4	– 8	6.0	☹
AC/CC-10	**1 498.7**	**1 318.3**	**962.4**	**– 1.6**	**– 0.9**	**– 35.8**	**– 7.1**	**– 31.7**	☺
Malta	-	2.2	2.8	2.4	-	-	-	-	-

Note: The year 2001 refers to the last reported year, as many countries did not provide complete time series: Bulgaria (last reported year 1999), Hungary (last reported year 2000), Lithuania (last reported year 1998), Slovenia (last reported year 1996). For missing years, a gap-filling procedure was used. Malta is not included, as it has no Kyoto target.

Source: Submissions by the AC and CC (CRF tables, IPCC tables), UNFCCC database.

2.3.4. Emission trends

All the AC and CC except Malta and Slovenia achieved substantial GHG emission cuts between 1990 and 2001. The emissions were reduced in particular in the first half of the 1990s. The further development of GHG emissions was more individual and depended on country-specific economic developments. The emissions in Slovenia, the Czech Republic, Poland, Hungary, Slovakia and Malta showed increases. The other countries further decreased or stabilised their emissions. Between 2000 and 2001, emissions increased in the Czech Republic, Slovakia and Latvia (Table 14).

Most of the AC and CC have already achieved or will achieve the aim of the UNFCCC to keep GHG emissions below 1990 levels by 2000 ([24]). The results of simple extrapolation of emission trends

([24]) Not all of these countries provided data for 2000.

Figure 45 Change in sectoral emissions in 10 acceding and candidate countries from the base year to 2001 and share of sectors and gases in 2001

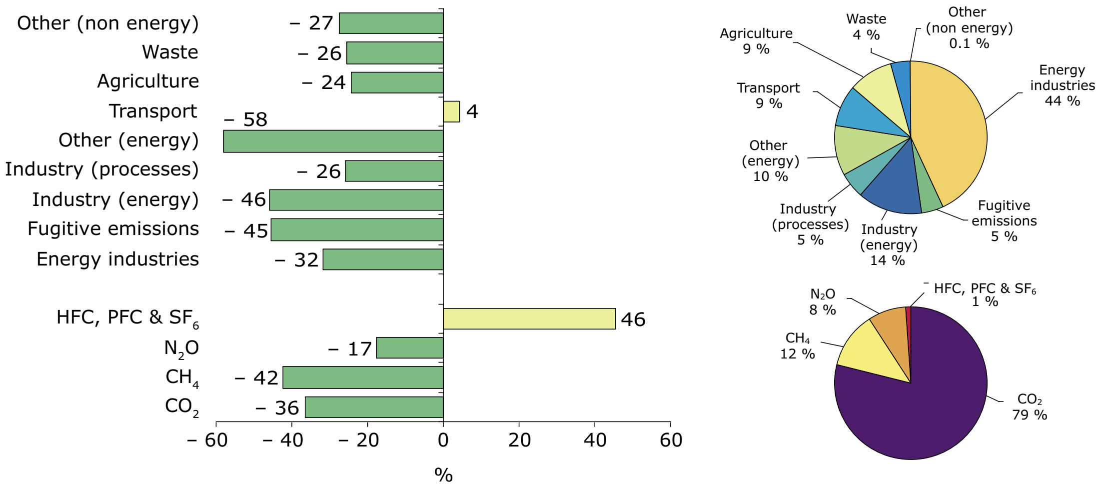
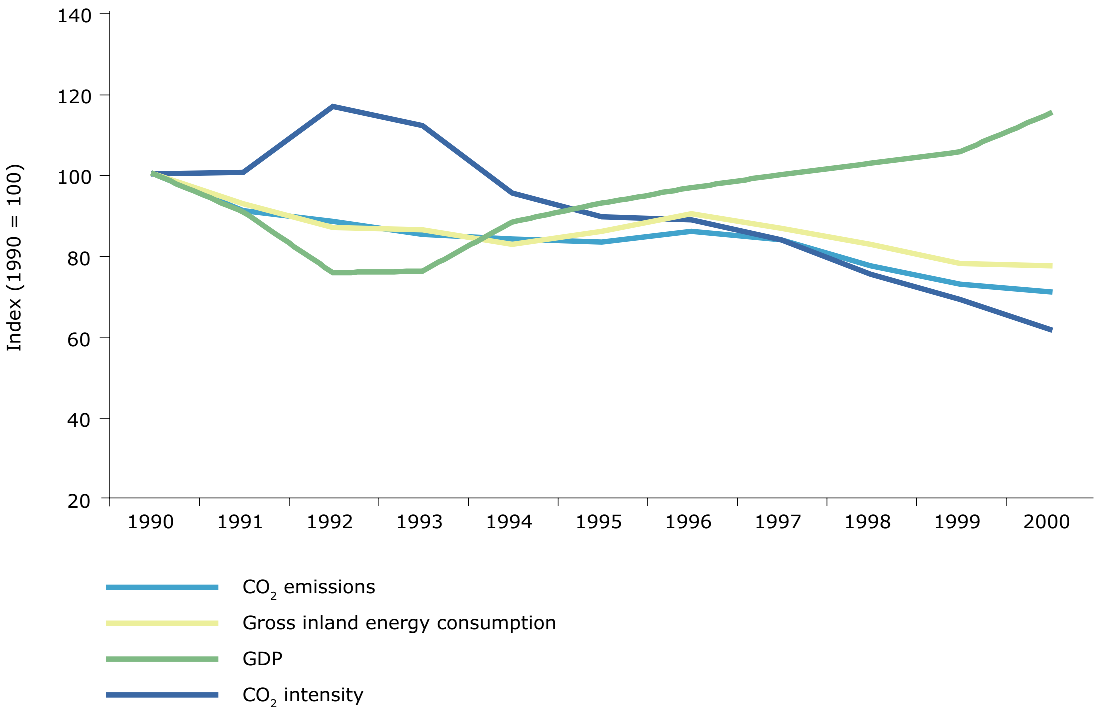


Figure 46 Acceding and candidate countries' CO_2 emissions (excluding LUCF) in relation to GDP and energy consumption



Note: Data on gross inland energy consumption provided by Eurostat are not complete for all years and countries, therefore the presented trend is indicative only.

Source: Submissions by the AC and CC (CRF tables), UNFCCC database, EMEP database, Eurostat and EIA webpage.

from the previous year indicate that Slovenia will need additional domestic measures to fulfil its commitments.

Figure 45 shows that emissions decreased in all sectors except transport (+ 4 %). The most significant decreases occurred in the sectors related to fossil fuels combustion (from – 32 to – 58 %). Changes in agriculture (– 24 %), industry (– 26 %), and waste (– 26 %) were significant as well. Total emissions of fluorinated gases are small (about 1 % of the total emissions), but they showed an increase of 46 % compared with the base year ([25]).

([25]) Note that the base year for fluorinated gases differs between countries (1990 or 1995).

In the AC and CC, CO_2 is by far the most important GHG (about 79 %), the second largest gas being CH_4 and the third largest N_2O. Fluorinated gas emissions are not yet reported consistently in all the AC and CC, but in general they contribute by less than 1 % to the national totals. Compared with the base year, the share of CO_2 and CH_4 emissions decreased slightly, and the share of N_2O in total GHG emissions in the region increased from 6.6 to 8.0 %. These changes were partly influenced by inconsistent N_2O calculation methods in some countries and might change after revision of the national totals during the commitment period.

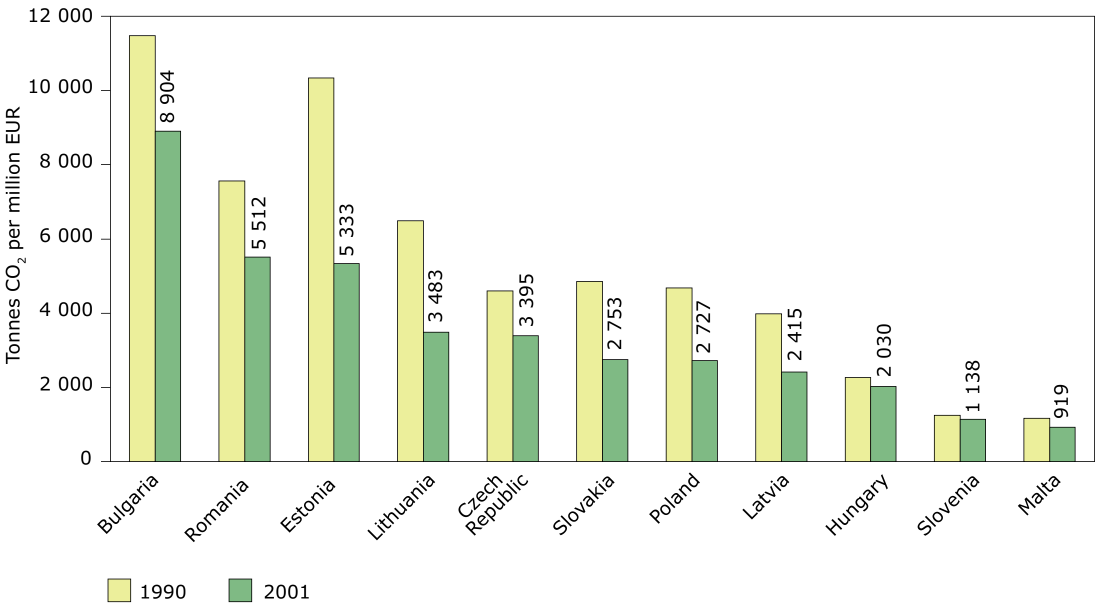
Although the GDP data are not available for all countries for the whole period, it can be said that the GDP is growing faster than GHG emissions in all countries. The increasing gap between emissions and GDP shows that the energy use must have decoupled considerably from the economic activity in the region. Gross inland energy consumption shows the same trend as CO_2 emissions. The intensity of CO_2 was almost 40 % below 1990 levels in 2000 (Figure 46).

Note: It is difficult to calculate consistent GDP values for economies in transition for the whole period from 1990 to 2001. In most countries the calculation methods of GDP changed in 1992, 1993 and 1994. The GDP for earlier years is not always available (Baltic countries, Slovenia, Slovakia) or they were estimated retrospectively.

Figure 47 shows that in the AC and CC, emissions per GDP vary between approximately 1 tonne per million euro for Malta and 8.9 tonnes for Bulgaria. Emissions per GDP were below 1990 levels in all the AC and CC. Large decreases from 1990 to 2001 appeared in the Baltic countries. In Hungary, Slovenia and Malta the reductions were small.

Figure 48 shows that in the AC and CC, emissions per capita vary between 4.8 tonnes for Latvia and 14.4 tonnes for the Czech Republic. Emissions per capita were below 1990 levels in most AC and CC (except Slovenia, Malta and Hungary). Large decreases from 1990 to 2001 appeared in Baltic countries and in Bulgaria. In the Czech Republic, Poland and Slovakia the reductions were smaller.

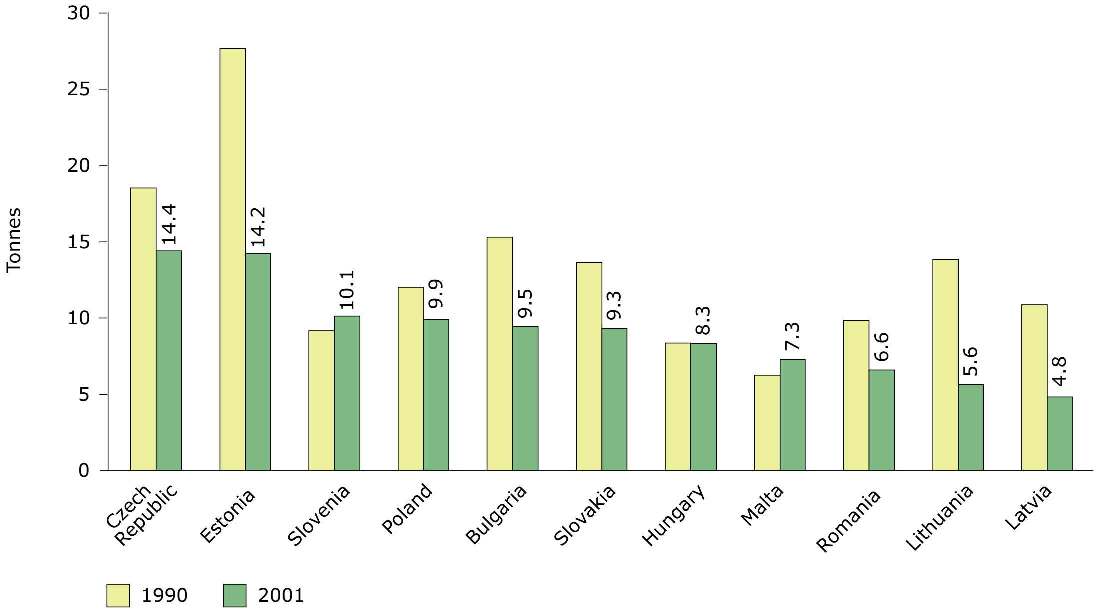
Figure 47 Acceding and candidate countries' greenhouse gas emissions per GDP by country for the 1990 and 2001



Note: GDP in million EUR (1995 prices and exchange rates). For lack of data, for some acceding and candidate countries the comparison refers to years other than 1990–2001: Bulgaria (1990–99), Estonia (1992–2001), Hungary (1990–2000), Latvia (1991–2001), Lithuania (1990–2000), Malta (1990–2000) and Slovenia (1990–2000).

Source: Eurostat and EIA webpage.

Figure 48 **Acceding and candidate countries' greenhouse gas emissions (CO_2 equivalent) per capita by country, 1990 and 2001**



Note: For lack of data, for some acceding and candidate countries the comparison refers to years other than 1990–2001: Bulgaria (1990–99), Hungary (1990–2000), Lithuania (1990–2000) and Slovenia (1990–2000).

Source: Submissions by the AC and CC (CRF tables, IPCC tables), UNFCCC database, population — Eurostat.

3. Greenhouse gas emissions projections in Europe

3.1. EU Member States' projections and policies and measures

3.1.1. Introduction

This section presents the latest greenhouse gas emissions projections reported by Member States under the EU monitoring mechanism and compares these projections with the EU's Kyoto commitment and the targets set under the EU burden sharing agreement.

Two types of emissions projections are shown for each Member State (where available):

- 'with (existing) domestic measures' projection;
- 'with additional domestic measures' projection.

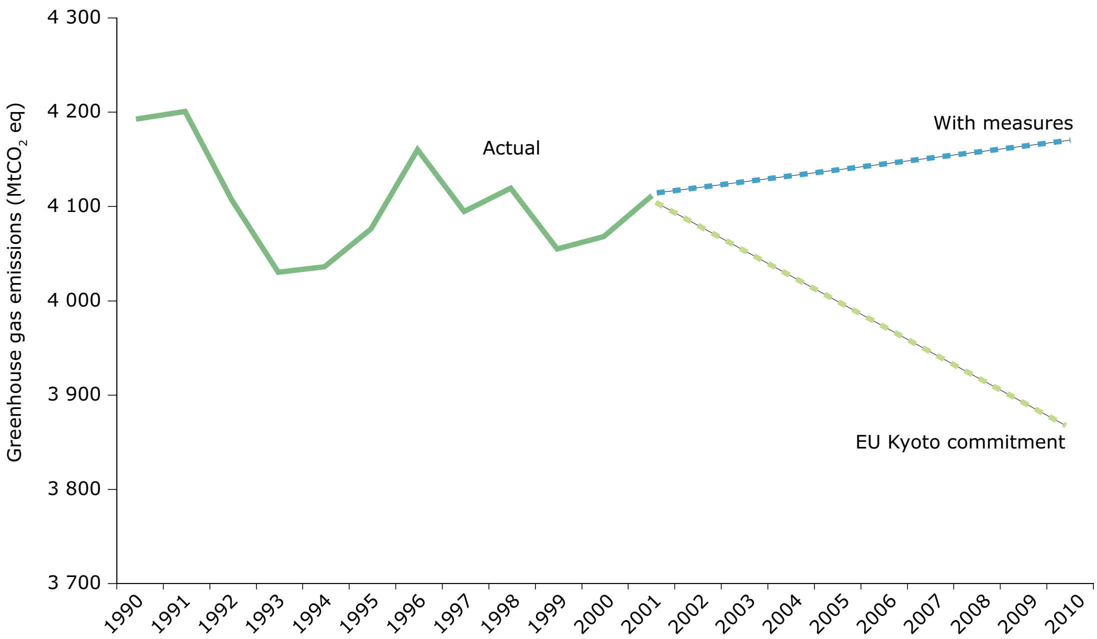
A with existing domestic measures projection encompasses currently implemented and adopted policies and measures. This is also sometimes called a 'baseline projection'. A with additional domestic measures projection also includes the effects of planned policies and measures ([26]).

3.1.2. With existing domestic measures projections

This section compares the latest with existing domestic measures projections from Member States with their EU-burden sharing commitments for 2010. This comparison is useful in revealing the gap between what implemented policies and measures are expected to deliver and the Member States' and EU's commitment under the protocol.

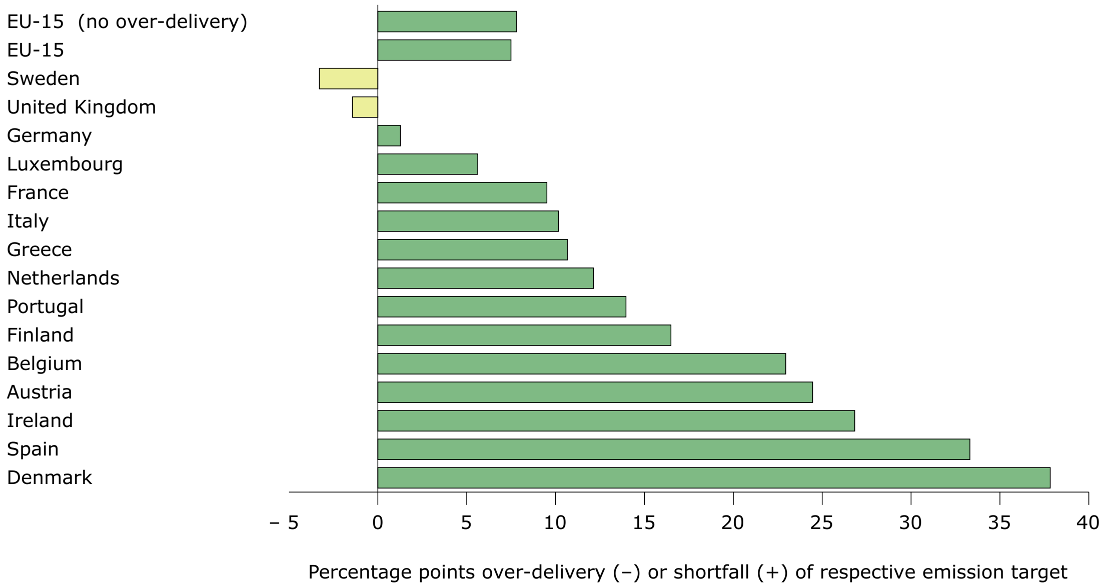
Figure 49 shows the actual progress between 1990 and 2001 and the

Figure 49 Actual and projected progress for the EU based on Member States' projections



([26]) Implemented policies and measures are those for which one or more of the following applies: (a) national legislation is in force; (b) one or more voluntary agreements have been established; (c) financial resources have been allocated; (d) human resources have been mobilised. Adopted policies and measures are those for which an official government decision has been made and there is a clear commitment to proceed with implementation. Planned policies and measures are options under discussion and having a realistic chance of being adopted and implemented in future.

