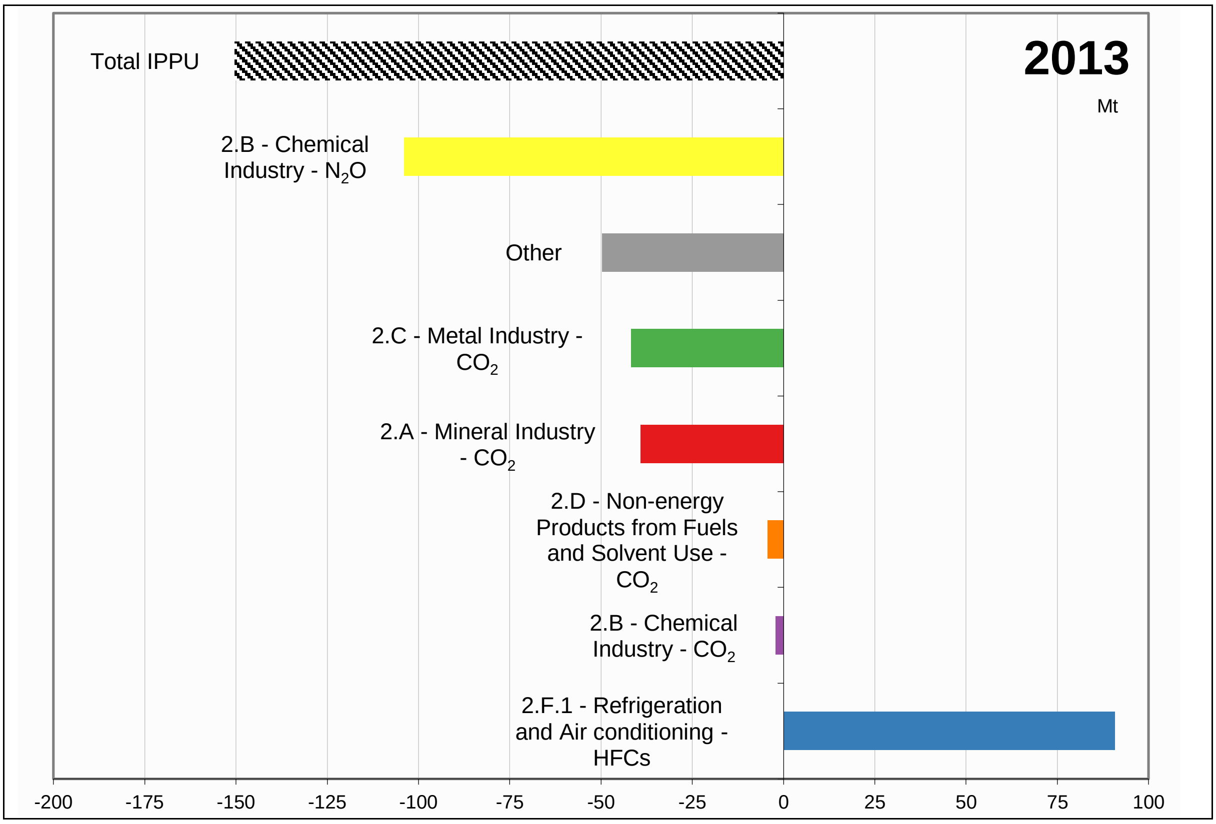

2013
Mt
Total IPPU
2.B - Chemical Industry - N_2O
Other
2.C - Metal Industry - CO_2
2.A - Mineral Industry - CO_2
2.D - Non-energy Products from Fuels and Solvent Use - CO_2
2.B - Chemical Industry - CO_2
2.F.1 - Refrigeration and Air conditioning - HFCs
-200
-175
-150
-125
-100
-75
-50
-25
0
25
50
75
100

4.2 Source categories and methodological issues

4.2.1 Mineral industry (CRF Source Category 2A)

The source category 2A Mineral industry includes two key categories: CO_2 from 2A1 Cement production and CO_2 from 2A2 Lime production CO_2. In source category 2A1 Cement production by-product CO_2 emissions occur during the production of clinker, an intermediate component in the cement manufacturing process. Source category 2A2 Lime production accounts for CO_2 emitted through the calcination of the calcium in limestone or dolomite for lime production.

Table 4.1 summarises Member States' emissions from Mineral industry in 1990 and 2013. CO_2 emissions from Mineral industry have decreased by 3 % since 2012 and by 27 % since 1990. A large part of this fall has been since 2007, due to the decrease in cement production due to the economic crisis. Notwithstanding the overall decrease, six Member States (Croatia, Cyprus, Estonia, Ireland, Poland and Sweden), have higher CO_2 emissions in 2013 compared to their 1990 levels.

Table 4.1 2A Mineral industry: Member States total GHG and CO_2 emissions

Member State	GHG emissions in 1990 (kt CO2 equivalents)	GHG emissions in 2013 (kt CO2 equivalents)	CO2 emissions in 1990 (kt)	CO2 emissions in 2013 (kt)
Austria	3 092	2 720	3 092	2 720
Belgium	5 323	4 504	5 323	4 504
Bulgaria	3 243	1 914	3 243	1 914
Croatia	1 281	1 291	1 281	1 291
Cyprus	759	780	759	780
Czech Republic	4 103	2 156	4 103	2 156
Denmark	1 078	995	1 078	995
Estonia	614	695	614	695
Finland	1 178	1 026	1 178	1 026
France	16 463	11 608	16 463	11 608
Germany	22 780	18 513	22 780	18 513
Greece	6 788	4 286	6 788	4 286
Hungary	2 773	966	2 773	966
Ireland	1 117	1 302	1 117	1 302
Italy	20 714	12 290	20 714	12 290
Latvia	589	550	589	550
Lithuania	2 142	517	2 142	517
Luxembourg	623	409	623	409
Malta	1	0	1	0
Netherlands	1 248	1 077	1 248	1 077
Poland	8 792	9 255	8 792	9 255
Portugal	3 586	3 550	3 586	3 550
Romania	6 530	3 966	6 530	3 966
Slovakia	2 714	2 132	2 714	2 132
Slovenia	706	477	706	477
Spain	15 157	10 372	15 157	10 372
Sweden	1 687	1 936	1 687	1 936
United Kingdom	9 812	6 429	9 812	6 429
EU-28	**144 893**	**105 713**	**144 893**	**105 713**

Abbreviations explained in the Chapter 'Units and abbreviations'.

4.2.1.1 2A1 Cement production

CO_2 emissions from Cement production account for 2 % of total EU-28 GHG emissions in 2013. In 2012, CO_2 emissions from Cement production were 30 % below 1990 levels in the EU-28 (Figure 4.3).

