

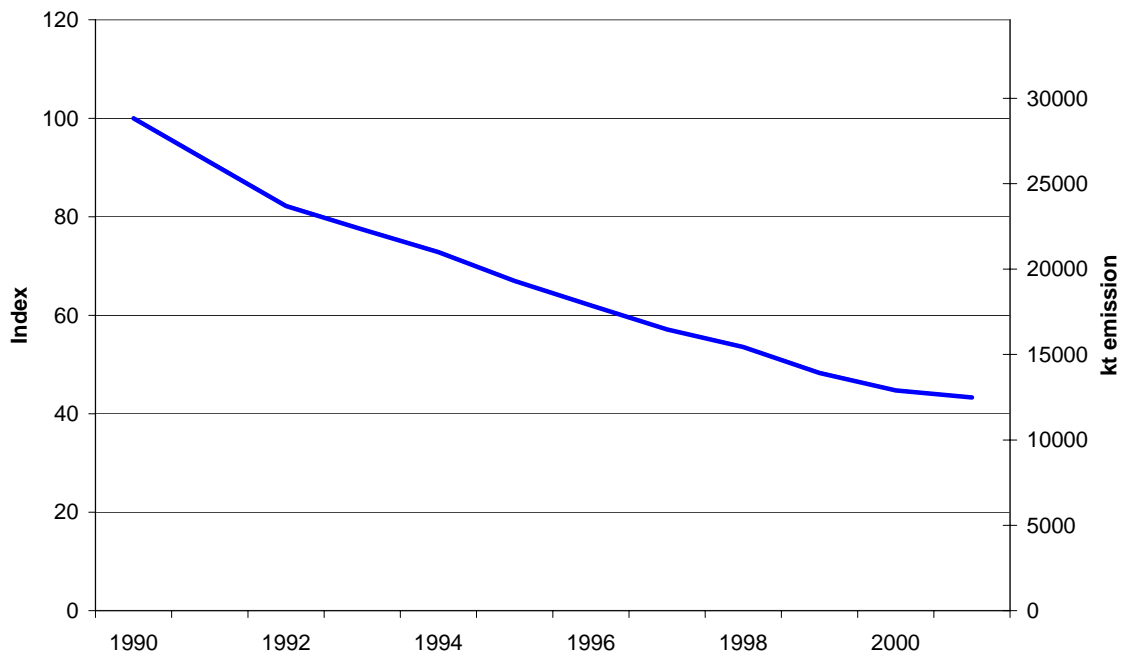
AP1 – EEA31 emissions of SO₂

Key messages

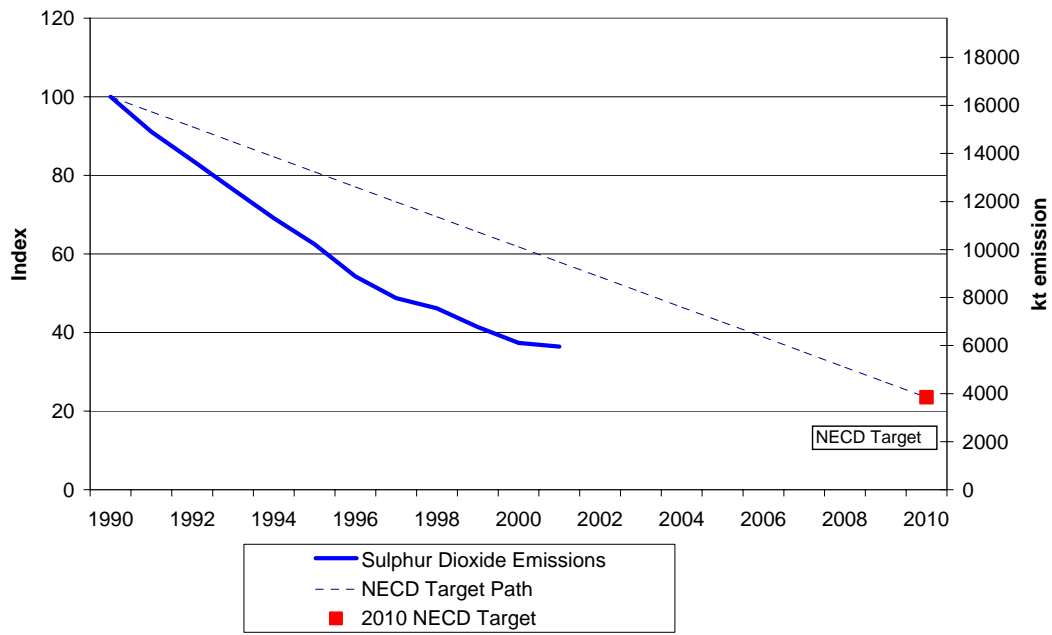
- ☺ EEA31 emissions of SO₂ have decreased by 57% between 1990 and 2001.
- ☺ The EU15 emissions of SO₂ have been reduced by 64% since 1990. This is mainly due to flue gas treatment and use of low-sulphur fuels in power plants.
- ☺ In 2001 the SO₂ emissions in 9 Accessing countries (AC) have been reduced by more than 60% since 1990. This is mainly due to significant reduction in the energy sector - implementation market economy principles, closing of inefficient plants, less use of sulphurous fuels and flue gas desulphurisation.
- ☺ The EU15 emissions of SO₂ are significantly below the linear target path towards the 2010 target of the National Emission Ceilings Directive. This is mainly due to the substantial emission reductions in Germany and the UK.
- ☺ Most EU Member States have reduced their SO₂ emissions well below their linear target paths and are approaching or have reached the 2010 target of the National Emission Ceilings Directive.
- ☺ Portugal, Ireland and Spain need to make significant reductions to reach the 2010 target of the National Emission Ceilings Directive.
- ☺ All Accessing and candidate countries have reduced their SO₂ emissions well below their linear target paths and are approaching or have reached the 2010 target of the Gothenburg protocol.
- ☺ Slovenia will need additional measures to reach the 2010 target. SO₂ emissions in Turkey (+33%) and Cyprus (+2%) increased in 2001 comparing to 1990.

Title: Emission trends of SO₂ for a) EEA31; b) EU15; c) AC10; d) EFTA3 and e) CC3