Figure 50 **Relative gap (over-delivery or shortfall) between with existing domestic measures projections and targets for 2010 for EU-15 and Member States ([27])**



Note: Germany's projections are preliminary results from an ongoing study provided in June 2003 (German Environmental Agency, 2003).

aggregate with existing domestic measures projections for the Member States in 2010. Since 1990, greenhouse gas emissions have fallen by 2.3 %. This trend is expected to reverse as the aggregate projections for 2010 show emissions rising again to just 0.5 % below 1990 levels. This leaves a shortfall of 7.5 % to reach the EU's Kyoto commitment of an 8 % reduction in emissions in 2010 compared with 1990 levels.

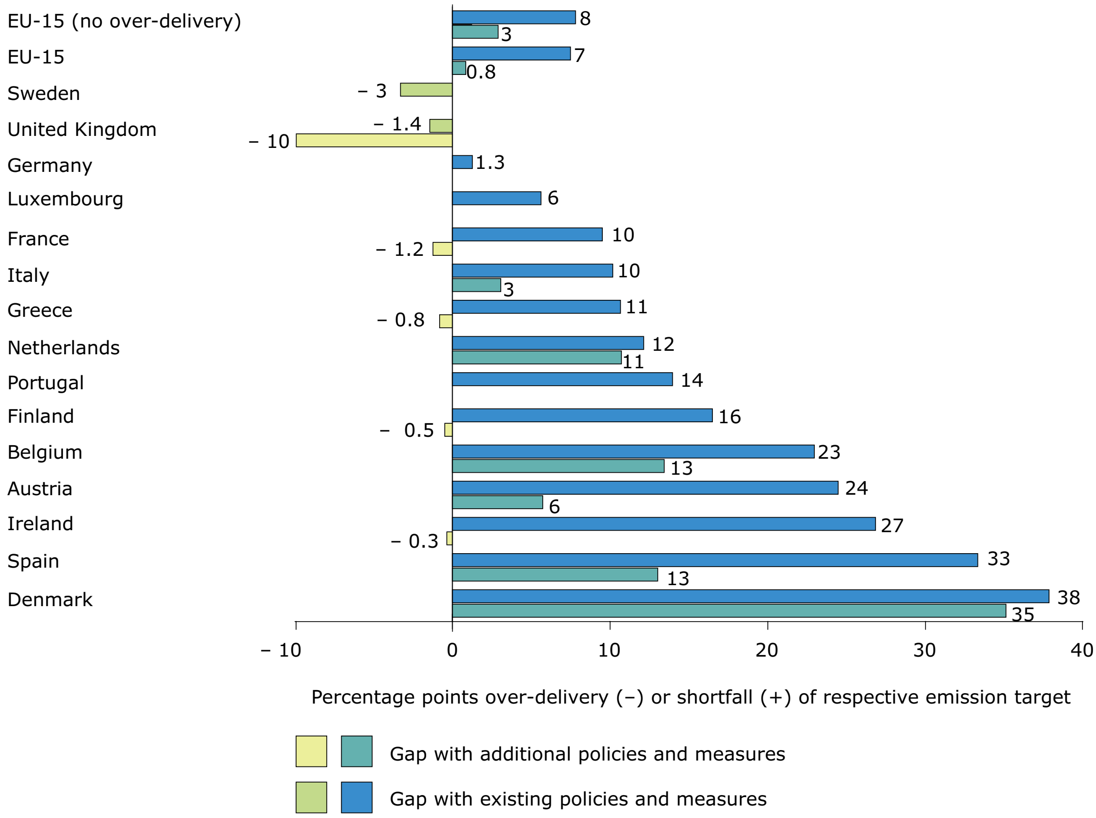
Looking at the projections at a country level (Figure 50), the situation varies significantly between Member States. The United Kingdom and Sweden project that existing domestic policies and measures will be sufficient to meet their burden sharing targets. Denmark, Spain, Portugal, Ireland, Austria, Belgium, Finland, the Netherlands, and Greece are all projected to be significantly above their commitment with existing domestic measures, not including any contribution from the Kyoto Protocol mechanism. If the United Kingdom and Sweden meet but do not exceed their target, the gap for the EU as a whole increases to around 7.8 %.

These projections do not take into account emissions and removals from land-use change and forestry, which are considered separately in Section 3.3.

The gap between the aggregate with existing domestic measures projections and the Kyoto commitment for the EU is significantly larger than that calculated last year. This is due in particular to the updated projections from Germany (preliminary information given in June 2003). According to this new information, Germany's large over-delivery on its burden sharing target, reported last year, was changed to a slight shortfall in 2010. For the current analysis only Germany, Denmark, Greece and Italy provided new projections. In the case of Germany, Denmark and Greece, the new projections show higher emissions under the with existing domestic measures scenario in 2010. These increases are only partially offset by Italy, for which the new projections are lower.

([27]) The projections exclude emissions and removals from land-use change and forestry and use of the Kyoto mechanisms.

Figure 51 Relative gap (over-delivery or shortfall) between with additional domestic measures projections and targets for 2010 for EU-15 and Member States



Note: Germany's projections are preliminary results from an ongoing study provided in June 2003 (German Environmental Agency, 2003).

3.1.3. With additional domestic measures projections

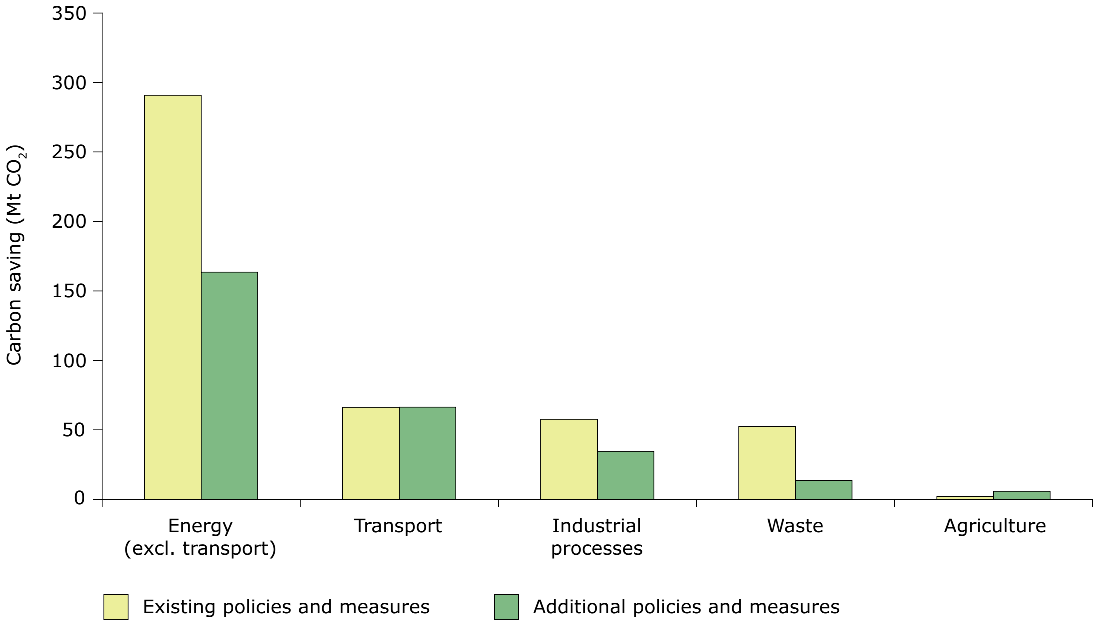
In 3.1.2, with existing domestic measures projections for the Member States are presented that indicate that in 2010, on the basis of implemented policies and measures, there will be an aggregate shortfall of 7.5 % between the projected level of greenhouse gas emissions and the EU's Kyoto commitment. Most Member States have also reported on planned (additional) policies and measures that they are developing to achieve further reductions in greenhouse gas emissions.

Figure 51 shows a comparison for each Member State of the relative gap between the with additional domestic measures projection and their Kyoto commitment. If all existing and additional domestic measures are taken into account, then the EU as a whole will deliver savings 0.8 % short of the Kyoto commitment. Under the with additional domestic measures projections, several other Member States are projected to exceed their targets (Finland, France, Greece and Ireland) in addition to those that have already exceeded their targets in the with existing domestic measures projection (Sweden and the United Kingdom). If all these Member States are assumed to meet, but not to exceed, their targets in the with additional domestic measures projections, then for the EU as a whole there would be a shortfall of 2.9 % from the target.

Finland, France, Greece and Ireland have identified savings from planned domestic measures that meet or almost meet the shortfall between the with existing domestic measures projection and their commitments.

For Austria, Belgium, Denmark, the Netherlands and Spain, the savings identified from planned domestic policies and measures are not sufficient

Figure 52 EU-15 projected greenhouse gas savings by sector in 2010



to achieve their burden sharing targets and these countries have indicated they will use the Kyoto mechanisms to help them meet their targets

Luxembourg and Portugal have yet to quantify the savings from any planned domestic policies and measures that they are considering. Portugal has indicated its intention of using the Kyoto mechanisms.

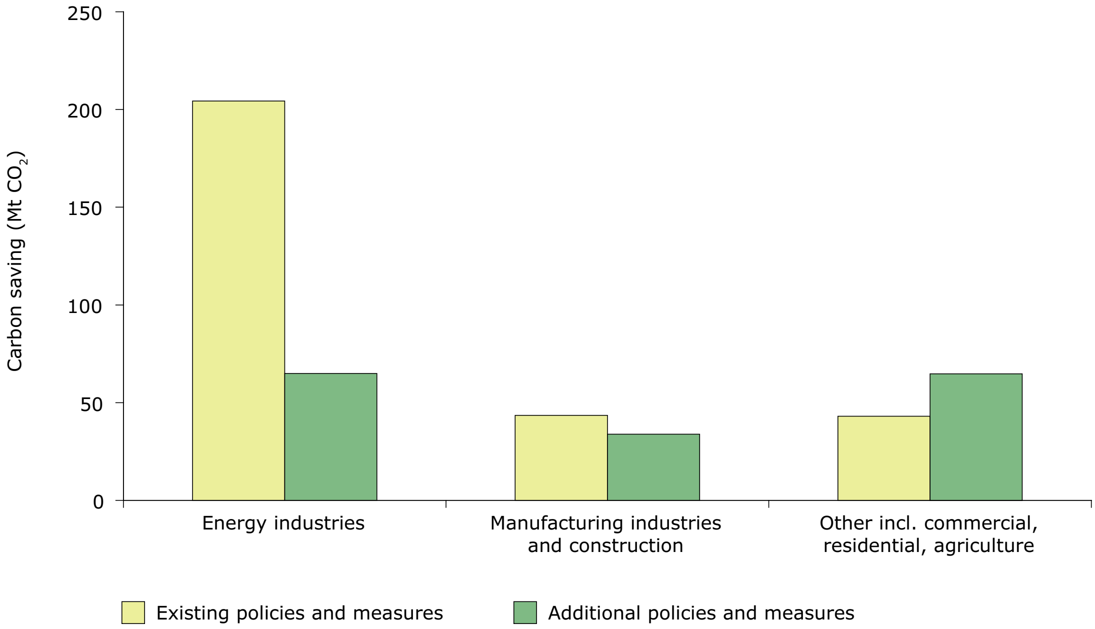
3.1.4. *Savings from implemented and planned polices and measures*

Figure 52 provides an overview of the estimated effects of national policies and measures on total EU greenhouse gas emissions in each of the main sectors. The projected savings are shown for implemented domestic measures (those included in the with existing domestic measures projection) and planned domestic policies and measures (those in the with additional domestic measures projection). All Member States provided sectoral breakdowns for at least one of the projections except for Portugal and Spain. Not all Member States quantified the savings from all policies and measures; eight Member States have provided information on the savings from at least some implemented policies and measures and 10 Member States report quantified savings from planned policies and measures.

Policies and measures in the energy sector (all energy-related emissions except transport) account for 62 % of the total savings from implemented domestic measures and 58 % of the planned domestic measures savings for the EU as a whole. The high contribution of this sector is because the majority of both implemented and planned policies and measures are targeted at moving to cleaner and more efficient energy production or making energy use more efficient. Transport measures are expected to deliver the second highest savings, followed by the effect of measures on industrial processes. As transport is the most rapidly growing source of greenhouse gases, the measures implemented and planned by Member States only go a small way to addressing this, providing 14 and 23 % of the total savings from implemented and planned policies and measures respectively. Finally, savings from measures in the waste and agriculture sectors are expected to be small over the period in question.

Figure 53 provides a breakdown of projected greenhouse gas savings in the energy sector. Savings from policies

Figure 53 A breakdown of projected greenhouse gas emission savings in the energy sector



and measures acting on energy supply are the most significant, accounting for 70 and 40 % of savings in the energy sector from implemented and planned measures respectively, with countries such as Germany and Italy continuing to move to cleaner fuels. Policies and measures applied to the end-use sectors of manufacturing and to commercial, residential and agriculture energy use also make significant contributions to savings in the energy sector. This possibly reflects the fact that in the EU as a whole there are many zero or low cost options for improvements in energy efficiency that can make industry and commerce more competitive. These are stimulated by economic instruments and voluntary agreements.

3.1.5. Key policies and measures for the European Union

An analysis of Member States' policies and measures identified six broad areas of policy intervention that are both widespread and projected to deliver substantial greenhouse gas emissions reductions. In the energy supply and use sectors, these were the use of renewable energy, CHP, energy-efficient appliances and building standards; in transport, the EU-wide ACEA agreement; and for the waste sector, the landfill directive. This section examines the contribution of these key policies and measures to greenhouse emissions reductions across the EU.

All Member States have provided at least some information on the six policies and measures except for Luxembourg, Belgium and Finland, where savings are not allocated to policies in the information supplied. The savings shown in Table 15 are savings allocated to policies. Eleven Member States provided savings covering these policies for the with existing domestic measures projections and eight Member States covered the key policies in the with additional domestic measures projections. A range of different policies and measures provide the rest of the savings in Member States.

Table 15 lists the emissions savings from the key policies in the with existing domestic measures projections: renewable energy policies generate the most carbon savings, by a significant margin, with renewable energy policies being particularly successful for Spain. The landfill directive has the next largest impact, though the majority of the savings can be attributed to Germany, France and Ireland.

Table 15 Greenhouse gas savings from the six key policies for the with existing domestic measures projections (Mt CO_2 equivalent)

Member State	Renewable energy	CHP	Energy-efficient appliances	Building standards	ACEA agreement	Landfill directive
Austria	1.2	0.0	0.0	0.5	0.5	0.0
Belgium (1)						
Denmark	3.0	0.6	0.0	0.0	0.0	0.0
Finland (1)						
France	0.9	3.7	0.0	1.5	0.0	12.2
Germany	22.3	23.0	8.0	20.0	11.0	31.0
Greece	3.1	0.0	0.0	0.0	0.4	5.9
Ireland	0.0	0.0	0.0	0.0	0.0	0.0
Italy	6.1	0.0	0.0	5.7	6.8	0.0
Luxembourg (1)						
Netherlands	2.0	0.5	0.8	0.0	1.2	0.0
Portugal	5.2	0.0	0.0	0.0	0.0	0.0
Spain	30.1	0.0	0.0	0.0	0.0	0.0
Sweden	1.0	0.0	0.0	0.0	0.0	0.0
United Kingdom	14.7	0.0	0.0	0.0	0.0	1.1
EU-15	**89.6**	**27.8**	**8.8**	**27.7**	**19.9**	**50.2**

(1) Country greenhouse gas savings are not split by policy.

Table 16 Greenhouse gas savings from the six key policies and measures in the with additional domestic measures projections

Member State	Renewable energy	CHP	Energy-efficient appliances	Building standards	ACEA agreement	Landfill directive
Austria	1.7	0.5	0.0	0.2	0.0	0.0
Belgium (1)						
Denmark	0.0	0.0	0.0	0.0	0.0	0.0
Finland (1)						
France	4.6	0.0	0.0	0.0	0.0	0.0
Germany	0.0	0.0	0.0	0.0	0.0	0.0
Greece	6.4	0.0	2.3	0.0	0.0	0.0
Ireland	1.0	0.3	0.0	0.9	0.8	0.9
Italy	9.1	1.2	0.0	0.0	0.0	0.0
Luxembourg (1)						
Netherlands	0.2	0.0	0.0	0.0	0.0	1.0
Portugal	0.0	0.7	0.0	0.0	0.4	0.0
Spain	0.0	0.0	0.0	0.0	0.0	0.0
Sweden	0.0	0.0	0.0	0.0	0.0	0.0
United Kingdom	0.0	3.3	1.1	5.5	14.7	0.0
EU-15	**22.9**	**5.9**	**3.4**	**6.6**	**15.8**	**1.9**

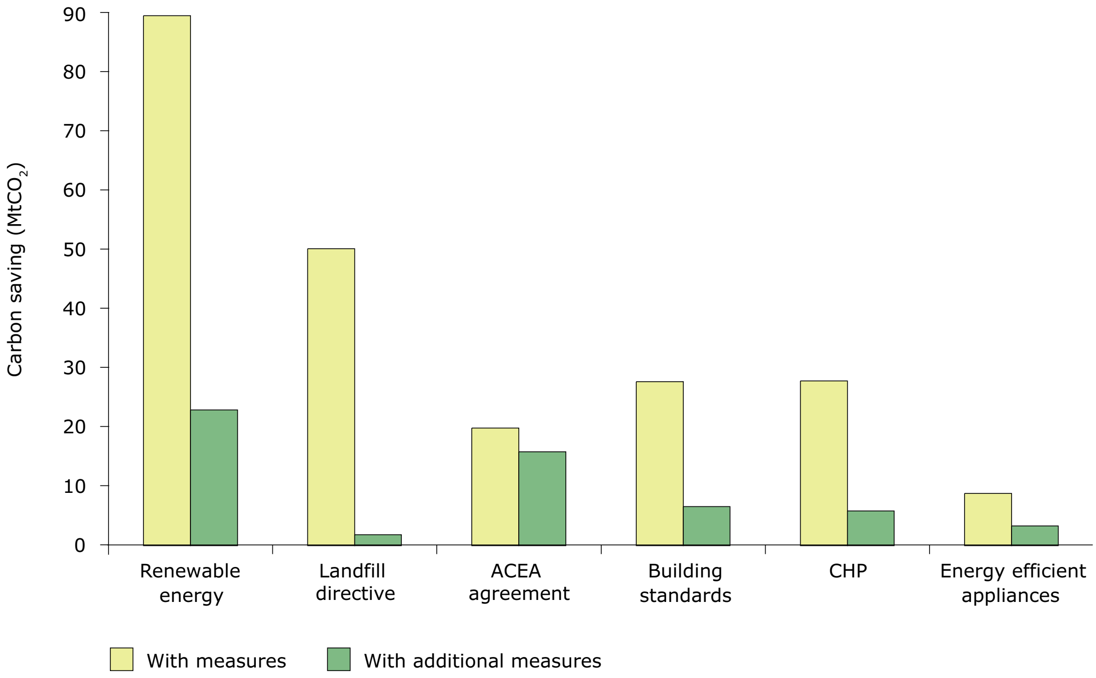
(1) Country greenhouse gas savings are neither split by policy nor quantified.

Note: The reported effects of single quantified measures are not necessarily the sum of the projections for the total effect of all reported measures. Therefore, the amounts for additional domestic measures in Table 16 are not the difference between the with existing domestic measures projections and the with additional domestic measures projection. For this reason, also hypothetical without measures projections cannot be derived from the information in Table 15.

