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Baseline emission projections for the revision of the Gothenburg protocol up to 2020

Background paper for the 42nd Session of the Working Group on Strategies and Review of the Convention on Long-range Transboundary Air Pollution

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CIAM Report 2/2008
EMEP Centre for Integrated Assessment Modelling (CIAM)

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Executive Summary

In 2007 the Convention on Long-range Transboundary Air Pollution has initiated the revision of its Gothenburg multi-pollutant/multi-effect protocol. As one input to this process, the draft plan for the revision of the Gothenburg Protocol prepared by the Secretariat of the Convention on Long-range Transboundary Air Pollution (ECE/EB.AIR/WG.5/2008/13) foresees presentation of initial baseline projections of the future air pollution situation in Europe at the 42nd Session of the Working Group on Strategies and Review.

This report presents a projection of future emissions and air quality impacts as it could be expected from the implementation of current legislation on emission controls in each country, as well as a hypothetical scenario that quantifies the environmental improvements that would result from a full implementation of the most advanced technical emission control measures that are on the market today.

For the Parties that are EU Member States, the baseline presented in this report assumes an energy projection that meets the targets of the Climate and Energy Package that has been proposed by the European Commission in January 2008. For agricultural activities, national projections are employed. For the other Parties, the baseline relies on the most recent activity projections that are available to IIASA.

For the EU Member States as well as for Norway and Switzerland the baseline scenario assumes for 2020 as a starting point (i) the implementation of all emission control legislation as is already laid down in national laws, (ii) compliance with the existing National Emission Ceilings Directive as well as (iii) the implementation of the Commission's recent proposals on further emission control measures. For the other Parties baseline assumes that emissions of SO_2 and NO_x from stationary and mobile sources will remain uncontrolled up to 2020. For PM, a set of control technologies for stationary emission sources has been assumed that reflect the current level of control of dust emissions from power plant and industrial sources.

In addition to the baseline case, a hypothetical scenario has been calculated that estimates the potential and costs for further emission reductions that are achievable with a full application of the most advanced technical (add-on) emission control measures that are on the market today.

The baseline projection foresees for the EU countries sharp declines in emissions between 2000 and 2020. SO_2 emissions are projected to shrink by more than 70 percent, NO_x by 50 percent, VOC by about 40 percent, PM2.5 by approx. 30 percent and NH_3 by 10 percent. In contrast, emissions from the other Parties are expected to increase by up to 20 percent.

As a consequence, air quality impacts are generally expected to improve in the EU countries, but deteriorate in the eastern part of Europe.

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1 Introduction

In 2007 the Convention on Long-range Transboundary Air Pollution has initiated the revision of its Gothenburg multi-pollutant/multi-effect protocol. As one input to this process, the draft plan for the revision of the Gothenburg Protocol prepared by the Secretariat of the Convention on Long-range Transboundary Air Pollution (ECE/EB.AIR/WG.5/2008/13) foresees presentation of initial baseline projections of the future air pollution situation in Europe at the 42nd Session of the Working Group on Strategies and Review.

This report presents a projection of future emissions and air quality impacts as it could be expected from the implementation of current legislation on emission controls in each country, as well as a hypothetical scenario that quantifies the environmental improvements that would result from a full implementation of the most advanced technical emission control measures that are on the market today.

The remainder of the report is organized as follows: Section 2 introduces projections of energy consumption and agricultural activities that are used for the baseline emission projections. For the Parties that are EU Member States, the baseline assumes an energy projection that meets the targets of the Climate and Energy Package that has been proposed by the European Commission in January 2008. For agricultural activities, national projections are employed. For the other Parties, the baseline relies on the most recent activity projections that are available to IIASA. Section 3 summarizes the assumptions on emission control measures that are considered part of the baseline projection, and presents the impacts on air pollution emissions. Using a set of environmental indicators, Section 4 discusses future air quality impacts that would result from the baseline emission path. Conclusions are drawn in Section 5.

All underlying data can be extracted from the Internet through the online version of the GAINS model (http://gains.iiasa.ac.at/gains/EU/index.login?logout=1, Scenario group “NEC6”, “C&E Package, current policy”).

2 Baseline activity projections

As a basis for the analysis of future air pollution emissions and air quality impacts, this report assumes the following projections of future anthropogenic activities (i.e., energy use, transport demand, industrial production, and agricultural activities):

- For the 27 EU Member States, this report employs a set of activity projections for the year 2020 that is consistent with the proposal of the European Commission on the Climate & Energy Package of January 2008 (CEC, 2008a), and which reflects national perspectives on the development of the agricultural sector that have been provided to CIAM/IIASA. While the employed energy projection does not originate from national submissions of individual Parties, the approach follows the decision of the Task Force on Integrated Assessment Modelling (34th Meeting, May 8-9, 2008) on the use of projections that reflect latest policy developments: *"The Task Force agreed that scenario analysis* [for the revision of the Gothenburg Protocol] *would use the PRIMES model data for EU Member States unless the Party submitted its updated projection to CIAM. Such updated projections should be consistent with climate policies and other relevant policies, e.g. on agriculture and biomass production. The Task Force expressed a serious concern that the use of national projections, which was inconsistent with climate policies, would not be an equal basis.*" (see ECE/EB.AIR/GE.1/2008/4, para 5). Since no updated projections have been received from Parties by CIAM to date, the PRIMES projection has been used for the baseline analysis presented in this report. This projection is identical to the "Climate and Energy Package" projection that is reported in the recent NEC Report #6 (Amann *et al.*, 2008).
- For the Parties within the modelling domain that are not Member States of the European Union, the analysis employs the most recent activity projections that are currently available in the GAINS model. These have been presented to the 41st Meeting of the Working Group on Strategies and Review (see CIAM Report 1/2008, Cofala *et al.*, 2008), and no further information has been received after that date.

The following sections summarize the activity projections in more detail.

2.1 EU Member States

2.1.1 Statistics for the year 2000

For reference, statistics for the year 2000 are presented in Table 2.1, Table 2.2, Table 2.3 and Figure 2.1.

Table 2.1: Primary energy consumption in 2000 [PJ]. Source: GAINS (based on national and EUROSTAT energy balances)

	Coal	*Biomass, waste*	*Heavy fuel oil*	*Diesel*	*Gasoline, LPG*	*Natural gas*	*Nuclear*	*Other renew.*	*Electr. import*[1)]	Total
Austria	119	128	114	253	114	332	0	153	-5	1208
Belgium	257	49	78	497	447	655	496	2	15	2496
Bulgaria	268	23	57	60	64	145	196	10	-17	806
Cyprus	1	0	47	19	25	1	0	1	0	95
Czech Rep.	823	28	58	147	112	385	147	6	-38	1668
Denmark	165	70	72	152	125	205	0	19	2	811
Estonia	120	21	10	16	14	31	0	0	-3	208
Finland	207	237	80	171	117	189	236	47	39	1324
France	494	440	452	1811	1351	1727	4538	259	-250	10822
Germany	3327	221	741	2469	2252	3334	1851	117	11	14321
Greece	382	40	170	279	223	96	0	19	0	1208
Hungary	156	16	94	87	107	423	153	1	12	1049
Ireland	117	8	70	160	97	144	0	5	0	600
Italy	426	139	1262	1213	1335	2473	0	339	150	7337
Latvia	3	49	9	19	16	41	0	10	16	164
Lithuania	3	23	43	26	24	86	93	1	-14	286
Luxembourg	5	2	1	55	40	28	0	1	21	152
Malta	0	0	19	6	9	0	0	0	-1	34
Netherlands	269	60	112	504	569	1542	39	4	68	3167
Poland	2279	166	210	320	296	557	0	8	-23	3812
Portugal	155	133	247	220	175	99	0	44	3	1076
Romania	273	120	172	138	98	628	59	53	-3	1538
Slovakia	136	47	22	33	28	315	178	17	-10	766
Slovenia	57	17	6	51	39	35	52	15	-11	263
Spain	830	155	610	1027	853	800	672	125	16	5087
Sweden	95	294	131	222	261	57	619	286	14	1979
UK	1771	58	176	1119	1735	3983	822	88	51	9802
EU-27	12737	2545	5062	11074	10526	18310	10152	1629	45	72081

[1)] Exports are indicated by negative numbers.

Table 2.2: Energy consumption of the EU-27 by fuel and sector in 2000 [PJ]. Source: GAINS (based on national and EUROSTAT energy balances)

	Coal	Biomass waste	Heavy fuel oil	Diesel	Gasoline LPG	Natural gas	Nuclear	Other renew.	Electr.[1)]	Total
Power sector	9697	439	1544	173	18	4689	10152	1595	-10549	17758
Industry	1590	728	1163	411	354	5144	0	1	3741	13132
Conversion	317	14	951	133	77	1257	0	0	1587	4337
Domestic	594	1364	117	2749	590	6495	0	33	5031	16974
Transport	0	0	72	7435	7633	53	0	0	234	15427
Non-energy	539	0	1215	173	1855	671	0	0	0	4453
Sum	12736	2545	5062	11074	10526	18310	10152	1629	45	72081

[1)] Power sector reflects gross power generation (reported with a negative sign); the conversion sector includes own use of energy industries as well as transmission and distribution losses; Total refers to domestic consumption excluding net electricity exports. Exports are indicated by negative numbers.

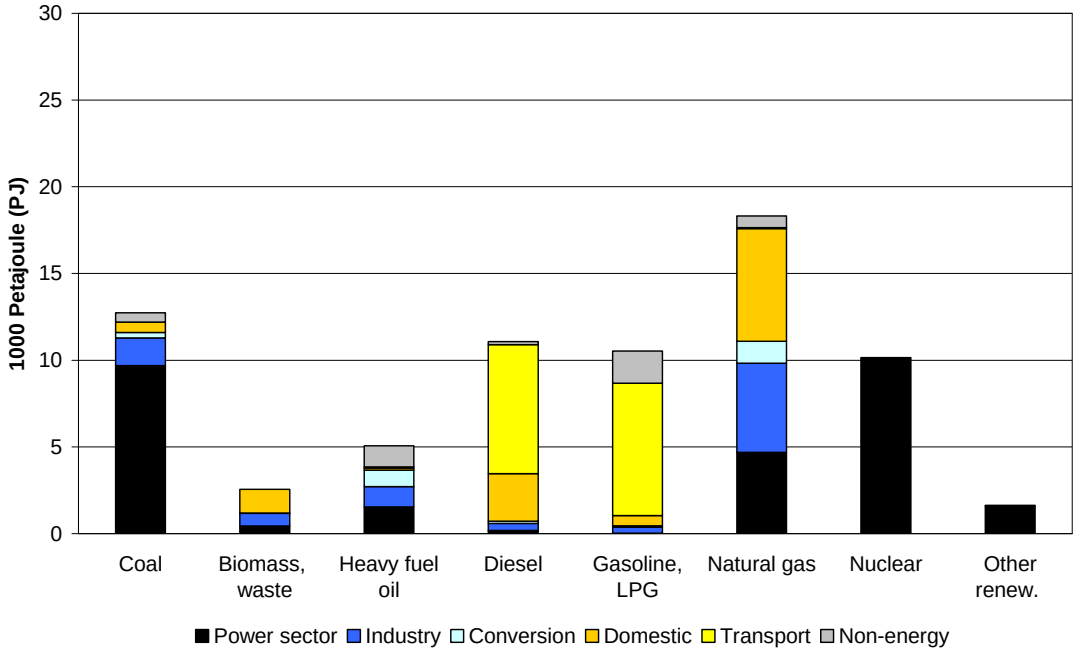

Figure 2.1: Energy consumption of the EU-27 in 2000 by fuel and sector

Table 2.3: Agricultural activities in the year 2000. (Source: GAINS, based on EUROSTAT and national statistics)