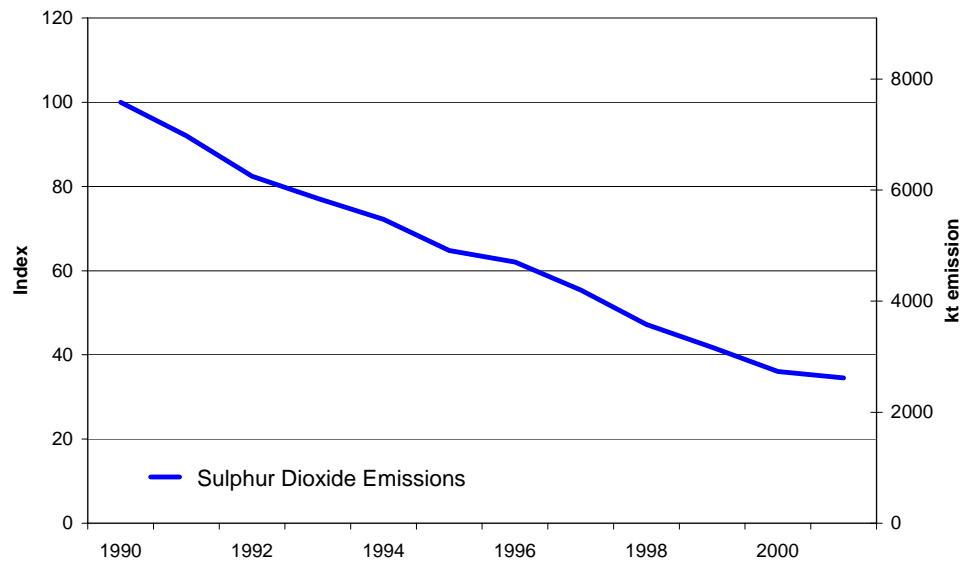
a) EEA31



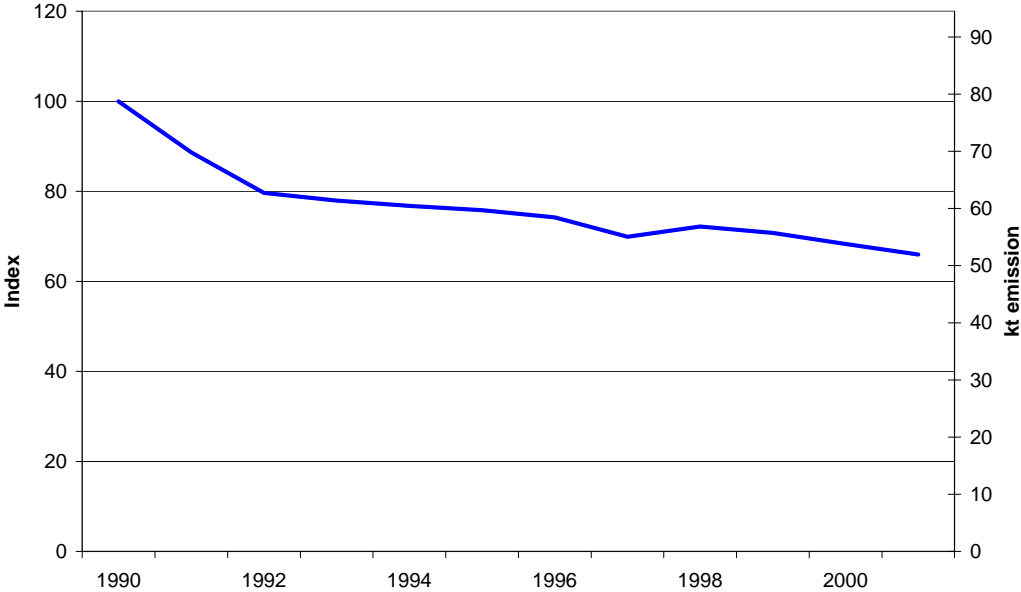
b) EU15



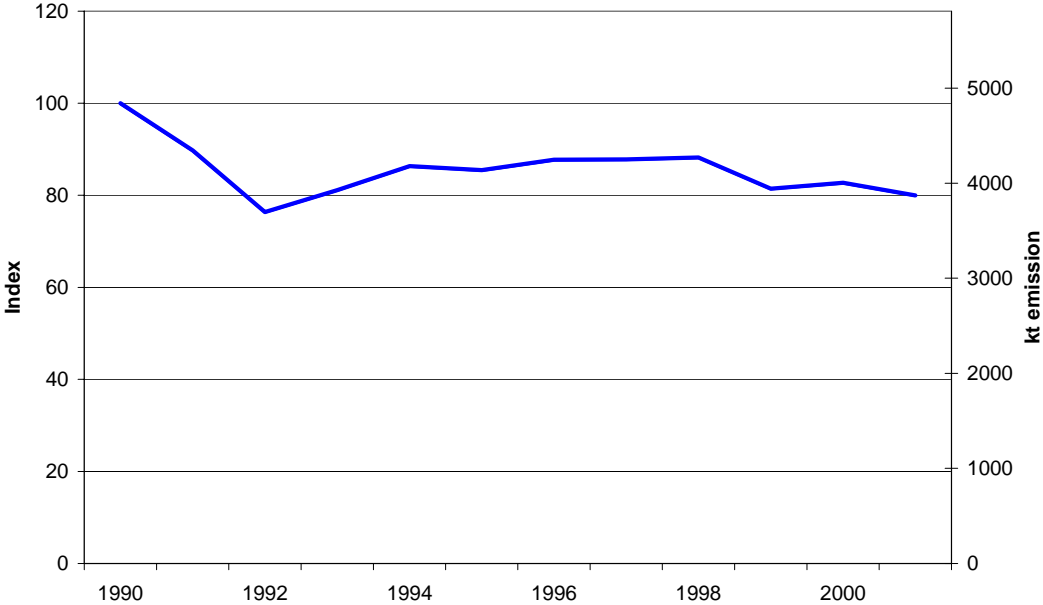
c) AC10



d) EFTA3

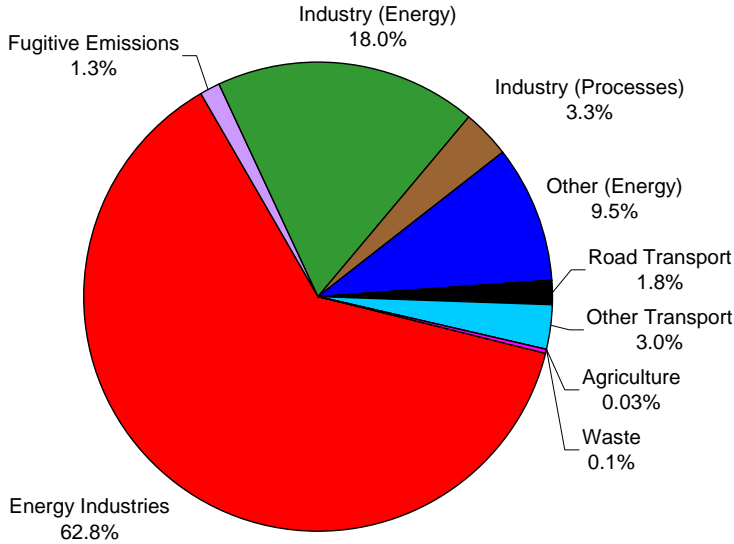


e) CC3

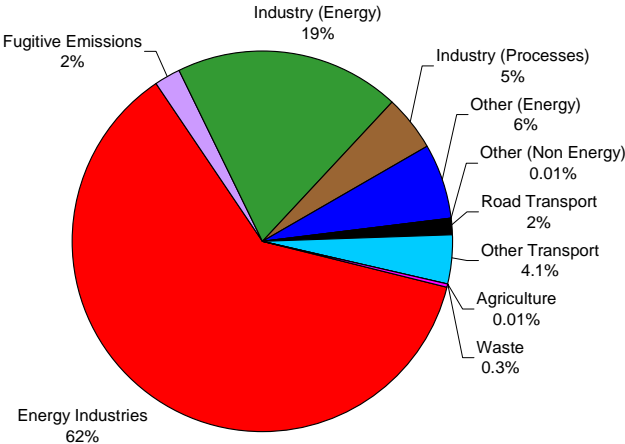


Title: Sector split of SO₂ emissions in 2001 for a) EEA31; b) EU15; c) AC10; d) EFTA3 and e) CC3 (%).