Table 16 shows that out of the six policies, renewable energy has the highest impact for the additional domestic measures projections, as was the case for implemented policies, with Italy making the greatest contribution to savings. The ACEA agreement has a significant role in generating savings in planned policies, with the United Kingdom providing the majority of the savings for this policy.

Figure 54 shows the overall savings from each of the key policies (both implemented and planned). In total these six key policies are expected to

Figure 54 Aggregated savings for the six key policies in the with existing domestic measures and with additional domestic measures scenarios



deliver savings of about 165 Mt CO_2. They are therefore very important in helping the EU to achieve its emission commitments. Renewable energy policies show the largest savings (90 Mt CO_2). The ACEA agreement and landfill directive, which are both specific common or coordinated policies are also expected to make a significant contribution to carbon reductions (25 Mt CO_2 and 21 Mt CO_2 respectively).

3.2. Sectoral assessment of projections and policies and measures in the EU

Figure 55 shows the total greenhouse gas emissions projections for the whole energy sector, including transport, from Member States and the European Union ([28]). Not all Member States have provided with additional domestic measures projections, therefore, in this figure and those which follow, only the aggregate with existing domestic measures projection is presented for the EU ([29]). Emissions from the energy sector in the EU are projected to increase by 12 % compared with 1990. Except for the United Kingdom and Luxembourg, the with existing domestic measures projections of all countries show increased emissions compared with 1990. Additional domestic measures reduce this to below the 1990 level for Italy and Austria.

Some Member States give separate projections for transport, allowing projections for the energy sector excluding transport to be calculated as shown in Figure 56. The aggregate projection for the EU includes only those Member States that gave a separate transport projection and so is not strictly comparable with the aggregate projection in Figure 55.

The with existing domestic measures projections of energy (including transport) are compared with the assumptions in the projections regarding GDP in Figure 57. For all Member

([28]) Disaggregated data for Germany and Portugal were not available at the date this report was prepared (July 2003).
([29]) The aggregate total is based on only those MS providing disaggregated data and therefore represents the trends for only part of the EU.

Figure 55 Member States' projections for emissions in 2010 from the energy sector (1990 = 100)

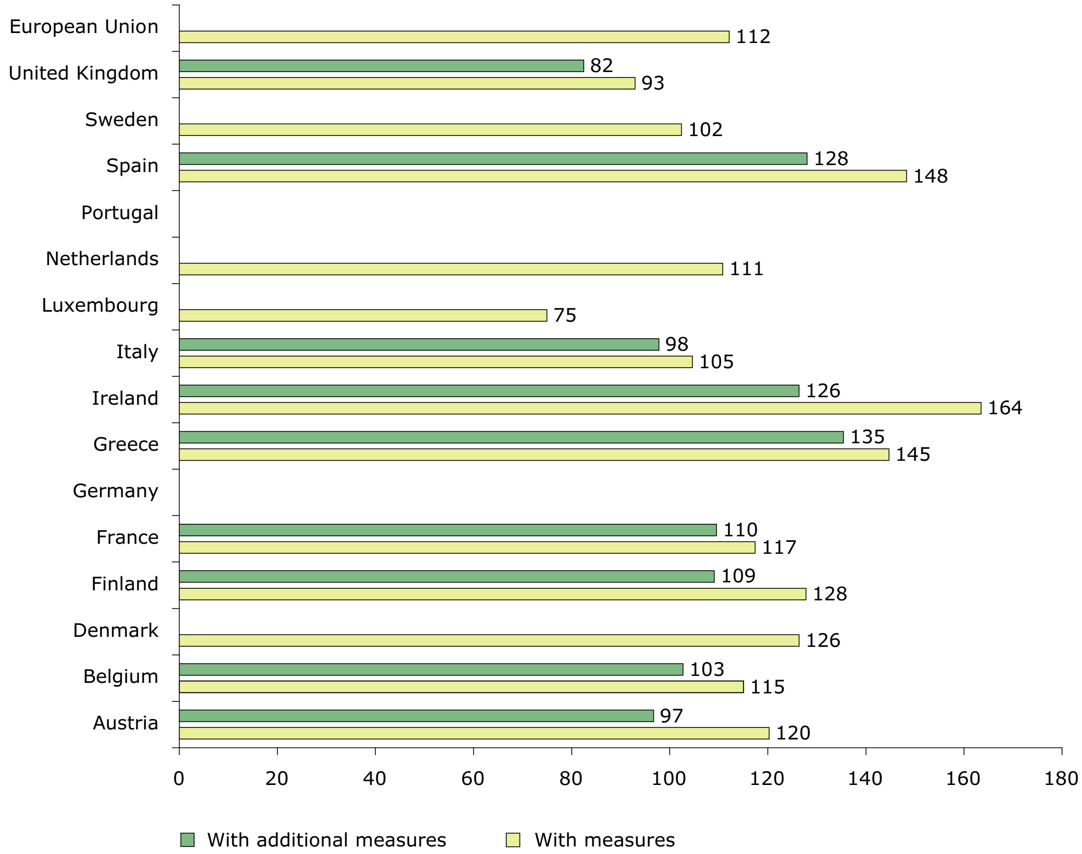


Figure 56 Member States' projections for emissions in 2010 from the energy sector excluding transport (1990 = 100)

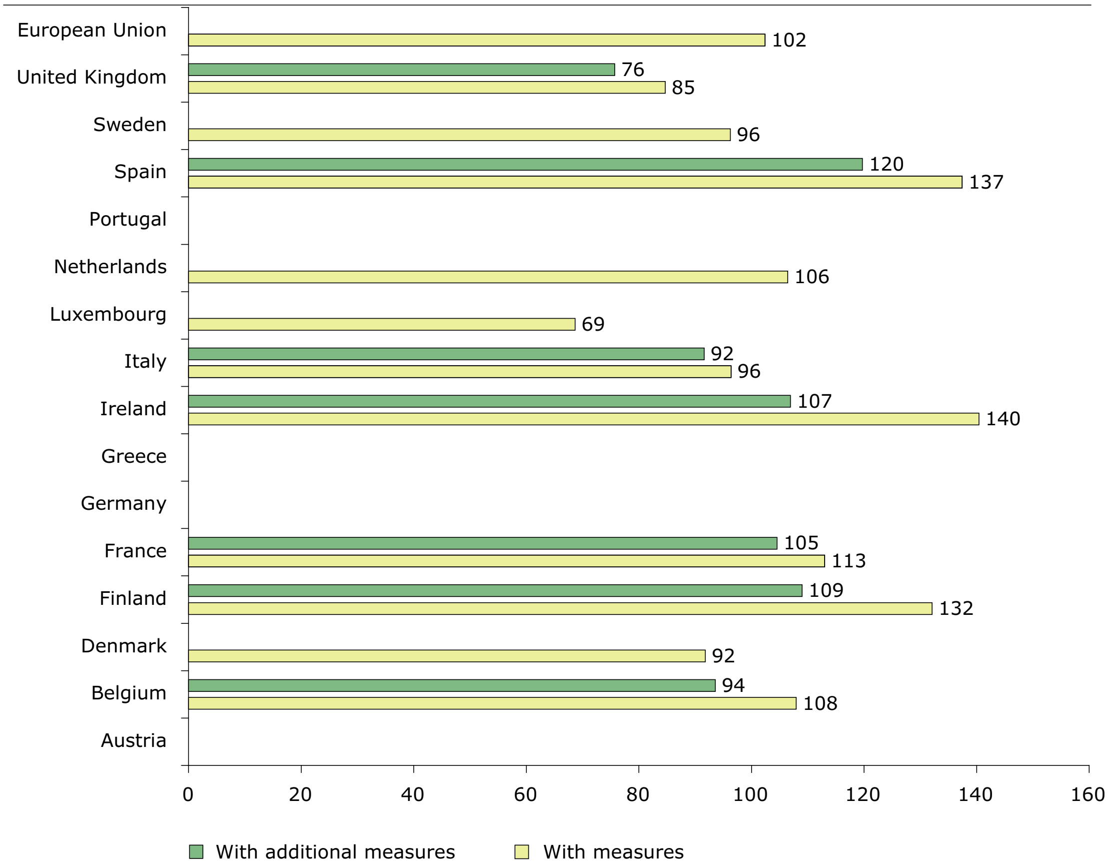
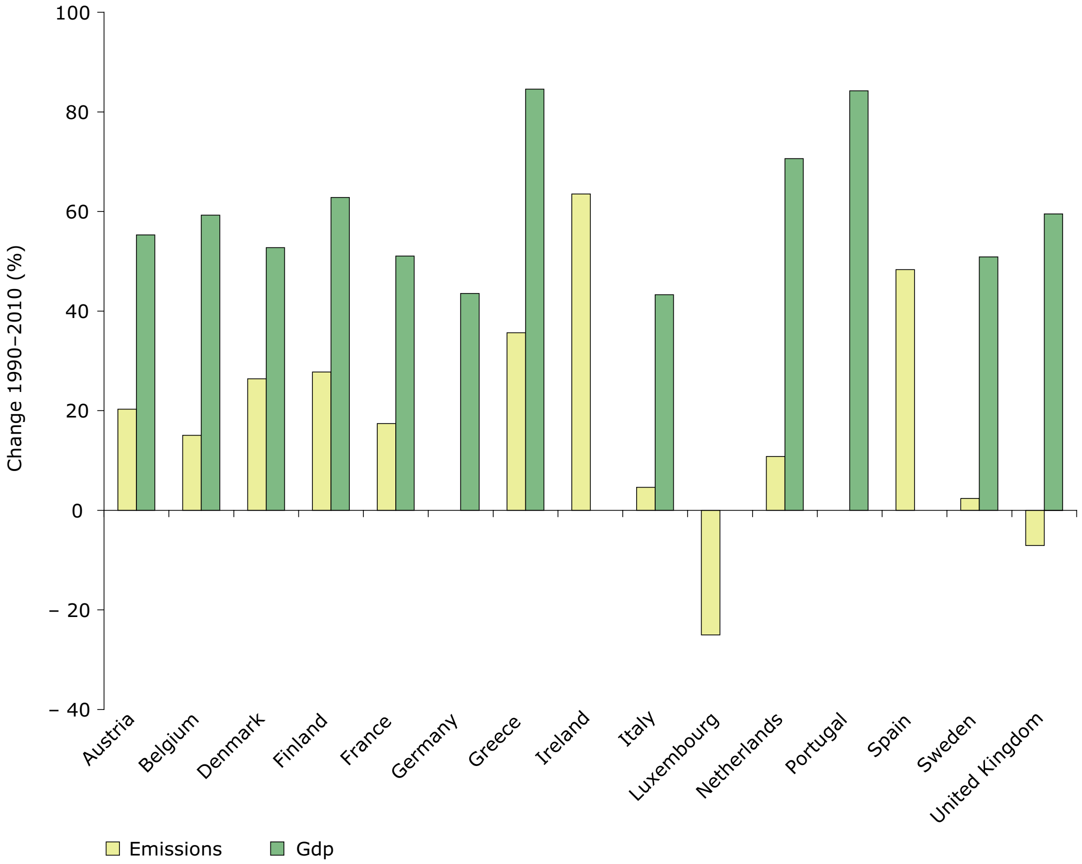


Figure 57 Trends in energy-related emissions and GDP



States where the data are available, the projected increase in total energy-related emissions is well below the GDP growth over the period. Luxembourg and the United Kingdom project decreases in energy-related emissions even though GDP increases. For the United Kingdom, this relates in part to decreasing carbon intensity in the electricity supply industry in the 1990s.

3.2.1. Transport

Eleven Member States have reported separate emissions projections for the transport sector and all projected increased emissions in 2010 compared with 1990 (Figure 58). On aggregate, EU transport emissions are projected to increase by 34 % compared with 1990 in the with existing domestic measures projections. Ireland, Luxembourg, Spain and Belgium project the strongest growth, with Ireland expecting that emissions will more than double by 2010. Ireland, Italy, Spain and the United Kingdom expect that additional domestic measures will significantly reduce the projected growth in emissions. For the other Member States, any additional domestic measures are more limited in their effect.

The assumptions made on growth rates in the transport sector that underlie the emissions projections are only available for a few Member States (Figure 59 and Figure 60). For those Member States where both the projections and growth rates are available, the with existing domestic measures projections are largely in line with the growth rate assumed for passenger transport. The with existing domestic measures projection for Sweden is for a growth in emissions that is significantly less than the increase in transport (13 % compared with 25 %). A number of measures are in place to decrease energy or emissions intensity of road transport in Sweden, including promotion of economical driving and more environment-compatible cars. The projected trends suggest that these measures are assumed to be effective. The historical growth between 1990 and 1999 is also

Figure 58 **Member States' projections for emissions in 2010 from the transport sector (1990 = 100)**

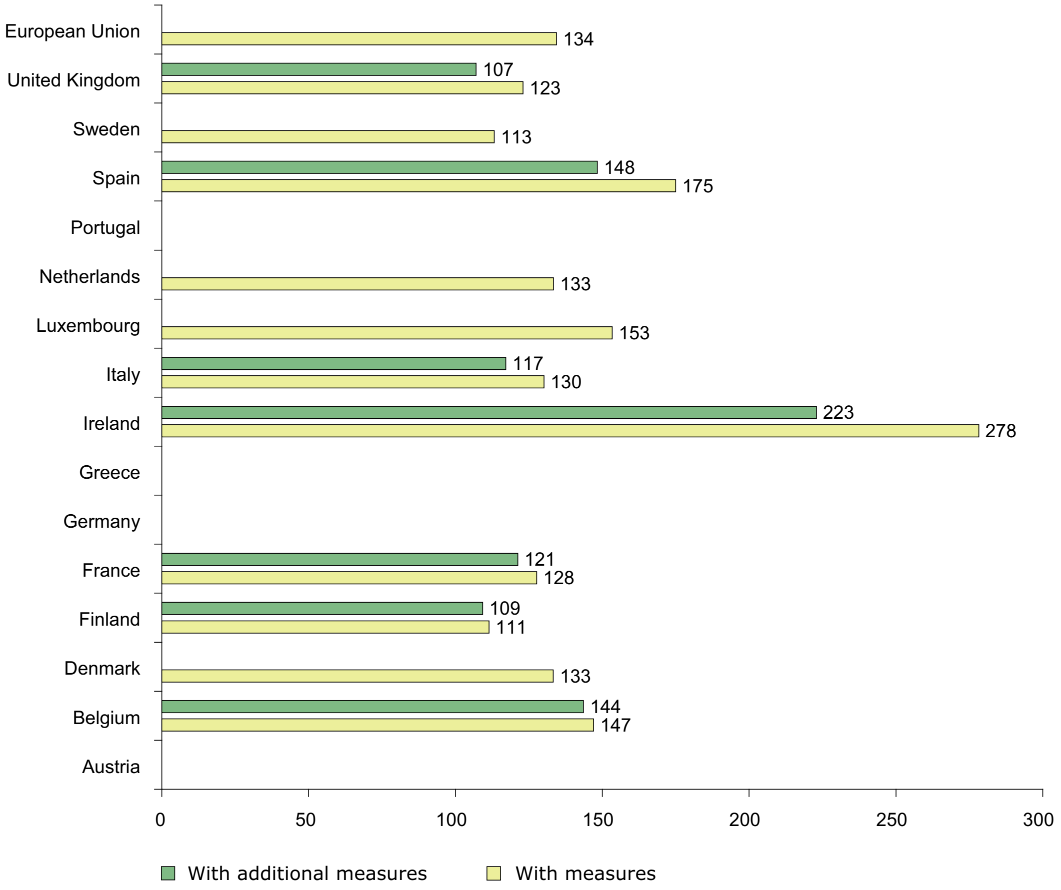


Figure 59 **Assumptions regarding growth in passenger transport (passenger km except number of passenger cars for Austria and Ireland) and actual growth, 1990–99**

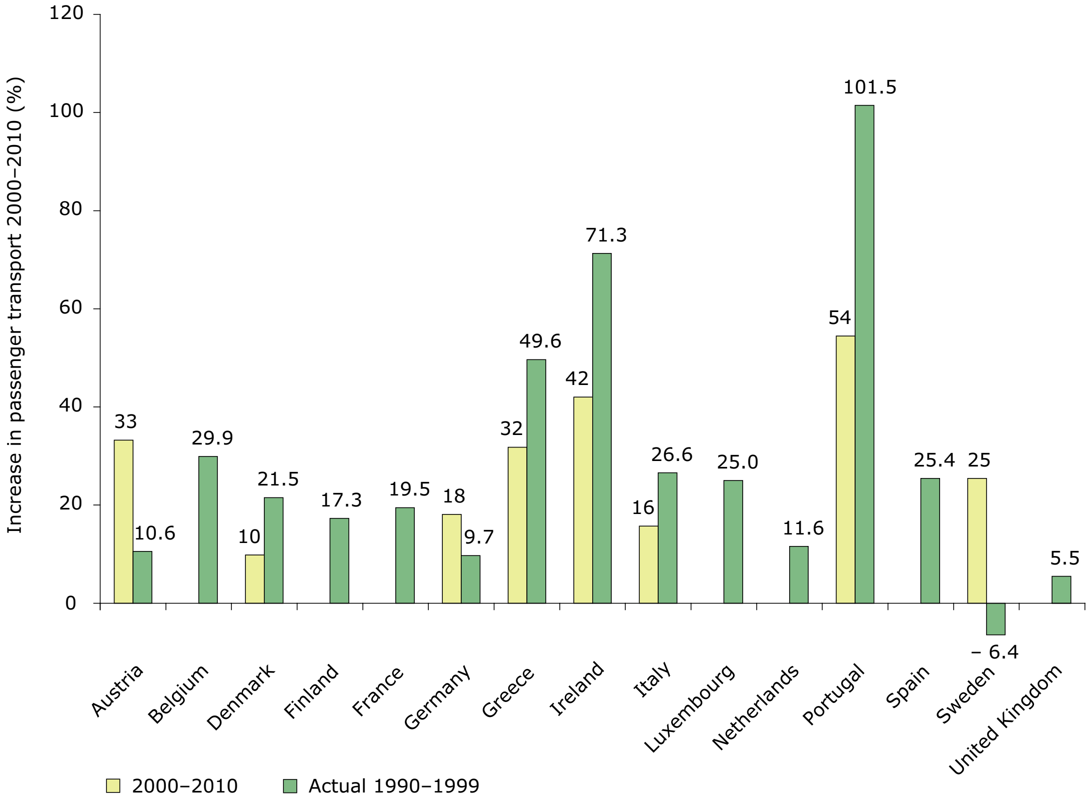
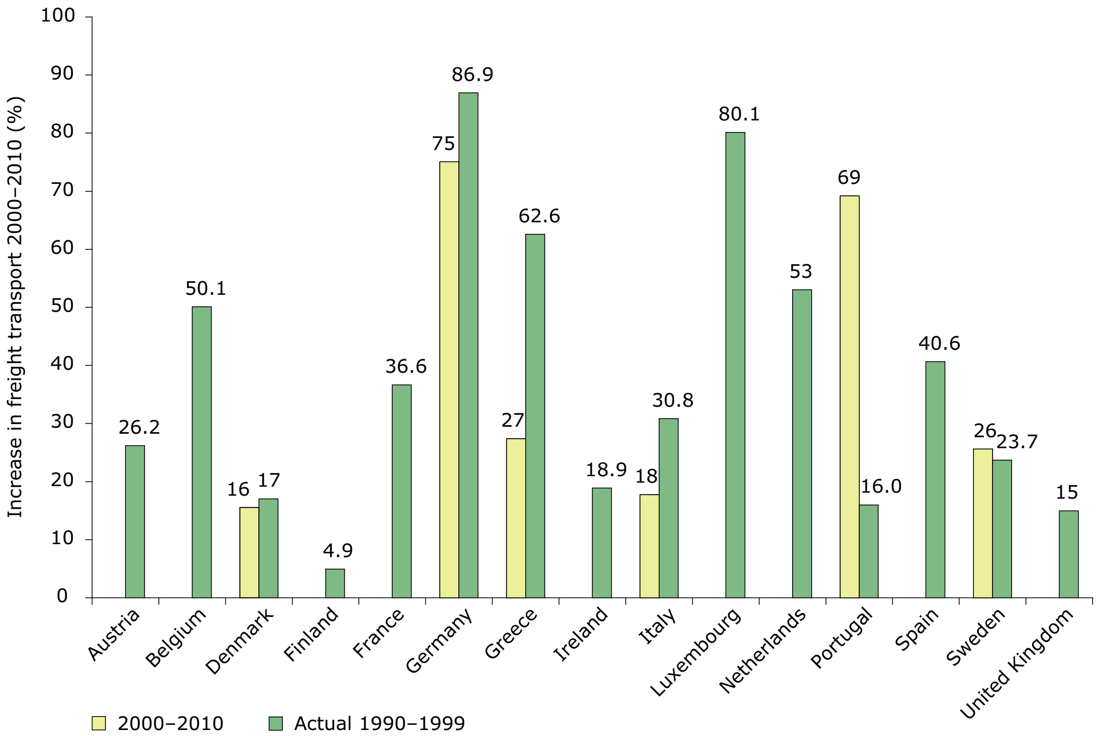


Figure 60 Assumptions regarding growth in freight transport (tonnes km) and actual growth, 1990–99



shown in Figure 59. For most countries the historical growth over the last 10 years has been faster than the rate assumed for 2000 to 2010, although in Sweden there has been a decrease in the period 1990–99. For freight transport, Portugal projects a much more rapid increase over the period from 2000 to 2010 than has been seen in the past.