	Cattle	Pigs	Chicken and poultry	Sheep and goats	Horses	Fertilizer consumption	Fertilizer production
			1000 animal heads			kt N	
Austria	2155	3348	11787	395	82	121	185
Belgium	3001	7266	39728	176	73	145	1440
Bulgaria	652	1512	14963	3595	374	145	404
Cyprus	54	408	3310	625	7	8	0
Czech Rep.	1609	3315	32043	118	26	213	306
Denmark	1868	11922	21831	91	150	252	133
Estonia	253	300	2366	32	4	22	38
Finland	1057	1298	12570	107	57	167	245
France	20310	14930	270989	10788	444	2571	1494
Germany	14538	23400	121792	2743	735	2014	1308
Greece	566	936	28193	14449	140	285	216
Hungary	805	4834	31244	1219	79	320	290
Ireland	6558	1732	15338	7957	80	408	248
Italy	7245	8307	176722	12464	337	786	428
Latvia	367	394	3105	39	20	29	0
Lithuania	898	936	6373	39	75	98	530
Luxembourg	200	83	70	8	2	17	0
Malta	19	80	830	17	1	0	0
Netherlands	4070	13118	104972	1487	118	339	1300
Poland	5723	15447	111900	337	550	896	1497
Portugal	1172	2359	41195	4145	80	170	125
Romania	2532	4797	70076	8195	865	239	872
Slovakia	647	1488	12446	399	10	82	286
Slovenia	493	604	5107	118	14	34	0
Spain	6074	24367	169133	26892	499	1255	899
Sweden	1684	1918	16900	437	300	189	94
UK	11134	6482	168973	42340	291	1036	490
EU-27	95684	155582	1493955	139213	5413	11839	12827

2.1.2 An energy projection that meets the targets of the EU Climate & Energy Package

This report considers a set of activity projections for the year 2020 that is consistent with the proposal of the European Commission on the Climate & Energy Package of January 2008 (CEC, 2008a) and reflects national perspectives on the development of the agricultural sector that have been provided to IIASA. In particular, the projections used for this analysis are consistent with option 4 of the Impact Assessment of the Climate & Energy Package (CEC, 2008b, CEC, 2008c). The scenario assumes that the national targets on greenhouse gas emissions for the non-ETS sources are met in each Member State and that there is full trade of renewable energy within the EU-27. It is further assumed that CDM/JI is implemented so that carbon prices in both the ETS and non-ETS sectors do not exceed €30/t CO_2. Following these assumptions, the PRIMES model has been used to quantify the implications on the national energy systems in the year 2020 starting from the macro-economic development and international energy prices as they have been adopted for the November 2007

version of the PRIMES baseline energy projection (Capros *et al.*, 2008, see Table 2.4). Detailed information on the projected energy use for each country, sector and fuel is available from the GAINS online version (http://gains.iiasa.ac.at/gains/EU/index.login?logout=1, Scenario group "NEC6", "C&E Package, current policy").

Table 2.4: Assumptions on population development and economic growth of the PRIMES 2007 baseline projection (Source: Capros *et al.*, 2008)

	Population (million people)		GDP/capita (€/person)		Increase in GDP
	2000	2020	2000	2020	2000 to 2020
Austria	8.0	8.4	28510	39720	47%
Belgium	10.2	10.8	27115	37925	47%
Bulgaria	8.2	6.8	2061	7247	192%
Cyprus	0.7	0.9	16899	26851	100%
Czech Rep.	10.3	9.9	8114	17999	114%
Denmark	5.3	5.5	36553	50873	44%
Estonia	1.4	1.3	5431	18848	217%
Finland	5.2	5.4	26911	40974	59%
France	58.8	63.6	26995	38302	53%
Germany	82.2	82.7	26420	35407	35%
Greece	10.9	11.4	13396	24863	95%
Hungary	10.2	9.7	7028	15216	105%
Ireland	3.8	4.8	33093	60118	129%
Italy	56.9	58.3	24115	31978	36%
Latvia	2.4	2.1	3651	15009	266%
Lithuania	3.5	3.2	4046	14044	215%
Luxembourg	0.4	0.5	58814	98538	103%
Malta	0.4	0.5	11816	16467	65%
Netherlands	15.9	17.2	30094	40825	47%
Poland	38.7	37.1	5431	12738	125%
Portugal	10.2	10.8	14031	19758	49%
Romania	21.9	20.3	2742	9101	208%
Slovakia	5.4	5.3	5641	14719	155%
Slovenia	2.0	2.0	11724	21520	86%
Spain	40.1	45.6	19282	30966	83%
Sweden	8.9	9.6	28909	43970	64%
UK	58.8	62.9	27001	40683	61%
EU-27	480.5	496.4	20908	31599	56%

As a consequence, the PRIMES model projects the EU-27 total primary energy consumption to increase by 10% between 2000 and 2020 (compared to 17 percent for the case without the Climate & Energy Package). Most markedly, biomass and other forms of renewable energy will increase by 235 percent and 65 percent, respectively, and coal consumption will decline by 10 percent. Transport fuels would grow by only 8 percent (compared to 16 percent), and natural gas would see lower growth rates too. As a consequence, this projection sees CO_2 emissions of the EU-27 declining by 11 percent between 2000 and 2020. Part (six percentage points of the 20 percent in GHG reduction in 2020 compared to 1990) would come from reductions outside the EU through JI/CDM limiting the reduction in the EU's GHG emissions to around 15% below 1990 level. Since mitigation measures for non-CO_2 GHG emissions are more cost-effective than those for CO_2, the cut in total CO_2 emissions

(compared to 1990) amounts to around 11 percent. Energy-related CO_2 emissions are reduced by about 12 percent in 2020 compared to 1990 (Table 2.7). Projected fuel demand in 2020 is provided in Table 2.5, Table 2.6 and Figure 2.2.

Table 2.5: Primary energy consumption of the energy projection with the Climate & Energy Package in 2020 [PJ]. Source: GAINS, based on the PRIMES model

	Coal	*Biomass, waste*	*Heavy fuel oil*	*Diesel*	*Gasoline LPG*	*Natural gas*	*Nuclear*	*Other renew.*	*Electr. import*[1)]	Total
Austria	109	334	62	326	144	317	0	188	5	1485
Belgium	170	172	133	440	230	700	380	52	21	2299
Bulgaria	157	113	48	123	89	121	229	36	-27	890
Cyprus	1	2	25	20	32	21	0	8	0	110
Czech Rep.	489	259	99	250	228	412	328	36	-46	2055
Denmark	133	203	33	168	127	65	0	49	10	787
Estonia	68	58	13	37	19	29	0	8	-5	227
Finland	158	476	60	152	141	123	377	61	26	1573
France	226	998	407	2031	1221	1540	5125	447	-179	11816
Germany	3751	1146	436	1907	2087	3422	368	539	57	13714
Greece	136	162	111	353	290	245	0	78	9	1384
Hungary	40	218	54	160	151	507	165	22	13	1329
Ireland	73	56	63	189	149	148	0	52	4	733
Italy	673	598	649	1534	1194	3530	0	583	161	8924
Latvia	3	125	8	51	27	46	0	16	9	286
Lithuania	7	102	35	55	37	114	117	6	-17	457
Luxembourg	2	16	1	93	42	52	0	5	14	225
Malta	0	0	9	10	10	3	0	2	4	36
Netherlands	245	241	220	383	645	1646	43	89	25	3536
Poland	1790	628	289	640	464	885	0	95	-21	4769
Portugal	138	215	149	270	245	176	0	129	4	1325
Romania	310	320	95	273	181	764	122	102	-15	2152
Slovakia	125	91	23	74	64	323	170	26	-2	893
Slovenia	36	48	13	85	38	48	62	22	9	360
Spain	782	816	482	1543	829	1197	628	483	9	6769
Sweden	117	534	79	220	278	126	659	302	-59	2255
UK	750	559	320	1193	1838	3474	315	373	35	8856
EU-27	10489	8490	3914	12581	10799	20035	9086	3808	44	79246

[1)] Exports are indicated by negative numbers.

Table 2.6: Energy consumption of the EU-27 in 2020 by fuel and sector for the energy projection complying with the Climate & Energy Package [PJ]. Source: GAINS, based on the PRIMES model

	Coal	*Biomass waste*	*Heavy fuel oil*	*Diesel*	*Gasoline LPG*	*Natural gas*	*Nuclear*	*Other renew.*	*Electr.*[1)]	Total
Power sector	8214	4224	282	1	0	6321	9086	2923	-13368	17683
Industry	1732	650	940	161	295	4075	0	0	4743	12597
Conversion	184	1726	811	7	27	1339	0	0	1831	5926
Domestic	321	1889	45	1917	496	7153	0	885	6523	19228
Transport	0	0	71	10298	7808	77	0	0	314	18568
Non-energy	37	0	1765	196	2173	1072	0	0	0	5243
Sum	10489	8490	3914	12581	10799	20035	9086	3808	44	79245

[1)] Power sector reflects gross power generation (reported with a negative sign); the conversion sector includes own use of energy industries as well as transmission and distribution losses; Total refers to domestic consumption excluding net electricity exports. Exports are indicated by negative numbers.

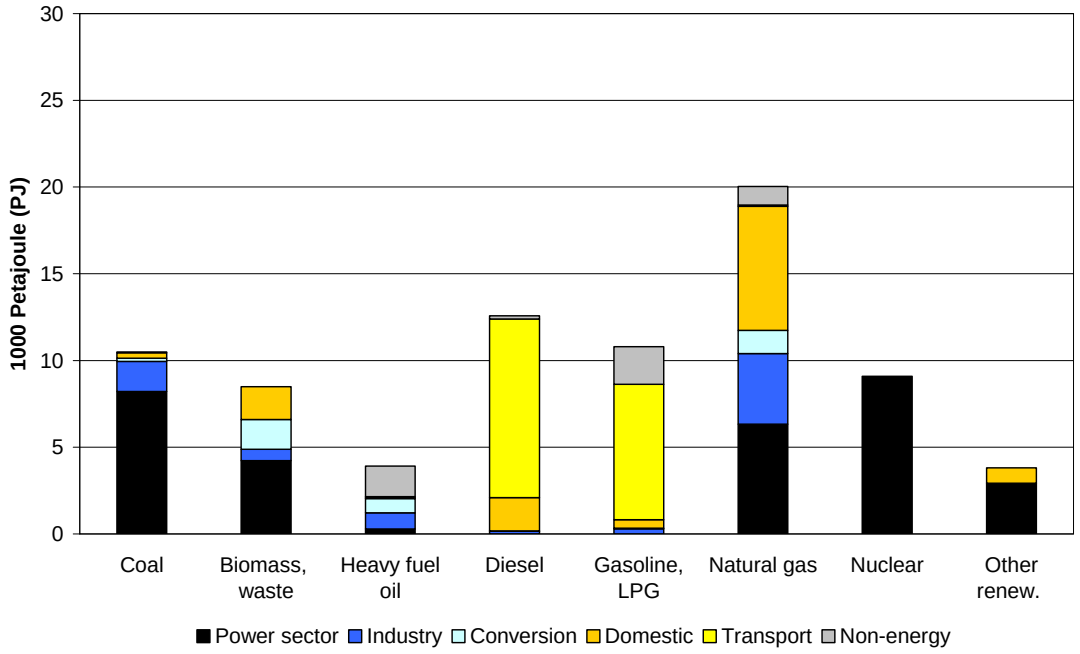

Figure 2.2: Energy consumption of the EU-27 of the energy projection with the Climate & Energy Package for 2020

Table 2.7: Energy-related CO_2 emissions [Mt CO_2] for 1990, 2005 and the projection with the Climate and Energy Package in 2020. Source: PRIMES energy model

	1990	*2005*	*C&E Package* Mt CO_2	Change relative to 1990
Austria	55.2	73.7	61.1	11%
Belgium	106.2	107.8	100.5	-5%
Bulgaria	72.4	45.1	35.6	-51%
Cyprus	4.4	7.4	6.4	47%
Czech Rep.	154.8	114.8	95.9	-38%
Denmark	51.7	48.9	36.7	-29%
Estonia	39.2	15.2	12.5	-68%
Finland	54.4	54.1	42.2	-22%
France	352.9	378.4	306.2	-13%
Germany	959.8	804.8	726.1	-24%
Greece	71.2	96.2	76.9	8%
Hungary	65.5	55.0	48.5	-26%
Ireland	30.9	45.7	41.1	33%
Italy	386.9	451.0	447.0	16%
Latvia	19.2	7.3	7.9	-59%
Lithuania	32.5	12.6	12.4	-62%
Luxembourg	10.6	12.4	12.1	14%
Malta	1.8	3.0	2.2	23%
Netherlands	152.2	171.6	157.9	4%
Poland	332.2	290.7	291.7	-12%
Portugal	39.0	61.6	60.3	54%
Romania	166.7	89.7	101.4	-39%
Slovakia	53.3	37.1	37.7	-29%
Slovenia	13.2	15.2	14.1	7%
Spain	203.3	339.4	318.1	56%
Sweden	50.5	48.5	47.9	-5%
UK	566.9	559.7	459.7	-19%
EU-27	4046.9	3947.0	3560.2	-12%

2.1.3 National projections of agricultural activities

In the process of the preparation of the revision of the NEC directive, DG Environment of the European Commission invited all Member States to provide official national projections of their agricultural activities up to 2020 as a basis for the revision of the NEC Directive. These projections should reflect national agricultural policies (as laid down, e.g., in governmental plans). Furthermore, these projections must include all necessary measures to comply with the Kyoto targets on greenhouse gas emissions and the burden sharing agreement for 2012. For 2020, it should be assumed as a minimum that the Kyoto emission caps remain unchanged. With these requirements, the national agricultural projections for the revision of the NEC Directive should be consistent with the agricultural projections presented by the Member States to UNFCCC in their Fourth National Communications in 2006, however not taking into consideration areas outside of the modelling domain.