Figure 4.3 2A1 Cement production: EU-28 CO_2 emissions

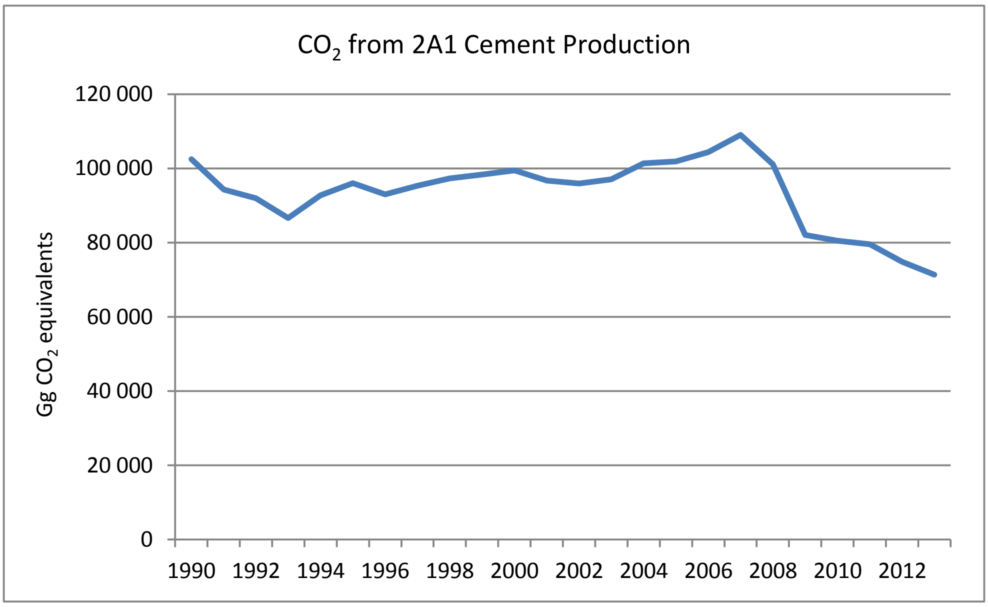


Table 4.2 provides information on emission trends of the key source CO_2 from 2A1 Cement production by Member State. In 2013, Germany, Italy and Spain were the largest emitters accounting for 17 %, 12 % and 11 % respectively of EU-28 cement related emissions. Emissions from 2A1 Cement production declined significantly after 2007 in all Member States due to the economic crisis which reduced construction activities in all countries. In 2013 CO_2 emissions decreased by 5 % across the EU-28. Compared to 2012, only Greece, United Kingdom, Portugal and Cyprus had significant increases in emissions from Cement production.

Table 4.2 2A1 Cement production: Member States' contributions to CO_2 emissions

Member State	CO2 emissions in kt			Share in EU28 emissions in 2013	Change 2012-2013		Change 1990-2013		Method applied	Emission factor
	1990	2012	2013		kt CO2	%	kt CO2	%		
Austria	2 033	1 673	1 659	2%	-14	-1%	-375	-18%	-	-
Belgium	2 824	2 643	2 541	4%	-101	-4%	-282	-10%	T3	PS
Bulgaria	2 100	998	897	1%	-101	-10%	-1 203	-57%	T2	CS
Croatia	1 086	1 017	1 141	2%	124	12%	55	5%	T2	CS
Cyprus	697	505	752	1%	248	49%	55	8%	CS	CS
Czech Republic	2 489	1 517	1 332	2%	-185	-12%	-1 157	-46%	T3	PS
Denmark	882	871	867	1%	-4	0%	-15	-2%	T2	PS
Estonia	483	407	399	1%	-8	-2%	-84	-17%	T2	PS
Finland	734	500	486	1%	-14	-3%	-248	-34%	T2	CS
France	10 937	7 502	7 300	10%	-202	-3%	-3 638	-33%	-	-
Germany	15 146	13 028	12 258	17%	-770	-6%	-2 888	-19%	T2	CS
Greece	5 762	3 099	3 639	5%	540	17%	-2 123	-37%	CS	OTH
Hungary	1 636	678	516	1%	-163	-24%	-1 120	-68%	CS	CS
Ireland	884	1 177	1 112	2%	-65	-6%	228	26%	T3	PS
Italy	15 846	10 071	8 877	12%	-1 194	-12%	-6 969	-44%	T2	CS,PS
Latvia	371	572	538	1%	-35	-6%	167	45%	T2	PS
Lithuania	1 668	395	461	1%	66	17%	-1 207	-72%	T2	PS
Luxembourg	570	375	365	1%	-9	-3%	-204	-36%	T2	CS,PS
Malta	NO	NO	NO	-	-	-	-	-	NA	NA
Netherlands	416	308	274	0%	-34	-11%	-142	-34%	CS	PS
Poland	5 453	6 384	5 874	8%	-510	-8%	421	8%	T1	D
Portugal	3 176	2 550	2 814	4%	264	10%	-362	-11%	T3	OTH
Romania	4 445	3 150	2 695	4%	-456	-14%	-1 751	-39%	CS,T2	PS
Slovakia	1 464	1 096	1 135	2%	39	4%	-329	-22%	T2	CS
Slovenia	482	316	391	1%	75	24%	-91	-19%	T2	CS
Spain	12 279	8 754	7 642	11%	-1 112	-13%	-4 637	-38%	T2	CS
Sweden	1 272	1 479	1 392	2%	-87	-6%	120	9%	-	-
United Kingdom	7 295	3 724	4 029	6%	305	8%	-3 266	-45%	T2	CS
EU-28	**102 432**	**74 790**	**71 386**	**100%**	**-3 404**	**-5%**	**-31 045**	**-30%**		

Abbreviations explained in the Chapter 'Units and abbreviations'.

Table 4.3 shows information on methods applied, activity data, emission factors for CO_2 emissions from 2A1 Cement production for 1990 and 2013. Almost all EU-28 Cement production emissions are estimated with higher Tier methods and most MS use plant-specific emission factors.

The implied emission factors per tonne of clinker produced range from 0.45 t CO_2/t of clinker produced for Netherlands to 0.60 t CO_2/t of clinker produced for the United Kingdom. Except for Portugal and Greece, all MS use country-specific and plant-specific emission factors and have comparable types of activity data (clinker production). In 2013 the EU-28 IEF remained at 0.53 t CO_2/t of clinker produced, the same as for the previous year when an IEF was calculated using the same approach.

In the period 1990 to 2013 only Denmark, Netherlands and Luxembourg have noticeable decrease in the IEF. The IEF for the Netherlands changes after 2005 due to the use of an average EF for the earlier years and plant-specific parameters. There is no significant change in the IEFs for the other member states.

The EF in Denmark decreased primarily during 1990 and 1996 (-18 %) which is due to the ratio of white/grey cement and the ratio rapid cement (GKL-clinker)/basis cement (FHK-clinker)/low alkali cement (SKL-RKL-clinker). The ratio of white/grey cement is known from 1990-1997 with maximum in 1990 and thereafter decreasing.

