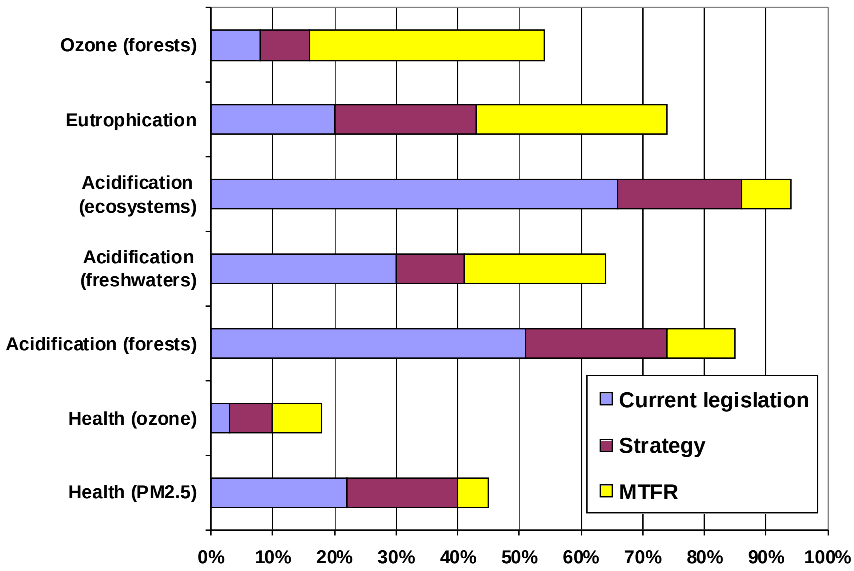
CLEAN AIR FOR EUROPE

Figure 1. Estimated improvement of health and environmental indicators resulting from the baseline scenario (CLE) and additional improvements from the strategy and the maximum technically feasible reductions (MTFR) scenario.



Note: The figure shows per cent gap-closure towards the no-effect level from the base year 2000 to the target year 2020. Figures on health impacts are based on change in the number of premature deaths, while figures on ecosystem impacts are based on change in exceedance of critical loads and levels.

The CAFE programme and the thematic strategy on air pollution

Current levels of air pollution cause severe health impacts in the European Union, resulting in some 370,000 premature deaths each year, increased hospital admissions, extra medication, and millions of lost working days. Additionally, there is widespread and significant damage to ecosystems, agricultural crops, modern materials, and the cultural heritage.

The annual cost to society of health impacts alone from fine particles and ozone for the year 2000 has been estimated to amount to between 276 and 790 billion euro.

Adopted by the Council and the European Parliament in July 2002, the EU's Sixth Environmental Action Programme (6EAP) establishes the objective of achieving levels of air quality that do not give rise to significant negative impacts on and risks to human health and the environment. For ecosystems this includes the requirement that critical loads and levels shall not be exceeded.

The Clean Air For Europe (CAFE) programme was launched by the Commission in 2001, with the aim of reviewing current air quality policies and assessing progress towards the long-term objectives of the 6EAP. (See box for more details about the aims and activities of CAFE.)

The 6EAP calls on the Commission to develop seven thematic strategies, including one on air pollution. One of the main tasks of CAFE up to 2005 has been to inform and assist the development of the thematic strategy on air pollution.

Emission trends up to 2020

In order to assess the effectiveness of current air quality policies, CAFE constructed a baseline scenario (also called the "current legislation" scenario – CLE) showing the expected emission levels up to 2020.

The main tool used for the scenario construction and analysis was the RAINS computer model for integrated assessment, essentially the same as that used a few years ago in putting together the directive on national emission ceilings. In addition, other computer models were employed to provide

Environmental
Fact sheet No. 19
Extended version
January 2006

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No. 18, September 2005:
Renewable energy in the EU

No. 17, September 2004:
EU emission standards for light and heavy road vehicles

No. 16, May 2004:
EU directive on national emission ceilings (NEC)

No. 15, March 2004:
EU policy on climate change: Targets, strategies and legislation

No. 10, June 2002:
EU legislation on air pollution

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information on trends in the energy, transport and agriculture sectors.

The baseline energy scenario provides a consistent EU-wide view of energy developments, including certain measures needed for implementation of the Kyoto Protocol. It results in a reduction in CO_2 emissions of 7.4 per cent by 2010 and 3.6 per cent by 2020, as compared to the base year 1990.

Based on this energy scenario, and assuming full implementation of current air quality legislation[1], emissions of sulphur dioxide (SO_2) in the 25 EU member countries will fall by two-thirds by 2020, as compared to the base year 2000. Emissions of nitrogen oxides (NO_x), volatile organic compounds (VOCs), and fine particles ($PM_{2.5}$) will be reduced by nearly half, while those of ammonia (NH_3) are expected to remain more or less the same up to 2020. See Figure 2.

Concentrations and depositions of air pollutants are also influenced by emissions from international shipping in the sea areas surrounding Europe. In contrast to the progress in reducing emissions from land-based sources, shipping emissions are expected to continue increasing.

Even after accounting for enforcement of MARPOL Annex VI and the new EU directive on sulphur in marine fuels, emissions of SO_2 from ships are expected to increase by more than 42 per cent by 2020, and those of NO_x by two-thirds. In both cases, by 2020 the emissions from international shipping around Europe will have surpassed the total from all land-based sources in the 25 member states combined.

[1] Some directives of importance for air pollutants emissions were not included in the baseline scenario, namely the air quality framework and daughter directives, the national emission ceilings directive, and the directive on integrated pollution prevention and control.

Current legislation inadequate

Damage to health is caused primarily by two types of air pollutants, namely fine particles and ozone. The latter is formed in the atmosphere from the reactions of NO_x and VOCs. It is a strongly oxidising gas that can damage vegetation (including agricultural crops and forest trees), certain type of materials, and human health.

Concentrations of $PM_{2.5}$ are increased through direct emissions of so-called primary particles, as well as indirectly through the release of gaseous pollutants (especially SO_2, NO_x, and NH_3) that react in the atmosphere to form so-called secondary particles.