20 Member States as well as Norway and Switzerland have supplied national agricultural projections to IIASA for implementation into the GAINS model (Table 2.8). Collectively, these projections constitute the "National projections" baseline scenario for the revision of the NEC Directive. For those Member States that have not provided their own agricultural projection, the "National

projections" baseline case assumes by default the agricultural development as outlined by the CAPRI (EEA, 2004) and EFMA (EFMA, 2005) agricultural and fertilizer projections (see Amann *et al.*, 2007). For Member States for which CAPRI and/or EFMA projections are unavailable, projections developed by the Food and Agricultural Organization (FAO) have been used (Bruinsma, 2003).

For the EU-27 as a whole (Table 2.9), these national projections anticipate between 2000 and 2020 for cattle a 16 percent decline in livestock numbers (about equal drop is projected for dairy cows and beef cattle), for sheep a reduction by 10 percent and increases of six and 11 percent in the numbers of pigs and poultry, respectively. Use of nitrogen fertilizers is estimated to decline in the EU-27 by about six percent.

While these national projections reflect the latest governmental views of the individual Member States on the future agricultural development, there is no guarantee of Europe-wide consistency in terms of assumptions on economic development trends, as well as national and EU-wide agricultural policies.

Table 2.8: Data sources for the "National projections" NEC baseline scenario

	Data source	*Date of last information exchange*	*Comments*
Austria	National (2006)	9 January 2006	
Belgium	National (2007)	30 April 2007	
Bulgaria	FAO (2003)		Update using CRONOS database
Cyprus	FAO (2003), EFMA (2005)		
Czech Rep.	National (2005)	26 June 2006	
Denmark	National (2006)	10 November 2006	
Estonia	National (2006)	4 May 2006	
Finland	National (2006)	1 March 2007	
France	National (2004)	18 May 2004	
Germany	National (2007)	21 January 2008	As a result, also some estimates for historical years are affected
Greece	CAPRI (2004), EFMA (2005)		
Hungary	National (2006)		Projection submitted to CLRTAP
Ireland	National (2007)	20 November 2007	
Italy	National (2006)	31 August 2006	
Latvia	National (2006)	7 February 2006	
Lithuania	CAPRI (2004), EFMA (2005)		
Luxembourg	CAPRI (2004), EFMA (2005)		
Malta	National (2006)	27 January 2007	For some categories discrepancies for historical years, supplementary data from FAO, IFA , and CRONOS database used
Netherlands	National (2006)	14 September 2006	
Poland	National (2005)	19 October 2005	
Portugal	National (2006)	16 October 2006	
Romania	FAO (2003), National (2007)	26 January 2007	For some categories discrepancies for historical years, supplementary data from FAO and IFA used
Slovakia	CAPRI (2004), EFMA (2005)		
Slovenia	National (2006)	6 September 2006	
Spain	National (2007)	24 May 2007	
Sweden	National (2006)	2 July 2006	
UK	National (2006)	27 July 2006	

Table 2.9: National projections of agricultural activities for the year 2020 (Source: GAINS, based on national submissions)

	Cattle	Pigs	Chicken and poultry	Sheep and goats	Horses	Fertilizer consumption	Fertilizer production
	1000 animal heads					kt N	
Austria	1896	3228	13007	389	87	102	225
Belgium	2586	7266	39728	129	73	142	1440
Bulgaria	677	1100	22958	2411	373	151	350
Cyprus	48	457	4830	655	7	7	0
Czech Rep.	1400	3800	36234	260	28	230	310
Denmark	1310	14728	18146	95	168	176	0
Estonia	222	448	2640	87	4	21	38
Finland	791	1270	13113	97	65	145	210
France	19145	16327	226966	9971	458	2313	1374
Germany	8457	23983	141374	2491	1169	1828	1000
Greece	520	994	23923	14819	140	202	200
Hungary	907	7000	43000	1600	82	398	250
Ireland	5475	1503	13200	4824	85	332	0
Italy	6418	9181	197983	11320	337	799	428
Latvia	350	508	5091	55	16	35	0
Lithuania	766	1208	12782	38	65	119	500
Luxembourg	189	94	86	7	2	16	0
Malta	19	82	1010	26	3	1	0
Netherlands	3506	11181	108629	1951	165	272	1000
Poland	4850	15598	171500	340	355	963	1450
Portugal	1256	2064	38699	3992	40	170	152
Romania	2630	7300	90000	8297	800	391	800
Slovakia	693	1901	11602	359	10	101	270
Slovenia	527	665	5552	142	17	33	0
Spain	6173	26447	227461	26119	733	995	650
Sweden	1455	2490	20000	395	300	170	65
UK	8317	4835	175620	33813	291	976	500
EU-27	80583	165657	1665133	124681	5873	11088	11212

2.2 Other Parties

2.2.1 Statistics for 2000

Table 2.10: Primary energy consumption in the non-EU countries in 2000 [PJ]. Source: GAINS (based on national and IEA energy balances)

	Coal	Biomass, waste	Heavy fuel oil	Diesel	Gasoline, LPG	Natural gas (1)	Nuclear	Other renew.	Electr. import (2)	Total
Albania	2	11	23	15	8	11	0	15	1	86
Belarus	35	41	166	76	58	618	0	0	26	1021
Bosnia-H.	115	2	41	26	12	33	0	14	-1	244
Croatia	30	22	99	56	42	121	24	16	11	421
T.F.Y.R.O. M.	60	0	18	12	12	13	0	3	3	121
Norway	56	49	9	151	147	245	0	512	-69	1101
Republic of Moldova	75	0	38	33	10	172	0	1	0	330
Russia	1126	197	1400	676	986	10812	1387	202	15	16800
Serbia-Montenegro	293	2	84	70	42	86	0	25	-17	583
Switzerland	8	72	25	270	237	101	289	133	-25	1108
Turkey	881	274	404	375	485	602	0	173	12	3206
Ukraine	1172	20	89	195	171	2935	845	41	-14	5454
Total non-EU Europe	3853	690	2397	1955	2210	15749	2545	1134	-58	30476

[1)] Exports are indicated by negative numbers.

Table 2.11: Energy consumption of the non-EU European countries by fuel and sector in 2000 [PJ]. Source: GAINS (based on national and EUROSTAT energy balances)

	Coal	Biomass, waste	Heavy fuel oil	Diesel	Gasoline LPG	Natural gas	Nuclear	Other renew.	Electr.[1)]	Total
Power sector	1966	183	912	69	8	8314	2545	1075	-4082	10990
Industry	807	60	437	193	39	2423	0	0	1438	5398
Conversion	626	6	299	16	18	1657	0	0	1032	3654
Domestic	366	440	249	351	166	2577	0	59	1413	5621
Transport	0	0	13	1326	1840	2	0	0	141	3324
Non-energy	88	0	487	0	140	775	0	0	0	1490
Sum	3853	690	2397	1955	2210	15749	2545	1134	-58	30476

[1)] Power sector reflects gross power generation (reported with a negative sign); the conversion sector includes own use of energy industries as well as transmission and distribution losses; Total refers to domestic consumption excluding net electricity exports. Exports are indicated by negative numbers.

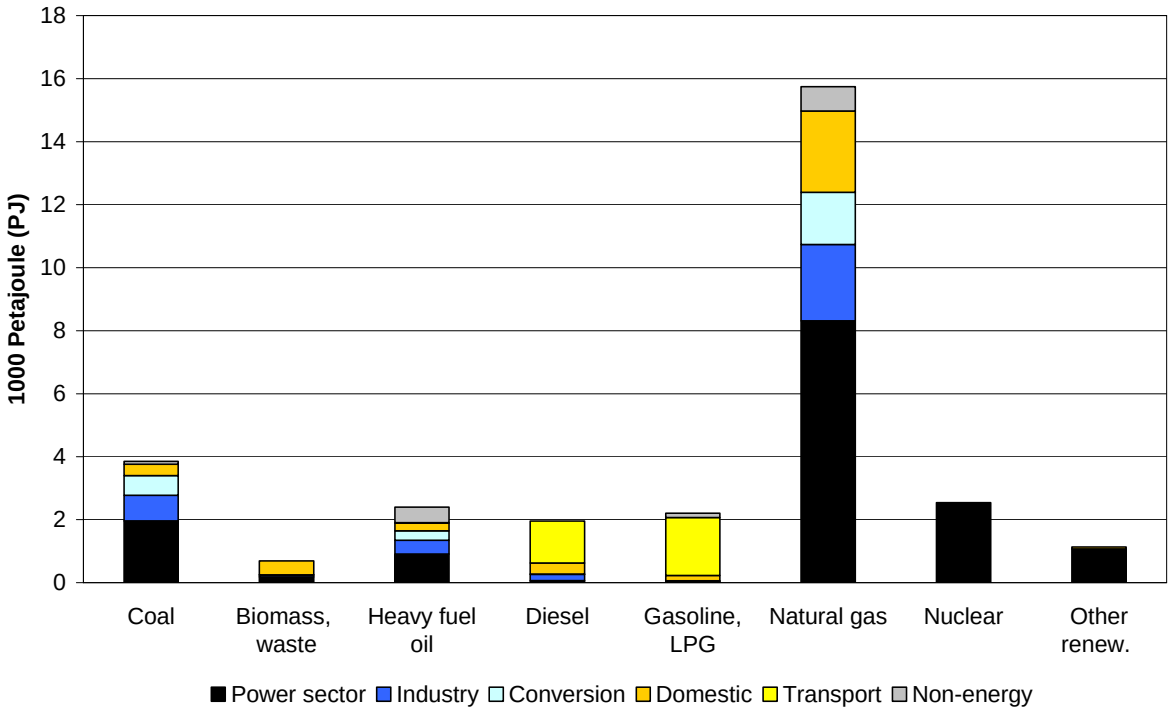

Figure 2.3: Energy consumption of the non-EU European countries in 2000 by fuel and sector

Table 2.12: Agricultural activity data for the year 2000

	Cattle	*Pigs*	*Chicken and poultry*	*Sheep and goats*	*Horses*	*Fertilizer consumption*	*Fertilizer production*
	1000 animal heads					kt N	
Albania	780	258	8424	3375	200	30	30
Belarus	4326	3566	27400	150	229	280	574
Bosnia Herzegovina	685	550	8000	1080	56	10	10
Croatia	427	1233	11251	608	15	116	328
Macedonia	285	174	22000	2351	39	3	8
Norway	987	609	12080	1841	48	103	618
Republic of Moldova	970	1487	19000	1300	45	99	0
Russia	20408	14030	246845	10610	526	960	5464
Serbia and Montenegro	1991	4092	21000	2752	68	95	85
Switzerland	1543	1498	6983	483	62	55	15
Turkey	11219	3	246477	38030	989	1276	479
Ukraine	10627	10073	139000	1885	709	350	2130
Total Non-EU	54248	37574	768460	64465	2986	3377	9741

Data source: GAINS, based on FAO, IFA, national statistical yearbooks, and bilateral consultations with national experts (the latter for Switzerland and Norway only).

2.2.2 Energy projections

For the integrated assessment exercise for the revision of the Gothenburg Protocol, input data have been collected from a variety of sources. These include, inter alia, recent energy projections produced with the PRIMES energy model by the Technical University of Athens (Capros *et al.*, 2007) and projections provided by national experts in the course of bilateral consultations on the RAINS model. For countries where such information was not available, the data used by the RAINS model for the analysis for the Gothenburg Protocol were used (Table 2.13). It needs to be mentioned that these data have received only limited review from national experts.