Table 4.3 2A1 Cement production: Information on methods applied and emission factors for CO_2 emissions

Member State	Method applied	Emission factor	1990 Activity data Description	1990 Activity data (kt)	1990 Implied emission factor (t/t)	1990 CO_2 emissions (Gg)	2013 Activity data Description	2013 Activity data (kt)	2013 Implied emission factor (t/t)	2013 CO_2 emissions (Gg)
Austria	-	-	Cement clinker	3694	0.55	2033	Cement clinker	3156	0.5255	1659
Belgium	T3	PS	Clinker production	5292	0.53	2824	Clinker production	4694	0.541	2541
Bulgaria	T2	CS	Clinker production	3987	0.53	2100	Clinker production	1676	0.54	897
Croatia	T2	CS	Clinker production	2062	0.53	1086	Clinker production	2196	0.520	1141
Cyprus	CS	CS	Clinker production	1249	0.56	697	Clinker production	1418	0.53	752
Czech Republic	T3	PS	Clinker production	4726	0.53	2489	Clinker production	2472	0.539	1332
Denmark	T2	PS	Clinker production	1406	0.63	882	Clinker production	1613	0.54	867
Estonia	T2	PS	Clinker production	790	0.61	483	Clinker production	691	0.58	399
Finland	T2	CS	Clinker production	1470	0.50	734	Clinker production	973	0.499	486
France	-	-	Clinker production	20854	0.52	10937	Clinker production	13778	0.530	7300
Germany	T2	CS	Clinker production	28577	0.53	15146	Clinker production	23128	0.530	12258
Greece	CS	OTH	Clinker production	10645	0.54	5762	Clinker production	6915	0.5262	3639
Hungary	CS	CS	Clinker production	3210	0.51	1636	Clinker production	1018	0.5067	516
Ireland	T3	PS	Clinker production	1610	0.55	884	Clinker production	2065	0.54	1112
Italy	T2	CS,PS	Clinker production	29786	0.53	15846	Clinker production	16902	0.525	8877
Latvia	T2	PS	Clinker production	669	0.55	371	Clinker production	1055	0.51	538
Lithuania	T2	PS	Clinker production	3058	0.55	1668	Clinker production	855	0.539092	461
Luxembourg	T2	CS,PS	Clinker production	1048	0.54	570	Clinker production	743	0.49	365
Malta	NA	NA	-	0	NO	NO	-	0	NO	NO
Netherlands	CS	PS	Clinker production	770	0.54	416	Clinker production	610	0.45	274
Poland	T1	D	Clinker production	10309	0.53	5453	Clinker production	10855	0.541	5874
Portugal	T3	OTH	Clinker production	6128	0.52	3176	Clinker production	5427	0.52	2814
Romania	CS,T2	PS	Clinker production	8379	0.53	4445	Clinker production	5040	0.535	2695
Slovakia	T2	CS	Cement clinker	2836	0.52	1464	Cement clinker	2161	0.525	1135
Slovenia	T2	CS	Clinker production	891	0.54	482	Clinker production	743	0.53	391
Spain	T2	CS	Clinker production	23212	0.53	12279	Clinker production	14615	0.523	7642
Sweden	-	-	Clinker production	2348	0.54	1272	Clinker production	2599	0.536	1392
United Kingdom	T2	CS	Clinker production	13199	0.55	7295	Clinker production	6712	0.6003	4029
EU-28			**EU-28**	**192203**	**0.53**	**102432**	**EU 28**	**134112**	**0.532**	**71386**

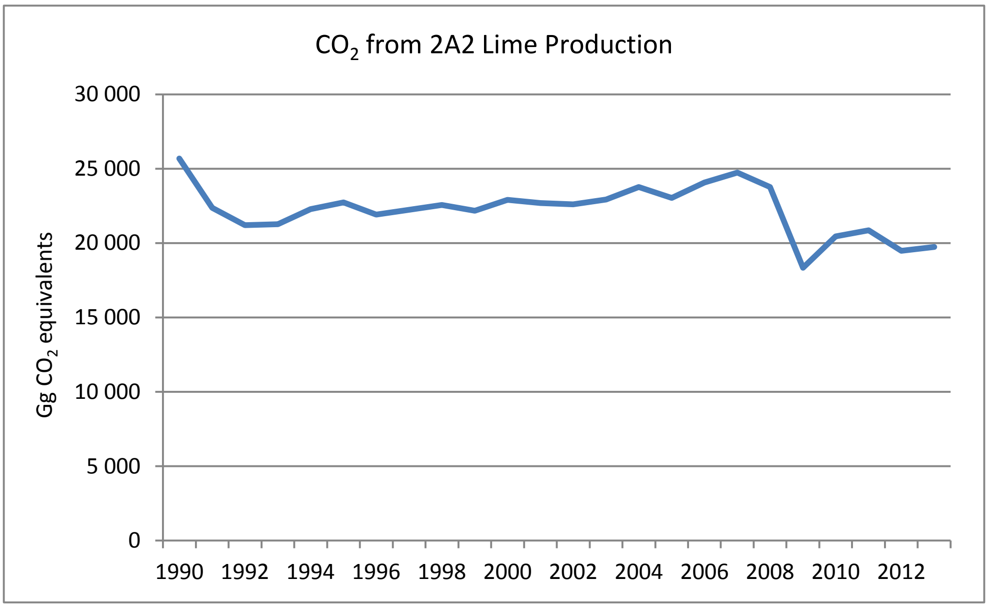
Abbreviations explained in the Chapter 'Units and abbreviations'.

4.2.1.2 2A2 Lime production

CO_2 emissions from 2A2 Lime production account for 0.4 % of total GHG emissions in 2013. Between 1990 and 2013, CO_2 emissions from this source decreased by 23 % in the EU-28. Germany, France and Italy are the largest emitters contributing 24 %, 13 % and 10 % respectively of EU-28 emissions from the sector.

In 2009, lime production decreased sharply due to the economic crisis in all MS, many MS also showed decreasing lime production in 2007 and 2008 (Figure 4.4). In 2013 lime production increased by 1 % compared to the previous year.

Figure 4.4 2A2 Lime production: EU-28 CO_2 emissions



The decrease of emissions in the early nineties was dominated by the drop in German lime production due to the sector's restructuring following German reunification, as well as economic factors and development of competing and substitute products. In 2013, ten Member States have increased their emissions since 1990 and eighteen Member States have decreased emissions from this source category (Table 4.4).

Table 4.4 2A2 Lime production: Member States' contributions to CO_2 emissions

Member State	CO2 emissions in kt			Share in EU28 emissions in 2013	Change 2012-2013		Change 1990-2013		Method applied	Emission factor
	1990	2012	2013		kt CO2	%	kt CO2	%		
Austria	396	569	587	3%	18	3%	191	48%	-	-
Belgium	2 097	1 612	1 629	8%	17	1%	-468	-22%	T3	PS
Bulgaria	371	184	203	1%	18	10%	-168	-45%	T2	D
Croatia	153	107	97	0%	-10	-9%	-57	-37%	T2	CS
Cyprus	5	3	3	0%	-1	-20%	-3	-49%	T1	D
Czech Republic	1 337	597	606	3%	9	1%	-731	-55%	T1	CS
Denmark	105	57	54	0%	-2	-4%	-51	-48%	T1	D
Estonia	130	49	47	0%	-1	-3%	-82	-64%	T1,T2	D,PS
Finland	383	403	401	2%	-2	0%	18	5%	T2	CS
France	2 743	2 232	2 470	13%	239	11%	-273	-10%	-	-
Germany	5 987	4 712	4 811	24%	99	2%	-1 175	-20%	T2	D
Greece	404	209	294	1%	85	41%	-110	-27%	CS	OTH
Hungary	614	140	131	1%	-9	-6%	-483	-79%	CS	CS
Ireland	214	216	190	1%	-26	-12%	-24	-11%	T3	PS
Italy	1 877	2 038	1 892	10%	-146	-7%	15	1%	T2	CS,PS
Latvia	149	2	0	0%	-1	-84%	-149	-100%	T1,T2,T3	D,PS
Lithuania	223	37	29	0%	-8	-22%	-193	-87%	T2	D
Luxembourg	NO	NO	NO	-	-	-	-	-	NA	NA
Malta	1	NO	NO	-	-	-	-1	-100%	D	D
Netherlands	IE	IE	IE	-	-	-	-	-	NA	NA
Poland	2 461	1 352	1 274	6%	-77	-6%	-1 187	-48%	T1	D
Portugal	197	318	312	2%	-5	-2%	115	58%	T3	OTH
Romania	1 898	925	901	5%	-25	-3%	-997	-53%	T2	CS,D
Slovakia	795	736	662	3%	-73	-10%	-133	-17%	T2	CS
Slovenia	201	74	59	0%	-15	-21%	-142	-71%	T3	CS
Spain	1 146	1 240	1 350	7%	110	9%	204	18%	D	CS,D,PS
Sweden	335	489	504	3%	16	3%	170	51%	-	-
United Kingdom	1 462	1 178	1 239	6%	61	5%	-223	-15%	T3	CS
EU-28	**25 683**	**19 477**	**19 747**	**100%**	**270**	**1%**	**-5 936**	**-23%**		