For $PM_{2.5}$ the RAINS model estimates changes in the loss of statistical life expectancy that can be attributed to changes in anthropogenic emissions. It should be noted that these calculations do not include secondary organic aerosols and they only refer to impact on the population over 30 years of age, thus underestimating the total impact.

Using the pollution levels for the year 2000, it is estimated that $PM_{2.5}$ results in an average shortening of statistical life expectancy of more than eight months in the EU, equivalent to 3.6 million life years lost annually. Under current legislation, by 2020 this figure comes down to about 5.5 months (equivalent to 2.5 million life years lost). See Figure 4.

When it comes to ozone, the RAINS model estimates the number of premature deaths associated with ozone levels above a cut-off level of 35 parts per billion (ppb). Since there is medical evidence of health impact even below 35 ppb, the use of this cut-off level results in an underestimation of the impact. The number of premature deaths estimated as above will gradually decrease up to 2020 as a result of decreased emissions of the ozone precursors NO_x and VOCs.

Acidification, i.e. excess deposition of acidifying sulphur and nitrogen compounds, causes damage to both freshwater and terrestrial ecosystems. For the year 2000, nearly one quarter of a million square kilometres – or 21 per cent – of the forest area received acid deposition above the sustainable levels (the critical loads). By 2020 this is calculated to come down to about 10 per cent. See Figure 5.

Excess input of nutrient nitrogen, in the form of nitrogen oxides or ammonia, to terrestrial ecosystems gives rise to changes in plant communities and a consequent loss of biodiversity. The present nitrogen deposition exceeds the critical loads over 57 per cent of the area of sensitive ecosystems – a figure that will come down to 46 per cent by 2020. See Figure 6.

The critical level for protecting forest trees from ozone damage is currently exceeded over two-thirds of the ecosystem area. Under current legislation, by 2020 this figure will only be marginally reduced.

Table 1 provides a summary of the health and environmental impacts of various scenarios analysed by CAFE. It is clear that

Clean Air for Europe – the CAFE programme

The Clean Air for Europe (CAFE) programme was launched by the European Commission in 2001, with the aim of reviewing current air quality policies and assessing progress towards attainment of the EU's long-term air quality objectives, as laid down in the Sixth Environment Action Programme. CAFE has dealt with health and environmental problems related to fine particles (PM), ground-level ozone, acidification, and eutrophication.

CAFE has provided the analysis for the EU's thematic strategy on air pollution, which was adopted by the Commission in September 2005. The idea is that CAFE should evolve into an ongoing five-year cyclical programme, in which the 2005 thematic strategy on air pollution simply marks the first milestone.

The activities of the programme include:

❑ Developing and collecting scientific information on the effects of air pollution, making inventories and projections of emissions and air quality, doing studies of cost-effectiveness and carrying out integrated assessment modelling – all leading to new and/or revised objectives in respect of air quality and pollutant deposition, and identifying the measures required for reducing emissions.

❑ Supporting the implementation of existing legislation and reviewing its effectiveness, especially in view of the directives on air quality and on national emission ceilings, and developing new proposals for measures to abate emissions.

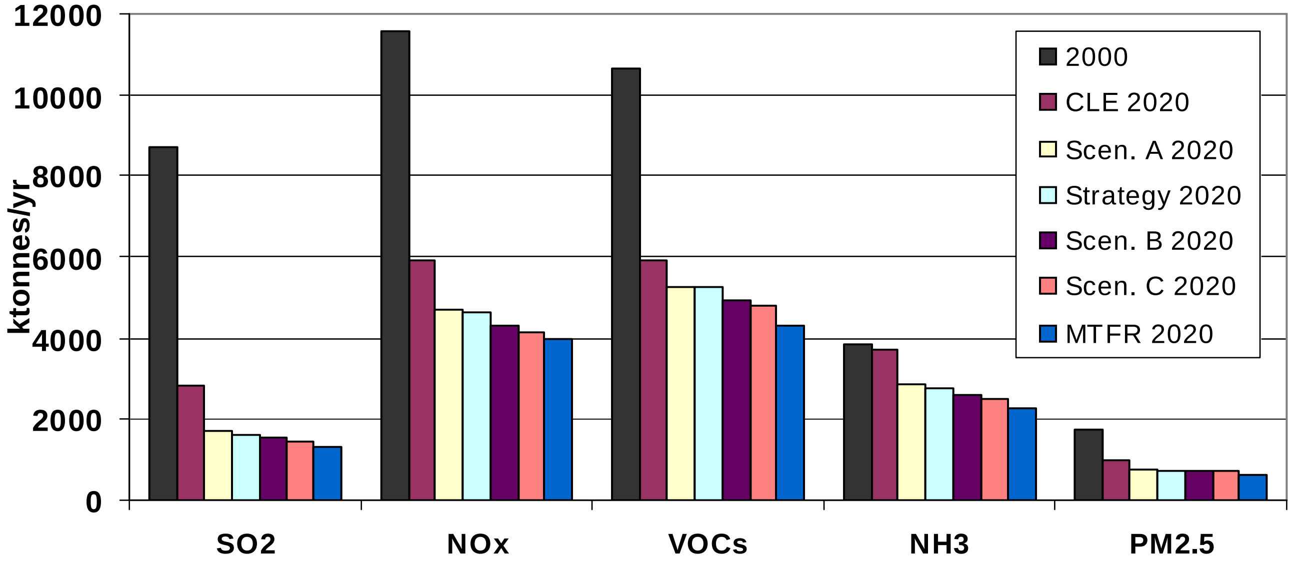
❑ Determining at regular intervals an integrated strategy to define appropriate air-quality objectives for the future and cost-effective measures for meeting those objectives.

❑ Disseminating the information emerging from the programme.