Table 2.13: Sources of energy projections used for this analysis

Country	Data source
Albania	National path used for Gothenburg Protocol (UN/ECE database, values from 1996)
Belarus	National path used for Gothenburg Protocol (UN/ECE database, values from 1996) adjusted by IIASA to account for statistical values in 2000 - 2003
Bosnia-Herzegovina	National path used for Gothenburg Protocol (UN/ECE database, values from 1996)
Croatia	National path used for Gothenburg Protocol (UN/ECE database, values from 1996)
T.F.Y.R.O. Macedonia	National path used for Gothenburg Protocol (UN/ECE database, values from 1996)
Rep. of Moldova	National path used for Gothenburg Protocol (UN/ECE database, values from 1996)
Norway	National path NEC 2006/2007
Russia	National path based on official Russian energy policy document. Input to RAINS prepared by expert from Siberian Energy Institute (December 2002)
Serbia-Montenegro	National path used for Gothenburg Protocol (UN/ECE database, values from 1996)
Switzerland	National path NEC 2006/2007
Turkey	PRIMES baseline 2006 pathway
Ukraine	National path prepared by experts from the Institute of General Energy on the Ukrainian Academy of Sciences (October 2004)

Table 2.14: Assumptions on population development for the non-EU European countries, million people (Source: GAINS database)

	1990	2005	2020
Albania	3.29	3.23	3.56
Belarus	10.26	9.98	9.51
Bosnia-Herzegovina	4.31	4.21	4.24
Croatia	4.52	4.66	4.58
T.F.Y.R.O. Macedonia	1.91	2.06	2.08
Norway	4.24	4.57	4.76
Republic of Moldova	4.36	4.24	4.11
Russia	117.69	111.83	102.92
Serbia-Montenegro	10.16	10.47	10.19
Switzerland	6.71	7.17	7.24
Turkey	56.2	72.06	83.79
Ukraine	51.89	47.3	41.48
Total non-EU Europe	275.54	281.78	278.46

While underlying assumptions on economic growth are unavailable in many cases, the collective energy projections suggest total primary energy consumption to increase by 27% between 2000 and 2020. Coal consumption would increase by 25 percent, while natural gas would see a growth rate of 15 percent only. The consumption of transport fuels would double. This projection sees CO_2 emissions of the EU-27 increasing by 23 percent between 2005 and 2020, although in 2020 they would be still 17 percent below the 1990 level (Table 2.15, Table 2.16).

Table 2.15: Primary energy consumption of the non-EU countries in 2020 [PJ]. Source: GAINS database

	Coal	Biomass waste	Heavy fuel oil	Diesel	Gasoline LPG	Natural gas(1)	Nuclear	Other renew.	Electr. import(2)	Total
Albania	1	10	19	28	15	51	0	15	0	139
Belarus	35	41	145	125	75	695	0	0	31	1148
Bosnia-H.	103	2	43	46	22	89	0	13	-1	319
Croatia	31	17	80	68	55	187	25	21	4	487
T.F.Y.R.O.M.	48	0	11	21	21	49	0	2	3	155
Norway	49	59	13	205	178	276	0	467	27	1274
Rep. Moldova	54	0	39	38	14	176	0	1	0	323
Russia	1507	275	882	1841	1366	10919	2454	178	261	19682
Serbia-M.	368	2	92	91	59	164	0	32	-17	791
Switzerland	9	91	23	291	196	115	308	151	-23	1161
Turkey	935	325	483	662	1128	1791	0	416	-10	5731
Ukraine	1691	107	154	398	496	3662	1051	80	-90	7547
Total non-EU Europe	4830	930	1983	3814	3626	18173	3838	1378	186	38758

(1) Including other gases

(2) Exports are indicated by negative numbers.

Table 2.16: Energy consumption of the non-EU countries in 2020 by fuel and sector [PJ]. Source: GAINS database

	Coal	*Biomass waste*	*Heavy fuel oil*	*Diesel*	*Gasoline LPG*	*Natural gas*	*Nuclear*	*Other renew.*	*Electr.*[1)]	Total
Power sector	2988	277	651	57	2	9759	3838	1137	-5690	13019
Industry	932	70	699	192	195	2653	0	0	2187	6927
Conversion	544	9	236	12	21	1583	0	0	1050	3455
Domestic	291	574	161	355	111	3197	0	241	2327	7259
Transport	0	0	8	3194	3131	3	0	0	311	6646
Non-energy	75	0	228	4	166	979	0	0	0	1451
Sum	4830	930	1983	3814	3626	18173	3838	1378	186	38758

[1)] The power sector includes gross power generation (reported with a negative sign); the conversion sector includes own use of energy industries as well as transmission and distribution losses; Total refers to domestic consumption excluding net electricity exports. Exports are indicated by negative numbers.

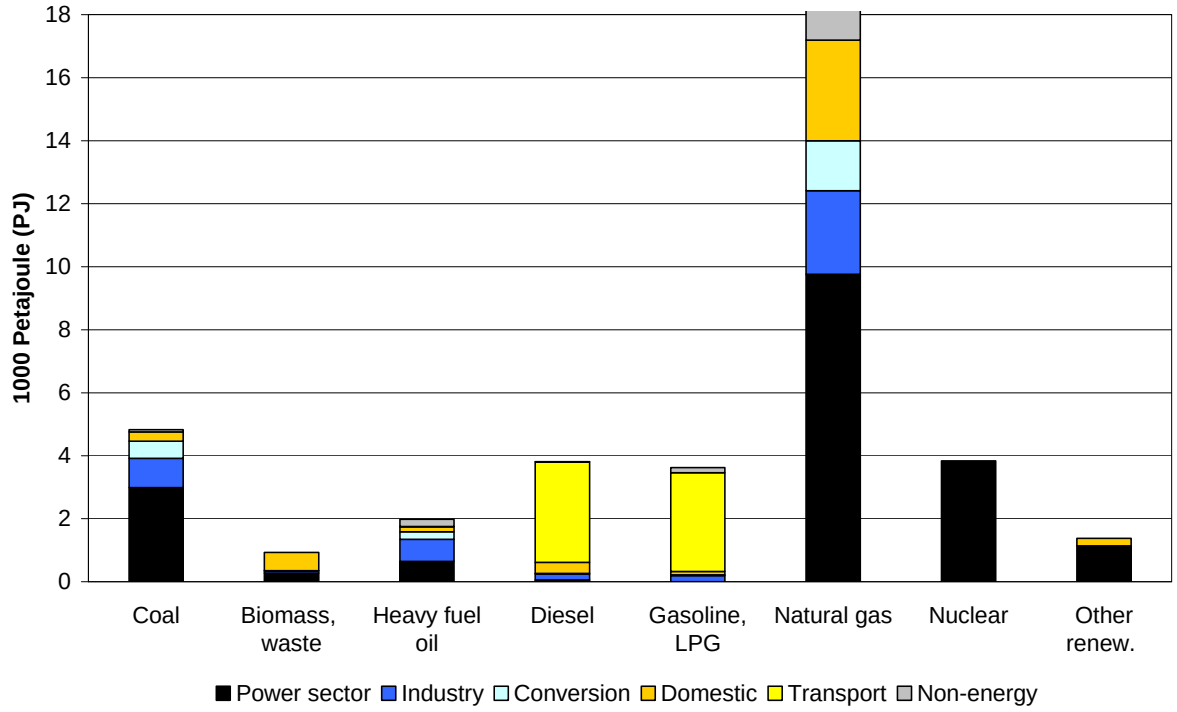

Figure 2.4: Energy consumption of the non-EU Parties projected for 2020

Table 2.17: Energy-related CO_2 emissions [Mt CO_2] for 1990, 2005 and 2020. Source: GAINS, preliminary estimates

	1990	2005	2020	Change relative to 1990
Albania	6.2	4.8	7.3	18%
Belarus	114.4	60.6	67.0	-41%
Bosnia-Herzegovina	22.0	19.5	22.0	0%
Croatia	22.1	24.4	27.3	23%
T.F.Y.R.O. Macedonia	12.4	10.4	11.5	-7%
Norway	30.3	39.4	43.1	42%
Republic of Moldova	28.9	24.9	21.7	-25%
Russia	1471.3	929.7	1055.8	-28%
Serbia-Montenegro	62.5	51.2	62.4	0%
Switzerland	43.1	44.9	42.0	-3%
Turkey	149.3	241.5	388.6	160%
Ukraine	676.5	324.6	440.9	-35%
Total non-EU Europe	2638.9	1775.8	2189.5	-17%

2.2.3 National projections of agricultural activities

In the course of the bilateral consultations in 2005-2006, Norway and Switzerland have supplied national agricultural projections to IIASA for implementation into the GAINS model (Table 2.18). Other countries have not provided any national data. For Croatia, Belarus, Russia, Turkey and Ukraine there exist livestock projections developed by the Food and Agricultural Organization (FAO) (Bruinsma, 2003). For the remaining countries the old RAINS projections were used so far.

For the non-EU as a whole (Table 2.19), these national projections anticipate between 2000 (Table 2.12) and 2020 for cattle an eight percent decline in livestock numbers, for pigs a reduction by 19 percent, for sheep a reduction by six percent, and about 17 percent increase in the number of poultry. Use of nitrogen fertilizers is estimated to increase in the non-EU countries by about 10 percent.

Table 2.18: Data sources for the projections in the baseline scenario

	Data source	*Date of last information exchange*	*Comments*
Albania			
Belarus	FAO (2003)		
Bosnia Herzegovina			
Croatia	FAO (2003)		
Macedonia			
Norway	National (2005)	10 February 2005	Submission to the UNECE
Republic of Moldova			
Russia	FAO (2003)		
Serbia and Montenegro			
Switzerland	National (2007)	10 January 2007	
Turkey	FAO (2003)		Update using CRONOS database
Ukraine	FAO (2003)		

Table 2.19: National projections of agricultural activities for the year 2020. Source: GAINS, based on national submissions to IIASA

	Cattle	*Pigs*	*Chicken and poultry*	*Sheep and goats*	*Horses*	*Fertilizer consumption*	*Fertilizer production*
	1000 animal heads					kt N	
Albania	780	258	8424	3375	200	60	60
Belarus	4837	3660	35504	225	160	278	650
Bosnia Herzegovina	685	550	8000	1080	56	10	10
Croatia	566	1273	12589	916	14	116	300
Macedonia	285	174	22000	2351	39	3	8
Norway	907	633	14290	1416	55	90	630
Republic of Moldova	970	1487	19000	1300	45	228	0
Russia	16736	10300	235243	12782	470	1050	5760
Serbia and Montenegro	1991	4092	21000	2752	68	145	85
Switzerland	1403	1357	7490	485	72	50	15
Turkey	14561	4	344710	32000	664	1200	600
Ukraine	5962	6566	167128	1770	712	483	2500
Total Non-EU	49682	30355	895378	60453	2555	3713	10618

Data sources: GAINS, based on national submissions to IIASA

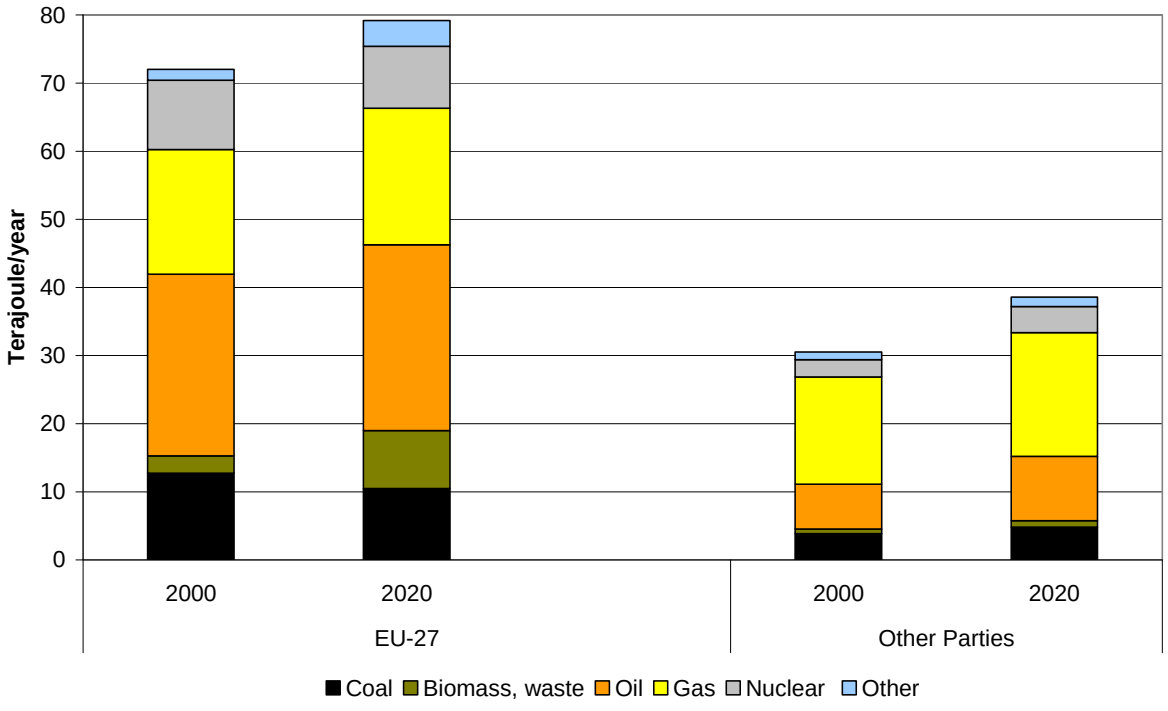

Figure 2.5: Total primary energy consumption for the EU and non-EU Parties, for 2000 and the baseline projection for 2020

3 Baseline emission projections

In order to provide a quantitative basis for an analysis of the needs for further emission reductions, the baseline scenario outlines the evolution of emissions as it could be expected from the implementation of all currently decided emission control legislation without assuming additional measures. The baseline scenario takes stock of country-specific implementation schedules of existing and decided legislation for all sectors and all pollutants. The following Sections summarize the assumptions (i) for the EU Member States and (ii) for all other Parties within the modelling domain.