Emissions of the Netherlands are included in 2D2 Food industries.
Abbreviations explained in the Chapter 'Units and abbreviations'.

Table 4.5 shows information on methods applied and emission factors for CO_2 emissions from 2A2 Lime production for 1990 to 2013. All EU-28 MS that report emissions from lime production use lime production as activity data for calculating CO_2 emissions, The IEF in 2013 is 0.75 t CO_2/t of lime produced. The implied emission factors per tonne of lime produced range from 0.55 for Latvia to 0.80 for Belgium. Seventeen MS estimate emissions using higher tier methodologies (country-specific, Tier 2 and Tier 3) which accounts for more than 80 % of emissions from this category.

Table 4.5 2A2 Lime production: Information on methods applied, activity data, emission factors for CO_2 emissions

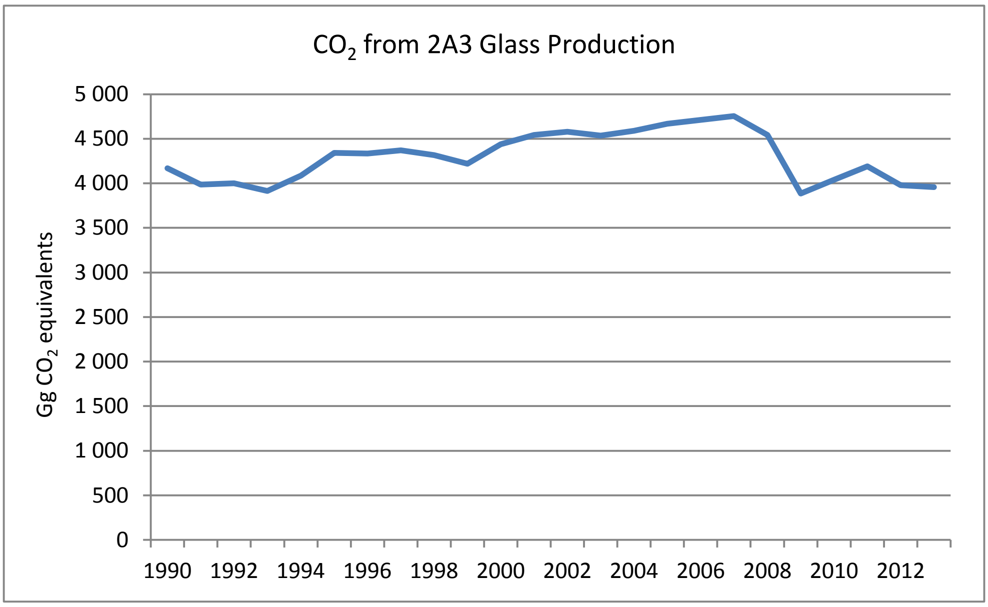
Member State	Method applied	Emission factor	1990 Activity data Description	1990 Activity data (kt)	1990 Implied emission factor (t/t)	1990 CO_2 emissions (Gg)	2013 Activity data Description	2013 Activity data (kt)	2013 Implied emission factor (t/t)	2013 CO_2 emissions (Gg)
Austria	-	-	Lime Production	513	0.77	396	Lime Production	779	0.7538	587
Belgium	T3	PS	Lime Production	2660	0.79	2097	Lime Production	2035	0.801	1629
Bulgaria	T2	D	Lime Production	490	0.76	371	Lime Production	274	0.74	203
Croatia	T2	CS	Lime Production	232	0.66	153	Lime Production	127	0.762	97
Cyprus	T1	D	Lime Production	7	0.75	5	Lime Production	4	0.75	3
Czech Republic	T1	CS	Lime Production	1823	0.73	1337	Lime Production	799	0.758	606
Denmark	T1	D	Lime Production	134	0.78	105	Lime Production	69	0.78	54
Estonia	T1,T2	D,PS	Lime Production	185	0.70	130	Lime Production	70	0.68	47
Finland	T2	CS	Lime Production	488	0.78	383	Lime Production	511	0.785	401
France	-	-	Lime Production	3589	0.76	2743	Lime Production	3647	0.677	2470
Germany	T2	D	Lime Production	7927	0.76	5987	Lime Production	6414	0.750	4811
Greece	CS	OTH	Lime Production	491	0.82	404	Lime Production	0	0.0000	294
Hungary	CS	CS	Lime Production	831	0.74	614	Lime Production	175	0.7520	131
Ireland	T3	PS	Lime Production	255	0.84	214	Lime Production	251	0.75	190
Italy	T2	CS,PS	Lime Production	2583	0.73	1877	Lime Production	2647	0.715	1892
Latvia	T1,T2,T3	D,PS	Lime Production	225	0.66	149	Lime Production	0	0.55	0
Lithuania	T2	D	Lime Production	288	0.77	223	Lime Production	38	0.773393	29
Luxembourg	NA	NA	Lime Production	0	NO	NO	Lime Production	0	NO	NO
Malta	D	D	Lime Production	2	0.75	1	Lime Production	0	NO	NO
Netherlands	NA	NA	Lime Production	0	IE,NO	IE	Lime Production	0	IE,NO	IE
Poland	T1	D	Lime Production	3464	0.71	2461	Lime Production	1761	0.724	1274
Portugal	T3	OTH	Lime Production	291	0.68	197	Lime Production	476	0.66	312
Romania	T2	CS,D	Lime Production	2414	0.79	1898	Lime Production	1128	0.798	901
Slovakia	T2	CS	Lime Production	1076	0.74	795	Lime Production	849	0.780	662
Slovenia	T3	CS	Lime Production	275	0.73	201	Lime Production	80	0.74	59
Spain	D	CS,D,PS	Lime Production	1601	0.72	1146	Lime Production	1866	0.724	1350
Sweden	-	-	Lime Production	443	0.75	335	Lime Production	674	0.749	504
United Kingdom	T3	CS	Lime Production	2067	0.71	1462	Lime Production	1712	0.7237	1239
EU-28			**EU-28**	**34355**	**0.75**	**25683**	**EU 28**	**26385**	**0.748**	**19747**

Abbreviations explained in the Chapter 'Units and abbreviations'.