A steering group comprising representatives of the member states and stakeholders (e.g. industry and environmental NGOs) meets two or three times a year to advise the Commission on the strategic direction of the programme. In addition, during 2001–2005 four consultative working groups have been engaged. Altogether, the CAFE programme held more than one hundred stakeholder meetings in the last four years.

More information on the CAFE programme can be found on the website of the Commission's environment directorate: http://europa.eu.int/comm/environment/air/cafe/index.htm

Figure 2. Emissions in EU25 of SO_2, NOx, VOCs, NH_3, and $PM_{2.5}$ in the base year 2000 and six scenarios for 2020.



CLE is based on full implementation of current EU legislation; scenarios A, B and C are policy scenarios reflecting various level of ambition; Strategy illustrates the ambition level of the Commission's proposed Thematic Strategy; and MTFR illustrates implementation of so-called maximum technically feasible reductions (MTFR). (thousand tons)

significant negative impacts will persist and that the objectives of the 6EAP will not be achieved by 2020, even with effective implementation of current legislation.

Emission reduction potential

In order to assess the emission reduction potential of applying currently available technical abatement measures, a so-called maximum technically feasible reductions (MTFR) scenario was investigated. As indicated by the name, it does not include structural abatement measures such as fuel switching or energy efficiency improvements.

This scenario would result in a cut in SO_2 emissions of 85 per cent, while those of NOx, VOCs and $PM_{2.5}$ would all come down by between 60 and 70 per cent. Emissions of NH_3 would be reduced by about 40 per cent (see Figure 2).

The MTFR scenario has been criticized for not properly accounting for all available opportunities to reduce emissions, which means that the actual emission reduction potential is underestimated.

Three policy scenarios

Following the production of the CLE and the MTFR scenarios, a number of scenarios were investigated, all set to achieve interim environmental targets with various levels of ambition. For practical reasons, the analysis was limited to the range of emission levels that exists between the CLE and the MTFR scenarios.

The three final policy scenarios were arrived at through a series of model iterations, and they can be said to reflect a lower (A), a medium (B), and a higher (C) overall level of ambition.

Besides providing country-by-country figures on the resulting emission levels of the five air pollutants (SO_2, NOx, VOCs, NH_3, and $PM_{2.5}$), the analysis also includes estimates of the resulting health and environmental impacts in each member state, as well as estimates of the costs and benefits associated with the additional emission reductions. See Table 1.

For the EU as a whole, the additional annual costs range between 6 and 15 billion euro for the year 2020, equal to about 13–33 euro per person in 2020. The estimated costs could be compared to monetised annual health benefits of the three policy scenarios, which were valued at 37–160 billion euro for the year 2020, equal to 83–359 euro per person. See Figure 3.

Cleaner air brings huge benefits

Earlier benefit analyses have shown that improvements in health generate the largest quantified monetary benefits when air pollution is reduced. The health assessment addresses impact related to both long-term (chronic) and short-term (acute) exposures. It deals with both mortality (i.e. deaths) and morbidity (i.e. illness).

Table 1. Summary table of the CAFE analysis and the strategy.

		Human health			Natural environment (km^2)		
	Cost of reduction (euro bn)	Life years lost due to $PM_{2.5}$ (million)	Premature deaths due to $PM_{2.5}$ and O_3	Monetised health benefits (euro bn)	Acidification (forest area exceeded)	Eutrophication (ecosystem area exceeded)	Ozone (forest area exceeded)
2000	-	3.62	370,000	-	243,000	733,000	827,000
Baseline 2020	-	2.47	293,000	-	119,000	590,000	764,000
Scen. A 2020	5.9	1.97	237,000	37-120	67,000	426,000	699,000
Strategy 2020	7.1	1.91	230,000	42-135	63,000	416,000	699,000
Scen. B 2020	10.7	1.87	225,000	45-146	59,000	375,000	671,000
Scen. C 2020	14.9	1.81	219,000	49-160	55,000	347,000	652,000
MTFR 2020	39.7	1.72	208,000	56-181	36,000	193,000	381,000

Note: Costs and benefits are given as annual amounts for the year 2020, and only costs and benefits of moving beyond the baseline scenario are included. Benefits to the natural environment and the cultural heritage have not been monetised. MTFR illustrates "maximal technical feasible reductions" and does not include structural abatement measures such as fuel switch or energy efficiency.

Table 2. Effects of air pollution that are not quantified in monetary terms.

Health
- ❑ Ozone: chronic effects on mortality and morbidity
- ❑ SO_2: chronic effects on morbidity
- ❑ Direct effects of VOCs
- ❑ Social impacts of air pollution on health
- ❑ Altruistic effects

Materials
- ❑ Effects on cultural assets

Crops
- ❑ Indirect air pollution effects on livestock
- ❑ Visible injury following ozone exposure
- ❑ Interactions between pollutants, with pests and pathogens, climate...

Forests
- ❑ Effects of O_3, acidification and eutrophication

Freshwaters
- ❑ Acidification and loss of invertebrates, fish, etc.

Other ecosystems
- ❑ Effects of O_3, acidification and eutrophication on biodiversity

Visibility
- ❑ Change in amenity

Groundwater quality and supply of drinking water
- ❑ Effects of acidification

The morbidity effects that can be quantified include hospital admissions and the development of chronic respiratory disease, but also less serious effects, which are likely, however, to affect a greater number of people. These include changes in the frequency of use of medicine to control asthma, and days of restricted activity.

Concentrations of $PM_{2.5}$ have a much more important effect than ozone with respect to mortality. Significant reductions in concentrations and impacts are expected over the period 2000 to 2020, especially regarding $PM_{2.5}$ (see Table 1). The annual health benefits of implementing current legislation up to 2020 are valued at between 89 and 193 billion euro, for the year 2020. This translates to an estimated annual average benefit across the EU of 191–397 euro per person.

Moreover, two additional types of air pollution impact have been quantified in economic terms, namely the effects of ozone on crop yield and the damage to modern buildings. For the year 2000, this damage was valued at 2.8 and 1.1 billion euro, respectively.