3.1 EU Member States

The baseline scenario assumes for 2020 as a starting point (i) the implementation of all emission control legislation as is already laid down in national laws, (ii) compliance with the existing National Emission Ceilings Directive as well as (iii) the implementation of the Commission's recent proposals on further emission control measures for heavy duty vehicles (EURO-VI, CEC, 2007a) and for stationary sources the revision of the IPPC Directive (CEC, 2007b).

However, the analysis does not consider the impacts of other legislation for which the actual impacts on future activity levels cannot yet be quantified. This includes compliance with the air quality limit values for PM, NO_2 and ozone established by the new Air Quality Directive, which could require, inter alia, traffic restrictions in urban areas and thereby modifications of the traffic volumes assumed in the baseline projections. Although some other relevant directives such as the Nitrates Directive are part of current legislation, there are some uncertainties on how the measures can be represented in the framework of integrated assessment modelling.

As a first step, the assessment projects emissions in 2020 as they would result as a consequence of the assumed economic activities, country- and sector-specific emission factors and the progressing implementation rates of already decided emission control legislation as currently laid down in national laws. This corresponds to the "Current legislation" (CLE) projections in the earlier NEC and CAFE reports. From there, the second step constructs a "Current policy" case that quantifies the impacts of the proposed additional emission control legislation which is presently in the decision phase of the European Institutions.

The analysis considers a detailed inventory of national emission control legislation (including the transposition of EU-wide legislation) as of mid 2006 (Table 3.1 to Table 3.5), and assumes that these regulations are fully implemented in all Member States according to the foreseen time schedule. This "Current legislation" case, however, does not contain additional existing international legislation that is not yet put into national legislation (e.g., additional measures that are necessary to comply with the National Emission Ceilings Directive, etc.).

Table 3.1: Legislation considered in the CLE projection for SO_2 emissions

Large Combustion Plants Directive
Directive on the sulphur content in liquid fuels
Directives on quality of petrol and diesel fuels
IPPC requirements for industrial processes as currently laid down in national legislation
Sulphur content of gasoil used by non-road mobile machinery and inland waterway vessels (reduction from 1000 ppm to 10 ppm) according to the Proposal COM(2007) 18 of the Directive of the European Parliament and of the Council to amend Directives 98/70/EC and 1999/32/EC.
National legislation and national practices (if stricter)

Table 3.2: Legislation considered in the CLE projection for NO_x emissions

Large Combustion Plants Directive
EURO-standards, including adopted EURO-5 and EURO-6 for light duty vehicles
EU emission standards for motorcycles and mopeds
Legislation on non-road mobile machinery
Higher real-life emissions of EURO-II and EURO-III for diesel heavy duty and light duty vehicles compared with the test cycle
IPPC requirements for industrial processes as currently laid down in national legislation
National legislation and national practices (if stricter)

Table 3.3: Legislation considered in the CLE projections for NH_3 emissions

IPPC Directive for pigs and poultry production as interpreted in national legislation
National legislation including elements of EU law, i.e., Nitrates and Water Framework Directives
Current practice that includes implementation of *Code of Good Agricultural Practice* which is mandatory under the CLRTAP Gothenburg Protocol

Table 3.4: Legislation considered in the CLE projection for VOC emissions

Stage I Directive (liquid fuel storage and distribution)
Directive 91/441 (carbon canisters)
EURO-standards, including adopted EURO-5 and EURO-6 for light duty vehicles
Fuel Directive (RVP of fuels)
Solvents Directive
Products Directive (paints)
National legislation, e.g., Stage II (gasoline stations)

Table 3.5: Legislation considered in the CLE projections for PM2.5 emissions

Large Combustion Plants Directive
EURO-standards, including the adopted EURO-5 and EURO-6 standards for light duty vehicles
Emission standards for motorcycles and mopeds
Legislation on non-road mobile machinery
IPPC requirements for industrial processes as currently laid down in national legislation
National legislation and national practices (if stricter)

The baseline projection considers, on top of the "Current legislation", the implementation of the recent Commission proposals on the introduction of EURO-VI standards for heavy duty vehicles (CEC, 2007a) and on the revision of the Integrated Pollution Prevention and Control (IPPC) Directive for large stationary sources (CEC, 2007b). For EURO-VI, the GAINS analysis assumes emission limit

values corresponding to “Scenario A” of the Commission Staff Document (CEC, 2007c) and implementation starting from 2014 onwards.

For the IPPC Directive, the analysis assumes emission limit values for boilers in industry and in the power plant sector from the proposed IPPC Directive (the so-called less strict BAT case in CEC, 2007d if they are more stringent than current national legislation). The exact timing of introduction of these standards in each Member State can be extracted from the GAINS-online model.

With these additional measures, the baseline projection for the Climate & Energy Package together with the national projections of agricultural activities suggests for 2020 excess of the 2010 national emission ceilings (European Community, 2001) for NO_x for Austria and Luxembourg (Table 3.6), for NH_3 for Belgium, Germany, Netherlands, Slovenia and Spain, and for VOC in Spain. The baseline assumes for these countries that the most effective control measures (according to the GAINS cost curves) that are still available in that country will be taken to a degree that the 2010 emission ceilings will be complied with in 2020 (except for the NO_x ceiling for Luxembourg, which is unattainable for the given activity projection even if all emission control measures were applied to the full extent).

In addition to the baseline case, a hypothetical scenario is presented that estimates the potential for further emission reductions that are achievable through a full application of the most advanced technical (add-on) emission control measures that are on the market today. This scenario does not consider premature scrapping of existing capital stock before the end of its technical life time; it excludes the potential for emission reductions from fuel substitution and energy efficiency improvements, and it does not assume changes in personal behaviour or in the demand for energy services (e.g., smaller cars, lower room temperature, heating of less living space, changes in diets, etc.). Obviously, such a full implementation of all available emission control measures would involve considerable costs, which are however not considered in this analysis.

This “MRR” scenario (**M**aximum **R**eduction case applying all measures in the **R**AINS model) reflects the “Maximum technically feasible emission reduction” (MTFR) case as it was frequently computed with the RAINS model before, but it does not include the additional potential for emission reductions through structural changes and efficiency improvements that is quantified in the new GAINS model setup.

Table 3.6: Emissions for the year 2000, the 2020 baseline and the maximum reduction case of all measures that are considered in the RAINS model (the MRR case) [kt]. Source: GAINS

	SO_2			NO_x			PM2.5		
	2000	2020 baseline	2020 MRR	2000	2020 baseline	2020 MRR	2000	2020 baseline	2020 MRR
Austria	34	17	16	202	103	90	31	23	16
Belgium	175	83	58	351	148	121	35	24	17
Bulgaria	900	139	51	162	97	65	62	45	13
Cyprus	45	4	1	23	10	8	2	1	1
Czech Rep.	252	81	52	315	181	139	57	40	17
Denmark	28	17	13	213	95	82	25	17	8
Estonia	90	16	9	39	21	13	23	8	3
Finland	76	35	32	212	107	88	31	16	7
France	617	188	135	1323	541	435	363	227	113
Germany	630	403	349	1750	790	643	158	106	88
Greece	483	62	29	326	165	133	48	30	15
Hungary	484	55	18	186	89	57	52	20	8
Ireland	132	34	20	132	56	42	16	8	6
Italy	755	290	126	1353	700	556	158	108	71
Latvia	14	10	8	34	29	21	18	17	4
Lithuania	48	29	12	50	35	23	13	11	3
Luxembourg	4	1	1	33	13	12	3	2	2
Malta	34	1	1	8	3	2	1	0	0
Netherlands	75	45	38	410	178	153	27	18	15
Poland	1509	498	280	840	424	340	197	160	71
Portugal	289	65	32	279	130	104	81	47	14
Romania	771	166	70	323	228	157	130	143	28
Slovakia	128	50	24	109	58	37	25	12	7
Slovenia	124	15	8	60	34	32	12	6	3
Spain	1457	361	191	1343	719	546	143	96	65
Sweden	44	49	36	224	115	102	25	15	11
UK	1155	210	144	1855	615	445	121	60	46
EU-27	10352	2924	1755	12155	5684	4446	1857	1263	655

Table 3.7: Emissions of NH_3 and VOC for the year 2000, the 2020 baseline projection, and the maximum reduction case (MRR) assuming all measures that are considered in the RAINS model [kt]

	NH_3			VOC		
	2000	2020 baseline	2020 MRR	2000	2020 baseline	2020 MRR
Austria	60	60	35	184	120	77
Belgium	84	77	68	225	128	109
Bulgaria	69	68	53	133	87	44
Cyprus	7	7	5	15	6	5
Czech Rep.	83	77	56	234	181	78
Denmark	91	53	47	141	73	47
Estonia	10	11	7	39	21	13
Finland	35	30	25	160	88	57
France	704	650	379	1651	756	489
Germany	630	566	338	1451	867	596
Greece	56	48	34	291	138	78
Hungary	78	90	49	161	96	52
Ireland	125	104	84	86	50	28
Italy	429	390	252	1509	681	506
Latvia	13	15	8	69	42	16
Lithuania	38	40	24	69	54	30
Luxembourg	6	6	4	13	7	6
Malta	2	3	2	8	3	2
Netherlands	149	129	118	259	161	129
Poland	317	313	203	577	361	206
Portugal	76	70	42	270	167	110
Romania	138	177	86	421	339	135
Slovakia	30	32	17	88	52	34
Slovenia	20	21	13	53	31	15
Spain	392	353	210	1125	662	523
Sweden	56	51	37	255	123	98
UK	322	268	198	1383	855	657
EU-27	4021	3709	2394	10867	6146	4138

Table 3.8: Emissions by SNAP sector for the year 2000, the 2020 baseline projection, and the maximum reduction case (MRR) assuming all measures that are considered in the RAINS model [kt]

	SO_2			NO_x			PM2.5		
	2000	2020 baseline	2020 MRR	2000	2020 baseline	2020 MRR	2000	2020 baseline	2020 MRR
1: Power generation	7085	917	667	2494	1136	786	199	69	52
2: Domestic	741	427	255	705	647	493	581	460	97
3: Industrial combust.	1375	764	404	1363	1063	453	130	122	87
4: Industrial processes	747	692	380	217	223	113	308	284	156
5: Fuel extraction	0	0	0	0	0	0	7	5	5
6: Solvents	0	0	0	0	0	0	0	0	0
7: Road traffic	156	11	11	5508	1343	1343	310	91	91
8: Off-road sources	234	101	33	1846	1254	1254	159	70	70
9: Waste management	8	6	4	10	8	4	85	84	63
10: Agriculture	5	5	0	11	11	0	77	78	33
Sum	10352	2924	1755	12155	5684	4446	1857	1263	655

Table 3.9: Emissions of NH_3 and VOC by SNAP sector for the year 2000, the 2020 baseline projection, and the maximum reduction case (MRR) assuming all measures that are considered in the RAINS model [kt]

	NH_3			VOC		
	2000	2020 baseline	2020 MRR	2000	2020 baseline	2020 MRR
1: Power generation	10	19	26	107	138	138
2: Domestic	18	21	20	1110	776	134
3: Industrial combust.	3	6	10	52	59	59
4: Industrial processes	75	64	30	1156	1032	801
5: Fuel extraction	0	0	0	710	558	419
6: Solvents	0	0	0	3781	2556	1632
7: Road traffic	78	20	20	2941	423	423
8: Off-road sources	1	1	1	830	419	419
9: Waste management	180	175	175	103	109	103
10: Agriculture	3657	3402	2112	77	77	10
Sum	4021	3709	2394	10867	6146	4138

3.2 Other Parties

For Norway and Switzerland, the baseline current emission control legislation, which is virtually the same as for the EU Member States (see preceding Section).