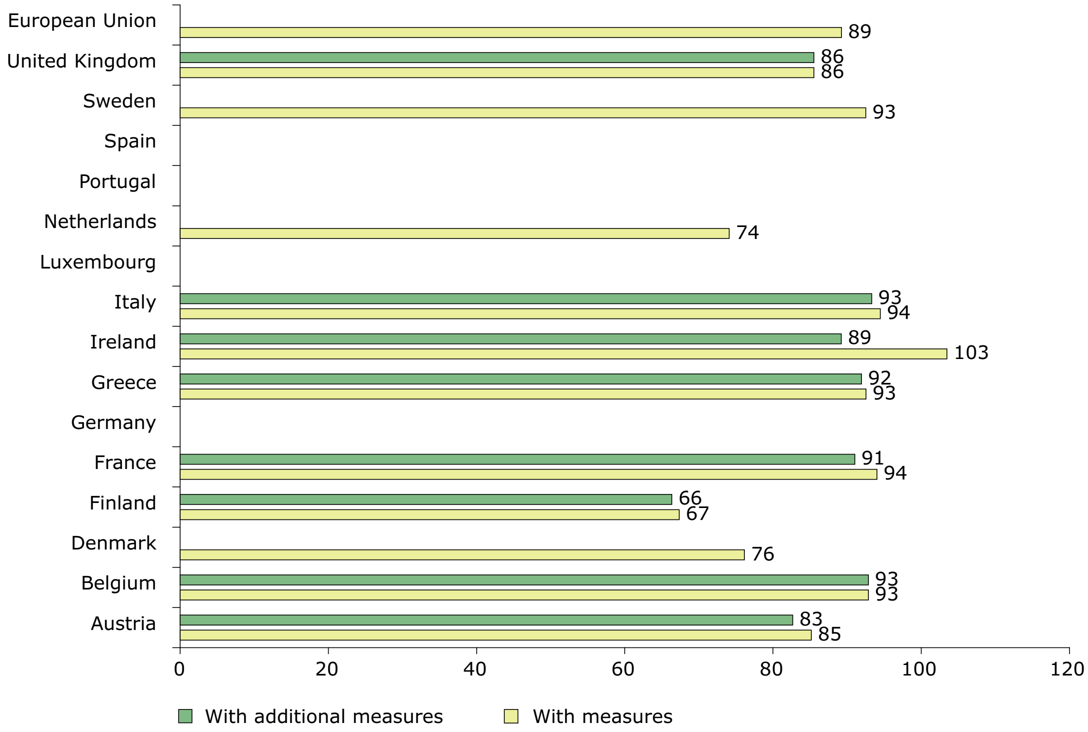
3.2.2. Agriculture

Figure 61 shows emissions projections for the agricultural sector. For most Member States, emissions are expected to decrease compared with 1990 in both the with existing domestic measures and with additional domestic measures projections. For the EU as a whole, the aggregate with existing domestic measures projection shows an 11 % decrease in 2010 compared with 1990. Very few Member States have significant additional domestic measures in the agriculture sector. In Ireland, emissions are projected to increase in the with existing domestic measures projection and additional domestic measures are identified to reduce this increase. Few Member States provide information on the drivers for the agricultural sector. Factors such as decreases in fertiliser use and increases in the productivity of cattle will contribute to decreasing emissions.

3.2.3. Industrial processes

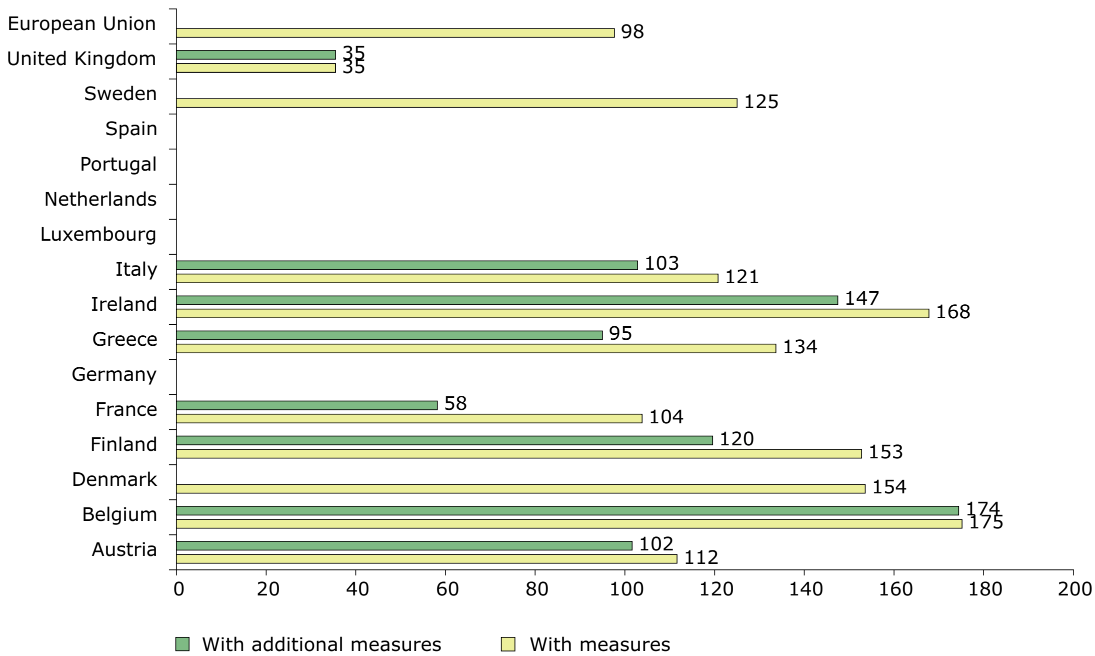
Member State projections from industrial processes are shown in Figure 62. These emissions include, for example, CO_2 from cement manufacture, nitrous oxide from adipic and nitric acid production and HFCs from HCFC-22 manufacture. The projected trends are quite different in different Member States because of the variety of sources. In the United Kingdom, emissions are projected to decrease by 65 % in the with existing domestic measures projections due to improved abatement in the manufacture of adipic acid and other industries. France has already decreased by 60 % its emissions of nitrous oxide from the industrial process between 1990 and 1999, by imposing strong regulations on the industry, and projects additional reductions with additional domestic measures. Most other Member States project increases compared

Figure 61 Member States' projections for emissions in 2010 from the agricultural sector (1990 = 100)



Note: Where a with additional domestic measures projection is shown equal to the with existing domestic measures projection, the MS has provided the data but there are no additional domestic measures in that sector. Where there is no additional domestic measures projection shown, the MS has not provided disaggregated data for this projection.

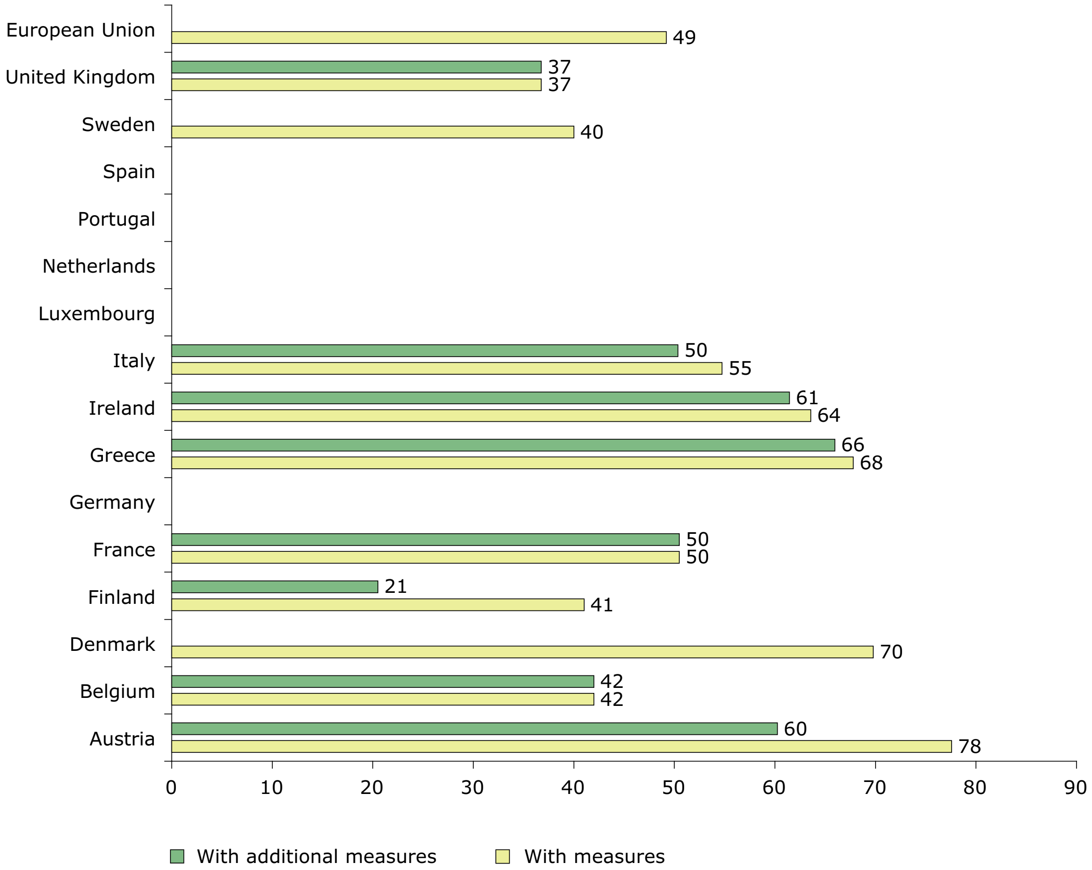
Figure 62 Member States' projections for emissions in 2010 from the industrial process (1990–95 = 100) (1)



(1) 1995 has been chosen as the base year for fluorinated gases for all Member States in this analysis, even though France has indicated that it is likely to use 1990.

Note: Where a with additional domestic measures projection is shown equal to the with existing domestic measures projection, the MS has provided the data but there are no additional domestic measures in that sector. Where there is no additional domestic measures projection shown, the MS has not provided disaggregated data for this projection.

Figure 63 Member States' projections for emissions in 2010 from the waste sector (1990 = 100)



Note: Where a with additional domestic measures projection is shown equal to the with existing domestic measures projection, the MS has provided the data but there are no additional domestic measures in that sector. Where there is no additional domestic measures projection shown, the MS has not provided disaggregated data for this projection.

with 1990 as growth in some of these industrial sectors is strongly linked to GDP.

3.2.4. Waste

The with existing domestic measures projections for the waste sector from Member States (Figure 63) are generally for a significant decrease compared with 1990 and this leads to an aggregate projected decrease for the EU of 51 %. The decrease in emissions for the other Member States largely arises from the implementation of the landfill directive, which limits the amount of biodegradable waste disposed to landfills and implements controls and landfill gas recovery. National measures have also been introduced in some countries, for example Germany. Only a few Member States have reported the assumptions made in the waste sector regarding tonnes of waste disposed to landfill.

3.2.5. Domestic policies and measures by type

Table 17 to Table ***21*** show the types of domestic policy or measure being used by Member States in each of the five main sectors. Across all Member States and all sectors, regulatory and fiscal policies and measures are the most popular and are predicted to generate the largest proportion of greenhouse gas emissions reductions. Education, research and information are used very little apart from in the transport sector where education and information are significant.

Table 17 shows that fiscal and regulatory policies are projected to have the greatest impact on emissions in the

Table 17 Type of policies and measures applied to the energy sector (30)

	Economic		Fiscal		Voluntary/ negotiated		Regulatory		Inform-ation		Education		Research		Other	
	Imp	Add	Imp	Add	Imp	Add	Imp	Add	Imp	Add	Imp	Add	Imp	Add	Imp	Add
Austria	✓✓	✓	✓		✓	✓✓	✓✓	✓	✓✓✓	✓✓	✓					
Belgium	✓✓✓	✓✓	✓✓✓	✓	✓✓✓	✓✓	✓✓	✓✓✓	✓		✓✓✓					
Denmark	✓✓✓		✓✓		✓		✓✓✓		✓				✓		✓	
Finland	✓✓✓	✓	✓✓	✓✓	✓✓		✓✓	✓✓	✓	✓✓	✓	✓✓				✓
France	✓✓✓	✓	✓	✓	✓	✓✓	✓✓	✓			✓	✓			✓	✓
Germany	✓✓✓		✓✓✓		✓✓✓		✓✓✓				✓✓✓					
Greece	✓✓✓	✓✓					✓	✓✓	✓							
Ireland		✓		✓		✓		✓								✓✓✓
Italy	✓	✓		✓		✓✓✓	✓	✓		✓		✓				✓✓✓
Luxembourg		✓	✓✓✓	✓✓	✓	✓	✓✓	✓								
Netherlands	✓✓		✓✓✓		✓✓✓		✓✓✓								✓✓	
Portugal	✓✓✓		✓				✓✓✓						✓			
Spain	✓✓✓	✓	✓✓✓				✓✓✓	✓				✓			✓✓✓	✓✓✓
Sweden	✓✓✓		✓✓✓			✓	✓	✓	✓✓				✓		✓	
UK		✓	✓	✓✓✓		✓	✓✓✓	✓✓✓								

Note: Imp — implemented policies and measures, Add — additional policies and measures.

Table 18 Type of policies and measures applied to the transport sector (30)

	Economic		Fiscal		Voluntary/ negotiated		Regulatory		Inform-ation		Education		Research		Other	
	Imp	Add	Imp	Add	Imp	Add	Imp	Add	Imp	Add	Imp	Add	Imp	Add	Imp	Add
Austria			✓	✓	✓		✓	✓	✓✓	✓	✓	✓	✓			
Belgium			✓	✓✓✓	✓✓	✓		✓			✓✓✓	✓			✓✓✓	✓✓
Denmark				✓			✓		✓	✓						
Finland	✓✓	✓✓	✓	✓	✓✓	✓	✓		✓✓✓	✓✓	✓✓	✓✓				
France	✓	✓	✓	✓	✓	✓	✓✓	✓			✓	✓			✓✓	✓
Germany	✓✓✓	✓	✓						✓							
Greece		✓			✓		✓	✓								
Ireland				✓		✓		✓				✓				
Italy		✓		✓		✓✓		✓		✓						✓
Luxembourg				✓												✓
Netherlands			✓		✓✓		✓				✓				✓	
Portugal																
Spain	✓		✓		✓		✓	✓	✓		✓					
Sweden					✓								✓		✓✓	
UK			✓	✓		✓✓										

energy sector (excluding transport). Economic instruments and voluntary agreements are also used to significant effect. Research, education and information are predicted to have a low impact on future emissions in the energy sector.

The most favoured and effective methods to change behaviour in the transport sector are through voluntary agreements and fiscal incentives, subsidies and taxes. The results in Table 18 indicate that these measures will have a significant impact on transport emissions. In contrast to the energy sector, Member States have given economic and regulatory transport policies the same significance as information and education policies.

There are far fewer policies for agriculture than for energy and transport and the overall greenhouse gas savings

(30) For most Member States, the number of ticks in the table relates to the magnitude of the contribution of the policy instrument to the country's total carbon saving. For example, for the Netherlands, policies instruments saving < 1 Mt CO_2 receive one tick, 1–2 Mt CO_2 receive two ticks and > 2 Mt CO_2 receive three ticks. The size of these bands varies between countries depending on the magnitude of savings. For countries that only provide qualitative details of policies (indicated by italics), the number of policies of each type is scored. For example, Belgium has two implemented regulatory policies for energy and thus has two ticks. Portugal has not provided information on the types of policy instruments used.

Table 19 Type of policies and measures applied to the agriculture sector (30)

	Economic		Fiscal		Voluntary/ negotiated		Regulatory		Inform- ation		Education		Research		Other	
	Imp	Add	Imp	Add	Imp	Add	Imp	Add	Imp	Add	Imp	Add	Imp	Add	Imp	Add
Austria			✓				✓	✓	✓	✓			✓	✓		
Belgium			✓ ✓ ✓	✓ ✓ ✓		✓	✓	✓ ✓ ✓				✓ ✓ ✓	✓			
Denmark			✓				✓									
Finland	✓						✓									
France	✓	✓	✓				✓								✓	
Germany							✓									
Greece		✓						✓								
Ireland				✓ ✓				✓ ✓						✓		
Italy			✓	✓				✓								✓
Luxembourg																
Netherlands	✓		✓		✓ ✓		✓ ✓								✓ ✓	
Portugal																
Spain		✓ ✓ ✓				✓ ✓		✓ ✓ ✓				✓				✓
Sweden	✓						✓								✓	
UK				✓												

Table 20 Type of policies and measures applied to the waste sector (30)

	Economic		Fiscal		Voluntary/ negotiated		Regulatory		Inform- ation		Education		Research		Other	
	Imp	Add	Imp	Add	Imp	Add	Imp	Add	Imp	Add	Imp	Add	Imp	Add	Imp	Add
Austria	✓	✓	✓		✓	✓	✓	✓ ✓	✓	✓	✓	✓	✓	✓		
Belgium						✓	✓ ✓ ✓	✓ ✓			✓				✓	
Denmark			✓				✓									
Finland			✓	✓ ✓ ✓			✓ ✓	✓ ✓ ✓								
France							✓ ✓	✓								
Germany		✓					✓ ✓ ✓	✓								
Greece		✓					✓ ✓	✓								
Ireland				✓												
Italy			✓	✓		✓	✓	✓							✓	
Luxembourg																
Netherlands															✓	
Portugal							✓									
Spain		✓						✓								
Sweden			✓				✓ ✓ ✓									
UK			✓				✓									

to come from this sector will be small. Table 19 shows that Member States favour the use of regulatory policies, backed up by fiscal measures to control agricultural emissions. Voluntary agreements, education, information and research are rarely used. Spain is unique in that it predicts a high contribution to total country emission savings to come from agricultural policies, which include economic and regulatory measures. Five countries are using less than three types of agricultural policies and measures, including the United Kingdom, which only uses fiscal measures.