Those effects of air pollution that were not quantified in monetary terms, and thus would ordinarily be omitted from a cost-benefit analysis, were covered by a so-called extended analysis, see Table 2. Some conclusions from the extended analysis were that:

❑ Inclusion of impacts on forests, freshwater and other ecosystems could add significantly to the quantified benefits;

❑ Inclusion of the effects of chronic exposure to ozone on health, social impacts of air pollution on health, altruistic effects and damage to cultural assets may be important, but there is currently inadequate evidence available to make a firm conclusion; and,

❑ Other effects are unlikely to make a substantial difference to quantified benefits at the European level, but may be significant in some areas.

The thematic strategy

Following the CAFE analysis of the various scenarios, the Commission adopted in September 2005 its thematic strategy on air pollution.

By establishing interim environmental objectives for 2020 in the strategy, the Commission sets the level of ambition regarding air quality in the EU up to 2020.

The interim objectives are shown in Table 1, which also shows the estimated costs and benefits of the strategy. When compared to the CAFE policy scenarios, the Commission's chosen level of ambition is between scenarios A and B.

Although this means some improvements as compared to "business as usual", it is clear that significant damage from air pollution will remain in 2020. The emission reductions needed to achieve the strategy's interim objectives can be seen in Figure 2.

On top of the analysis of costs and benefits, the wider economic and social im-

Overestimated costs and underestimated benefits

There are several factors that have led to an overestimate of the incremental cost of the various CAFE scenarios. They include the following:

❑ The estimates of incremental costs were based on the application of technical abatement measures only, and did not account for structural measures – such as switching fuels, increasing energy efficiency, greater use of alternative energy sources and changes in the transportation and agricultural sectors. These measures can reduce emissions more and at much lower cost as compared to relying solely on technical "end-of-pipe" solutions.

❑ The performance of the technical abatement measures was based on the current situation, i.e. technical developments and improvements have not been accounted for.

❑ The baseline scenario failed to include implementation of some important air pollution directives, for example those on national emission ceilings and air quality limit values. Similarly, for agriculture, the impact of the Common Agriculture Policy reform or the implementation of the nitrate and IPPC directives were not accounted for.

❑ The underlying energy scenario assumed a reduction in emissions of the major greenhouse gas CO_2 of only 3.6 per cent between 1990 and 2020, which is contradictory to the EU's commitment to reduce greenhouse gas emissions. In March 2005, the EU Heads of State agreed a target to reduce overall emissions of greenhouse gases by 15-30 per cent by 2020. Measures aimed at reducing CO_2 emissions will in general also reduce emissions of SO_2, NO_x, and $PM_{2.5}$, and applying a "lower-CO_2" energy scenario would therefore reduce the estimated costs for additional emission reductions.

These shortcomings in the analysis are of major importance, because the combined result of overestimating the costs of attaining various targets and underestimating the real potential for emission reductions gives a false impression that ambitious environmental targets are very costly or even "unattainable", which leads to a general lowering of the level of ambition of the strategy.

While only some of the benefits can be estimated in monetary terms, the quantifiable health gains of the CAFE scenarios have been estimated to range from 37 to 181 billion euro in the year 2020, i.e. up to 20 times higher than the (over)estimated costs. Even for the most ambitious of the scenarios investigated, the MTFR scenario, the benefits still outweigh the costs by 1.4 to 4.5 times. Among the gains *not* included in these figures are less acidification of soil and water, less eutrophication, fewer effects on biological diversity, less long-term effect on forest productivity, and less damage to the cultural heritage.

pacts were also investigated. The costs of meeting scenarios A, B and C were estimated at respectively 0.04, 0.08, and 0.12 per cent of EU GDP in 2020. The overall impact on employment was negligible, and EU competitiveness relative to other industrialised countries such as the USA and Japan would not be affected. It should be noted that the positive impacts of reduced mortality and better health were not taken into account in this analysis.

As regards specific legislative proposals, the strategy is accompanied by a proposal to merge the air quality framework directive and three so-called daughter directives containing minimum requirements for air quality. The proposed new directive aims to clarify and simplify provisions, and to modernise and streamline monitoring and reporting requirements. It also introduces new provisions for fine particles ($PM_{2.5}$).

When it comes to emission reductions, there are no specific proposals for new or revised EU legislation presented together with the strategy. The Commission announces however that it will review the national emission ceilings (NEC) directive, and in late 2006 propose revised emission ceilings that will be based on the level of ambition set out in the strategy.

In addition, the strategy outlines a number of expected or possible actions at EU level, for example:

❑ Strengthened emission standards for new road vehicles;

❑ Revision of the directive on integrated pollution prevention and control (IPPC), including a possible expansion to cover small combustion plants;

❑ A possible new directive to reduce VOC emissions from petrol stations; and,

❑ Measures to reduce NO_x emissions from shipping.

The Commission also makes clear that meeting air quality targets will require efforts in other policy areas, in particular the energy, transport and agriculture sectors, and for each of the sectors a number of possible actions are discussed.

It is foreseen that the strategy will be reviewed in 2010, and that the results will feed into the review of the 6EAP.

Figure 3. Comparison of estimated annual costs and monetised health benefits in 2020 (billion euro).