Although also in other countries national emission and fuel standards are in force, there are large uncertainties about the actual implementation and enforcement of these standards. Analysis presented in CIAM report 1/2008 (Cofala *et al.*, 2008) explored the scope for implementation of the existing legislation in these countries through two scenarios, i.e., (i) a baseline case, which employs very conservative assumptions about the actual implementation of decided measures, and (ii) a "with measures" case that assumes that all measures that are already put in legislation will be implemented.

This report presents the baseline case, i.e., it assumes that baseline emissions of SO_2 and NO_x from stationary and mobile sources will remain uncontrolled up to 2020. For PM, a set of "typical" control technologies for stationary emission sources has been assumed. These technologies reflect, according to experts' opinion, current level of control of dust emissions from power plant and industrial sources.

In addition to the baseline case, a hypothetical scenario has been calculated that estimates the potential for further emission reductions that are achievable with a full application of the most advanced technical (add-on) emission control measures that are on the market today. This scenario does not consider premature scrapping of existing capital stock before the end of its technical life time; it excludes the potential for emission reductions from fuel substitution and energy efficiency improvements, and it does not assume changes in personal behaviour or in the demand for energy services (e.g., smaller cars, lower room temperature, heating of less living space, changes in diets, etc.).

Table 3.10: Emissions for the year 2000, the 2020 baseline projection, and the maximum reduction case (MRR) assuming all measures that are considered in the RAINS model [kt]

	SO_2			NO_x			PM2.5		
	2000	2020 baseline	2020 MRR	2000	2020 baseline	2020 MRR	2000	2020 baseline	2020 MRR
Albania	32	31	11	22	36	31	9	7	3
Belarus	159	182	43	193	239	175	43	47	18
Bosnia-H.	420	380	21	53	58	42	20	16	5
Croatia	108	62	15	87	53	32	21	13	4
FYROM	90	72	7	38	43	35	9	8	3
R. Moldova	114	102	14	64	63	46	23	13	7
Norway	27	26	22	212	152	126	56	44	14
Russia	2399	3125	669	2592	3297	2555	576	635	279
Serbia-M.	397	168	36	166	173	122	42	42	13
Switzerland	20	18	18	91	49	49	12	7	7
Turkey	1646	911	211	822	731	419	313	289	74
Ukraine	1134	1866	258	873	1363	930	281	315	114
Total	6546	6943	1327	5214	6256	4562	1405	1435	541

Table 3.11: Emissions of NH_3 and VOC for the year 2000, the 2020 baseline projection, and the maximum reduction case (MRR) assuming all measures that are considered in the RAINS model [kt]

	NH_3			VOC		
	2000	2020 baseline	2020 MRR	2000	2020 baseline	2020 MRR
Albania	23	27	15	33	43	29
Belarus	117	133	76	236	252	180
Bosnia-H.	18	19	11	39	51	42
Croatia	29	33	15	102	42	25
FYROM	15	15	8	25	36	32
R. Moldova	37	46	24	37	41	32
Norway	24	21	13	380	90	67
Russia	565	539	289	2836	3329	2463
Serbia-M.	69	75	39	139	155	124
Switzerland	52	41	41	137	79	79
Turkey	405	468	277	786	481	270
Ukraine	301	263	134	641	1198	920
Total	1656	1678	942	5393	5796	4262

Table 3.12: Emissions by SNAP sector for the year 2000, the 2020 baseline projection, and the maximum reduction case (MRR) assuming all measures that are considered in the RAINS model [kt]

	SO_2			NO_x			PM2.5		
	2000	2020 baseline	2020 MRR	2000	2020 baseline	2020 MRR	2000	2020 baseline	2020 MRR
1: Power generation	4032	4078	181	1906	1189	270	130	162	32
2: Domestic	593	393	227	252	271	170	372	316	104
3: Industrial combust.	969	1107	238	548	769	187	123	177	42
4: Industrial processes	639	658	207	201	229	145	475	364	51
5: Fuel extraction	0	0	0	0	0	0	3	3	3
6: Solvents	0	0	0	0	0	0	0	0	0
7: Road traffic	166	446	446	1603	2597	2597	87	168	168
8: Off-road sources	138	251	24	684	1185	1185	58	88	88
9: Waste management	5	5	4	15	11	9	51	51	39
10: Agriculture	5	5	0	5	5	0	106	106	14
Sum	6546	6943	1327	5214	6256	4562	1405	1435	541

Table 3.13: Emissions of NH_3 and VOC by SNAP sector for the year 2000, the 2020 baseline projection, and the maximum reduction case (MRR) assuming all measures that are considered in the RAINS model [kt]

	NH_3			VOC		
	2000	2020 baseline	2020 MRR	2000	2020 baseline	2020 MRR
1: Power generation	2	2	13	49	29	29
2: Domestic	8	8	8	412	371	57
3: Industrial combust.	1	1	5	16	18	18
4: Industrial processes	29	32	3	503	542	440
5: Fuel extraction	0	0	0	528	292	170
6: Solvents	0	0	0	1266	1231	413
7: Road traffic	5	4	4	1964	2575	2575
8: Off-road sources	0	0	0	413	496	496
9: Waste management	37	37	37	49	50	45
10: Agriculture	1574	1594	871	192	192	20
Sum	1656	1678	942	5393	5796	4262

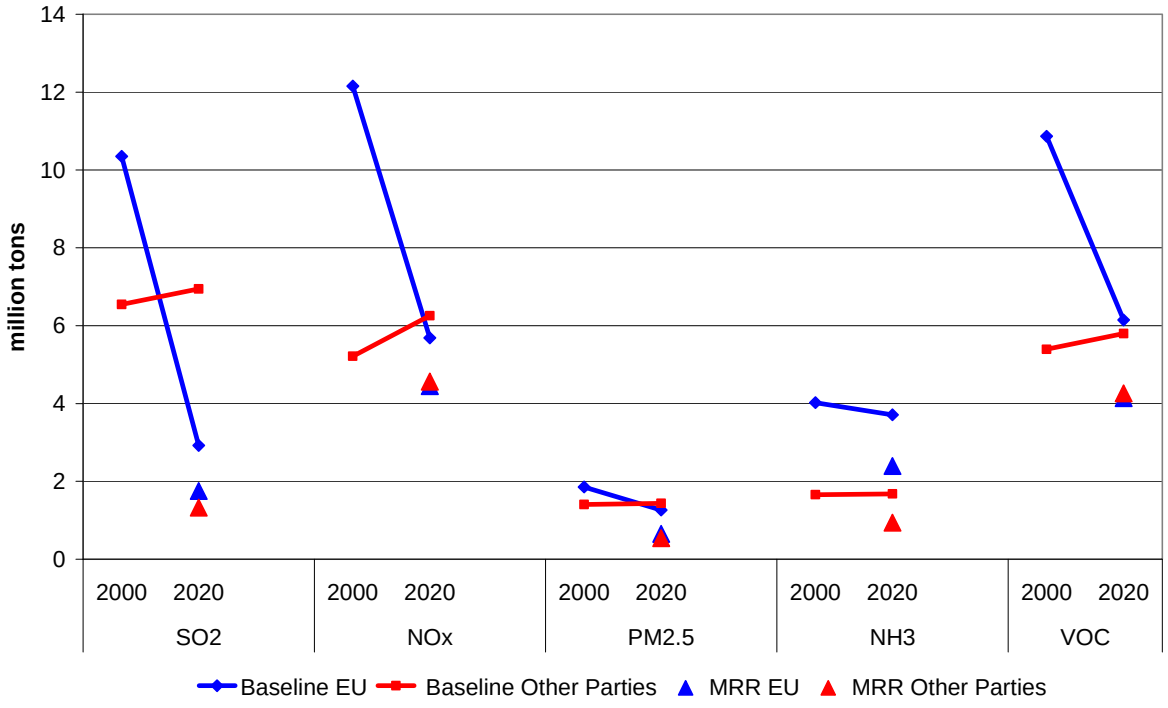

Figure 3.1: Baseline emissions and MRR cases for the EU and other Parties

4 Air quality impacts

Following the expected changes in emissions, air quality and resulting impacts are envisaged to change in the future accordingly. This section presents estimates of such changes that have been derived with the GAINS model, with the assumptions and methodologies that are consistent with the recent analysis for the revision of the NEC directive as presented in Amann *et al.*, 2008. The analysis employs source-receptor relationships developed from a sample of model runs with the EMEP Eulerian model (Simpson *et al.*, 2003) for the meteorological conditions of five years (1996, 1997, 1998, 2000 and 2003) and relies on the critical loads database of 2006 (Slootweg *et al.*, 2007). For health impacts, the GAINS methodology approved by the Task Force on Health (TFH, 2003) was used with population projections for 2010. For ozone it is assumed that the hemispheric background in 2020 will be 2.4 ppb higher than in 2000 (Raes and Hjorth, 2006), and that this increase cannot be influenced by emission reductions in Europe. Calculations of the protection of ecosystems from excess nitrogen deposition are based on ecosystem-specific deposition calculations. For emissions from international shipping, the projection developed by Cofala *et al.*, 2007 has been employed (Table 4.1). This projection, however, does not take into account the April 2008 proposal of the International Maritime Organisation's (IMO) Marine Environment Protection Committee (MEPC) for new limits for reducing emissions from ships to be implemented by 2020 because this agreement is to be confirmed by the next MEPC in October 2008.

Table 4.1: Emissions in 2000 and 2020 assumed for marine sources [kt]

	SO_2		NO_x		*PM2.5*		NH_3		*VOC*	
	2000	2020	2000	2020	2000	2020	2000	2020	2000	2020
NE Atlantic	494	804	723	1048	56	91	0	0	24	35
Baltic Sea	187	171	278	404	21	29	0	0	10	22
Black Sea	56	90	81	118	6	10	0	0	3	7
Medit. Sea	1070	1714	1564	2311	121	198	0	0	53	114
North Sea	443	406	649	946	50	68			23	41
Sum	2250	3186	3295	4827	254	396	0	0	114	219

The GAINS model has been used to estimate, for the three emission scenarios, impact indicators for health impacts from PM2.5, eutrophication, acidification and ground-level ozone. Results are presented in Table 4.2 to Table 4.6 and Figure 4.1 to Figure 4.4. The exact way how impact indicators should be presented for a potential target setting exercise for the revision of the Gothenburg Protocol needs further consultations with other groups under the Convention and input from the negotiation process.