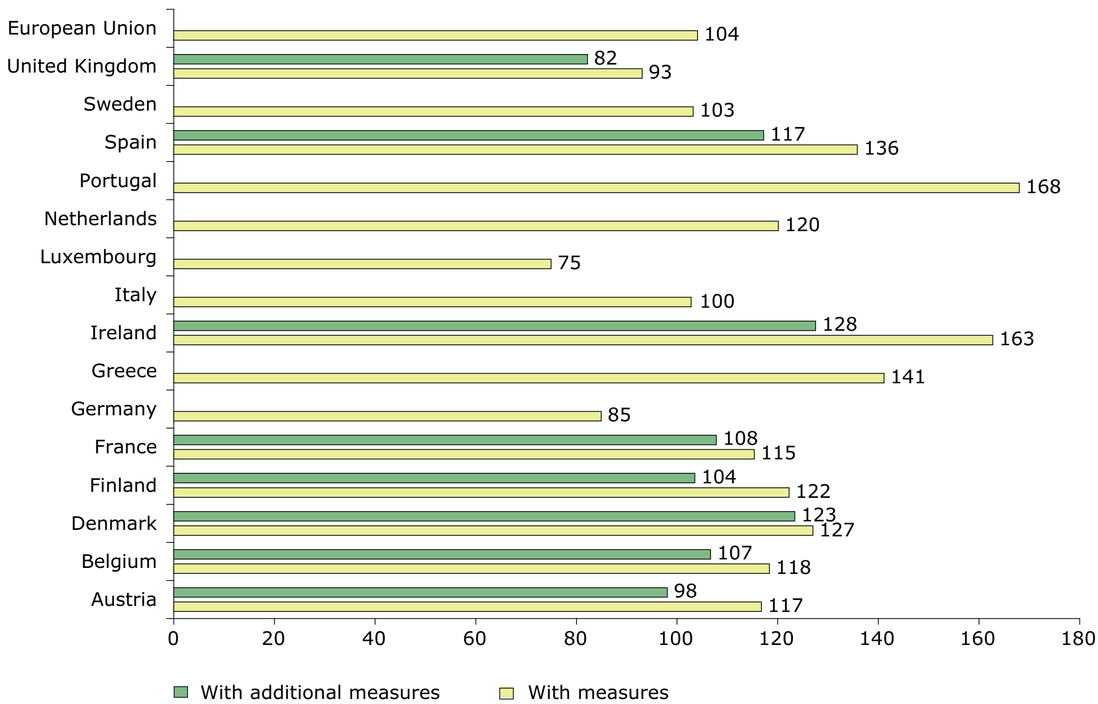
The waste sector policy instrument use follows a similar pattern to that in agriculture, with regulatory measures being the most commonly used instrument, followed by fiscal measures (Table 20). Other types of policy are rarely used, only Austria has taken advantage of a full suite of policy instruments to achieve its goals in this sector.

The results in Table 21 show that regulatory policies and measures are projected to have the largest impact on industrial process emissions. The Netherlands has a disproportionately high contribution from measures in this sector to total savings, they achieve this by using all four financial instruments. This sector has not been targeted at all

Table 21 Type of policies and measures applied to industrial processes ([30])

	Economic		Fiscal		Voluntary/ negotiated		Regulatory		Inform- ation		Education		Research		Other	
	Imp	Add	Imp	Add	Imp	Add	Imp	Add	Imp	Add	Imp	Add	Imp	Add	Imp	Add
Austria						✓	✓	✓						✓		
Belgium							✓	✓ ✓								
Denmark			✓				✓									
Finland																
France		✓	✓				✓ ✓ ✓	✓				✓		✓		✓
Germany		✓			✓ ✓ ✓	✓	✓	✓	✓	✓		✓				
Greece						✓		✓								
Ireland						✓										
Italy																
Luxembourg																
Netherlands	✓ ✓ ✓		✓ ✓ ✓		✓ ✓ ✓		✓ ✓ ✓								✓ ✓ ✓	
Portugal	✓						✓									
Spain		✓														✓
Sweden							✓									
UK																

Figure 64 Member States' projections for CO_2 (1990 = 100)



in several cases: four member States have no policies and measures in place specifically to target industrial processes.

3.2.6. Assessment of projections by gas

Carbon dioxide emissions

Member State projections for CO_2 emissions in 2010 are shown in Figure 64. Overall in the EU, CO_2 emissions are projected to increase by 4 % in the with existing domestic measures projection. The majority of Member States project an increase in CO_2 emissions in the with existing domestic measures projections. Only Luxembourg and the United Kingdom project decreased emissions compared with 1990. Greece, Ireland, the Netherlands, Portugal and Spain project significant increases in CO_2 emissions in the with existing domestic measures projections. In the with additional domestic measures projections more Member States project a decrease in emissions between 1990 and 2010. These projections are mainly driven

Figure 65 Member States' projections of methane emissions in 2010 (1990 = 100)

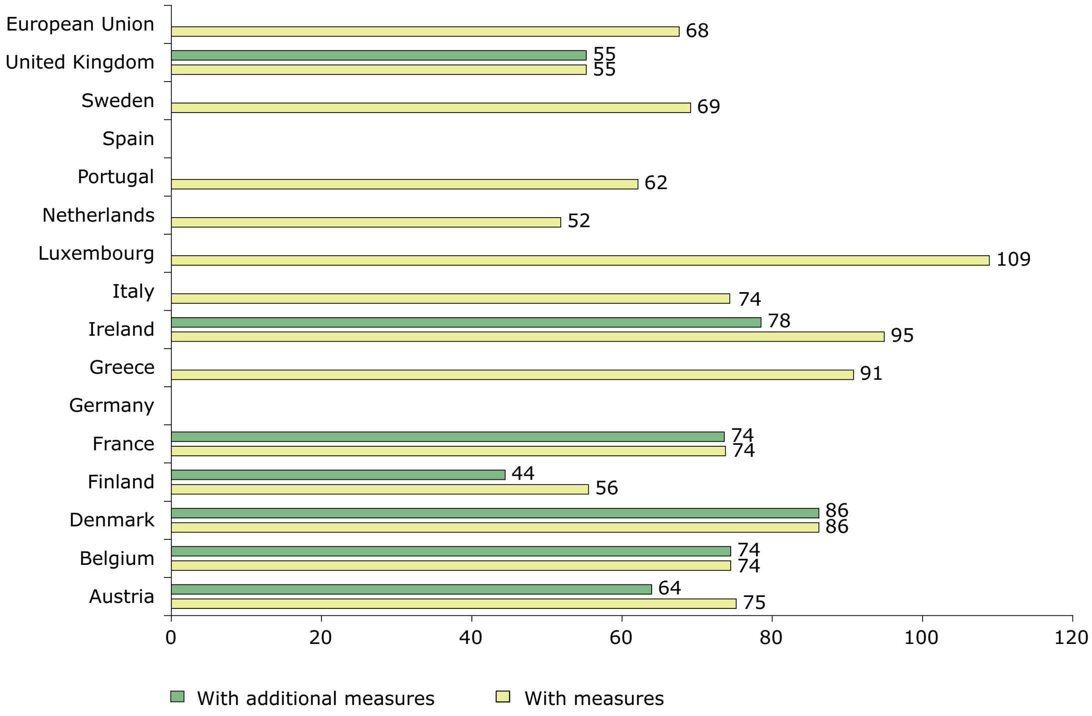
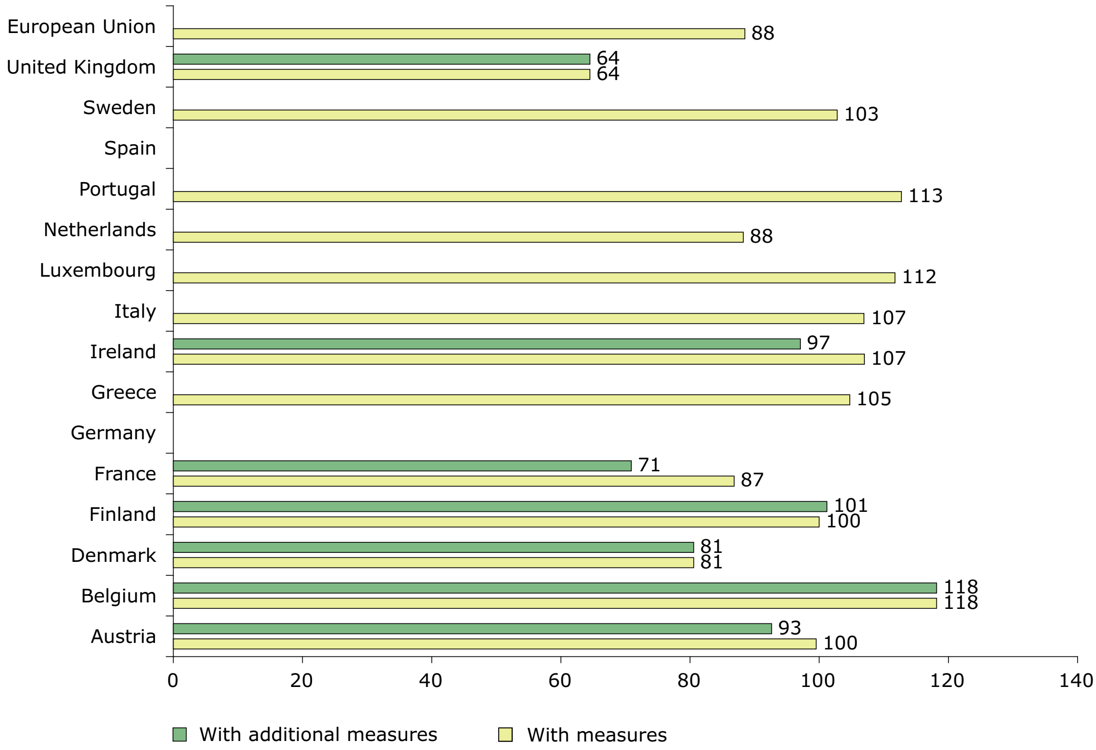


Figure 66 Member States' projections for nitrous oxide emissions in 2010 (1990 = 100)



by developments in the energy sector (supply and use).

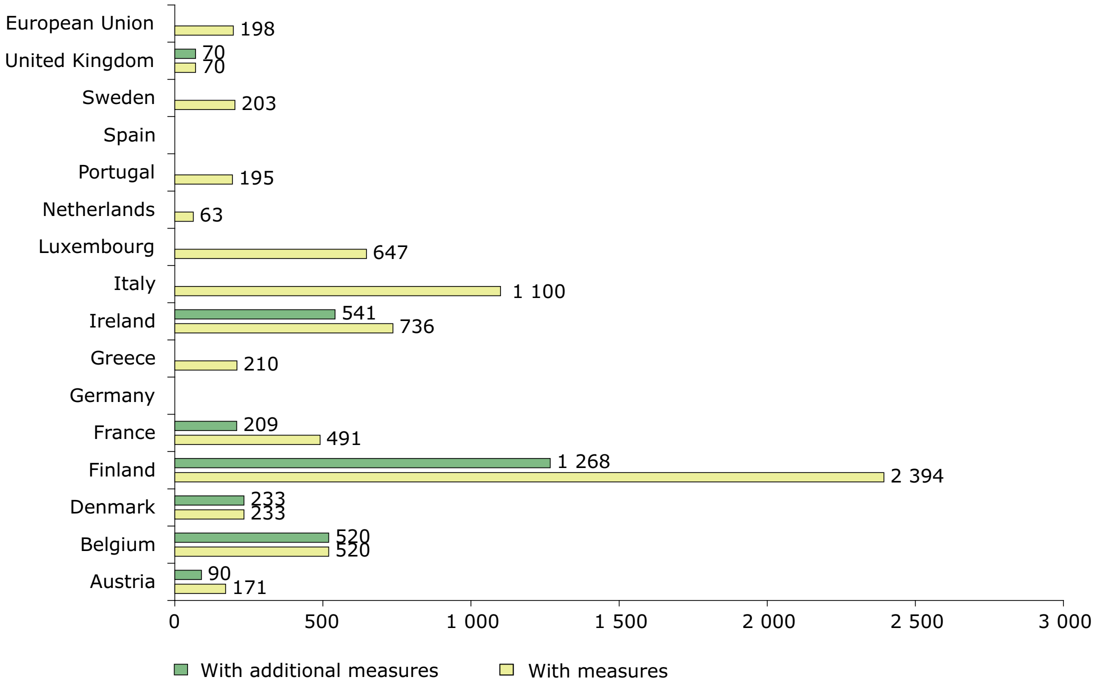
Methane emissions

Methane emissions arise predominantly from waste and agriculture and trends in these sectors determine the projections. Overall methane emissions are projected to decrease by around 32 % for the with existing domestic measures projections (Figure 65).

Most of this reduction arises from the implementation of the landfill directive and other national waste policies.

In contrast to other Member States, Portugal and Luxembourg project increased emissions.

Figure 67 Member States' projections of fluorinated gas emissions in 2010 (1995 = 100) (*)



(*) The base year chosen in this analysis is 1995 for fluorinated gases for all Member States, even though France has indicated that it is likely to use 1990.

Nitrous oxide

Nitrous oxide emissions arise mainly from industry and from agriculture. Emissions are projected to decrease in most Member States under both projections, leading to an EU-wide reduction of 12 % in the with existing domestic measures projection (Figure 66). This decrease is linked to reductions in the agricultural sector, particularly in France, and to abatement of emissions from adipic acid manufacture in some Member States. Emissions are projected to increase significantly compared with 1990 in the with existing domestic measures projections for Portugal, Luxembourg and Belgium.

Fluorinated gases

Overall, the EU projection for fluorinated gases (Figure 67) is for a 98 % increase compared with the base year of 1995. This reflects increased activity in this area mainly from the phasing out of ozone-depleting substances, but also due to other factors such as increased use of air conditioning. The United Kingdom has introduced measures to reduce certain process emissions of fluorinated gases and their with existing domestic measures projection is for a 30 % decrease compared with 1995. Most other Member States project an increase in emissions in the with existing domestic measures projections, but Austria and the Netherlands have additional domestic measures that bring the total to below the base-year level. France, Ireland and Finland also have additional domestic measures that reduce the emissions of fluorinated gases significantly.

3.3. Use of carbon sinks under the Kyoto Protocol by EU Member States

Introduction

In addition to reducing or limiting emissions of greenhouse gases, Member States can make use of CO_2 removals by land-use change and forestry activities, or 'carbon sinks' under the Kyoto Protocol to achieve their UNFCCC and EU 'burden sharing' targets.

Box 1: Carbon sinks under the Kyoto Protocol

The rules about how carbon sinks are accounted for under the Kyoto Protocol are described in Articles 3.3, 3.4 and in the UNFCCC Marrakesh accords (2001).

Article 3.3 activities

All industrialised countries have to account for Article 3.3 activities in their GHG inventories, which include net changes in greenhouse gas emissions by sources and removals by sinks resulting from direct human-induced land-use change and forestry activities, limited to afforestation, reforestation and deforestation since 1990.

Article 3.4 activities

Article 3.4 identifies human-induced activities related to changes in greenhouse gas emissions by sources and removals by sinks in the agricultural soil and other land-use change and forestry categories that a country may choose to use in order to meet its Kyoto Protocol target. In the Marrakesh accords, Article 3.4 activities were defined as forest management, revegetation, cropland management and grazing land management. The extent to which parties can account for emissions and removals from these activities, for the first commitment period, is limited by a capping system.

1. If a party's afforestation, reforestation and deforestation activities result in more emissions than removals, then the party may offset these emissions through forest management activities, up to a total level of 9 Mt of carbon per year for the five-year commitment period.

2. The extent to which forest management activities can be accounted for to help meet emission targets beyond 9 Mt of carbon per year is subject to an individual cap for each party, listed in the Marrakesh accords. This cap includes joint implementation projects involving forest management.

3. Emissions and removals from cropland management, grazing land management and revegetation can be accounted for to help meet emission targets on a net basis (e.g. changes in carbon stocks during 1990, times five, will be subtracted from the changes in carbon stocks during the first commitment period, on land where these activities will take place).

Article 3.7

Article 3.7 describes how carbon sinks affect the calculation of base year emissions for a country under the protocol. This is only relevant for those countries for which land-use change and forestry constituted a net source of greenhouse gas emissions in the base year. In such cases, countries have to include in their base year calculation the emissions by sources minus removals by sinks from land-use change in the base year.

These carbon sinks include mandatory activities covered by Article 3.3 of the protocol (afforestation, reforestation and deforestation — ARD) and voluntary activities under Article 3.4 (forest management, cropland management, grazing land management and revegetation). Further information on the use of carbon sinks under the Kyoto Protocol is given in Box 1.

Information from Member States on the use of carbon sinks

Eight Member States — Austria, Belgium, Finland, the Netherlands, Portugal, Spain, Sweden and United Kingdom — have provided information on their intended use of carbon sinks through a questionnaire sent out in 2002 under the EU GHG monitoring mechanism.

Member States have to account for afforestation, reforestation and deforestation activities under Article 3.3 of the Kyoto Protocol. Only Austria, the Netherlands, Portugal, Spain and the United Kingdom provided estimates for their projected annual net carbon stock change under Article 3.3 during the commitment period (Table 22). Austria and Sweden expect additional

Table 22 Projected net carbon stock changes under Article 3.3 for the Kyoto Protocol commitment period, 2008–12 (afforestation, reforestation and deforestation)

Member State	Net carbon stock change during 2008–12 (Mt CO_2/year)	Type of carbon pools included
Austria	0.733 (large uncertainties)	Not indicated
Belgium	Estimates not yet available	—
Finland	Estimates not yet available	—
Netherlands	– 0.11	—
Portugal	– 1.4 to – 1.7	—
Spain	– 6.82	Not indicated, probably only above ground biomass
Sweden	Probably small net debit	—
United Kingdom	– 2.2	Above ground and below ground biomass, litter and soil organic matter
EU total	– 9.8 to – 10.1	

Note: Consistent with inventory reporting, a negative sign is used for removal and a positive sign for emissions.

Table 23 Intention to elect Article 3.4 activities for accounting in the first commitment period under the Kyoto Protocol

Member State	No election of Art. 3.4 activities	Not yet decided	Yes, election of Art. 3.4 activities
Austria			√ (Forest management)
Belgium		√ Walloon region: inventory of possible 3.4 activities under elaboration; Flemish region: sink contribution not considered key with regard to compliance with Kyoto commitments	
Finland		√	
Netherlands		√	
Portugal			√ (Forest management, other options under consideration)
Spain			√ (Forest management)
Sweden	Will not be used to achieve national target	√	
United Kingdom		√	

Table 24 Potential projected net carbon stock changes from forest management under Article 3.4 for the Kyoto Protocol commitment period, 2008–12

Member State	Net carbon stock change during 2008–12 (Mt C/year)	Maximum allowance for forest management (Mt C/year)	C pools included
Austria	No data provided	– 0.63	
Belgium	No data provided	– 0.03	
Finland	No data provided	– 0.16	
Netherlands	No data provided	– 0.01	
Portugal	– 0.43	– 0.22	Not clearly indicated
Spain	– 0.22	– 0.67	Not clearly indicated, probably only above ground biomass
Sweden	Amount is likely to be larger than maximum allowance	– 0.58	Not clearly indicated
United Kingdom	– 3.4 to – 3.7	– 0.37	Above ground and below ground biomass, litter and soil organic matter
EU total		– 0.81 to – 2.97 Mt CO_2 /a	

Note: Consistent with inventory reporting, a negative sign is used for removal and a positive sign for emissions.

emissions from ARD activities during the commitment period, whereas the Netherlands, Portugal, Spain and the United Kingdom estimate net sequestration effects from these activities. Belgium, Finland and Sweden have not yet quantified the expected effects from Article 3.3 activities.