4.2.1.3 2A3 Glass production

CO_2 emissions from 2A3 Glass production contributed only 0.1 % of total GHG emissions in 2013. Emissions from glass production in 2013 are 5 % lower than 1990 levels. Between 1990 and 2007, CO_2 emissions from this source increased by 14 %. In 2013 emissions were 17 % lower than the 2007 peak (Figure 4.5).

Figure 4.5　　2A3 Glass production: EU-28 CO_2 emissions



In 2013, Germany was responsible for 22 %, Italy for 14 % and France for 13 % of the emissions from this source. The largest absolute reduction in since 1990 was in France (-287 kt or -36%).

Table 4.6　　2A3 Glass production: Member States' contributions to CO_2 emissions

Member State	CO2 emissions in kt			Share in EU28 emissions in 2013	Change 2012-2013		Change 1990-2013		Method applied	Emission factor
	1990	2012	2013		kt CO2	%	kt CO2	%		
Austria	39	37	39	1%	2	6%	1	1%	-	-
Belgium	266	188	167	4%	-22	-12%	-100	-37%	T3	CS,PS
Bulgaria	138	65	63	2%	-2	-3%	-76	-55%	T1	CS
Croatia	36	30	29	1%	0	0%	-6	-18%	T3	CS
Cyprus	NO	NO	NO	-	-	-	-	-	NA	NA
Czech Republic	124	109	116	3%	7	6%	-8	-6%	T1	D
Denmark	20	10	7	0%	-3	-28%	-13	-65%	T1	D
Estonia	1	10	11	0%	2	16%	10	828%	T1	D
Finland	21	2	2	0%	0	26%	-19	-90%	T3	CS
France	797	523	510	13%	-13	-2%	-287	-36%	-	-
Germany	780	823	875	22%	52	6%	95	12%	T2	CS
Greece	20	16	17	0%	1	7%	-4	-18%	CS	CS
Hungary	75	54	52	1%	-2	-4%	-22	-30%	CS	CS
Ireland	13	NO	NO	-	-	-	-13	-100%	T1,T3	D,PS
Italy	453	547	546	14%	-1	0%	92	20%	T2	CS,PS
Latvia	0	4	3	0%	-1	-20%	3	746%	T1	D
Lithuania	12	7	8	0%	1	12%	-4	-31%	T2	D
Luxembourg	54	60	43	1%	-17	-28%	-10	-19%	CS	PS
Malta	NO	NO	NO	-	-	-	-	-	NA	NA
Netherlands	142	97	84	2%	-13	-14%	-58	-41%	CS	CS
Poland	106	265	266	7%	0	0%	160	151%	T1	D
Portugal	84	155	157	4%	2	1%	73	88%	T3	OTH
Romania	150	62	62	2%	0	0%	-88	-58%	T2	CS,D
Slovakia	8	11	13	0%	2	15%	5	68%	T3	PS
Slovenia	3	10	9	0%	-1	-12%	6	175%	T3	D
Spain	374	464	474	12%	9	2%	99	26%	D	CS,D,PS
Sweden	45	48	17	0%	-31	-65%	-28	-63%	-	-
United Kingdom	408	382	389	10%	7	2%	-19	-5%	T2	CS
EU-28	**4 169**	**3 980**	**3 959**	**100%**	**-21**	**-1%**	**-211**	**-5%**		

Abbreviations explained in the Chapter 'Units and abbreviations'.

Table 4.7 provides information on methods applied, activity data, emission factors for CO_2 emissions from 2A3 Glass production for 1990 to 2013. The table shows that almost all MS (except Finland, Ireland and Slovakia) use production as activity data for calculating CO_2 emissions, and the different EFs reflect this. The use of plant-specific data reported and verified under the EU ETS by Member States can be considered as equivalent to a Tier 2 or Tier 3 method. It is difficult to calculate a specific share of EU emissions calculated with higher tier methods in the absence of such IPCC definitions and due to the fact that MS's estimates are mostly composed by several sources with independent estimation methods, using partly higher tiers, partly default methods.

Table 4.7 2A3 Glass production: Information on methods applied, activity data, emission factors for CO_2 emissions

			1990				2013			
Member State	Method applied	Emission factor	Activity data		Implied emission factor	CO_2 emissions	Activity data		Implied emission factor	CO_2 emissions
			Description	(kt)	(t/t)	(Gg)	Description	(kt)	(t/t)	(Gg)
Austria	-	-	Glass Production	399	0.10	39	Glass Production	487	0.0801	39
Belgium	T3	CS,PS	Glass Production	1971	0.14	266	Glass Production	1547	0.108	167
Bulgaria	T1	CS	Glass Production	818	0.17	138	Glass Production	452	0.14	63
Croatia	T3	CS	Glass Production	275	0.13	36	Glass Production	303	0.097	29
Cyprus	NA	NA	Glass Production	0	NO	NO	Glass Production	0	NO	NO
Czech Republic	T1	D	Glass Production	1237	0.10	124	Glass Production	1158	0.100	116
Denmark	T1	D	Glass Production	200	0.10	20	Glass Production	96	0.07	7
Estonia	T1	D	Glass Production	12	0.10	1	Glass Production	84	0.14	11
Finland	T3	CS	Used carbonates	48	0.43	21	Used carbonates	5	0.398	2
France	-	-	Glass Production	4307	0.19	797	Glass Production	2581	0.198	510
Germany	T2	CS	Glass Production	6562	0.12	780	Glass Production	7407	0.118	875
Greece	CS	CS	Glass Production	135	0.15	20	Glass Production	114	0.1454	17
Hungary	CS	CS	Glass Production	418	0.18	75	Glass Production	437	0.1201	52
Ireland	T1,T3	D,PS	carbonate use	64	0.21	13	carbonate use	0	NO	NO
Italy	T2	CS,PS	Glass Production	3779	0.12	453	Glass Production	4771	0.114	546
Latvia	T1	D	Glass Production	44	0.01	0	Glass Production	16	0.18	3
Lithuania	T2	D	Glass Production	66	0.18	12	Glass Production	56	0.145831	8
Luxembourg	CS	PS	Glass Production	377	0.14	54	Glass Production	304	0.14	43
Malta	NA	NA	-	0	NO	NO	-	0	NO	NO
Netherlands	CS	CS	Glass Production	1095	0.13	142	Glass Production	1286	0.07	84
Poland	T1	D	Glass Production	1058	0.10	106	Glass Production	2656	0.100	266
Portugal	T3	OTH	Glass Production	614	0.14	84	Glass Production	1702	0.09	157
Romania	T2	CS,D	Glass Production	926	0.16	150	Glass Production	374	0.167	62
Slovakia	T3	PS	Used Carbonates	18	0.44	8	Used Carbonates	31	0.423	13
Slovenia	T3	D	Glass Production	25	0.13	3	Glass Production	70	0.13	9
Spain	D	CS,D,PS	Glass Production	2866	0.13	374	Glass Production	4405	0.107	474
Sweden	-	-	Glass Production	0	NE	45	Glass Production	0	NE	17
United Kingdom	T2	CS	Glass Production	3232	0.13	408	Glass Production	3305	0.1178	389
EU-28			**EU-28**	**30545**	**0.14**	**4169**	**EU 28**	**33648**	**0.118**	**3959**

Abbreviations explained in the Chapter 'Units and abbreviations'.