Table 4.2: Health impacts attributable to the exposure to PM2.5, life years lost (YOLLs) and loss in statistical life expectancy

Country	Years of Life Lost (YOLL), millions			Loss in statistical life expectancy (months)		
	2000	2020 Baseline	2020 MRR	2000	2020 Baseline	2020 MRR
Austria	3.5	2.1	1.3	7.8	4.5	2.9
Belgium	7.0	4.2	3.1	12.2	7.4	5.4
Bulgaria	3.5	2.3	1.0	8.2	5.5	2.3
Cyprus	0.2	0.1	0.1	4.4	3.1	1.5
Czech Rep.	5.4	3.2	1.9	9.6	5.6	3.3
Denmark	1.9	1.3	0.9	6.6	4.5	3.2
Estonia	0.3	0.3	0.1	4.8	4.1	2.0
Finland	0.8	0.7	0.4	2.9	2.5	1.3
France	24.6	13.6	8.7	7.6	4.2	2.7
Germany	44.4	26.9	18.9	9.3	5.7	4.0
Greece	4.9	2.9	1.6	7.7	4.5	2.4
Hungary	6.1	3.5	1.7	11.0	6.4	3.2
Ireland	0.8	0.4	0.3	3.8	2.1	1.5
Italy	27.9	16.1	10.4	8.1	4.7	3.0
Latvia	0.7	0.6	0.3	5.9	5.1	2.3
Lithuania	1.0	0.8	0.4	5.7	4.8	2.4
Luxembourg	0.2	0.1	0.1	9.1	5.3	3.6
Malta	0.1	0.1	0.1	6.2	4.7	3.7
Netherlands	10.2	6.5	5.0	11.5	7.3	5.6
Poland	19.6	13.0	7.0	10.0	6.6	3.6
Portugal	3.4	2.0	1.1	5.8	3.3	1.9
Romania	10.0	7.8	2.9	8.9	6.9	2.6
Slovakia	2.6	1.6	0.8	9.4	5.6	3.0
Slovenia	0.9	0.6	0.3	8.4	5.0	2.9
Spain	12.1	6.6	4.8	4.8	2.6	1.9
Sweden	1.7	1.2	0.8	3.4	2.5	1.7
UK	21.6	12.0	8.8	6.7	3.7	2.7
EU-27	215.6	130.4	82.8	8.0	4.8	3.1
Albania	0.8	0.5	0.2	5.5	3.6	1.8
Belarus	3.5	3.1	1.4	6.9	6.1	2.8
Bosnia-H	1.5	1.0	0.4	6.5	4.2	1.8
Croatia	2.2	1.3	0.6	8.9	5.2	2.6
FYROM	0.6	0.4	0.2	6.2	3.7	1.7
R Moldova	1.8	1.5	0.6	9.0	7.4	3.0
Norway	0.6	0.4	0.2	2.5	1.7	1.0
Russia	51.9	57.8	23.3	7.2	8.0	3.2
Serbia-M	4.3	2.7	1.1	8.0	5.0	2.1
Switzerland	2.6	1.3	1.0	6.4	3.2	2.4
Turkey						
Ukraine	21.2	21.2	8.2	8.7	8.7	3.4
Non-EU	90.9	91.1	37.2	7.4	7.4	3.0
Total	306.5	221.5	120.1	7.7	5.6	3.1

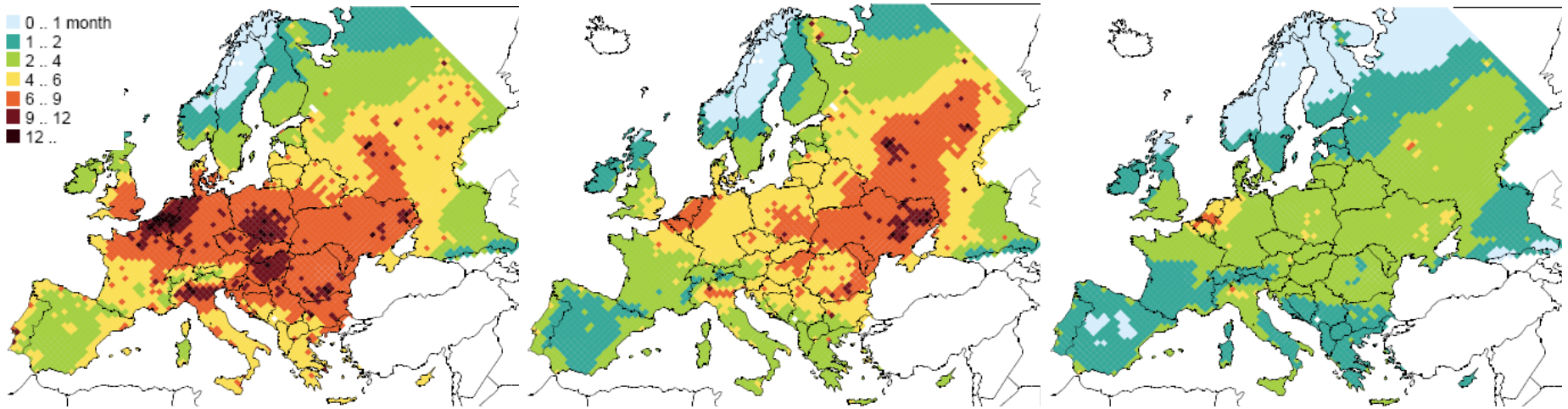

Figure 4.1: Loss in statistical life expectancy attributable to the human exposure of PM2.5, for the year 2000 (left panel), the baseline projection for 2020 (centre panel) and the MRR case (right panel), in months

Table 4.3: Ecosystems area with nitrogen deposition exceeding critical loads for eutrophication. Note that this calculation uses ecosystem-specific deposition calculation.

	Total area	2000		2020 baseline		2000 MRR	
	km^2	km^2	%	km^2	%	km^2	%
Austria	35745	35618	100%	28696	80%	6400	18%
Belgium	7052	6730	95%	6232	88%	4431	63%
Bulgaria	48330	45600	94%	40523	84%	15641	32%
Cyprus	4062	3049	75%	2939	72%	1590	39%
Czech Rep.	11178	11162	100%	10895	97%	9765	87%
Denmark	3149	3039	97%	2509	80%	2277	72%
Estonia	22411	12316	55%	7830	35%	1932	9%
Finland	240403	112220	47%	82404	34%	40327	17%
France	180102	176710	98%	157423	87%	90480	50%
Germany	104195	101804	98%	97521	94%	71414	69%
Greece	9326	9326	100%	9326	100%	9142	98%
Hungary	10448	10278	98%	8009	77%	2167	21%
Ireland	8936	7403	83%	6042	68%	5345	60%
Italy	125878	87696	70%	68933	55%	33105	26%
Latvia	27014	26781	99%	25724	95%	20313	75%
Lithuania	17651	17651	100%	17651	100%	17310	98%
Luxembourg	821	821	100%	821	100%	804	98%
Malta							
Netherlands	4393	4124	94%	3803	87%	3360	76%
Poland	88383	86408	98%	83864	95%	68081	77%
Portugal	21220	20107	95%	19549	92%	5366	25%
Romania	62807	60560	96%	60016	96%	47601	76%
Slovakia	19253	19236	100%	17882	93%	7918	41%
Slovenia	5264	5264	100%	5247	100%	4795	91%
Spain	85225	75050	88%	61225	72%	41025	48%
Sweden	225264	60026	27%	20522	9%	14973	7%
UK	74204	20972	28%	12663	17%	7916	11%
EU-27	1442715	1019951	71%	858250	59%	533478	37%
Albania	6334	6328	100%	6328	100%	6122	97%
Belarus	107841	57605	53%	55107	51%	27941	26%
Bosnia-H	10241	10199	100%	10007	98%	5472	53%
Croatia	7009	3043	43%	2478	35%	786	11%
FYROM	5068	5068	100%	5068	100%	2331	46%
R Moldova	11985	1	0%	1	0%	0	0%
Norway	318762	11700	4%	2907	1%	1026	0%
Russia	1821560	379853	21%	474971	26%	108206	6%
Serbia-M	21307	21226	100%	20290	95%	8242	39%
Switzerland	22790	18400	81%	11172	49%	4977	22%
Turkey							
Ukraine	63600	63600	100%	63600	100%	63600	100%
Non-EU	2396498	577024	24%	651929	27%	228703	10%
Total	3839212	1596975	42%	1510179	39%	762181	20%

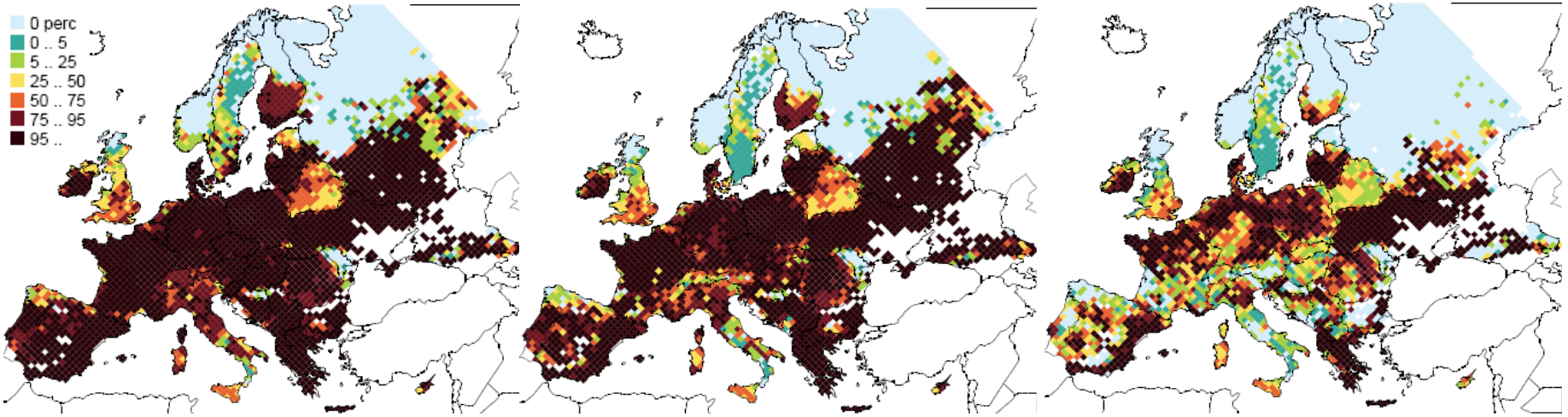

Figure 4.2: Percentage of ecosystems area that receives nitrogen deposition in excess of their critical loads (using ecosystem-specific deposition calculation)

Table 4.4: Forest area with acid deposition exceeding critical loads for acidification

	Total area	2000		2020 baseline		2000 MRR	
	km^2	km^2	%	km^2	%	km^2	%
Austria	35745	373	1%	0	0%	0	0%
Belgium	6315	4591	73%	955	15%	469	7%
Bulgaria	48330	0	0%	0	0%	0	0%
Cyprus	2320	0	0%	0	0%	0	0%
Czech Rep.	11178	9158	82%	3328	30%	969	9%
Denmark	3149	1200	38%	60	2%	21	1%
Estonia	21450	0	0%	0	0%	0	0%
Finland	240403	6115	3%	2966	1%	1463	1%
France	170657	19649	12%	5358	3%	1403	1%
Germany	100954	62491	62%	28175	28%	10472	10%
Greece	9326	943	10%	254	3%	38	0%
Hungary	10448	50	0%	0	0%	0	0%
Ireland	4254	1695	40%	558	13%	259	6%
Italy	89560	0	0%	0	0%	0	0%
Latvia	27014	538	2%	0	0%	0	0%
Lithuania	17651	13219	75%	9450	54%	1152	7%
Luxembourg	821	272	33%	166	20%	151	18%
Malta							
Netherlands	5640	5106	91%	4903	87%	4677	83%
Poland	88383	53034	60%	11108	13%	183	0%
Portugal	21220	3345	16%	1042	5%	81	0%
Romania	62807	3516	6%	398	1%	0	0%
Slovakia	19253	4707	24%	1598	8%	296	2%
Slovenia	5264	647	12%	2	0%	0	0%
Spain	85225	900	1%	50	0%	0	0%
Sweden	225264	58438	26%	17728	8%	5200	2%
UK	19748	9424	48%	2771	14%	1502	8%
EU-27	1332382	259412	19%	90868	7%	28337	2%
Albania	6334	0	0%	0	0%	0	0%
Belarus	91841	62154	68%	50127	55%	13291	14%
Bosnia-H	10241	5242	51%	2167	21%	0	0%
Croatia	6931	616	9%	0	0%	0	0%
FYROM	5068	1837	36%	0	0%	0	0%
R Moldova	313	44	14%	22	7%	0	0%
Norway	67011	2662	4%	299	0%	123	0%
Russia	1821560	27532	2%	37301	2%	4712	0%
Serbia-M	21307	8522	40%	1035	5%	17	0%
Switzerland	11612	1872	16%	595	5%	208	2%
Turkey							
Ukraine	63600	14562	23%	12060	19%	562	1%
Non-EU	2105818	125042	6%	103607	5%	18913	1%
Total	3438200	384454	11%	194475	6%	47250	1%

Table 4.5: Freshwater catchment area with acid deposition exceeding critical loads for acidification. Parties that have not submitted critical loads data for freshwater ecosystems are not listed.