With regard to Article 3.4 activities for accounting in the first commitment period, three countries (Austria, Portugal, Spain) that provided information in the questionnaire have already decided to account for forest management under Article 3.4 (Table 23). The United Kingdom has presented the amount of its net carbon stock change during the commitment period according to Article 3.4 activities, without taking any decision on accounting for these. Sweden has neither presented a definite amount nor yet taken a decision on the use of sinks under Article 3.4.

Portugal expects to use its maximum allowance for the accounting of forest management under Article 3.4 according to the Marrakesh agreements (Table 24). Most of the countries have not yet taken a final decision with regard to accounting of Article 3.4 activities.

Most of the parties reported considerable co-benefits from the increase in sinks, such as restoration of degraded and abandoned areas, protection against forest fires, pests and diseases, biodiversity or quality of life. These co-benefits are mostly the reasons why measures were adopted.

Policies related to carbon sinks are at least partly adopted in five from eight Member States that provided information (Austria, Belgium, the Netherlands, Spain, the United Kingdom). Only Belgium has given legal status to its plans to increase terrestrial carbon sequestration. Reported activities and quantitative effects are generally included in the national climate change strategy except for Finland. Belgium and Spain were the only countries that reported that they have allocated a

Box 2: Flexible mechanisms under the Kyoto Protocol

Joint implementation (JI)

Joint implementation is provided for under Article 6 of the Kyoto Protocol. It enables industrialised countries to work together to meet their emission targets. A country with an emissions reduction target can meet part of that target through a project aimed at reducing emissions in any sector of another industrialised country's economy. Any such projects need to have the approval of the countries involved and must result in emission reductions that would not have occurred in the absence of the JI project. The use of carbon sinks (e.g. forestry projects) is also permitted under joint implementation.

Clean development mechanism (CDM)

Article 12 of the Kyoto Protocol sets out a clean development mechanism. This is similar to JI, but project activities must be hosted by a developing country. As with JI, CDM projects must result in reductions that are additional to those that would have been achieved in the absence of the project. They also have the additional aim of promoting sustainable development in the host developing country. The CDM is supervised by an executive board, which approves projects. CDM projects have been able to generate credits since January 2000 and these can be banked for use during the first commitment period (2008–12). The rules governing CDM projects allow only certain types of sinks projects (afforestation and reforestation) and countries will not be able to use credits generated by nuclear power projects towards meeting their Kyoto targets. To encourage small-scale projects, special fast-track procedures are being developed.

Emissions trading (ET)

Article 17 of the Kyoto Protocol allows countries that have achieved emissions reductions over and above those required by their Kyoto targets to sell the excess to countries finding it more difficult or expensive to meet their commitments. In this way, it seeks to lower the costs of compliance for all concerned.

Table 25 Planned use of Kyoto Protocol mechanisms in EU Member States

Member State	Planned use of Kyoto Protocol mechanisms	Which Kyoto Protocol mechanisms (ET, CDM, JI)	Achieving the burden sharing target through domestic action (no use of Kyoto Protocol mechanisms)?	Projected emission reduction, 2008–12, through the use of Kyoto Protocol mechanisms (Mt CO_2 equivalents/year)
Austria	Yes	Priority on JI and CDM		No quantitative targets foreseen (31)
Belgium	Yes Trading simulation to gain experience	Not yet decided	Not yet decided	Not yet decided
Finland	Not yet decided Pilot programme to gain experience	Not yet decided	Not yet decided	Not yet decided
Netherlands	Yes	ET, CDM, JI	No	20 (32)
Portugal	Yes	ET, CDM, JI	No	Total international: 0.68–1.3 (33)
Spain	Yes	Priority on ET and CDM	No	Not yet decided
Sweden	Not yet decided May be decided after the review of the climate policies in 2004 or 2008	ET, CDM, JI	Yes	Not yet decided
United Kingdom	Yes	ET, CDM, JI	Yes (domestic trading scheme considered as domestic action)	Domestic trading scheme: 2.0

specific budget for carbon sequestration activities under Articles 3.3 and 3.4. The remaining countries have either not allocated a budget or did not provide any information on this subject.

Use of sinks for achieving the EU's Kyoto target

The preliminary and incomplete information from Member States presented in this chapter shows that so far a total of carbon sinks of about 10 million tonnes CO_2 per year of the commitment period has been identified from the enhancement of Article 3.3 activities, with a further 3 million tonnes CO_2 per year identified from Article 3.4 activities. These figures are very modest when compared with the EU's Kyoto commitment (almost 4 % of the total of 336 million tonnes CO_2 equivalents to be reduced by the EU in total). The European climate change programme estimates that potentially 93–103 million tonnes CO_2 (equivalent to about 30 % of the EU reduction) could be sequestered through the enhancement of sink activities in the agricultural and forestry sector (ECCP, 2003).

3.4. Use of flexible mechanisms under the Kyoto Protocol by EU Member States

Introduction

In addition to domestic measures, including EU common and coordinated measures, Member States are also allowed to make use of the flexible mechanisms under the Kyoto Protocol to achieve their EU 'burden sharing' targets. The Kyoto Protocol mechanisms are explained further in Box 2.

Information from Member States on the use of Kyoto Protocol mechanisms

Eight Member States — Austria, Belgium, Finland, the Netherlands, Portugal, Spain, Sweden and the United Kingdom — have provided information on their intended use of the Kyoto Protocol mechanisms through a

(31) Austria assumes a maximum of 50 % of the efforts required for compliance with its burden sharing target by means of JI and CDM.
(32) In the first commitment period a contribution of 100 Mt CO_2 equivalents from flexible mechanisms are expected (20 Mt CO_2 equivalents per year). By now 8.4 million tonnes (JI) and 36 million tonnes (CDM) have already been contracted. The contribution from international emissions trading is not yet decided
(33) Out of this amount, 0.32–0.4 Mt CO_2 equivalents shall be acquired within the European emissions trading scheme (EU ETS).

questionnaire sent out in 2002 under the EU GHG monitoring mechanism.

Six countries have already decided to use the Kyoto Protocol mechanisms (Table 25). Two countries (Finland and Sweden) have not yet taken decisions on the use of Kyoto Protocol mechanisms. However, activities to implement the two project-based mechanisms, joint implementation (JI) and the clean development mechanism (CDM), have also been started in these countries.

Quantitative estimates for the use of Kyoto Protocol mechanisms (JI and CDM) were only provided by the Netherlands and Portugal (see Table 25). The Netherlands is planning to meet 50 % of the effort to reach the Kyoto target through the use of Kyoto Protocol mechanisms (20 Mt CO_2 equivalents per year in the commitment period) ([34]). Portugal provides total contributions from the use of Kyoto Protocol mechanisms (0.68–1.3 Mt CO_2 equivalents) which amount to approximately 8–14 % of the projected gap between the Portuguese greenhouse gas emissions in 2010 with existing domestic measures and the burden sharing target. Austria has set a maximum of 50 % for the contribution of Kyoto Protocol mechanisms to cover its reductions commitment (gap between base-year emissions and target), which amounts to 5 Mt CO_2 equivalent emissions. The United Kingdom and Sweden indicate that they will reach their burden sharing targets through domestic measures without the use of Kyoto Protocol mechanisms under the Kyoto Protocol.

The status of preparations for the use of project-based activities differs between Member States. The Netherlands has made the strongest progress in the implementation of JI and CDM projects and allocated one of the largest budgets (EUR 225 million for the five-year commitment period). However, other Member States have also started to implement activities such as the preparation of the national legal framework (Austria, Belgium, Spain, Sweden), the start of pilot programmes (Finland) or the allocation of budgets for JI or CDM projects (Austria: at a maximum EUR 288 million ([35]), Finland: EUR 8.5 million, EUR Sweden: 37.5 million) ([36]).

Up to now, more agreements or contracts have been arranged for joint implementation; however, two countries (the Netherlands and Spain) prefer CDM project activities according to their responses. Most of the project-based activities initiated by Member States are in an early stage that does not yet allow evaluating their quantitative contribution to the burden sharing target during the commitment period.

Portugal integrated the use of Kyoto Protocol mechanisms in the 'with additional domestic measures' greenhouse gas projections; projections from the other countries do not include the effects from the use of Kyoto mechanisms on compliance.

The EU emissions trading scheme is due to start in 2005 and most Member States do not plan to establish additional domestic emissions trading schemes. The United Kingdom and Denmark have already implemented domestic schemes ([37]).

Taking into account the level of preparations and, in particular, the formal allocation of budgets and the starting of projects, it could be concluded that Austria and the Netherlands are projected to achieve their target through a combination of domestic policies and measures

([34]) In the national climate policy implementation plan of the Netherlands, which was approved in October 2000, a 'policy shortfall' was identified of 50 Mt CO_2 equivalents per year (NC3, p. 50) between the target (94 % of the 1990 emissions) and projected emissions in 2010 (137 % of 1990 emissions). It then was decided that for around 50 % of the effort to meet the Kyoto commitment flexible Kyoto mechanisms should be used.
([35]) EUR 36 million per year between 2003 and 2010.
([36]) All budgets refer to the total commitment period.
([37]) The United Kingdom estimates the contribution of the domestic trading scheme to emission reductions to be 2 000 Gg CO_2 equivalents which should be considered as part of domestic action.

and project-based Kyoto Protocol mechanisms (JI and CDM).

Use of Kyoto Protocol mechanisms on the EU's Kyoto target
The information from Member States presented in this chapter suggests that so far for each year of the commitment period, around 21 to 26 Mt CO_2 equivalents of savings have been identified from the Kyoto Protocol mechanisms under the Kyoto Protocol which corresponds to 6 to 8 % of the total required emission reduction for the EU as a whole of 336 Mt CO_2 equivalents. These mostly result from the Netherlands' proposed use of the mechanisms (20 Mt CO_2 equivalents).

3.5. EU-wide projections and policies and measures

3.5.1. EU-wide projections

Introduction
This section summarises the results of a comparison between the Member State GHG emissions projections (MSPs) and those from the latest EU-wide baseline projections made using the Primes model. The Primes baseline projections were produced by the National Technical University of Athens for the European Commission Energy and Transport DG and have been published in *European energy and transport trends to 2030*. More details of the comparison are given in Annex 7.

Scope and type of comparison
The coverage and disaggregation of the Primes baseline scenarios (PBLs) and the Member States' projections are quite different and this has limited the scope and type of comparison that has been possible. These differences arise in two main areas:

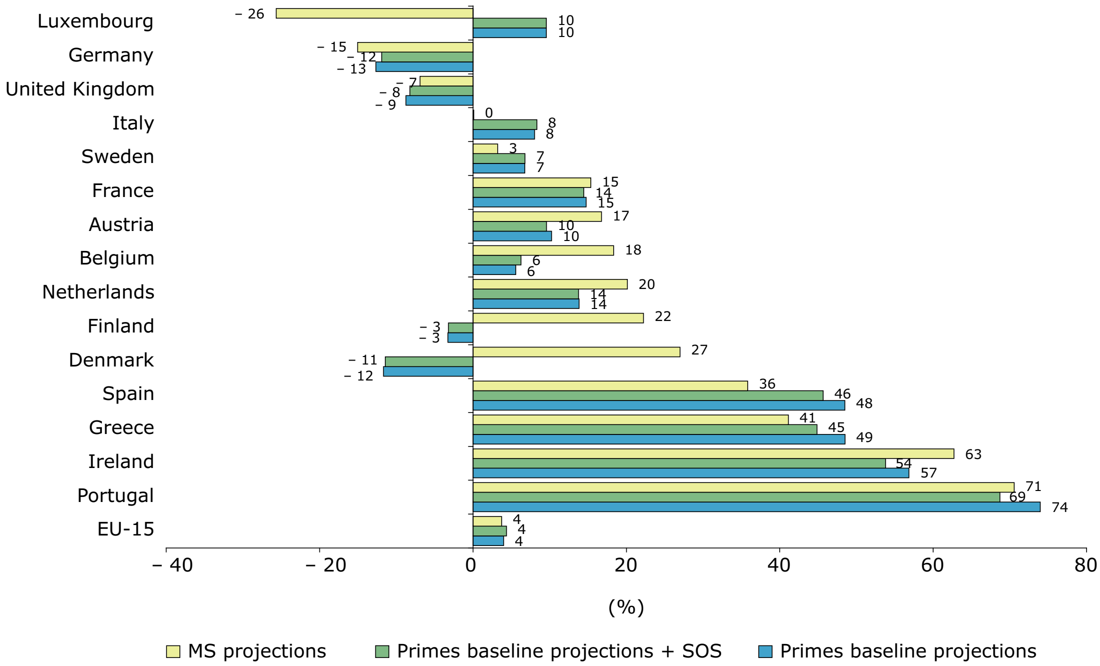
- sectoral coverage and level and type of breakdown;
- range of greenhouse gas emissions included, in particular the inclusion of bunker fuels in Primes but not in the MSPs.

Table 26 shows the disaggregation by sector and gas of both approaches. Whereas the MSPs comprise all greenhouse gases (in most cases), the PBLs covers only CO_2 emissions from fuel combustion (and exclude process emissions of CO_2). The sectoral coverage is also quite different. The MSPs are — or at least should be — disaggregated according to the UNFCCC common reporting format (CRF). The PBLs, in contrast, differentiate firstly between energy supply and energy demand sectors and then provide more detailed information by sub-sector.

Table 26 Disaggregation by sector and greenhouse gas in the Primes baseline projections and in the Member States' projections

	CO_2			CO_2	CH_4	N_2O	F gases
Primes baseline projections			**MS projections** (common reporting format)				
1. Energy supply			1. Energy				
1.1 Electricity generation			A. Fuel combustion				
1.2 Heat generation			1. Energy industries				
1.3 Refineries			2. Manufacturing industries and construction				
2. Energy demand			3. Transport				
2.1 Industry			4. Other sectors				
2.2 Transport			5. Other				
2.3 Tertiary			B. Fugitive emissions from fuels				
2.4 Households			2. Industrial processes				
			3. Solvent and other product use				
			4. Agriculture				
			6. Land-use change and forestry				
			6. Waste				
			7. Other				

Figure 68 Change of total CO_2 emissions between 1990 and 2010 according to the results of the Primes baseline projections and projections by individual Member States



In addition, most Member States break down their projections either by gas or by sector, but not by both gas and sector, so that the only figures for CO_2 are often only total emissions.

Given the constraints on the availability of consistent information from the two sets of projections, the comparison has focused on comparing:

- total CO_2 emissions;
- CO_2 emissions from transport.

In addition to the Member State comparison, some preliminary analysis has also been undertaken on comparing projections for the acceding and candidate countries.

Comparison of projections

Total CO_2 emissions

Total CO_2 emissions (excluding emissions or removals by sinks) are largely comprised of emissions from fuel combustion, with a minor share resulting from industrial processes. The PBLs therefore cover most CO_2 emissions (i.e. those from fuel combustion) but omit process-related CO_2 emissions. In contrast, the MS projections include all CO_2 emissions, but typically there is no breakdown between combustion emissions and those from processes.

Therefore, two comparisons have been made. In the first case, total CO_2 emissions from the MSPs are compared with combustion-related emissions from the PBLs. Secondly, the MSPs are compared with the results of the PBLs combined with an estimate of process-related CO_2 emissions taken from an older set of EU-wide projections, known as the sectoral objectives study (SOS) ([38]).

For the EU as a whole, total CO_2 emissions are projected to increase by 4%between 1990 and 2010 in both the Primes baseline projections and the aggregation of the projections provided by the individual Member

([38]) The sectoral objectives study was produced for the Environment DG in 2000 (http://www.europa.eu.int/comm/environment/enveco/climate_change/sectoral_objectives.htm) and includes projections for process-related CO_2 emissions. These projections are due to be updated shortly, but at least give an indication of whether the 'missing' emissions from the simple PBL–MSP comparison can explain any differences that are observed.

Figure 69 **Deviation of Primes baseline projections from Member State projections for total CO_2 emissions (1990 to 2010)**

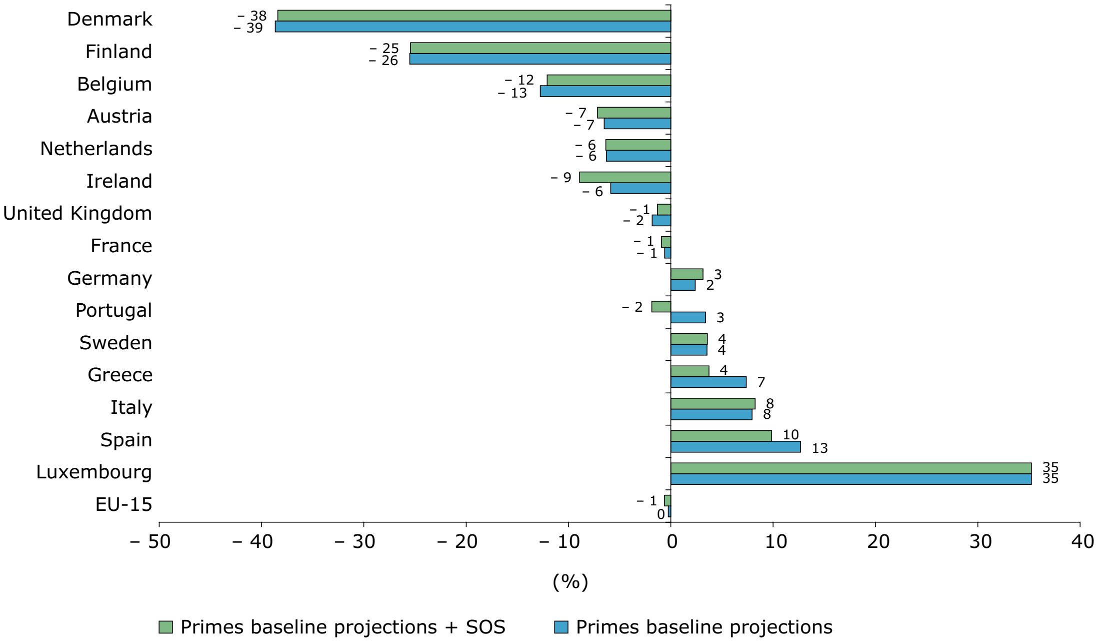
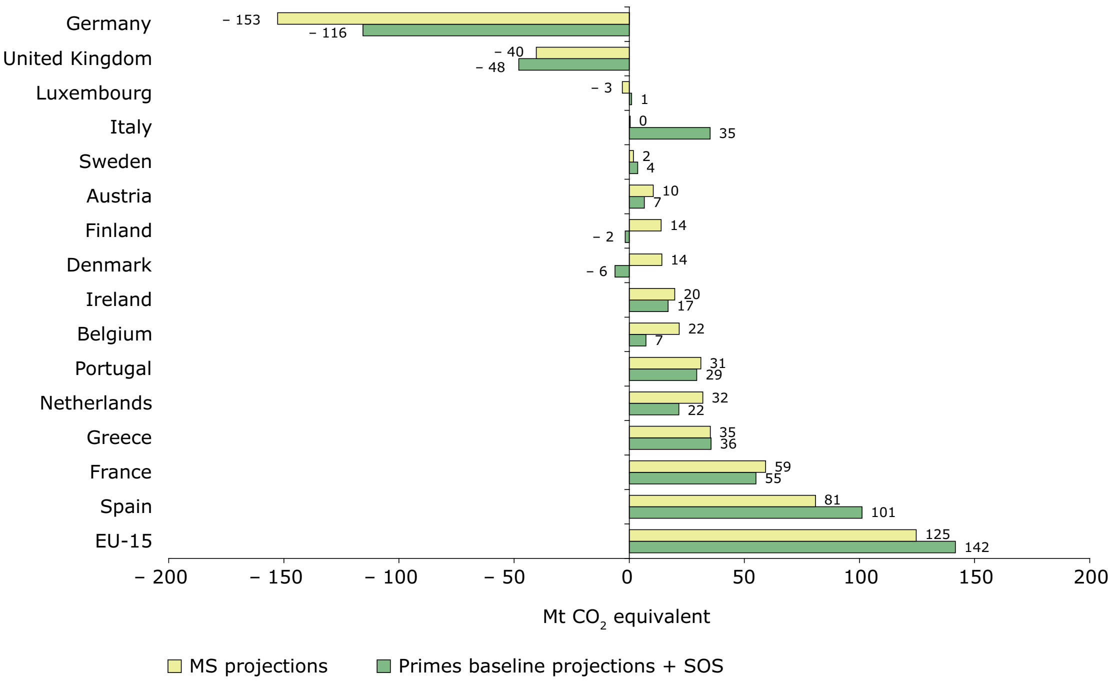