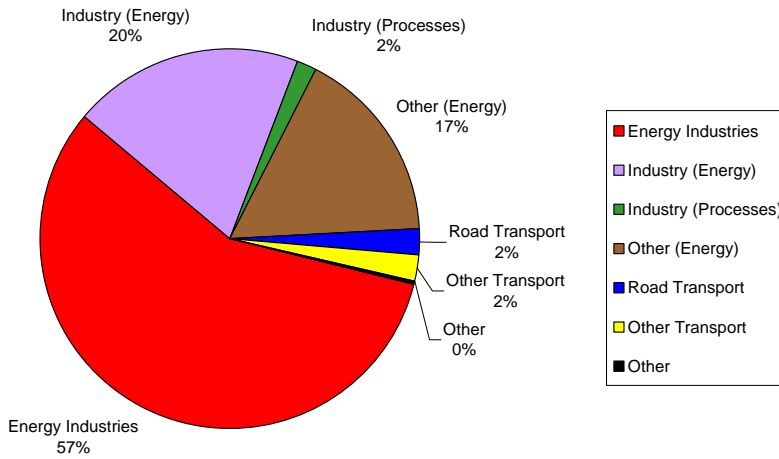
a) EEA31



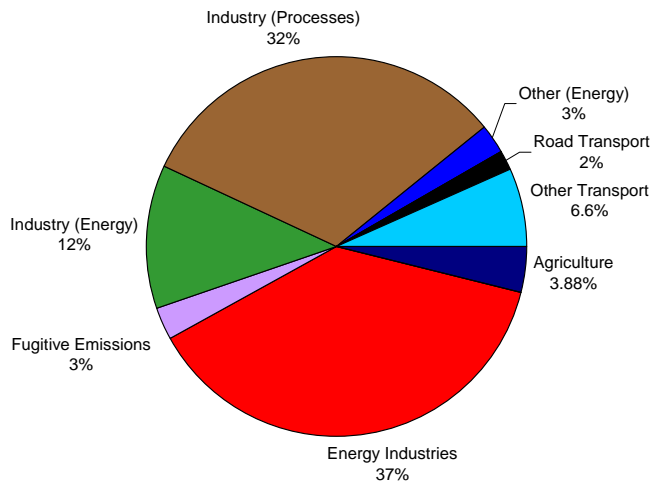
b) EU15



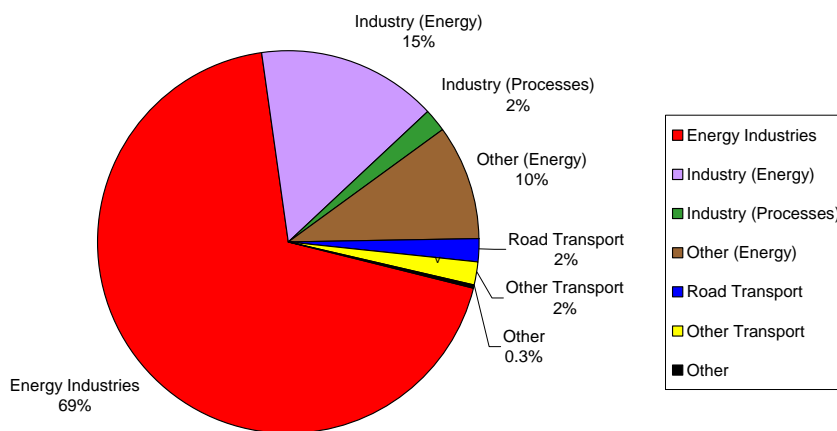
c) AC10



d) EFTA3

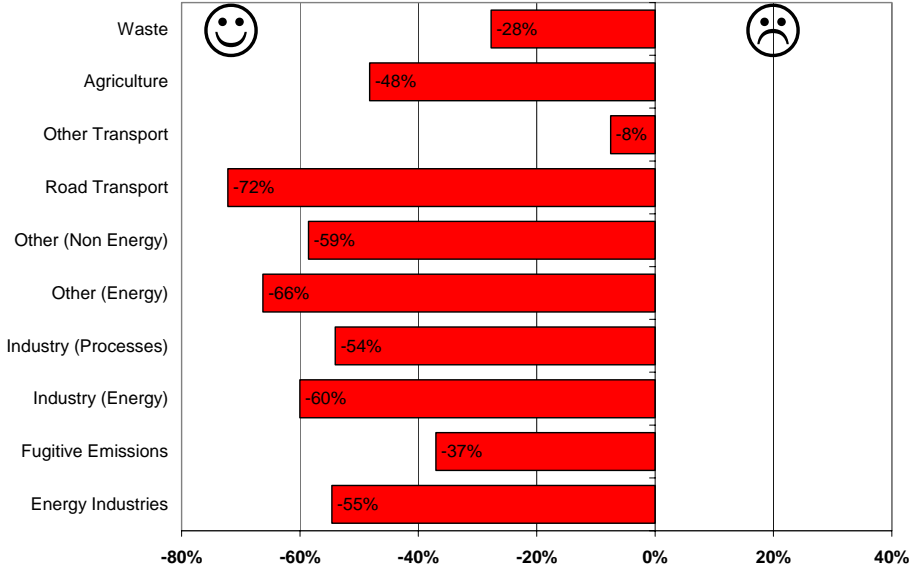


e) CC3

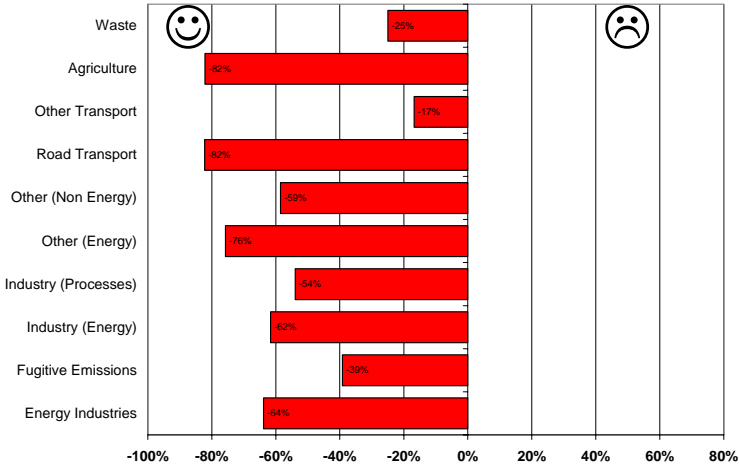


Title: Change in SO₂ emissions in each sector 1990 – 2001, for a) EEA31; b) EU15; c) AC10; d) EFTA3 and e) CC3 (%).