	Total area	2000		2020 baseline		2000 MRR	
	km^2	km^2	%	km^2	%	km^2	%
Finland	26426	93	0%	30	0%	10	0%
Italy	6	0	0%	0	0%	0	0%
Sweden	294079	32756	11%	20227	7%	13529	5%
UK	7788	665	9%	205	3%	121	2%
EU-27	328299	33514	10%	20462	6%	13659	4%
Norway	322150	63607	20%	37381	12%	28641	9%
Switzerland	165	131	79%	87	53%	56	34%
Non-EU	322315	63738	20%	37468	12%	28697	9%
Total	650614	97252	15%	57930	9%	42356	7%

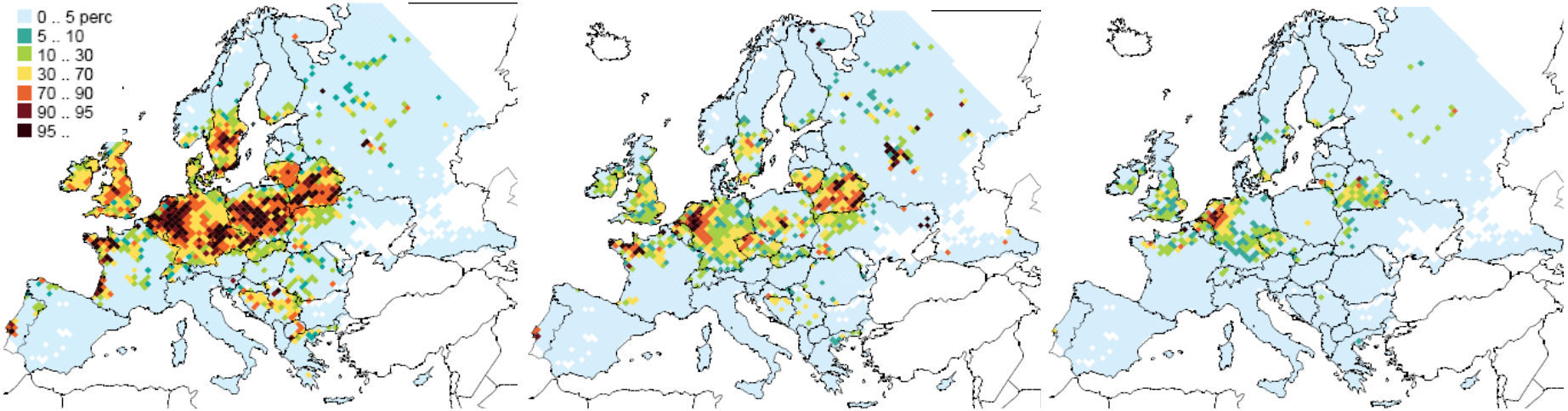

Figure 4.3: Percentage of forest area that receives acid deposition in excess of their critical loads, for the year 2000 (left panel), the baseline projection for 2020 (centre panel) and the MRR case (right panel),

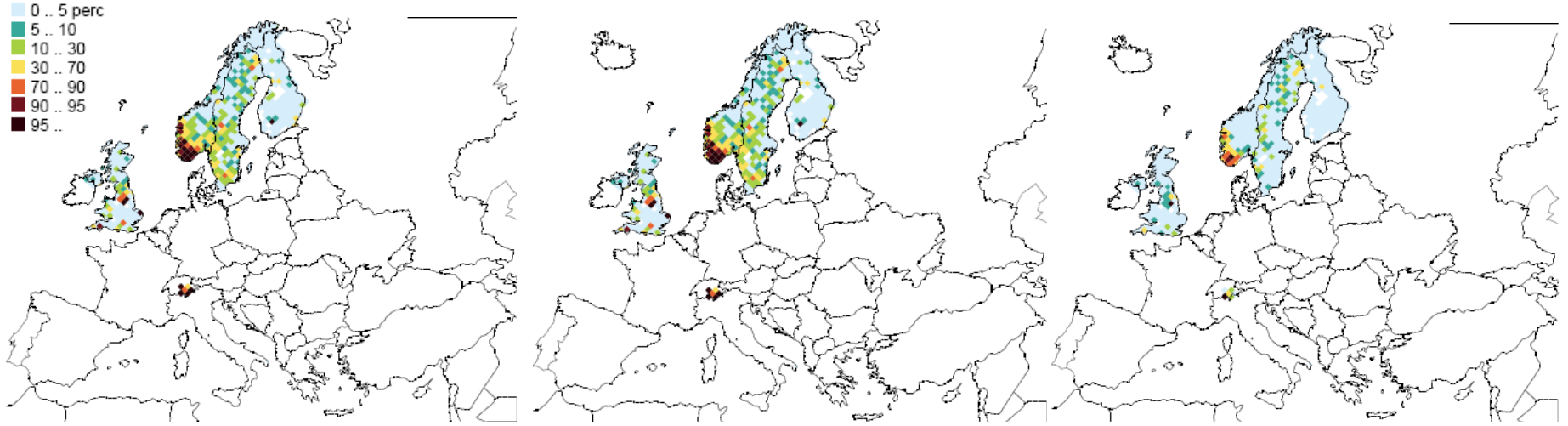

Figure 4.4: Percentage of freshwater catchment area that receives acid deposition in excess of their critical loads, for the year 2000 (left panel), the baseline projection for 2020 (centre panel) and the MRR case (right panel),

Table 4.6: Cases of premature deaths attributable to the exposure to ground-level ozone

	2000	2020 baseline	2020 MRR
Austria	397	299	252
Belgium	320	347	300
Bulgaria	482	448	353
Cyprus	29	27	24
Czech Rep.	514	407	326
Denmark	159	158	139
Estonia	18	21	18
Finland	41	50	45
France	2397	1877	1652
Germany	3743	3086	2663
Greece	567	532	456
Hungary	735	575	450
Ireland	57	81	76
Italy	4179	3440	3000
Latvia	46	48	41
Lithuania	74	72	60
Luxembourg	27	23	19
Malta	23	20	17
Netherlands	342	347	295
Poland	1347	1124	912
Portugal	396	455	412
Romania	1061	1002	772
Slovakia	234	186	140
Slovenia	105	80	65
Spain	1755	1565	1417
Sweden	164	169	151
UK	1083	1738	1582
EU-27	20295	18179	15637
Albania	129	104	88
Belarus	315	281	225
Bosnia-H	257	180	140
Croatia	358	242	195
FYROM	98	84	73
R Moldova	191	174	136
Norway	98	83	78
Russia	4509	4653	3988
Serbia-M	509	412	339
Switzerland	383	252	224
Turkey	2045	1831	1361
Ukraine	2509	2464	2005
Non-EU	11401	10761	8852
Total	31696	28940	24489

5 Conclusions

The baseline projection presented in this report foresees for the EU countries sharp declines in emissions between 2000 and 2020. SO_2 emissions are projected to shrink by more than 70 percent, NO_x by 50 percent, VOC by about 40 percent, PM2.5 by approx. 30 percent and NH_3 by 10 percent. In contrast, emissions from the other Parties are expected to increase by up to 20 percent.

As a consequence, air quality impacts are generally expected to improve in the EU countries, but deteriorate in the eastern part of Europe.

The baseline projection is sensitive towards alternative assumptions of economic development, and in particular, as has been pointed out earlier, towards different assumptions on climate policies and how they will be implemented in each country. With very few exceptions, the baseline activity projections presented in this paper result from international sources that are not necessarily fully shared by all Parties. A key element for reducing uncertainties in baseline projections would be the availability of information from Parties on how governments are planning plan to implement the forthcoming international agreements on climate change.

References

Amann, M., W. Asman, I. Bertok, J. Cofala, C. Heyes, Z. Klimont, W. Schöpp and F. Wagner (2007). Updated Baseline Projections for the Revision of the Emission Ceilings Directive of the European Union. NEC Scenario Analysis Report #4. International Institute for Applied Systems Analysis (IIASA), Laxenburg, Austria, http://www.iiasa.ac.at/rains/CAFE_files/NEC4-v1.pdf

Amann, M., I. Bertok, J. Cofala, C. Heyes, Z. Klimont, P. Rafaj, W. Schöpp and F. Wagner (2008). National Emission Ceilings for 2020 based on the 2008 Climate & Energy Package. NEC Scenario Analysis Report #6 International Institute for Applied Systems Analysis (IIASA) Laxenburg, Austria,

Bruinsma, J. (2003). World agriculture towards 2015/2030. An FAO Perspective. World Food and Agricultural Organization (Rome) and Earthscan (London),

Capros, P., L. Mantzos, V. Papandreou, N. Tasios and A. Mantzaras (2007). Energy Systems Analysis of CCS technology. PRIMES model scenarios. . Institute of Communications and Computer Systems, National Technical University of Athens. , Athens, Greece,

Capros, P., L. Mantzos, V. Papandreou and N. Tasios (2008). European Energy and Transport Trends to 2030 — Update 2007. European Commission Directorate-General for Energy and Transport, Brussels, Belgium,

CEC (2007a). Proposal for a Regulation of the European Parliament and of the Council on type-approval of motor vehicles and engines with respect to emissions from heavy duty vehicles (Euro VI) and on access to vehicle repair and maintenance information. COM(2007) 851 final. Commission of the European Communities. Brussels, Belgium.

CEC (2007b). Proposal for a Directive of the European Parliament and of the Council on industrial emissions (integrated pollution prevention and control). COM(2007) 844 final. Commission of the European Communities. Brussels, Belgium.

CEC (2007c). Commission Staff Working Document accompanying to the Proposal for a Regulation of the European Parliament and of the Council on the approximation of the laws of the Member States with respect to emissions from on-road heavy duty vehicles and on access to vehicle repair information. Impact Assessment's Summary. Commission of the European Communities. Brussels, Belgium.

CEC (2007d). Commission Staff Working Document Accompanying the Document to the Proposal for a Directive of the European Parliament and of the Council on Industrial Emissions (Integrated Pollution Prevention and Control). Impact Assessment. . Commission of the European Communities Brussels, Belgium,

CEC (2008a). 20 20 by 2020. Europe's climate change opportunity. Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions. COM(2008) 30 final. Commission of the European Communities. Brussels, Belgium.

CEC (2008b). Impact assessment. Document accompanying the Package of Implementation measures for the EU's objectives on climate change and renewable energy for 2020. . Commission of the European Communities, Brussels, Belgium,

CEC (2008c). Annex to the Impact Assessment. Document accompanying the Package of Implementation measures for the EU's objectives on climate change and renewable energy for 2020. Commission of the European Communities, Brussels, Belgium,

Cofala, J., M. Amann, C. Heyes, F. Wagner, Z. Klimont, M. Posch, W. Schöpp, L. Tarasson, J. E. Jonson, C. Whall and A. Stavrakaki (2007). Analysis of Policy Measures to Reduce Ship Emissions in the Context of the Revision of the National Emissions Ceilings Directive. Contract No 070501/2005/419589/MAR/C1, International Institute for Applied Systems Analysis (IIASA), Laxenburg, Austria,

Cofala, J., Z. Klimont, M. Amann, I. Bertok, C. Heyes, P. Rafaj, W. Schöpp and F. Wagner (2008). Scenarios of SO2, NOx, and PM emissions in the non-EU countries up to 2020. Background paper for the 41st Session of the Working Group on Strategies and Review of the Convention on Long-range Transboundary Air Pollution, Geneva, April 14-17, 2008. Centre for

Integrated Assessment Modelling (CIAM), International Institute for Applied Systems Analysis (IIASA), Laxenburg, Austria,

EEA (2004). Outlooks on selected agriculture variables for the 2005 State of the Environment and the Outlook Report. EEA/RNC/03/016, European Environment Agency, Copenhagen,

EFMA (2005). Forecast of Food, Farming and Fertilizer Use in the European Union 2005-2015., European Fertilizer Manufacturers Association, Brussels,

European Community (2001). DIRECTIVE 2001/81/EC OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 23 October 2001 on national emission ceilings for certain atmospheric pollutants.

Raes, F. and J. Hjorth (2006). Answers to the Urbino Questions. ACCENT's first policy-driven synthesis., ACCENT Secretariat, University di Urbino, Italy,

Simpson, D., H. Fagerli, J. E. Jonson, S. Tsyro and P. Wind (2003). Transboundary Acidification, Eutrophication and Ground-level Ozone in Europe. Unified EMEP Model Description. EMEP Report 1/2003, Norwegian Meteorological Institute, Oslo,

Slootweg, J., M. Posch and J.-P. Hettelingh (2007). Critical Loads of Nitrogen and Dynamic Modelling. CCE Progress Report 2007. Coordination Centre for Effects, Bilthoven, Netherlands

TFH (2003). Modelling and assessment of the health impact of particulate matter and ozone. EB.AIR/WG.1/2003/11, United Nations Economic Commission for Europe, Task Force on Health, Geneve,