Figure 70 **Change in total CO_2 emissions between 1990 and 2010**

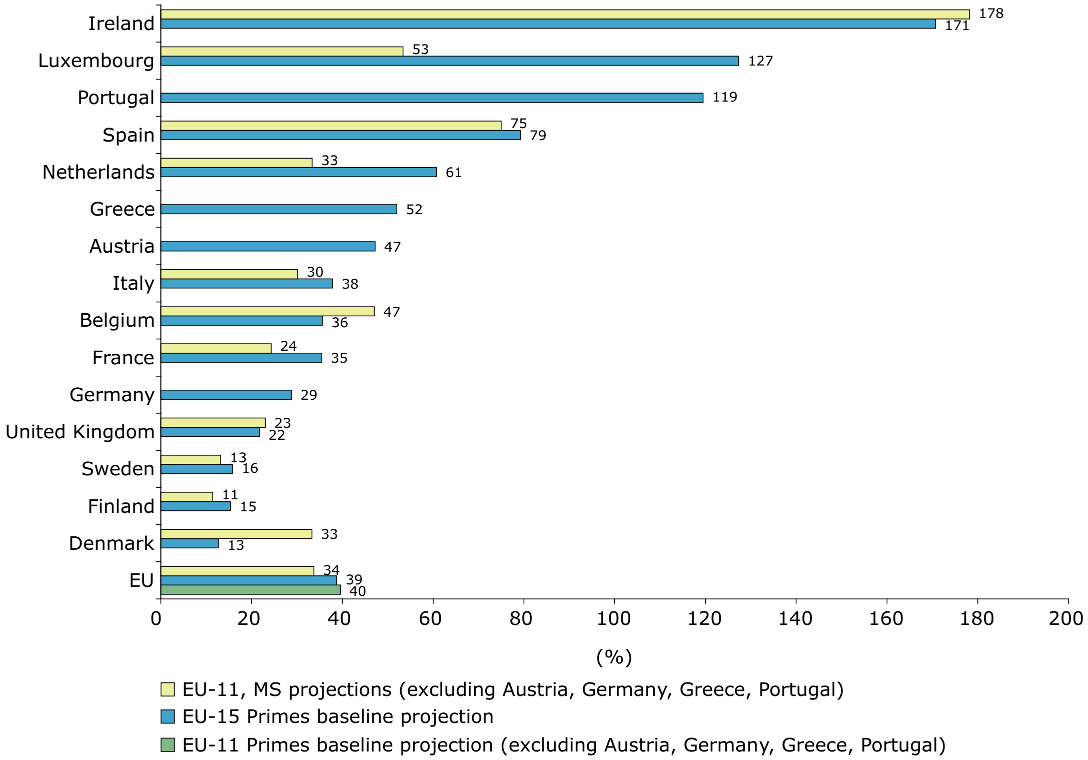


States (Figure 68). The impact of including process CO_2 emissions from the sectoral objectives study is small. At an aggregate level, the two sets of projections would therefore appear to agree fairly well.

Although the overall results for the EU are comparable, there are considerable differences in the projections at Member State level (Figure 69). In some cases the Primes baseline projections show a higher increase in emissions between 1990 and 2010 (Luxembourg, Spain, Italy, etc.), in other cases the Member State projects a stronger increase in CO_2 emissions than the Primes baseline projections (Denmark, Finland, Belgium, etc.) ([39]). For most of the larger Member States (France, the United Kingdom,

([39]) Reasons for differences in the projections are explained below.

Figure 71 Change of CO_2 emissions in the transport sector between 1990 and 2010 according to the results of the Primes baseline projections and projections by individual Member States



Germany) the difference between both projections is relatively small, within 5 %, which contributes to the relatively good agreement between the projections at EU level.

The highest deviation in percentage points is for Luxembourg, Denmark and Finland. However, the aggregated difference for these countries is similar to the absolute difference in the projections for Germany, which is small in terms of percentage points (Figure 70).

Figure 70 also indicates that in most cases the Primes baseline and the Member States' projections show the same trend between 1990 and 2010. However, in the case of Finland and Denmark, the Member States project an increase in CO_2 emissions whereas the Primes baseline projection results in a decrease of CO_2 emissions. In contrast, Luxembourg's projection shows a decrease of 3 Mt CO_2 equivalents and the Primes baseline projection results in an increase of 1 Mt CO_2 equivalents.

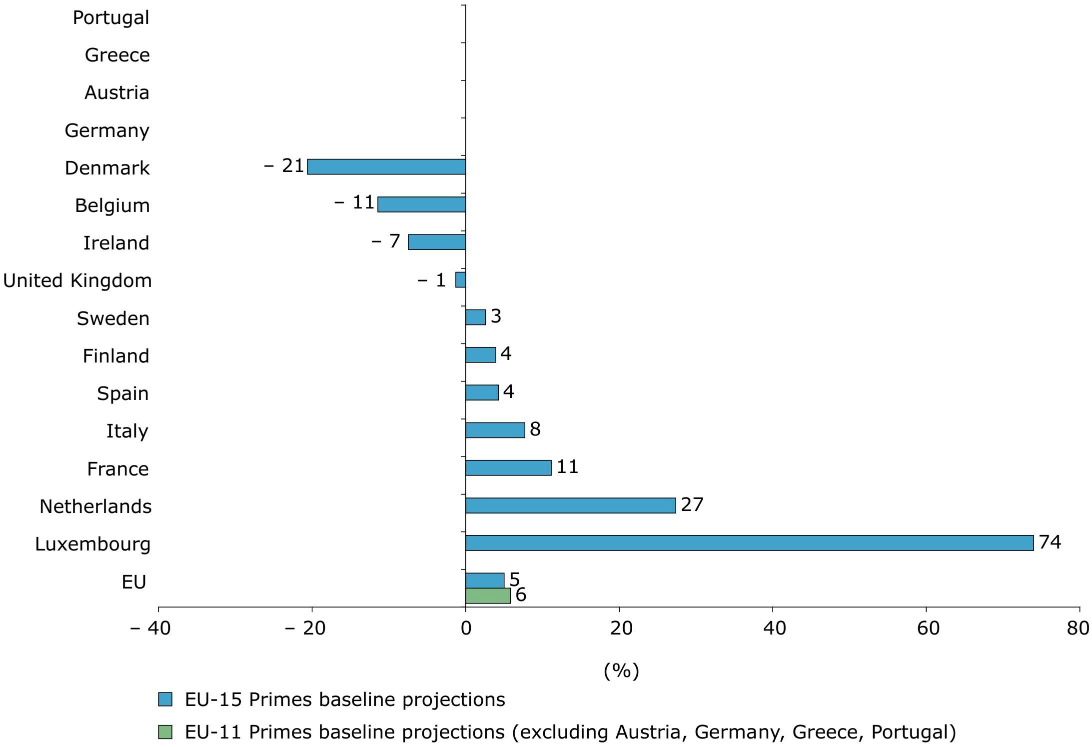
For the EU as a whole, the result of the Primes baseline projections is only 2 Mt CO_2 equivalents below the aggregate projections of the Member States.

Emissions of CO_2 from transport
Emissions of CO_2 in the transport sector are expected to increase in all Member States between 1990 and 2010 according to both the MSPs and the PBLs (Figure 71) ([40]). On average, the increase is expected to be 35 % according to the aggregated Member States' projections and about 39 % according to the Primes baseline projections, taking into account that the different treatment of bunker fuels for international aviation in the Primes baseline projections might explain at least 3 or 4 percentage points of the differences in the transport sector.

At Member State level, however, large differences between the projections can be seen. In terms of percentage points, the largest differences are between the projections for Luxembourg, the Netherlands and

([40]) Four Member States (Austria, Germany, Greece and Portugal) did not provide a breakdown of greenhouse gas by sector and have to be excluded from the analysis of the transport sector.

Figure 72 Deviation of Primes baseline projections for total CO_2.emissions in the transport sector in 2010 from Member State projections



for Denmark (Figure 72). The Danish projection results in emissions that are about 20 % higher than the Primes baseline, whereas the Netherlands and Luxembourg project much lower emissions than the Primes baseline projections.

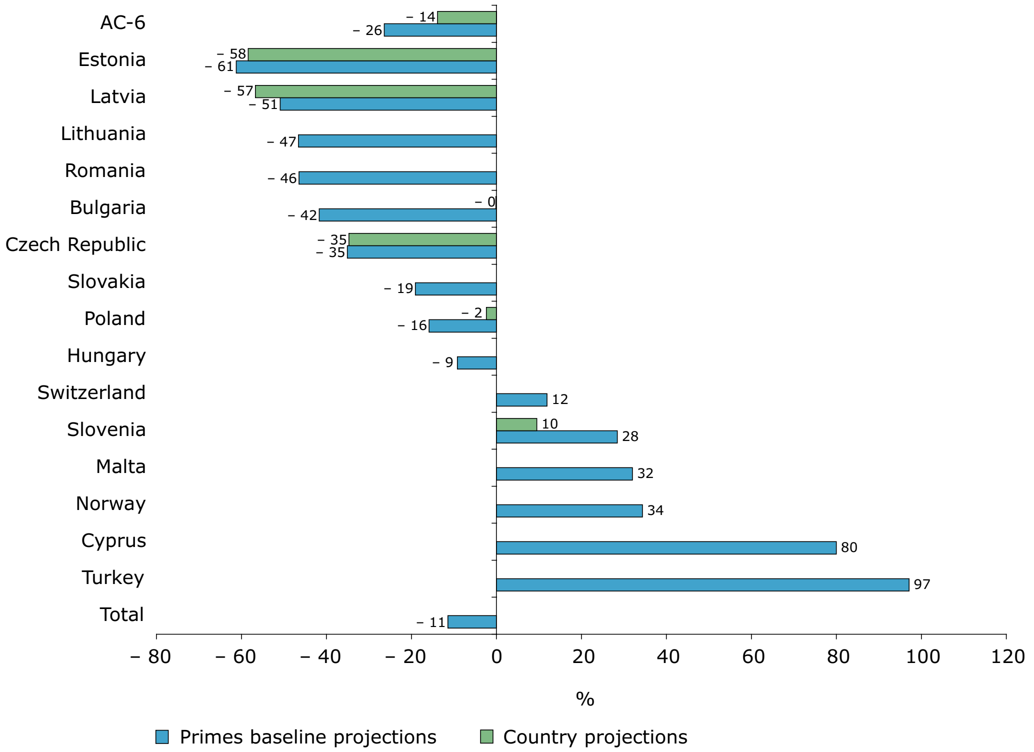
These differences might be explained, in particular in the case of Luxembourg, by different model assumptions about so-called tank-tourism. In the past, fuel taxes in Luxembourg have been much lower than in the neighbouring countries such as Belgium and Germany and this has attracted people from these countries to cross the border into Luxembourg for the sole purpose of refuelling their vehicles. In Primes it is assumed that these taxation differences will not change during the timespan of the projection. Unfortunately, no detailed information on the assumptions used in Luxembourg's projection on future taxation policies is available. However, the difference between both projections would be expected to decrease if the recent decisions about the harmonisation of fuel taxation in the EU are taken into account in Luxembourg's projection. In addition, this might also explain some of the large difference in the overall projections (Figure 69).

Figure 72 presents the deviation in the absolute change in CO_2 emissions in the transport sector of the Primes baseline projections from the Member States' projections. It shows again — like for total CO_2 emissions — that large percentage point deviations may be small in absolute terms (Luxembourg) and small percentage point deviations may be large in absolute terms (e.g. Spain). Most of the deviation for the EU as a whole can be attributed to the different approach with regard to emissions from bunker fuels in international aviation.

Acceding and candidate countries and EEA countries

Only six acceding and candidate countries have provided data on greenhouse gas projections for 2010 (Bulgaria, the Czech Republic, Estonia, Latvia, Poland, Slovenia; see Figure 73). Therefore, only projections from these countries can be compared with the results of the Primes baseline projections

Figure 73 **Change of total CO_2 emissions between 1990 and 2010 according to the results of the Primes baseline projections and projections by individual acceding and candidate countries or EEA countries**



Note: AC-6 = Bulgaria, Czech Republic, Estonia, Latvia, Poland, Slovenia.

for the acceding and candidate countries. The comparison is somewhat affected by the fact that, within the UNFCCC process, Bulgaria, Poland and Slovenia have opted for a base year different to 1990 (Bulgaria, Poland: 1988; Slovenia: 1986). Emission data for CO_2 in 1990 are, therefore, not available for theses countries and has been estimated ([41]).

Figure 73 shows the differences between the projections of the acceding and candidate countries and the Primes baseline projections for this group of countries. The aggregated result shows a 12 percentage points stronger decrease in CO_2 emissions than the Primes baseline projections. However, for some of the acceding and candidate countries the individual projections are quite comparable with the Primes baseline projections (the Czech Republic, Estonia, Latvia). Larger differences can be identified for Poland (14 percentage points) and Slovenia (16 percentage points). The largest difference in percentage terms is between Bulgaria's projection and the Primes baseline projection (42 percentage points).

Causes of differences in projections
The different comparisons carried out above have revealed several differences between the Primes baseline projections and the Member States' projections. These differences may occur for a number of different reasons. Some of the most important causes for such deviations are:

- differences in the database used: the Primes model is based on the Eurostat energy balances for the year 2000; some of the Member States (e.g. Italy) use different databases for their projections that are not fully compatible with the Eurostat data;
- different definition of sectors covered: an important example is the different approach for the consideration of emissions from

([41]) For these countries, only the base year and 1991 figures instead of the 1990 emission are given in the greenhouse gas database of the UNFCCC (http://www.unfccc.int). For the estimation of the 1990 emissions, it was assumed that the emissions developed on a linear path between the base year and 1991.

bunker fuels used in international aviation. While Primes takes international bunker fuels into account, they are excluded from the national projections;
- differences in emission factors: the Primes model applies individual emission factors for each Member State; the emission factors applied in the model are based on Eurostat's emission factor database; however, most Member States apply national emission factors, which are suited to national circumstances;
- differences in the models applied: the Primes model is an econometric model driven by prices that simulates economic decisions by representative sectors simultaneously; some of the Member States use quite different model approaches; Germany, for example, applies a technological optimisation model, which, in general, tends to show lower projections results than econometric models; hence, it is no surprise that Germany's projection results show lower emissions than the Primes baseline projection;
- different assumptions applied in the models including:
  - — different effectiveness of policies which are included or covered by the projection (see above: taxation policy in Luxembourg),
  - — growth assumptions on drivers of the models like population or GDP growth, fuel prices, etc.,
  - — technical features of models like demand elasticities that are, in general, quite sensitive to the model results or may refer to assumptions on technological development.

Despite the number of possible reasons for differences between the two sets of projections, it is useful to assess the results from different modelling approaches. The comparison may help to improve the EU-wide baseline projection and to achieve a more consistent view on the projected effects of policies aimed at emissions reductions.

3.5.2. Common and coordinated policies and measures

Introduction

In the last two years, the European climate change programme has analysed extensively the most environmentally beneficial and cost-effective additional policies and measures enabling the EU to meet its – 8 % target under the Kyoto Protocol. A second report on the progress of the ECCP was published in May 2003 ([42]). The report presents an overview of the work within different working groups of the ECCP and on implementation of the measures identified in the first phase of the ECCP.

Implementation of measures

The EU-wide emissions trading scheme is well under way. As a political agreement has been reached between the European Parliament and the Council, the directive will be formally adopted in the near future ([43]). The proposed scheme would apply to most of the significant emitting activities already covered by the integrated pollution prevention and control (IPPC) directive as well as some others. The only gas covered by the proposal is CO_2.

The European Commission has additionally proposed a directive for linking the emissions trading with the Kyoto Protocol's flexible mechanisms.

The legislative measures currently adopted by the EU (Council) or proposed by the Commission represent a potential of more than 300 million tonnes CO_2 equivalent. Key measures and their estimated greenhouse gas reduction potential are:

- the proposal for a directive, amending the directive establishing a scheme for greenhouse gas emission allowance trading within the EU, in respect of the Kyoto

([42]) http://europa.eu.int/comm/environment/climat/second_eccp_report.pdf
([43]) Proposal for a directive establishing a scheme for greenhouse gas emission allowance trading with the Union and amending Council Directive 96/61/EC, COM(2001) 581 final, 23 October (2001).

Protocol's flexible mechanism (Commission proposal of 23 July 2003 — COM(2003) 403 final);
- a proposal for a regulation of the European Parliament and of the Council on certain fluorinated gases (Commission proposal of 11 August 2003 — COM(2003) 492 final);
- a proposal for a directive of the European Parliament and the Council on establishing a framework for the setting of eco-design requirements for energy-using products (Commission proposal of 1 August 2003 — COM(2003) 453 final);
- the directive on the promotion of electricity from renewable energy (RES-E directive, implemented 2001);
- the proposal for a directive on combined heat and power to promote high efficiency cogeneration (adopted by the Commission in 2002);
- the directive on the energy performance of buildings to improve the energy performance of new buildings, as well as larger existing buildings when they undergo major renovations (adopted 2002);
- horizontal implementation of energy efficiency in the IPPC directive on pollution prevention and control in large industrial and agricultural installations to achieve co-benefits from air quality improvements for greenhouse gas reductions;
- the motor challenge programme, an EU voluntary programme to improve the energy efficiency of motor driven systems in industrial companies (launched 2003);
- the voluntary agreement to the Commission by car manufacturers (ACEA, JAMA, KAMA) to reduce the average CO_2 emissions of new passenger cars to 140g CO_2/km by 2008/2009;
- the proposal for the promotion of biofuels in the transport sector by setting targets and enabling reductions in excise duties on biofuels (reading in EP in 2003);
- the landfill directive to recover gases from biodegradation of waste in landfills (implemented).

Working groups in the second phase
In 2002, the active working groups were on agriculture, sinks in agricultural soil and forest-related sinks.