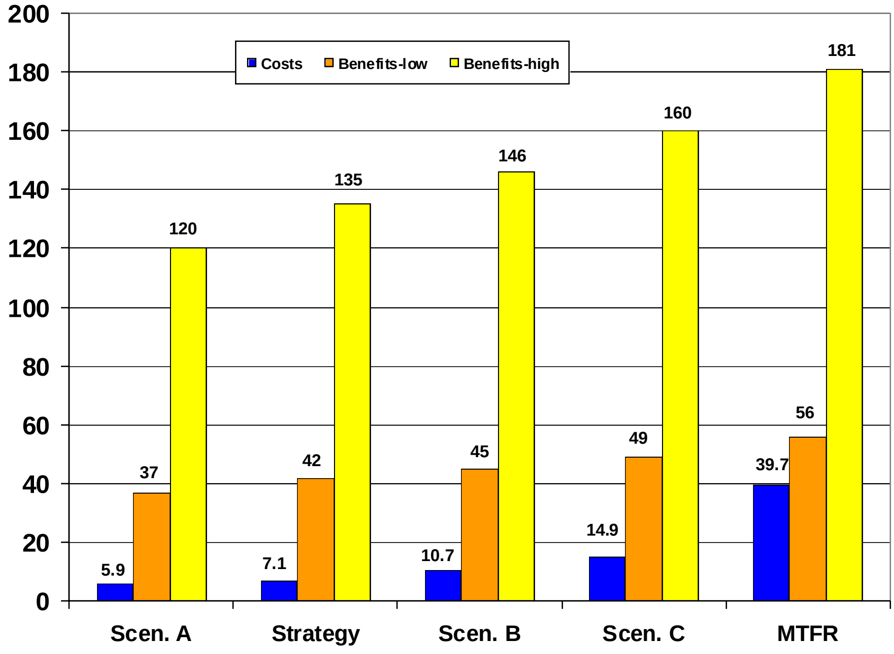


Table 3. Estimated annual costs and monetised health benefits in 2020 for the Thematic Strategy and Scenario C (million euro).

	Thematic Strategy		Scenario C	
Country	**Costs**	**Benefits**	**Costs**	**Benefits**
Austria	95	659 - 2070	316	816 - 2561
Belgium	298	1417 - 4495	727	1731 - 5484
Cyprus	9	6 - 14	23	7 - 17
Czech Rep.	172	1181 - 3931	239	1333 - 4426
Denmark	85	313 - 1068	290	426 - 1451
Estonia	14	27 - 100	27	35 - 127
Finland	62	41 - 131	208	62 - 197
France	1185	5872 - 17384	2354	7031 - 20782
Germany	1400	10198 - 35273	2320	11824 - 40826
Greece	73	304 - 1112	219	371 - 1351
Hungary	144	1426 - 5307	280	1594 - 5920
Ireland	93	186 - 478	260	240 - 616
Italy	695	4319 - 16100	1449	5285 - 19649
Latvia	14	96 - 251	33	125 - 328
Lithuania	49	102 - 488	145	139 - 661
Luxembourg	20	79 - 189	28	94 - 227
Malta	3	12 - 36	6	15 - 43
Netherlands	329	2517 - 7623	458	2959 - 8951
Poland	637	3911 - 12243	1107	4383 - 13695
Portugal	154	462 - 1574	307	563 - 1910
Slovakia	68	676 - 2065	149	774 - 2360
Slovenia	29	180 - 610	67	220 - 745
Spain	687	1626 - 5310	1584	1955 - 6370
Sweden	71	207 - 656	338	372 - 1183
UK	802	5902 - 16800	1920	6944 - 19750
Sum EU25	**7188**	**41719 - 135308**	**14854**	**49298 - 159630**

More information

① Communication from the Commission to the Council and the European Parliament: thematic strategy on air pollution. COM(2005) 446 final.

② Commission staff working paper: Impact assessment of the thematic strategy on air pollution and the directive on "Ambient air quality and cleaner air for Europe". SEC(2005) 1133.

③ Reports produced under the CAFE programme (scenario analysis, CBA, etc.). All documents and reports are available from the website of the Commission's environment directorate: http://europa.eu.int/comm/environment/air/cafe

Figure 4. Loss in statistical life expectancy that can be attributed to anthropogenic contributions to $PM_{2.5}$ (months). For the emission levels in the year 2000 (left), and for two projected emission levels for 2020: CLE (centre) and MTFR (right).

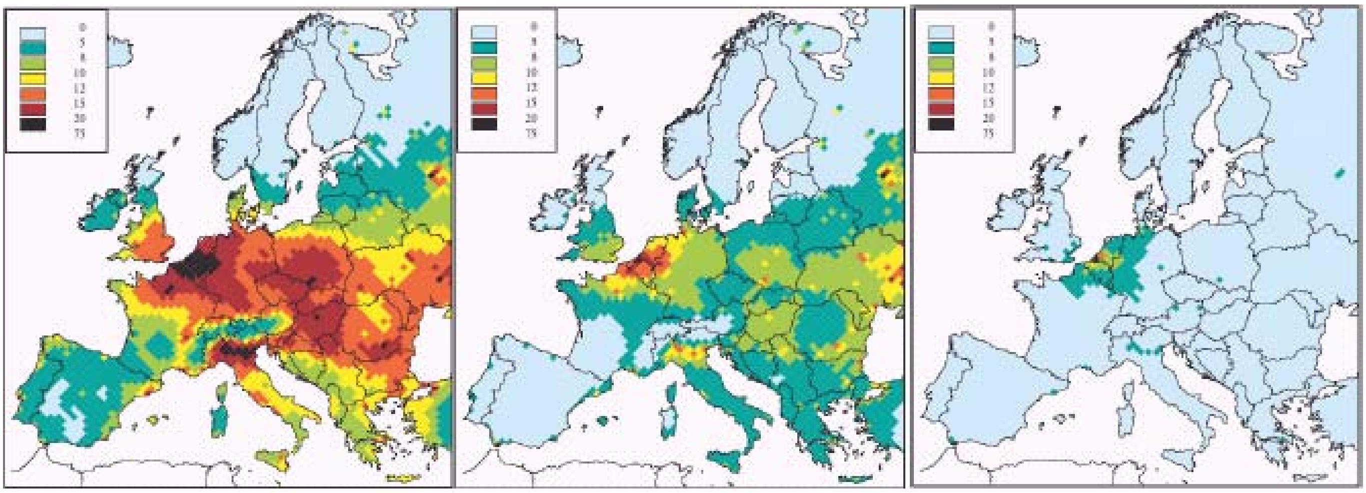


Figure 5. Percentage of forest area receiving acid deposition above the critical loads for acidification. For the emission levels in the year 2000 (left), and for two projected emission levels for 2020: CLE (centre) and MTFR (right).