4.2.1.4 2A4 Other process uses of carbonates

Table 4.8 2A4 Other process uses of carbonates: Member States' contributions to CO_2 emissions

Member State	CO2 emissions in kt			Share in EU28 emissions in 2013	Change 2012-2013		Change 1990-2013	
	1990	2012	2013		kt CO2	%	kt CO2	%
Austria	624	425	434	4%	9	2%	-190	-30%
Belgium	136	173	167	2%	-6	-3%	32	23%
Bulgaria	633	791	751	7%	-40	-5%	118	19%
Croatia	6	38	24	0%	-14	-36%	18	318%
Cyprus	57	19	24	0%	5	25%	-32	-57%
Czech Republic	153	107	103	1%	-5	-4%	-50	-33%
Denmark	71	56	67	1%	11	19%	-3	-5%
Estonia	0	203	237	2%	33	16%	236	77421%
Finland	41	177	137	1%	-39	-22%	97	239%
France	1 986	1 283	1 328	13%	45	4%	-658	-33%
Germany	867	544	568	5%	25	5%	-299	-34%
Greece	602	419	336	3%	-82	-20%	-266	-44%
Hungary	448	274	266	3%	-8	-3%	-182	-41%
Ireland	5	1	0	0%	0	-44%	-5	-94%
Italy	2 537	1 061	975	9%	-86	-8%	-1 562	-62%
Latvia	69	8	9	0%	2	20%	-60	-87%
Lithuania	240	16	18	0%	2	15%	-221	-92%
Luxembourg	NO	NO	NO	-	-	-	-	-
Malta	0	0	0	0%	0	0%	0	-56%
Netherlands	690	770	719	7%	-51	-7%	29	4%
Poland	771	1 860	1 841	17%	-19	-1%	1 069	139%
Portugal	128	340	266	3%	-74	-22%	138	108%
Romania	37	189	309	3%	119	63%	272	732%
Slovakia	447	378	322	3%	-56	-15%	-125	-28%
Slovenia	20	17	18	0%	1	8%	-2	-11%
Spain	1 358	1 065	906	9%	-159	-15%	-452	-33%
Sweden	36	20	22	0%	2	11%	-14	-38%
United Kingdom	647	777	772	7%	-5	-1%	125	19%
EU-28	**12 608**	**11 010**	**10 622**	**100%**	**-389**	**-4%**	**-1 987**	**-16%**

Abbreviations explained in the Chapter 'Units and abbreviations'.

4.2.2 Chemical industry (CRF Source Category 2B)

The key categories in the chemical industry include: 2B1 Ammonia production, 2B2 Nitric acid production, 2B3 Adipic acid production, 2.B.8 Petrochemical and Carbon black production, 2.B.9 Fluorochemical Production (HFCs) and 2B10 Other chemical industry.

The source category 2B1 Ammonia production covers CO_2 emissions that occur during the production of ammonia, a chemical used as a feedstock for the production of several chemicals. In most instances, anhydrous ammonia is produced by catalytic steam reforming of natural gas (mostly CH_4) or other fossil fuels. At plants using this process CO_2 is primarily released during regeneration of the CO_2 scrubbing solution, with additional but relatively minor emissions resulting from condensate stripping. The source category 2B2 Nitric acid production accounts for N_2O emitted as a by-product of the high temperature catalytic oxidation of ammonia (NH_3) in the production of nitric acid. Adipic acid production (2B3) also emits N_2O as a by-product when a cyclohexanone/cyclohexanol mixture is oxidized by nitric acid.

Table 4.9 summarises information on Member States' emissions from the chemical industry in 1990 and 2013 for CO_2, CH_4, N_2O and total CO_2e. Between 1990 and 2013 CO_2e emissions from 2B Chemical Industry decreased markedly due to the significant reduction in N_2O emissions which decreased by 93 %. The greatest absolute decreases in N_2O emissions were in UK, France and Germany.

Table 4.9 2B Chemical Industry: Member States' contributions total GHG and CO_2, N_2O and CH_4 emissions

Member State	GHG emissions in 1990 (kt CO2 equivalents)	GHG emissions in 2013 (kt CO2 equivalents)	CO2 emissions in 1990 (kt)	CO2 emissions in 2013 (kt)	N2O emissions in 1990 (kt CO2 equivalents)	N2O emissions in 2013 (kt CO2 equivalents)	CH4 emissions in 1990 (kt CO2 equivalents)	CH4 emissions in 2013 (kt CO2 equivalents)
Austria	1 555	696	643	599	877	48	35	49
Belgium	10 060	8 222	2 590	6 543	3 791	1 252	0	5
Bulgaria	4 532	1 439	2 880	1 316	1 647	123	5	0
Croatia	1 532	727	772	486	754	240	6	0
Cyprus	0	0	NO	NO	NO	NO	NO	NO
Czech Republic	2 944	1 879	1 783	1 546	1 125	286	36	46
Denmark	1 003	1	1	1	1 003	NA,NO	NA,NO	NA,NO
Estonia	419	154	419	154	NO	NO	NO	NO
Finland	1 861	1 121	269	910	1 592	211	NO,NA	NO,NA
France	33 188	3 677	3 752	2 641	23 648	853	93	51
Germany	35 730	10 759	8 021	9 201	21 557	819	334	464
Greece	2 931	538	681	517	1 066	21	1	NA,NO
Hungary	4 867	2 224	1 759	2 145	3 090	38	18	41
Ireland	1 986	0	990	NO	995	NO	NO	NO
Italy	10 546	3 139	2 577	1 336	6 418	222	61	6
Latvia	0	0	NO	NO	NO	NO	NO	NO
Lithuania	2 178	2 009	1 280	1 673	893	336	5	NO
Luxembourg	0	0	NO	NO	NO	NO	NO	NO
Malta	0	0	NO	NO	NO	NO	NO	NO
Netherlands	17 367	6 333	4 552	4 410	6 821	1 223	387	409
Poland	7 944	6 677	4 368	5 517	3 536	1 110	40	50
Portugal	1 170	159	658	90	498	57	14	12
Romania	7 494	1 667	3 309	1 148	4 135	508	50	12
Slovakia	2 020	1 601	878	1 470	1 142	130	0	1
Slovenia	70	45	66	45	NO	NO	4	NO,NA
Spain	9 133	3 867	3 156	3 062	2 788	439	149	141
Sweden	906	185	102	130	803	55	1	1
United Kingdom	44 792	5 047	6 377	4 740	23 797	45	214	104
EU-28	**206 227**	**62 168**	**51 884**	**49 680**	**111 975**	**8 017**	**1 453**	**1 391**

Abbreviations explained in the Chapter 'Units and abbreviations'.

4.2.2.1 2B1 Ammonia production

CO_2 emissions from 2B1 Ammonia production account for 0.6 % of total EU-28 GHG emissions in 2013. Between 1990 and 2013, CO_2 emissions from this source decreased by 16 % (Figure 4.6). Germany is responsible for 25 % of these emissions. The next largest contributors, Poland and Netherlands contribute 16 % and 14 % respectively. Bulgaria, Ireland, Italy, Romania and France had large reductions in absolute terms between 1990 and 2013. The reasons for these reductions include changes to low emitting technology and production decreases and the cessation of production in Ireland. The largest growth in emissions between 1990 and 2013 were in Germany, Poland and Belgium.