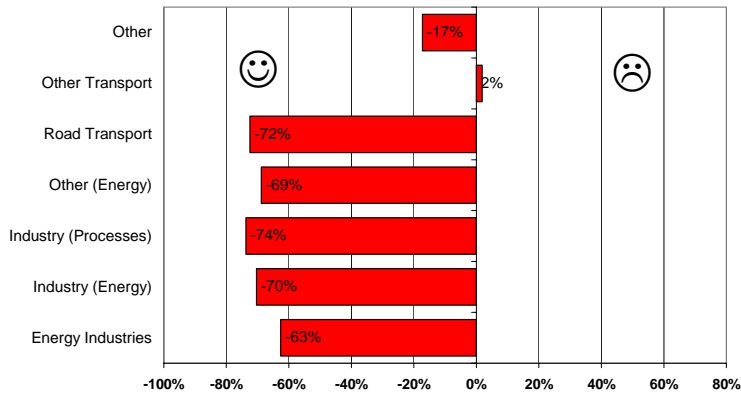
a) EEA31



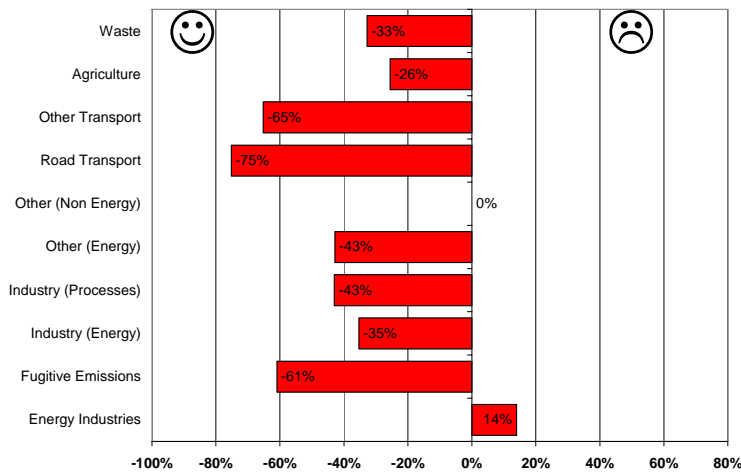
b) EU15



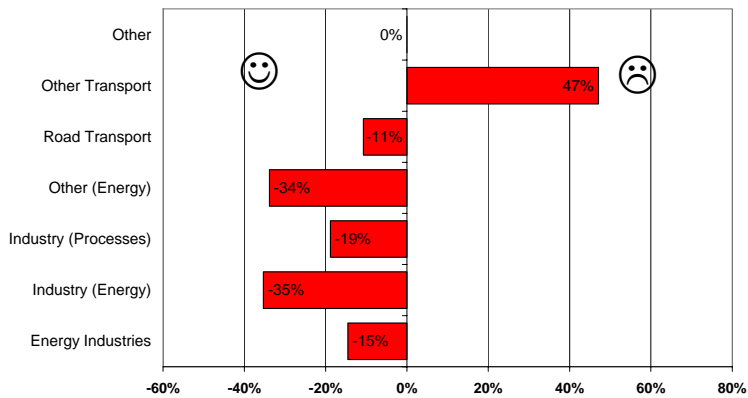
c) AC10



d) EFTA3

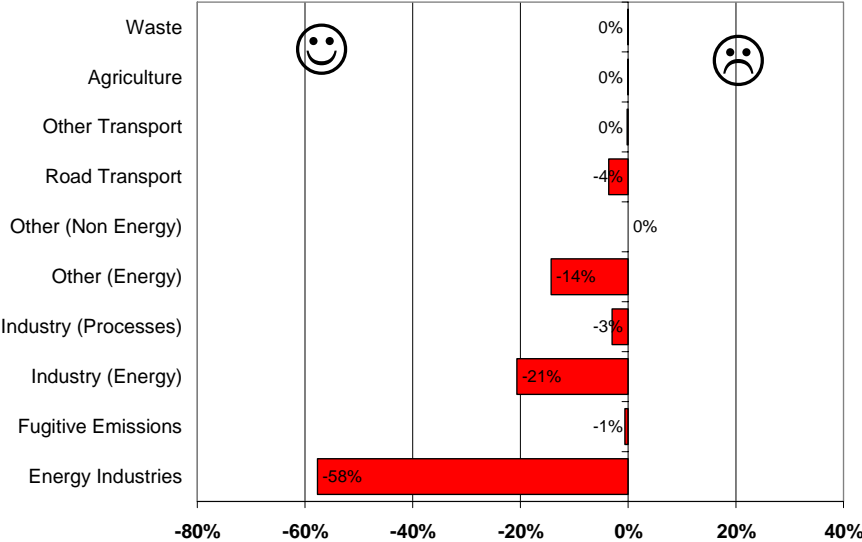


e) CC3

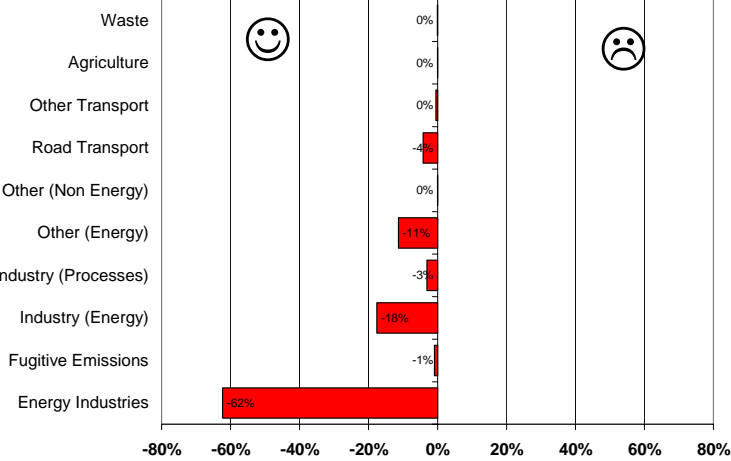


Title: Contribution to total sectoral change in SO₂ emissions for each sector 1990 – 2001, for a) EEA31; b) EU15; c) AC10; d) EFTA3 and e) CC3 (%)

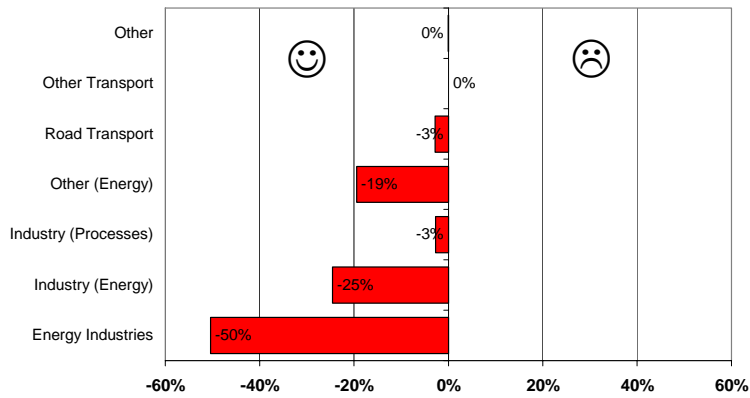
a) EEA31



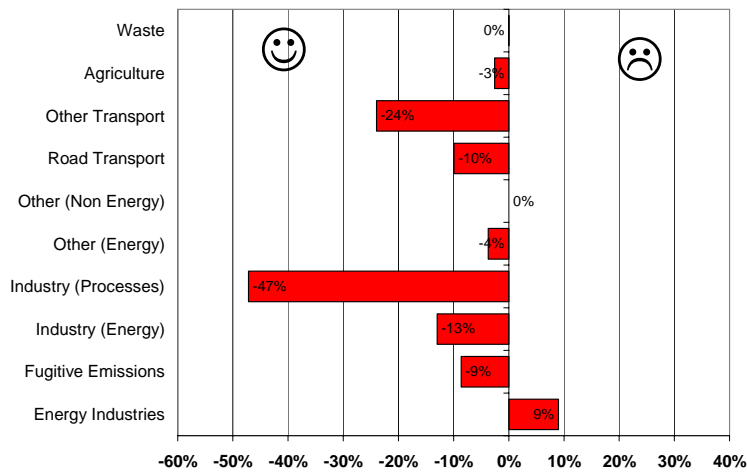
b) EU15



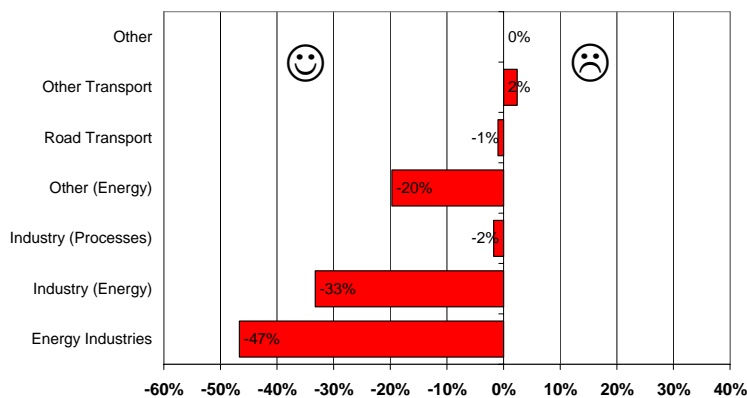
c) AC10



d) EFTA3



e) CC3



Notes: Emission targets for sulphur dioxide are set through the National Emission Ceilings Directive - NECD. The NECD specifies individual targets for Member States- and EU15- for sulphur dioxide, nitrogen oxide and ammonia respectively.