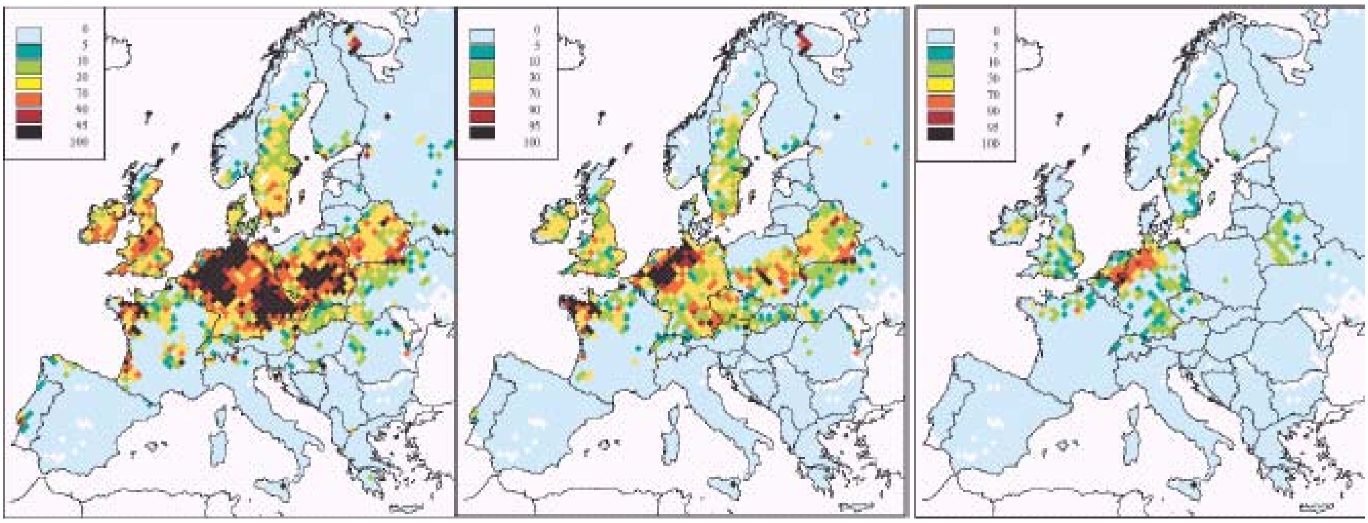


Figure 6. Percentage of total ecosystems receiving nitrogen deposition above the critical loads for eutrophication. For the emission levels in the year 2000 (left), and for two projected emission levels for 2020: CLE (centre) and MTFR (right).

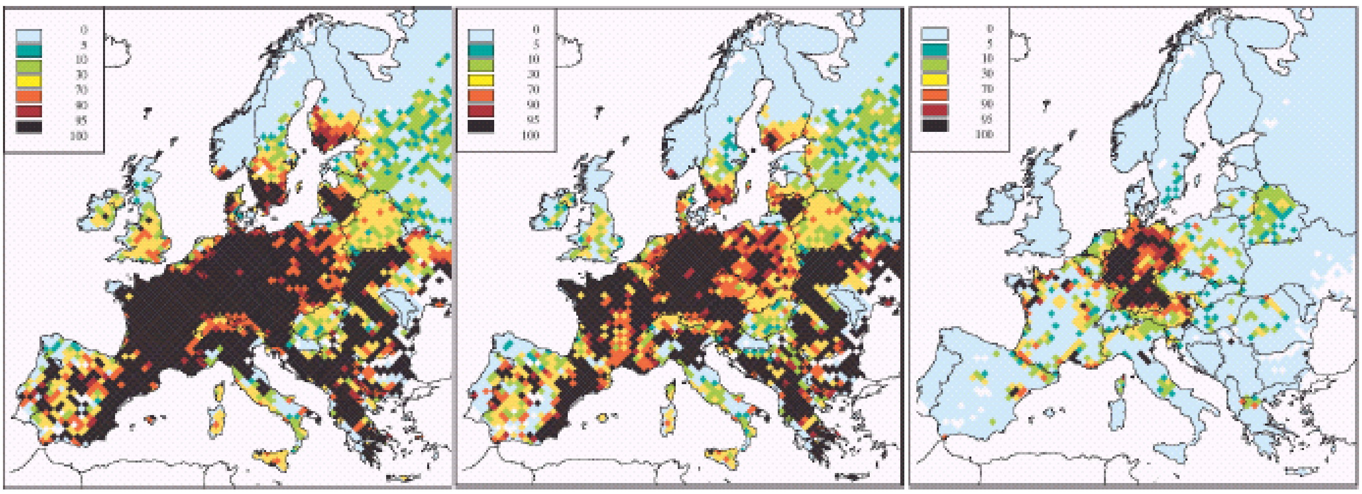


Table 4. Emission levels in 2000 and in 2020 for three scenarios: CLE, Thematic Strategy (TS) and MTFR. Emissions from international shipping are shown separately. (kilotonnes)

Sulphur dioxide

		2020 scenarios		
Country	**2000**	**CLE**	**TS**	**MTFR**
Austria	38	26	23	22
Belgium	187	83	57	50
Cyprus	46	8	8	3
Czech Rep.	250	53	33	26
Denmark	28	13	12	9
Estonia	91	10	6	3
Finland	77	62	59	46
France	654	345	188	148
Germany	643	332	267	220
Greece	481	110	74	40
Hungary	487	88	20	19
Ireland	132	19	13	10
Italy	747	281	135	113
Latvia	16	8	3	2
Lithuania	43	22	9	5
Luxembourg	4	2	1	1
Malta	26	2	2	1
Netherlands	84	64	45	42
Poland	1515	554	201	167
Portugal	230	81	48	34
Slovakia	124	33	18	13
Slovenia	97	16	6	5
Spain	1489	335	186	155
Sweden	58	50	50	39
UK	1186	209	135	115
SumEU25	8733	2806	1599	1288