Figure 4.6 2B1 Ammonia production: CO_2 emissions

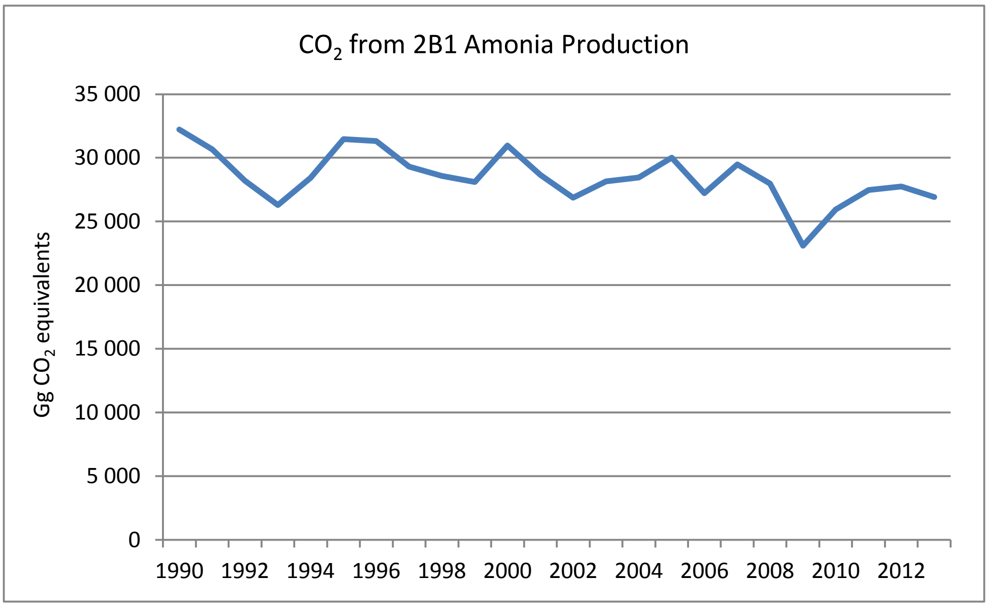


Table 4.10 2B1 Ammonia production: Member States' contributions to CO_2 emissions

Member State	CO2 emissions in kt			Share in EU28 emissions in 2013	Change 2012-2013		Change 1990-2013		Method applied	Emission factor
	1990	2012	2013		kt CO2	%	kt CO2	%		
Austria	467	471	423	2%	-48	-10%	-45	-10%	-	-
Belgium	423	1 128	1 247	5%	118	10%	824	195%	T3	D,PS
Bulgaria	2 508	758	802	3%	45	6%	-1 705	-68%	T2	CS
Croatia	552	479	486	2%	7	1%	-66	-12%	T3	PS
Cyprus	NO	NO	NO	-	-	-	-	-	NA	NA
Czech Republic	991	654	601	2%	-53	-8%	-390	-39%	T1	CS
Denmark	NO	NO	NO	-	-	-	-	-	NA	NA
Estonia	419	25	154	1%	129	519%	-265	-63%	T3	PS
Finland	93	NO	NO	-	-	-	-93	-100%	T1	D
France	2 016	1 054	1 118	4%	64	6%	-898	-45%	-	-
Germany	6 025	6 862	6 739	25%	-123	-2%	714	12%	T3	PS
Greece	652	179	212	1%	33	19%	-440	-67%	T1a	CS
Hungary	1 255	974	875	3%	-99	-10%	-380	-30%	T3	D
Ireland	990	NO	NO	-	-	-	-990	-100%	T1	CS
Italy	1 892	624	643	2%	19	3%	-1 249	-66%	T1	CR
Latvia	NO	NO	NO	-	-	-	-	-	NA	NA
Lithuania	1 256	2 118	1 673	6%	-445	-21%	417	33%	T3	CS
Luxembourg	NO	NO	NO	-	-	-	-	-	NA	NA
Malta	NO	NO	NO	-	-	-	-	-	NA	NA
Netherlands	3 730	3 627	3 760	14%	132	4%	30	1%	T1b	CS
Poland	2 910	4 473	4 403	16%	-69	-2%	1 493	51%	T2	CS
Portugal	569	NO	NO	-	-	-	-569	-100%	T2	PS
Romania	2 423	1 517	1 081	4%	-436	-29%	-1 342	-55%	T2	PS
Slovakia	332	546	674	3%	129	24%	343	103%	T3	PS
Slovenia	NO	NO	NO	-	-	-	-	-	NA	NA
Spain	709	701	652	2%	-49	-7%	-57	-8%	D	PS
Sweden	NO	NO	NO	-	-	-	-	-	NA	NA
United Kingdom	2 004	1 574	1 383	5%	-190	-12%	-621	-31%	T3	CS
EU-28	**32 216**	**27 763**	**26 927**	**100%**	**-836**	**-3%**	**-5 289**	**-16%**		

Abbreviations explained in the Chapter 'Units and abbreviations'.

Table 4.11 shows information on methods applied, activity data, emission factors for CO_2 emissions from 2B1 Ammonia production for 1990 to 2013. The table shows that all MS except for Ireland and

Romania use Ammonia production as activity data for this emissions category. It will be possible to calculate an IEF gap filling the activity of these MS. The table also shows that about 70 % of EU-28 emissions are estimated with higher Tier methods.

Table 4.11 2B1 Ammonia production: Information on methods applied, activity data, emission factors for CO_2 emissions

Member State	Method applied	Emission factor	1990				2013			
			Activity data		Implied emission factor	CO_2 emissions	Activity data		Implied emission factor	CO_2 emissions
			Description	(kt)	(t/t)	(Gg)	Description	(kt)	(t/t)	(Gg)
Austria	-	-	Ammonia Production	461	1.01	467	Ammonia Production	435	0.9716	423
Belgium	T3	D,PS	Ammonia Production	360	1.17	423	Ammonia Production	1083	1.151	1247
Bulgaria	T2	CS	Ammonia Production	0	C	2508	Ammonia Production	0	C	802
Croatia	T3	PS	Ammonia Production	345	2.24	552	Ammonia Production	418	2.017	486
Cyprus	NA	NA	Ammonia Production	0	NO	NO	Ammonia Production	0	NO	NO
Czech Republic	T1	CS	Ammonia Production	336	3.27	991	Ammonia Production	184	3.273	601
Denmark	NA	NA	Ammonia Production	0	NO	NO	Ammonia Production	0	NO	NO
Estonia	T3	PS	Ammonia Production	294	1.43	419	Ammonia Production	121	1.28	154
Finland	T1	D	Ammonia Production	28	3.27	93	Ammonia Production	0	NO	NO
France	-	-	Ammonia Production	1928	1.05	2016	Ammonia Production	1035	1.080	1118
Germany	T3	PS	Ammonia Production	2705	2.41	6025	Ammonia Production	3198	2.353	6739
Greece	T1a	CS	Ammonia Production	313	2.08	652	Ammonia Production	128	1.6555	212
Hungary	T3	D	Ammonia Production	25334	0.06	1255	Ammonia Production	16303	0.0561	875
Ireland	T1	CS	Natural Gas Feedstocks	430	2.30	990	Natural Gas Feedstocks	0	NO	NO
Italy	T1	CR	Ammonia Production	1455	1.30	1892	Ammonia Production	555	1.159	643
Latvia	NA	NA	Ammonia Production	0	NO	NO	Ammonia Production	0	NO	NO
Lithuania	T3	CS	Ammonia Production	568	2.27	1256	Ammonia Production	842	2.110860	1673
Luxembourg	NA	NA	Ammonia Production	0	NO	NO	Ammonia Production	0	NO	NO
Malta	NA	NA	-	0	NO	NO	-	0	NO	NO
Netherlands	T1b	CS	Ammonia Production	0	C	3730	Ammonia Production	0	C	3760
Poland	T2	CS	Ammonia Production	1532	1.90	2910	Ammonia Production	2228	1.976	4403
Portugal	T2	PS	Ammonia Production	0	C	569	Ammonia Production	0	NA,NO	NO
Romania	T2	PS	Natural Gas Consumption	1511	1.60	2423	Natural Gas Consumption	700	1.543	1081
Slovakia	T3	PS	Ammonia Production	360	1.71	332	Ammonia Production	475	1.870	674
Slovenia	NA	NA	Ammonia Production	0	NO	NO	Ammonia Production	0	NO	NO
Spain	D	PS	Ammonia Production	573	1.24	709	Ammonia Production	531	1.228	652
Sweden	NA	NA	Ammonia Production	0	NO	NO	Ammonia Production	0	NO	NO
United Kingdom	T3	CS	Ammonia Production	1328	1.51	2004	Ammonia Production	957	1.4454	1383
EU-28			**EU-28**	**39861**	**0.81**	**32216**	**EU 28**	**29193**	**0.922**	**26927**