Data for Malta not available and is not included in graphs.

Source: EEA/ETC-ACC (2003).

Results and assessment

Policy objectives and measures

Emissions of sulphur dioxide are addressed by the NEC Directive and the Gothenburg Protocol under UNECE CLRTAP (see below). The EU15 NEC directives emission reduction targets are slightly stricter (a 78% reduction target 1990-2010) than the targets set in the Gothenburg Protocol (a 75% reduction target 1990-2010). The NEC directives emission reduction targets do not apply for Acceding and candidate countries. In Acceding and candidate countries SO₂ emissions have been reduced as required by Gothenburg and Sulphur protocols. Cyprus, Estonia, Malta (AC) and Turkey (CC) are not signatory of these protocols.

This indicator constitutes relevant information for the Clean Air For Europe program (CAFE).

A number of policies are being implemented to reduce the emissions of sulphur dioxide. These include:

- The Gothenburg Protocol to the United Nations Economic Commission for Europe's (UNECE) Convention on Long-Range Transboundary Air Pollution (CLRTAP) to abate acidification, eutrophication and ground-level ozone (UNECE 1999). A key objective of the protocol is to regulate emissions on a regional basis and protect eco-systems from transboundary pollution by setting emission reduction targets for the pollutants, SO_x, (and NO_x, NH₃ and NMVOCs) to be reached by 2010;
- Directive 2001/81/EC, on national emissions ceilings (NECD) for certain atmospheric pollutants requires the introduction of national emission ceilings for emissions of SO₂ and NO_x in each Member State, as well as setting interim environmental objectives for reducing the exposure of ecosystems and human populations to the damaging levels of acid pollutants and ozone;
- the Directive for the Sulphur content of Certain Fuels (93/12/EC). The Directive requires Member States to cease the use of heavy fuel oil with a sulphur content greater than 1% by mass from 2001, and the use of gas oil with a sulphur content greater than 0.2% from 2001 and greater than 0.1% from 2008;
- The Large Combustion Plant Directive (2001/80/EC) is important in reducing emissions of SO₂, NO_x and dust from combustion plants with a capacity greater than 50 MW. The Directive sets emission limits for licensing of new plant and requires Member States to establish programmes for reducing total emissions. Emissions limits for all plant will be revised in 2007 under the IPPC Directive;
- the Directive on Integrated Pollution Prevention and Control (96/61/EC) entered into force in 1999. It aims to prevent or minimise pollution of water, air and soil by industrial effluent and other waste from industrial installations, including energy industries, by defining basic obligations for operating licences or permits and by introducing targets, or benchmarks, for energy efficiency. It also requires the application of Best Available Techniques (BAT) in new installations from now on (and for existing plants over the next 10 years according to national legislation);
- Directive 96/62/EC on ambient air quality assessment and management, established a framework under which the EU would set limit values for specific pollutants in the future. The "Daughter" Directive 99/30/EC entered into force in 1999 and sets limit values for concentrations of SO₂, NO_x, and PM₁₀, and requires Member States to reach limit values for SO₂ and NO_x by 2005 and 2010 respectively;
- the Directive on the promotion of electricity from renewable energy sources in the internal electricity market (2001/77/EC);
- the EU White Paper for a Community Strategy and Action Plan on Renewable Energy Sources, COM(97) 599 final.

Environmental Context

Sulphur dioxide is emitted when fuels containing sulphur are combusted. Emissions of sulphur dioxide are causing acidification through subsequent chemical reactions and deposition on ecosystems and materials. Deposition of acidifying substances causes damages to ecosystems, buildings and materials (corrosion). The adverse effect associated with each individual pollutant depends on its potential to acidify and the individual properties of the ecosystems and materials.

Sulphur dioxide is also a secondary particulate precursor affecting air quality and may therefore, indirectly, have adverse effects on human health (see factsheet 'AP5c Emissions of primary particulates and secondary particulate precursors').

Assessment

Sulphur dioxide emissions in the EU15 have reduced by 64% between 1990 and 2001. The decrease between 2000 and 2001 was 3%. The anthropogenic emission of SO₂ originates mainly from the combustion of sulphur containing fuels. The main sources in 2001 are the Energy sector (62%), Industry (Energy) (19%), Commercial and domestic combustion - Other (Energy) (6%) and Transport (6%).

Of most significance for the overall decrease in emissions have been the reductions from energy industries (64% between 1990 and 2001) and from energy use in industry (62% between 1990 and 2001). The emission reduction is mainly due to a switch from high sulphur, solid and liquid fuels to natural gas, in the energy industries, industry and domestic sectors, as well as construction of new power plant, the use of low sulphur coal and installation of flue gas desulphurisation equipment.

Further emission reductions are required in order that the EU-15 reaches the 2010 targets set out in the National Emission Ceilings Directive.

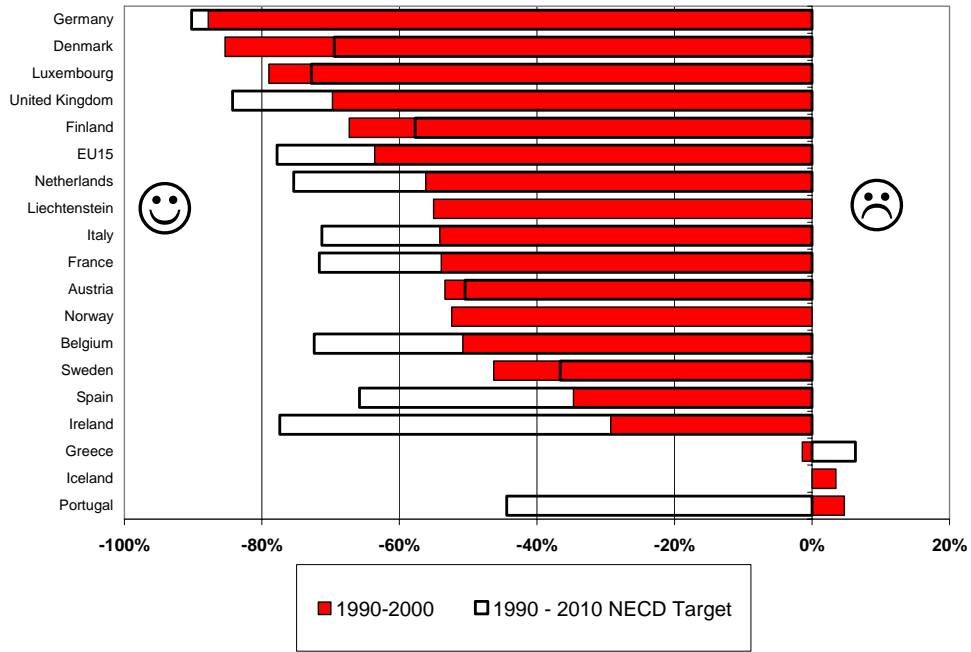
Sulphur dioxide emissions in the 9 candidate countries have reduced by 65% between 1990 and 2001. The decrease between 1999 and 2000 was 10%, change 2000/2001 was only minus 4%. The anthropogenic emission of SO₂ originates mainly from the combustion of sulphur containing fuels. The main sources in 2000 are the Energy sector (57%), Industry (20%), and Other (Energy) (17%). The share of Transport increased from 1% in 2000 to 4% in 2001.