Nitrogen oxides

		2020 scenarios		
Country	**2000**	**CLE**	**TS**	**MTFR**
Austria	192	127	108	94
Belgium	333	190	137	117
Cyprus	26	18	14	11
Czech Rep.	318	113	79	64
Denmark	207	105	84	77
Estonia	37	15	10	9
Finland	212	117	89	71
France	1447	819	626	540
Germany	1645	808	694	622
Greece	322	209	169	145
Hungary	188	83	61	45
Ireland	129	63	50	42
Italy	1389	663	534	457
Latvia	35	15	11	10
Lithuania	49	27	21	16
Luxembourg	33	18	13	12
Malta	9	4	2	2
Netherlands	399	240	201	186
Poland	843	364	276	221
Portugal	263	156	127	106
Slovakia	106	60	45	36
Slovenia	58	24	20	17
Spain	1335	681	519	447
Sweden	251	150	121	100
UK	1753	817	646	518
SumEU25	11579	5886	4657	3965

Volatile organic compounds

		2020 scenarios		
Country	**2000**	**CLE**	**TS**	**MTFR**
Austria	190	139	130	95
Belgium	242	147	118	114
Cyprus	13	6	6	5
Czech Rep.	242	120	97	72
Denmark	128	58	54	40
Estonia	34	17	15	12
Finland	171	97	90	63
France	1542	924	846	682
Germany	1528	777	741	652
Greece	280	144	110	81
Hungary	169	91	73	57
Ireland	88	47	37	31
Italy	1738	735	691	591
Latvia	52	28	23	13
Lithuania	75	44	39	23
Luxembourg	13	8	7	6
Malta	5	2	2	2
Netherlands	265	204	161	149
Poland	582	321	296	223
Portugal	260	164	147	115
Slovakia	88	65	59	33
Slovenia	54	21	19	13
Spain	1121	702	571	445
Sweden	305	179	153	121
UK	1474	880	766	663
SumEU25	10659	5920	5251	4301

Ammonia

		2020 scenarios		
Country	**2000**	**CLE**	**TS**	**MTFR**
Austria	54	54	50	28
Belgium	81	76	59	47
Cyprus	6	6	5	3
Czech Rep.	74	65	43	38
Denmark	91	78	62	41
Estonia	10	12	8	5
Finland	35	32	29	23
France	728	702	521	390
Germany	638	603	453	435
Greece	55	52	44	34
Hungary	78	85	48	41
Ireland	127	121	108	94
Italy	432	399	300	261
Latvia	12	16	12	8
Lithuania	50	57	50	40
Luxembourg	7	6	5	4
Malta	1	1	1	1
Netherlands	157	140	105	101
Poland	309	333	221	169
Portugal	68	67	62	42
Slovakia	32	33	23	17
Slovenia	18	20	14	10
Spain	394	370	285	199
Sweden	53	49	44	31
UK	315	310	220	204
SumEU25	3825	3687	2772	2266

Particulates (PM2.5)

		2020 scenarios		
Country	**2000**	**CLE**	**TS**	**MTFR**
Austria	37	27	22	20
Belgium	43	24	17	16
Cyprus	2	2	2	1
Czech Rep.	66	18	13	12
Denmark	22	13	12	10
Estonia	22	6	5	2
Finland	36	27	26	16
France	290	167	114	101
Germany	171	111	90	83
Greece	49	41	31	23
Hungary	60	22	9	8
Ireland	14	9	8	6
Italy	209	100	75	69
Latvia	7	4	3	2
Lithuania	17	12	9	5
Luxembourg	3	2	2	2
Malta	1	0	0	0
Netherlands	36	26	22	20
Poland	215	102	62	53
Portugal	46	37	24	21
Slovakia	18	14	7	6
Slovenia	15	6	3	3
Spain	169	91	64	56
Sweden	67	40	38	23
UK	129	68	54	48
SumEU25	1744	969	712	606

International shipping

Sulphur dioxide

		2020 scenarios	
Sea region	**2000**	**CLE**	**MTFR**
Baltic Sea	242	225	75
North Sea	460	423	141
NE Atlantic	396	632	122
Mediterranean	1237	2003	388
Black Sea	83	133	26
Sum Ships	2418	3416	752

Nitrogen oxides

		2020 scenarios	
Sea region	**2000**	**CLE**	**MTFR**
Baltic Sea	349	517	59
North Sea	659	971	111
NE Atlantic	566	834	95
Mediterranean	1808	2711	310
Black Sea	118	174	20
Sum Ships	3500	5207	595

Particulates (PM2.5)

		2020 scenarios	
Sea region	**2000**	**CLE**	**MTFR**
Baltic Sea	21	29	28
North Sea	40	54	53
NE Atlantic	34	56	46
Mediterranean	108	179	146
Black Sea	7	12	10
Sum Ships	210	330	283

Table 5. Health and environmental impacts in 2000 and in 2020 for three scenarios: CLE, Thematic Strategy (TS) and MTFR.

PM: Life years lost (million).

		2020 scenarios		
Country	2000	CLE	TS	MTFR
Austria	3.28	2.45	1.95	1.72
Belgium	7.61	5.13	4.10	3.72
Cyprus	0.21	0.18	0.18	0.18
Czech Rep.	5.05	3.32	2.41	2.16
Denmark	1.74	1.32	1.09	0.95
Estonia	0.26	0.20	0.18	0.16
Finland	0.74	0.63	0.60	0.53
France	26.09	17.95	13.96	12.25
Germany	43.30	30.70	22.86	20.76
Greece	3.96	3.07	2.85	2.73
Hungary	5.61	3.99	2.85	2.59
Ireland	0.80	0.53	0.41	0.36
Italy	30.16	17.70	14.27	12.98
Latvia	0.56	0.47	0.42	0.38
Lithuania	1.18	0.97	0.84	0.76
Luxembourg	0.24	0.17	0.12	0.11
Malta	0.12	0.09	0.08	0.08
Netherlands	10.55	7.48	5.65	5.09
Poland	19.17	13.00	10.15	9.35
Portugal	2.74	1.72	1.38	1.20
Slovakia	2.57	1.80	1.31	1.17
Slovenia	0.92	0.67	0.52	0.46
Spain	12.04	7.49	6.25	5.74
Sweden	1.70	1.31	1.16	0.97
UK	22.29	15.03	10.93	9.65
Sum EU25	202.9	137.4	106.5	96.05

PM: Premature deaths.