Greenhouse gas emissions from the agricultural sector have declined by 6 % in the period 1990–2000 and it is expected that the implementation of Agenda 2000 reform will strengthen this trend. Additional potential reductions of 12 Mt CO_2 equivalents have been identified for the first commitment period. The recent CAP reform proposals ([44]) contain some measures and incentives that if adopted could have a mitigating effect on greenhouse gas emissions. These include the introduction of cross-compliance requirements with environmental legislation and transfer of funds from the market support pillar of the CAP to the rural development pillar, where Member States may use it to support agri-environmental measures.

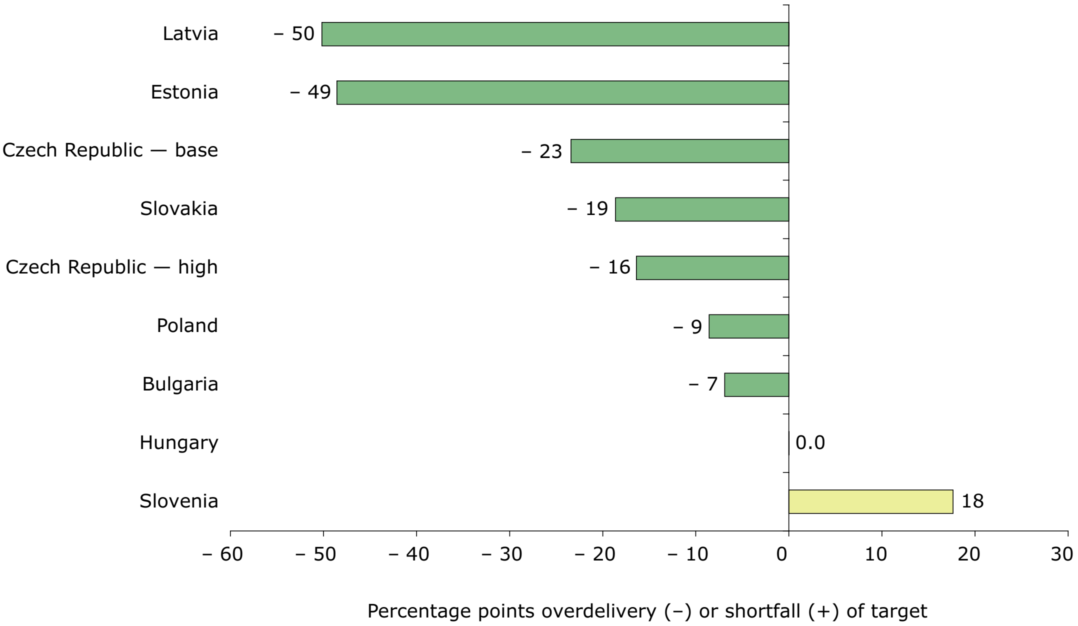
Following the Marrakesh accords, two further working groups relating to sinks were established. The total technical potential for the first commitment period identified is about 60–70 Mt CO_2 equivalents for soil and 33 Mt CO_2 equivalents for forests.

Increased demand for renewable raw resources for energy and material substitution opens up new opportunities for the agricultural and forestry sector. The CAP reform proposals include a specific support scheme for the promotion of energy crops.

Conclusions
The policies and measures outlined in the second ECCP report have a total emission reduction potential of 578–696 Mt CO_2 equivalents (excluding voluntary agreements with car manufacturers). This is around twice the emissions reductions required in the first commitment period. In addition, a potential 93–103 Mt CO_2 equivalents could be sequestered through the enhancement of sinks activities.

([44]) January 2003, COM(2003) 23 final.

Figure 74 **Relative gap (over-delivery or shortfall) between projections with existing domestic measures and targets for 2010 for eight acceding and candidate countries**



Note: Data exclude carbon sinks. With existing domestic measures reduction for Poland is for the energy sector only.

The legislative measures currently in force or already proposed represent a potential 276–316 Mt CO_2 equivalents. However, this ex ante evaluation of the potential is uncertain for several reasons:

- potential measures have not all been analysed in the same way and some have been analysed in more depth;
- for some measures, the estimated potential is based on reaching certain indicative targets, which will need to be proven practice (e.g. CHP and biofuels targets);
- the interactions between different measures have not necessarily been taken into account.

It is therefore recognised that the effectiveness of the measures needs to be closely monitored and their implementation reviewed if necessary.

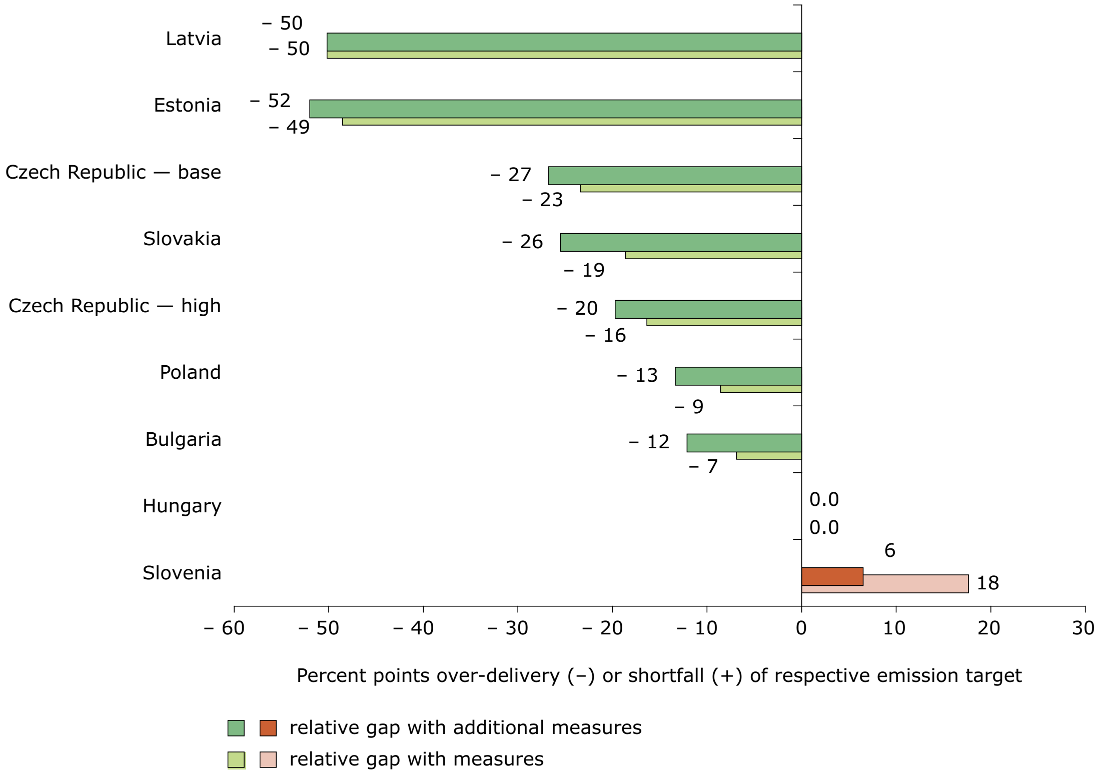
3.6. Acceding and candidate countries' projections, policies and measures

Acceding and candidate countries do not report formally to the monitoring mechanism, so the discussion in this section is based on third national communications (3NCs). Seven countries (Bulgaria, the Czech Republic, Estonia, Hungary, Latvia, Poland and Slovakia) had submitted 3NCs by June 2003. In addition, Slovenia produced its first national communication. Figure 74 shows the relative gap between the with existing domestic measures projections and the targets for the AC and CC.

The Czech Republic presents two projections, a reference scenario (labelled base in the Figure 74 above) and a scenario assuming high economic growth. Six countries have with existing domestic measures projections that show over-delivery against the Kyoto commitment. For Latvia and Estonia, the emissions are projected to be significantly lower than in 1990. The one exception is Slovenia which expects emissions to be above the target in 2010.

In part, the projected reductions in most AC and CC are the result of the economic restructuring that has already occurred in these countries. However, all countries have policies and measures in place to reduce greenhouse gas emissions. These

Figure 75 **Relative gap (over-delivery or shortfall) between projections and targets for 2010 for acceding and candidate countries**



Note: Data exclude carbon sinks.

measures are primarily aimed at energy use and waste but there are a limited number of measures in other sectors. The whole range of types of measures is used, although the use of voluntary agreements is limited. Measures implemented or proposed in most countries include:

- clean air legislation to reduce air pollution, this generally has a beneficial effect on greenhouse gas emissions;
- energy market liberalisation;
- changes in building regulations to improve energy efficiency;
- harmonisation with EU environmental legislation;
- measures to reduce traffic growth; and
- limitation on the disposal of biodegradable waste to landfills.

Despite mostly projecting that they will meet their Kyoto commitments, all but two AC and CC have identified additional domestic measures. Figure 75 shows the relative gap between the with existing domestic measures and with additional domestic measures projections and the target. Slovenia is still not expecting to meet its Kyoto commitment even under the with additional domestic measures projections.

Projections split by gas and sector are only available for a limited number of these AC and CC so further analysis of the projections is not presented in this report.

3.7. Quality and transparency of reporting

3.7.1. Current reporting

The quality of reporting for some Member States improved in 2003 either through the provision of a third national communication to the UNFCCC or through improved reports to the monitoring mechanism. Italy and Greece provided a third national communication in 2003.

The reporting of projections has been enhanced but is still facing some challenges. Disaggregation of the projections by gas and sector is more detailed and consequently more analysis has been possible than in previous years. Reporting of underlying parameters has also been more extensive, although there is still a limited number that can be compared between Member States.

Reporting of policies and measures is more comprehensive, including more consistent data on the type of measure and status of implementation. However, quantification of individual policies and measures for some Member States is still not available.

Acceding and candidate countries are not required to report formally to the monitoring mechanism and the discussion in this report is based on the third national communications. Reporting of policies and measures for most of the acceding and candidate countries gives reasonable levels of detail, including in many cases quantitative information on emissions reductions. With existing domestic measures and with additional domestic measures projections are generally provided and identified. However, tabulation of the results, particularly by gas and by sector is not available for all countries. The methodology for projections and the parameters used are presented but not always in detail.

3.7.2. *The sensitivity (range) in emissions projections*

Examples of country sensitivity analysis

Parties to the UNFCCC are advised to publish a sensitivity analysis of their projections, to help identify key parameters and assess uncertainty. The following European countries have provided sensitivity analyses in their third national communications: Austria, Belgium, Finland, the United Kingdom and the Czech Republic. There is no common framework for the sensitivity analysis so the results are presented separately.

Austria

Austria assessed sensitivity to parameters in the energy, agriculture and waste sectors. The results are presented below.

Belgium

Belgium assessed sensitivity to the type of model used. The difference between the projected emission of energy-related emissions of CO_2, N_2O and CH_4 from the two models that were compared is around 4 %.

Finland

Finland carried out a qualitative estimate of uncertainty. If the growth of the energy-intensive industrial branches of the industry is only moderate and the competitiveness of indigenous electricity production insufficient in relation to imports, the carbon dioxide emissions from combustion would clearly remain at a lower level than predicted. On the other hand, the levels of emissions can also rise higher than expected if the production conditions of the energy-intensive industry are better than anticipated or if there are only a few possibilities of importing electricity.

The trend will decisively depend on a few factors that are difficult to predict. The general economic development is one of the main factors, but the assumptions on the production growth rate of the energy-intensive branches,

Case scenario in 2010	Impact on sectoral CO_2 equivalents (%)	Impact on total CO_2 equivalents (%)
No increase in renewable energy production	+ 9 (energy sector)	+ 2
Increase in electricity demand is entirely met by electricity imports	– 18 (energy sector)	– 4
10 % increase in meat consumption implies higher number of cattle and so more CH_4 emissions	+ 6.4 (agricultural sector)	+ 0.4
10 % reduction in waste disposed to landfill	– 6.8 (waste sector)	– 0.4

Source of uncertainty in projections relative to base-year emissions estimate	Uncertainty in projections estimated relative to the central scenario in 2010	
	± Mt C/yr	Total CO_2 equivalents (± %)
Combination of GDP and fuel price	4	2.2
Economic modelling process for energy-related CO_2	9	5.1
Area and parameter assumptions driving land-use change emissions projection	2	1.1
Non-CO_2 greenhouse gas range	1	0.5
Combination (overall uncertainty)	10	5.6

such as the pulp and paper industry, manufacture of metals and the chemical industry will play a special role. Finally, meeting the wood-felling targets will also directly impact on the utilisation potential of energy from wood and thereby on the targets set for greenhouse gas emissions.

United Kingdom
Projections of the United Kingdom's carbon dioxide emissions are derived from the DTI's energy model. The key variables of the model are considered to be the GDP growth, the oil price, the tax structure and the temperature.

Six main scenarios were analysed, comprising combinations of three assumptions for economic growth and two for the overall level of energy prices. The central scenario for GDP growth assumed a 2.5 % increase a year for 2001–05 and 2.25 % a year for 2006–20. The oil price for the period 2001–20 ranges from USD 10 to 20 a barrel in 1999 prices. These different possible scenarios constitute altogether a source of uncertainty of ± 4 Mt C/yr for the calculated projections.

Three other sources of uncertainty have been identified and quantified (see table below). The second source of uncertainty displayed in the table is a concern arising from the economic modelling process itself, as distinct from the uncertainty due to assumptions about the economic drivers. This source of uncertainty can be seen as the minimum level of uncertainty in a modelling process, in other words the uncertainty that remains in the case where all economic assumptions and other input parameters agree perfectly.

The third source of uncertainty concerns the land-use change emission estimates. These estimates are produced with a spreadsheet model that uses land use data derived from periodic surveys, supplemented by an annual census of agricultural land uses. The key parameters to estimate gains and losses are the soil carbon densities and the transfer rate constants.

Projections of the non-CO_2 greenhouse gases are calculated using a specially built spreadsheet model that calculates emissions based on activity statistics, emission factors and sector-specific assumptions. The spreadsheet estimates the range of uncertainty associated with the total emissions for each gas using probabilistic modelling to calculate the confidence range for the projections.

The combined range of uncertainty is obtained using the error propagation equation. This is valid if the uncertainties are uncorrelated. This assumption is unlikely to be strictly true, but the largest uncertainty is unlikely to be correlated with any of the other factors, and cross-correlation between the other factors themselves will only be partial.

The Czech Republic
Because of the large uncertainty in future economic development in the Czech Republic, a sensitivity analysis was carried out on trends in GDP. The sensitivity of future trends in emissions of greenhouse gases on trends in GDP was analysed using two scenarios for trends in GDP, the high scenario and the reference scenario. In the high scenario, emissions are 13 Mt CO_2 equivalents (10 %) higher in 2010 and 25 Mt CO_2 equivalents (20 %) higher

in 2020 compared with the reference scenario. However, there is no direct proportionality between the rate of economic growth and the rate of increase in emissions, as in 2020 the rate of increase in GDP is about 60 % higher in the high scenario than in the reference scenario. This is because of the faster assumed rate of decrease in the overall energy intensity in the high scenario than in the reference scenario (4.1 % compared with 2.8 % in 2000–20).

Conclusion
A number of countries have reported sensitivity of projections, but this analysis is not widely reported in the third national communications. More work is needed under the EU GHG monitoring mechanism to achieve sensitivity analyses that are comparable between countries and to improve the reporting of the outcome of these analyses.

3.7.3. *Improving reporting and quality of projections*

In February 2003, a workshop on emissions and projections from agriculture was held at the EEA in Copenhagen. The main aims of the workshop were to:

- improve transparency and completeness of reporting of inventories and projections in agriculture;
- reduce the uncertainty in inventories and projections.

There were 53 participants from Member States, acceding and candidate countries, the JRC, the EEA, the OECD, the ETC and the Commission (the Environment DG and the Agriculture DG). Recommendations from the workshop for improving projections and policies and measures included:

1. report the methodology and describe the projected activity (agricultural scenario) and emissions factors used for major sources of emissions;
2. report actual values for activity and emissions factors used for at least base year and 2010;
3. report policies and measures assumed to be implemented in 2010 — the policies and measures reported should include any that have a material effect, for example, measures aimed at reducing air pollution;
4. report how the effect of the common agricultural policy is incorporated into projections of emissions;
5. report basis of underlying activity projections e.g. any assumptions of trade.

The workshop also recommended the following general improvements in projections.

1. For EU-wide projections, sufficient information on the scenarios of agricultural production and the underlying basis of these projections should be given to allow comparison with MS projections.
2. Good communication between national agricultural economics (scenarios) experts and emissions projections and inventory experts should be promoted both at the MS and EU level.
3. Some issues would be better addressed at the regional level and regional networking should be encouraged
4. Sharing good practice in preparing GHG emission projections from agriculture should be encouraged. Particular areas highlighted where this may be beneficial are:
   - how to incorporate policies and measures;
   - a review of projections including national agricultural scenario experts.
5. The effect of environmental policies on agricultural activity should be included in both MS and EU-wide projections. This may require model development and is thus a medium-term aim.

Details of the workshop are provided at:

http://air-climate.eionet.eu.int/docs/meetings/030227_AgricEmiss/meeting030227.html.

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Units and abbreviations

t	1 tonne (metric) = 1 megagram (Mg) = 10^6 g
Mg	1 megagram = 10^6 g = 1 tonne (t)
Gg	1 gigagram = 10^9 g = 1 kilotonne (kt)
Tg	1 teragram = 10^{12} g = 1 megatonne (Mt)
Mt CO_2 equivalents	Mega (million) tonnes of CO_2 equivalents

AC	acceding countries (Cyprus, the Czech Republic, Estonia, Hungary, Latvia, Lithuania, Malta, Poland, Slovakia, Slovenia)
Ac	accession
ACEA	European automobile manufacturers' association (EU-wide agreement with ACEA and similarly also with Japanese (JAMA) and Korean (KAMA) automobile manufacturing industries)
Ap	approval
ARD	afforestation, reforestation and deforestation
BS	burden sharing
BY	base year
C	carbon
CC	candidate countries (Bulgaria, Romania, Turkey)
CCPMs	common and coordinated policies and measures at EU level
CDM	clean development mechanism
CER	certified emission reduction
CHP	combined heat and power generation
CO_2	carbon dioxide
COP	conference of the parties
CRF	common reporting format
DTI	distance-to-target indicator

ECCP	European climate change programme
EEA	European Environment Agency
Eionet	European environment information and observation network
ERU	emission reduction unit
ET	emissions trading
ETC/ACC	European Topic Centre on Air and Climate Change
FAO	Food and Agriculture Organisation of the United Nations
F-gases	fluorinated gases (HFCs, PFCs, SF_6)
GDP	gross domestic production
GHG	greenhouse gas
GIEC	gross inland energy consumption
HFCs	hydrofluorocarbons
IE	included elsewhere
IEA	International Energy Agency
JAMA	Japanese automobile manufacturers' association
JI	joint implementation
JRC	Joint Research Centre
IPCC	intergovernmental panel on climate change
KAMA	Korean automobile manufacturers' association
KP	Kyoto Protocol
LUCF	land-use change and forestry
LULUCF	land use and land-use change and forestry
MoU	memorandum of understanding
MS	EU Member States
MSP	Member State GHG emissions projections
NA	not available
NE	not estimated
NO	not occuring

N_2O	nitrous oxide
nq	not quantified
PAMs	policies and measures
PBL	Primes baseline scenario
PFCs	perfluorocarbons
RES	renewable energy sources
SF_6	sulphur hexafluoride
UNFCCC	United Nations Framework Convention on Climate Change
3NC	third national communication