Of most significance for the overall decrease in emissions have been the in energy sector (around 70%). The emission reduction is mainly due to reduced energy consumption (except Slovenia and Poland), a switch from, high sulphur, solid and liquid fuels to natural gas, in the energy industries, industry and domestic sectors, as well as construction of new power plant and the use of low sulphur coal and flue gas desulphurisation. In year 2001 comparing to 2000 emissions from Industry (Processes) and Industry (Energy) increased by 29% and 6%, and emissions from Transport increased by 5%.

Changes are large however with different importance for the total emissions. The most important contribution to change in SO₂ emissions between 1990 and 2001 for AC and CC is in the Energy sector.

The deposition of acidifying substance still exceeds the critical loads of the ecosystems (see indicator and fact sheets on 'Areas exposed to acidification and eutrophication').

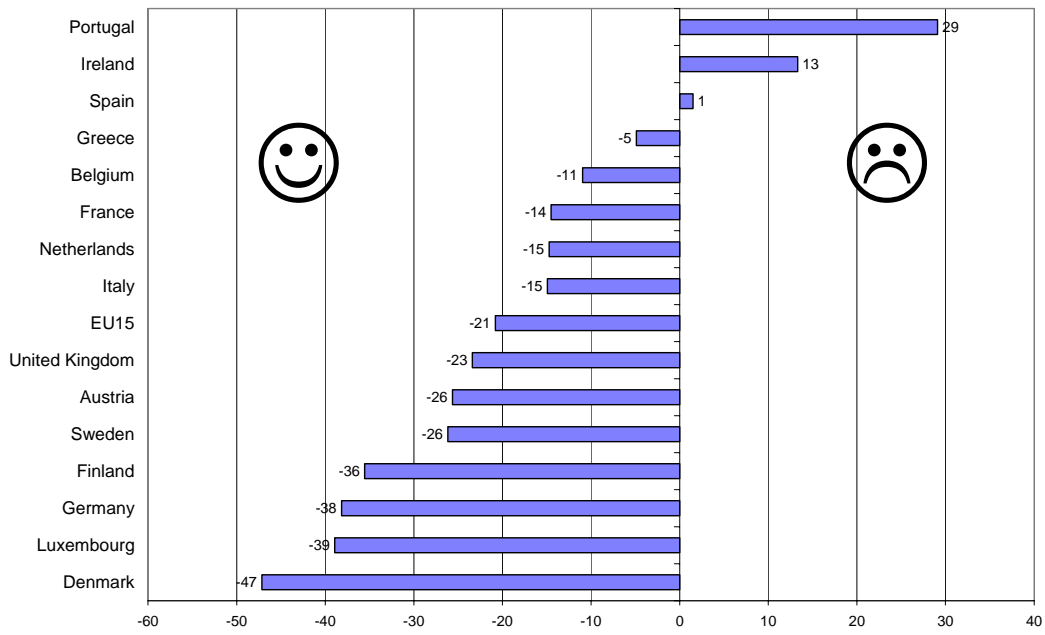
Title: Change in national SO₂ emissions since 1990 compared with the 2010 NECD targets EU15 (%).



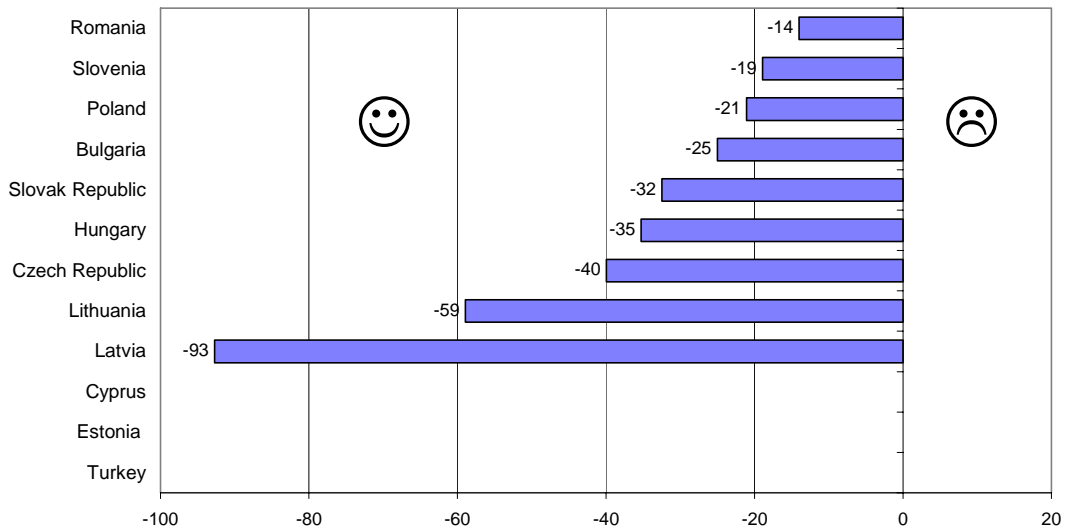
Title: Change in national SO₂ emissions since 1990 compared with the 2010 Gothenburg targets AC10+CC3 (%).



Title: Distance-to-target indicators (in index points) for the 2010 targets of the NECD, EU15.



Title: Distance-to-target indicators (in index points) for the 2010 targets, AC and CC.



Notes: Emission targets for sulphur dioxide are set through the National Emission Ceilings Directive - NECD.

The NECD and Gothenburg specify individual targets for countries for sulphur dioxide. The distance-to-target indicator is a measure of how close the current emissions (2001) are to a linear path of emissions reductions from 1990 to the target set for 2010.

Source : EEA/ETC-ACC (2003)

Assessment

EU15 and most Member States have made significant progress and are more than half way to the 2010 NECD targets. The EU15 emissions are more than twenty index points below its linear target path. This is mainly due to the substantial emission reductions in Germany and the UK. Eleven Member States were more than 10 index points below their linear path to the NECD target in 2001, representing substantial progress across the region in reducing emissions. Emissions from Portugal and Ireland are substantially higher than the target path and these countries therefore need to make significant reductions to reach the 2010 target of the National Emission Ceilings Directive.

Candidate countries have made significant progress and are more than half way to the 2010 Gothenburg protocol targets. In all candidate countries emissions were more than eight index points below its linear target path. Czech republic with 47 Lithuania 53 and Latvia 69 index points under the linear path are very close to their target reduction.

References

EEA (2001). Joint EMEP/CORINAIR Atmospheric Emission Inventory Guidebook, Third Edition. Copenhagen: European Environment Agency, 2001.

EEA/ETC-ACC (2003). Manipulated data based on 2003 update of Member States' data reported to UNECE/CLRTAP/EMEP. Base data are available on the EMEP web site (<http://webdab.emep.int/>)

EMEP (1998). "Transboundary Acidifying Air Pollution in Europe", Part 1: Estimated dispersion of acidifying and eutrophying compounds and comparison with observations. EMEP/MSW Report 1/98, July 1998.