		2020 scenarios		
Country	2000	CLE	TS	MTFR
Austria	5500	4590	3660	3230
Belgium	12880	10030	8010	7280
Cyprus	230	270	260	260
Czech Rep.	9070	6450	4680	4190
Denmark	3270	2730	2250	1960
Estonia	630	410	360	320
Finland	1270	1250	1200	1070
France	42090	34740	27010	23700
Germany	75040	62590	46610	42330
Greece	7230	6910	6410	6140
Hungary	12870	8410	6000	5460
Ireland	1170	960	760	650
Italy	50690	37890	30580	27840
Latvia	1330	910	810	730
Lithuania	2190	1680	1450	1310
Luxembourg	320	290	200	180
Malta	192	206	190	182
Netherlands	15440	13970	10550	9510
Poland	32850	24890	19440	17890
Portugal	5040	3540	2830	2460
Slovakia	4250	3390	2470	2210
Slovenia	1580	1280	1010	890
Spain	19940	14190	11830	10880
Sweden	3280	2680	2380	1990
UK	39470	27370	19910	17570
Sum EU25	347822	271626	210860	190232

Ozone: Premature deaths.

		2020 scenarios		
Country	2000	CLE	TS	MTFR
Austria	435	369	335	307
Belgium	364	381	374	350
Cyprus	33	42	41	39
Czech Rep.	521	414	367	333
Denmark	171	175	167	153
Estonia	22	20	19	17
Finland	58	71	66	62
France	2780	2750	2490	2300
Germany	4150	3790	3500	3222
Greece	711	789	752	710
Hungary	720	515	458	415
Ireland	71	96	91	86
Italy	5030	4710	4380	4085
Latvia	74	67	61	41
Lithuania	55	53	49	45
Luxembourg	16	16	15	14
Malta	21	25	25	23
Netherlands	415	460	450	420
Poland	1390	1240	1110	1019
Portugal	438	485	451	417
Slovakia	248	209	185	167
Slovenia	119	105	95	87
Spain	2030	2120	1880	1747
Sweden	196	206	193	180
UK	1320	1650	1610	1533
Sum EU25	21388	20758	19164	17772

Acidification forest soils (sq km exceeded)

		2020 scenarios		
Country	2000	CLE	TS	MTFR
Austria	5241	1625	801	162
Belgium	3618	1643	1002	868
Cyprus	0	0	0	0
Czech Rep.	14815	5485	1553	334
Denmark	956	172	43	9
Estonia	62	0	0	0
Finland	3802	2220	1746	874
France	20951	7091	4144	1131
Germany	74572	44339	23469	13281
Greece	82	0	0	0
Hungary	415	117	34	4
Ireland	1957	959	722	380
Italy	2083	657	244	241
Latvia	174	130	2	0
Lithuania	357	118	55	1
Luxembourg	328	128	13	0
Malta	0	0	0	0
Netherlands	3335	3045	2658	1975
Poland	52104	17356	927	177
Portugal	285	53	18	0
Slovakia	4130	1247	523	64
Slovenia	116	0	0	0
Spain	876	34	0	0
Sweden	42912	27734	22979	15197
UK	9717	4632	2353	1193
Sum EU25	242888	118785	63286	35891

Eutrophication (sq km exceeded)

		2020 scenarios		
Country	2000	CLE	TS	MTFR
Austria	34137	30730	27244	18795
Belgium	6134	4023	2246	1544
Cyprus	2296	3056	2363	635
Czech Rep.	17481	14072	6550	2193
Denmark	1597	1126	321	25
Estonia	2853	1409	1045	0
Finland	59985	34468	14991	0
France	171610	141840	98268	36132
Germany	102867	100868	97912	91449
Greece	10392	9993	7166	269
Hungary	3302	2630	1590	498
Ireland	1015	294	29	0
Italy	74548	57135	31727	15319
Latvia	16277	11399	4364	138
Lithuania	11209	10647	8182	575
Luxembourg	901	767	480	371
Malta	0	0	0	0
Netherlands	2158	1970	1640	867
Poland	78442	71871	58824	16209
Portugal	3280	1323	159	0
Slovakia	16179	10962	5139	794
Slovenia	4006	3739	3205	884
Spain	54410	42207	26605	5638
Sweden	48176	29702	15620	1051
UK	9792	4029	356	0
Sum EU25	733047	590260	416026	193386

Ozone forests (sq km exceeded)

		2020 scenarios		
Country	2000	CLE	TS	MTFR
Austria	38733	38733	38733	16743
Belgium	5983	5983	5974	5974
Cyprus	1370	1370	1370	303
Czech Rep.	25255	25255	25255	3631
Denmark	3895	3247	3189	990
Estonia	457	0	0	0
Finland	772	0	0	0
France	142272	141563	131881	87502
Germany	106613	106237	106217	85706
Greece	32773	32773	32416	8180
Hungary	19004	19004	19004	0
Ireland	2713	666	294	46
Italy	91523	91523	91523	90486
Latvia	2659	193	193	0
Lithuania	9232	1148	872	0
Luxembourg	1054	1054	1054	1054
Malta	9	9	9	9
Netherlands	3018	3016	2979	2925
Poland	97249	92543	62418	17
Portugal	28542	28340	26600	9409
Slovakia	21048	21048	14809	8
Slovenia	13371	13371	13371	2762
Spain	109150	109150	108215	61195
Sweden	55960	13667	5040	152
UK	14406	8624	7303	4282
Sum EU25	827061	758517	698719	381374