UNECE (1999). Protocol to the 1979 Convention on Long-range Transboundary Air Pollution (CLRTAP) to abate acidification, eutrophication and ground-level ozone, Gothenburg, Sweden, 1 December 1999.

Data

EEA31 SO₂ emissions by sector (ktonnes)

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	Change 1990-2001	Change 1990-2001 (%)	% contribution to Change
Energy Industries	17290	16008	14326	13629	12975	12266	11208	10323	9816	8765	8169	7851	-9439	-55%	-57.7%
Fugitive Emissions	258	219	223	250	229	227	216	211	221	204	200	163	-96	-37%	-0.6%
Industry (Energy)	5626	5049	4726	3892	3608	3418	3178	3026	2736	2418	2328	2249	-3377	-60%	-20.6%
Industry (Processes)	897	714	635	602	585	510	476	471	454	426	401	412	-485	-54%	-3.0%
Other (Energy)	3530	3136	2693	2892	2534	1910	1854	1676	1451	1382	1203	1191	-2339	-66%	-14.3%
Other (Non Energy)	1	1	1	1	1	1	1	1	1	0	0	0	-1	-59%	0.0%
Road Transport	819	736	713	683	695	624	533	372	351	316	233	228	-591	-72%	-3.6%
Other Transport	412	398	372	365	363	343	395	368	400	401	347	381	-31	-8%	-0.2%
Agriculture	8	6	6	5	5	4	5	4	4	4	4	4	-4	-48%	0.0%
Waste	24	24	26	28	28	26	24	27	23	22	18	17	-7	-28%	0.0%
Total	28864	26292	23722	22346	21022	19328	17889	16478	15458	13939	12904	12495	-16369	-57%	-

EU15 SO₂ emissions by sector (ktonnes)

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	Change 1990-2001	Change 1990-2001 (%)	% contribution to Change
Energy Industries	10155	9559	8850	7962	7169	6437	5436	4831	4606	4128	3782	3669	-6487	-64%	-62%
Fugitive Emissions	239	201	205	232	211	209	198	192	203	186	182	145	-93	-39%	-1%
Industry (Energy)	2970	2647	2475	2244	2012	1941	1710	1644	1468	1292	1170	1139	-1831	-62%	-18%
Industry (Processes)	594	436	387	345	354	339	313	310	310	292	271	274	-320	-54%	-3%
Other (Energy)	1560	1257	1021	933	757	584	560	509	468	414	355	379	-1182	-76%	-11%
Other (Non Energy)	1	1	1	1	1	1	1	1	1	0	0	0.4	-1	-59%	-0.01%
Road Transport	532	511	496	511	528	462	365	205	193	161	102	94	-437	-82%	-4%
Other Transport	291	270	257	255	255	229	281	259	283	282	234	242	-49	-17%	-0.5%

Agriculture	4	3	2	2	1	1	1	1	1	1	1	1	-3	-82%	-0.03%
Waste	23	23	25	27	27	26	24	27	22	22	18	17	-6	-25%	-0.06%
EU15 Total	16368	14907	13719	12512	11315	10229	8887	7979	7553	6777	6115	5960	-10409	-64%	-

AC SO₂ emissions by sector (ktonnes),

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	Change 1990-2001	Change 1990-2001 (%)	% contribution to Change
Energy Industries	3999	3705	3311	3118	2956	2993	2823	2543	2239	1917	1651	1497	-2503	-63%	-50%
Fugitive Emissions	3	3	3	3	3	3	3	3	3	3	3	3	0	0%	0%
Industry (Energy)	1733	1525	1398	981	923	823	799	704	595	514	483	513	-1220	-70%	-25%
Industry (Processes)	183	174	153	161	135	73	65	59	44	38	37	48	-135	-74%	-3%
Other (Energy)	1402	1365	1186	1438	1306	871	857	738	558	558	447	437	-965	-69%	-19%
Other (Non Energy)	0	0	0	0	0	0	0	0	0	0	0	0	0	-	0%
Road Transport	196	140	134	87	85	78	86	86	78	76	51	54	-142	-72%	-3%
Other Transport	62	61	60	59	61	65	67	62	62	60	60	63	1	2%	0%
Agriculture	1	1	1	1	1	1	2	2	1	1	1	1	0	0%	0%
Waste	1	1	1	1	1	0	0	0	0	0	0	0	-1	-99%	0%
Total	7580	6976	6247	5850	5471	4907	4701	4198	3580	3167	2734	2616	-4964	-65%	

Note: Data for Malta not available

EFTA3 SO₂ emissions by sector (ktonnes),

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	Change 1990-2001	Change 1990-2001 (%)	% contribution to Change
Energy Industries	17.3	17	17	17	17	17	17	17	19	19	20	20	2	14%	9%
Fugitive Emissions	3.8	2	2	2	2	2	2	2	2	2	2	1	-2	-61%	-9%
Industry (Energy)	9.8	8	8	8	9	7	8	8	7	7	6	6	-3	-35%	-13%
Industry (Processes)	29.4	25	20	21	21	23	22	20	19	19	19	17	-13	-43%	-47%
Other (Energy)	2.3	2	1	1	1	1	1	1	1	1	1	1	-1	-43%	-4%
Other (Non Energy)	0.0	0	0	0	0	0	0	0	0	0	0	0	0	-	0%
Road Transport	3.5	3	3	3	2	2	2	2	2	1	1	1	-3	-75%	-10%
Other Transport	9.8	9	8	7	6	6	4	3	4	3	4	3	-6	-65%	-24%
Agriculture	2.7	3	2	2	2	2	2	2	2	2	2	2	-1	-26%	-3%
Waste	0.0	0	0	0	0	0	0	0	0	0	0	0	0	-33%	0%
Total	78.7	70	63	61	60	60	58	55	57	56	54	52	-27	-34%	-

CC SO₂ emissions by sector (ktonnes),

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	Change 1990-2001	Change 1990-2001 (%)	% contribution to Change
Energy Industries	3118	2727	2147	2531	2833	2819	2932	2932	2952	2701	2716	2666	-452	-15%	-47%
Fugitive Emissions	13	13	13	13	13	13	13	13	13	13	13	13	0	0%	0%
Industry (Energy)	913	869	845	659	664	648	660	670	666	605	670	591	-322	-35%	-33%
Industry (Processes)	90	79	76	75	75	75	76	81	81	77	73	73	-17	-19%	-2%
Other (Energy)	565	513	485	520	469	453	436	427	424	409	400	374	-191	-34%	-20%
Other (Non Energy)	0	0	0	0	0	0	0	0	0	0	0	0	0	-	0%
Road Transport	88	81	80	81	79	81	81	80	79	78	79	78	-9	-11%	-1%
Other Transport	49	57	47	44	42	43	44	43	52	55	49	73	23	47%	2%
Agriculture	0	0	0	0	0	0	0	0	0	0	0	0	0	-	0%
Waste	0	0	0	0	0	0	0	0	0	0	0	0	0	-10%	0%
Total	4837	4340	3694	3924	4176	4133	4242	4246	4267	3938	4000	3867	-969	-20	-

SO₂ emissions by country 1990-2001, EU15 and EFTA3

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
Austria	79	72	59	58	52	52	51	46	43	39	38	37
Belgium	359	408	391	362	311	257	250	230	222	191	165	176
Denmark	180	240	188	156	161	152	182	112	76	55	29	26
Finland	260	195	142	123	115	96	107	101	91	88	75	85
France	1323	1440	1276	1110	1056	993	968	820	846	723	654	610
Germany	5324	3994	3308	2947	2475	1942	1340	1039	835	738	638	650
Greece	492	532	545	546	518	542	526	520	528	539	482	485
Ireland	186	180	172	161	175	161	147	166	176	158	131	131
Italy	1653	1540	1394	1334	1272	1321	1205	1076	1038	923	758	758
Luxembourg	15	15	15	15	13	9	8	6	4	4	3	3
Netherlands	203	205	201	191	176	142	139	114	108	103	92	89
Portugal	288	283	343	308	279	318	261	265	299	315	288	301
Spain	2182	2168	2138	2008	1956	1806	1579	1746	1611	1618	1517	1425
Sweden	106	99	88	78	80	73	97	70	67	54	57	57
United Kingdom	3719	3535	3461	3115	2675	2365	2029	1670	1608	1229	1188	1125
EU15	16368	14907	13719	12512	11315	10229	8887	7979	7553	6777	6115	5960
Iceland	26	25	26	26	26	26	25	25	27	27	27	27
Liechtenstein	0.11	0.11	0.10	0.09	0.08	0.08	0.07	0.07	0.06	0.06	0.05	0.05
Norway	53	45	37	35	34	34	33	30	30	29	27	25

SO₂ emissions by country 1990-2001 (ktonnes), AC and CC

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
Cyprus	51	37	43	48	47	46	50	53	53	56	55	52
Czech Republic	1879	1782	1541	1422	1273	1093	949	703	446	272	267	251
Estonia	256	249	191	157	153	122	129	123	114	106	95	92
Hungary	1011	914	828	758	741	705	673	659	592	590	486	401
Latvia	95	71	59	58	71	55	51	39	36	29	17	13
Lithuania	222	234	139	125	117	94	93	77	94	70	43	49
Malta	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Poland	3327	3063	2879	2774	2654	2428	2417	2225	1943	1768	1551	1564
Slovak Republic	543	447	381	326	239	240	228	203	180	172	124	129
Slovenia	197	180	187	183	176	125	112	118	123	105	97	66
AC	7580	6976	6247	5850	5471	4907	4701	4198	3580	3167	2734	2616
Bulgaria	1937	1634	1103	1410	1454	1455	1411	1350	1240	926	981	849
Romania	1310	1040	945	921	906	906	906	906	906	906	906	906
Turkey	1590	1666	1646	1593	1816	1772	1925	1990	2121	2106	2113	2113
CC	4837	4340	3694	3924	4176	4133	4242	4246	4267	3938	4000	3867

Note: Data from Malta not available

Change in SO₂ emissions since 1990 including the NECD and CLRTAP targets¹, EU15 and EFTA3

	Change 1990-2001	Change 1990-2001 (%)	1990 - 2010: NECD target	1990 - 2010: CLRTAP Gothenburg Protocol target
Austria	42	-53%	-50%	-50%
Belgium	182	-51%	-72%	-70%
Denmark	154	-85%	-69%	-69%
Finland	175	-67%	-58%	-55%
France	713	-54%	-72%	-70%
Germany	4674	-88%	-90%	-90%
Greece	7	-1%	6%	11%
Ireland	54	-29%	-77%	-77%
Italy	895	-54%	-71%	-70%
Luxembourg	12	-79%	-73%	-73%
Netherlands	114	-56%	-75%	-75%
Portugal	-13	5%	-44%	-41%
Spain	757	-35%	-66%	-65%
Sweden	49	-46%	-37%	-37%
United Kingdom	2594	-70%	-84%	-83%
EU15	10409	-64%	-78%	-75%
Iceland	-1	3%	-	-
Liechtenstein	0.06	-55%	-	-3%
Norway	28	-52%	-	-58%

Change in SO₂ emissions since 1990 including CLRTAP targets, AC and CC

	Change 1990-2001	Change 1990-2001 (%)	1990 - 2010: CLRTAP Gothenburg Protocol targets
Cyprus	1	2%	-
Czech Republic	-1628	-87%	-85%
Estonia	-164	-64%	-
Hungary	-610	-60%	-46%
Latvia	-82	-86%	12%
Lithuania	-173	-78%	-35%
Malta	0	NA	-
Poland	-1762	-53%	-58%
Slovak Republic	-415	-76%	-80%
Slovenia	-130	-66%	-86%
AC	-4964	-65%	-
Bulgaria	-1088	-56%	-56%
Romania	-404	-31%	-30%
Turkey	523	33%	-
CC	-969	-20%	-

¹ The actual 2010 targets of the CLRTAP Gothenburg Protocol are expressed as absolute emissions of SO₂, NO_x, NH₃ and NMVOC in ktonnes. As the 1990 base year emission may change due to updated and revised emission inventory guidelines, the targets expressed in % change from 1990 may also change.

Meta data

Technical information

1. *Data source*: Officially reported national total and sectoral emissions to UNECE/CLRTAP/EMEP, 2003 data submission.
2. *Description of data*: Emissions of combined SO₂ in 1000 tonnes (ktonnes). Combination of data officially reported to CLRTAP/EMEP. Gaps filled by ETC/ACC where necessary using simple interpolation techniques (see 6).
3. *Spatial Coverage*: EEA 31. Note: data for Malta not available.
4. *Temporal Coverage*: 1990 - 2001.
5. *Methodology*: Annual country data submissions to EMEP/CLRTAP. Combination of emission measurements and emission estimates based on volume of activities and emission factors. Recommended methodologies for emission data collection are compiled in the Joint EMEP/CORINAIR Atmospheric Emission Inventory Guidebook (2001), 3rd ed, EEA, Copenhagen.
6. *Methodology of manipulation*: ETC-ACC gap-filling methodology. Where countries have not reported data for one, or several years, data has been interpolated to derive annual emission when data is missing between two different years. If the reported data is missing either at the beginning or at the end of the time series period, the emission value has usually been considered to equal the first (or last) reported emission value. It is recognised that the use of gap-filling can potentially lead to artificial trends, but it is considered unavoidable if a comprehensive and comparable set of emissions data for European countries is required for policy analysis purposes. A list of the data used within this sheet which has been gap-filled is available from ETC-ACC upon request
7. *Strengths and weaknesses*:
Strength: officially reported data following agreed procedures and Emission Inventory Guidebook, e.g. regarding source sector splits.
Weakness: Reporting to CLRTAP/EMEP and EEA/ETC-ACC can be incompatible for some countries.
8. *Reliability, accuracy, robustness, uncertainty*: Sulphur dioxide emission estimates in Europe are thought to have an uncertainty of about $\pm 10\%$ as the sulphur emitted comes from the fuel burnt and therefore can be accurately estimated. However, because of the need for interpolation to account for missing data the complete dataset used here will have higher uncertainty. EMEP has compared modelled and measured concentrations throughout Europe (EMEP 1998). From these studies differences in the annual averages have been estimated in the order of $\pm 30\%$ consistent with an inventory uncertainty of $\pm 10\%$ (there are also uncertainties in the measurements and especially the modelling). The trend is likely to be more accurate than the individual absolute annual values - the annual values are not independent of each other.
9. *Overall scoring (1-3, 1=no major problems, 3=major reservations)*
Relevancy: 1
Accuracy: 2
Comparability over time: 2
Comparability over space: 2

Further work required:

Countries should improve the completeness of the time series of their estimates (filling gaps). Further validation and checking is the responsibility of the country and needs especially to lead to improved detailed sectoral time series of emissions. There is also a need for further validation and checking of emission estimates within the framework of CLRTAP/EMEP and EEA/ETC-ACC activities.