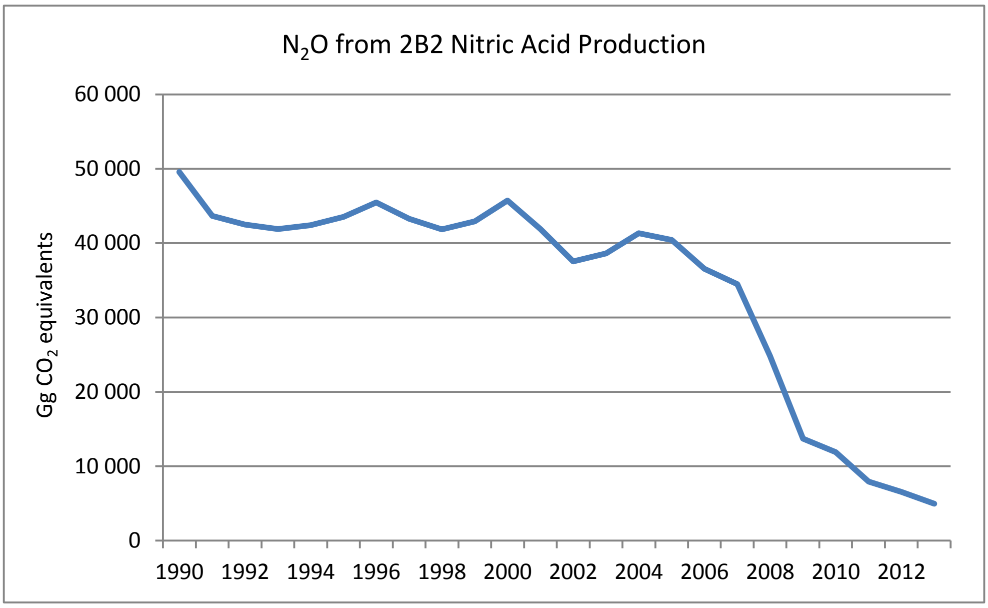
Abbreviations explained in the Chapter 'Units and abbreviations'.

4.2.2.2 2B2 Nitric acid production

N_2O emissions from 2B2 Nitric acid production account for 0.1 % of total EU-28 GHG emissions in 2013. Between 1990 and 2013, N_2O emissions from this source decreased by 90 % (Table 4.12). All Member States had reductions from this source between 1990 and 2013. The Netherlands and

France had the greatest reductions in absolute terms, due to the implementation of technical measures at all Dutch nitric acid plants and due to the improvement of the process and catalyst efficiency in France. production stopped in Denmark (middle of 2004) and ceased in Ireland in 2002 due to the insolvency of Irish Fertiliser Industries.

Figure 4.7 2B2 Nitric acid production: EU-28 N_2O emissions



The substantial decrease in N_2O emissions since 2006 is largely due to technical measures that have been implemented at all nitric acid plants. Special catalysts and improvement of the process efficiency led to a continuation of the trend in emissions. This trend of declining N_2O emissions continued between 2012 and 2013 with emissions decreasing by -25 %. Seven Member States reported small emission increases in this period.

Table 4.12 2B2 Nitric acid production: Member States' contributions to N_2O emissions

Member State	N2O emissions in kt CO2 equiv.			Share in EU28 emissions in 2013	Change 2012-2013		Change 1990-2013		Method applied	Emission factor
	1990	2012	2013		kt CO2 equiv.	%	kt CO2 equiv.	%		
Austria	877	51	48	1%	-3	-5%	-829	-95%	-	-
Belgium	3 424	654	555	11%	-99	-15%	-2 869	-84%	T3	PS
Bulgaria	1 647	125	123	2%	-2	-2%	-1 524	-93%	T1,T3	D,PS
Croatia	754	652	240	5%	-412	-63%	-514	-68%	T2	PS
Cyprus	NO	NO	NO	-	-	-	-	-	NA	NA
Czech Republic	1 050	378	212	4%	-166	-44%	-838	-80%	T1	PS
Denmark	1 003	NO	NO	-	-	-	-1 003	-100%	T1	PS
Estonia	NO	NO	NO	-	-	-	-	-	NA	NA
Finland	1 592	160	211	4%	51	32%	-1 381	-87%	T2	PS
France	6 316	481	444	9%	-37	-8%	-5 872	-93%	-	-
Germany	3 258	399	480	10%	82	20%	-2 778	-85%	T3	PS
Greece	1 066	295	21	0%	-274	-93%	-1 045	-98%	D	D
Hungary	3 090	22	38	1%	17	75%	-3 051	-99%	CS	PS
Ireland	995	NO	NO	-	-	-	-995	-100%	T1	PS
Italy	2 005	143	112	2%	-31	-22%	-1 894	-94%	T2	D,PS
Latvia	NO	NO	NO	-	-	-	-	-	NA	NA
Lithuania	893	573	336	7%	-237	-41%	-557	-62%	T2	PS
Luxembourg	NO	NO	NO	-	-	-	-	-	NA	NA
Malta	NO	NO	NO	-	-	-	-	-	NA	NA
Netherlands	6 085	254	274	6%	20	8%	-5 811	-96%	T2	PS
Poland	3 041	780	884	18%	104	13%	-2 157	-71%	T1	CS
Portugal	498	63	57	1%	-6	-10%	-441	-88%	D	PS
Romania	3 473	999	508	10%	-491	-49%	-2 965	-85%	T2	D
Slovakia	1 142	290	129	3%	-161	-55%	-1 012	-89%	T3	PS
Slovenia	NO	NO	NO	-	-	-	-	-	NA	NA
Spain	2 692	155	186	4%	31	20%	-2 506	-93%	T2	CS,PS
Sweden	782	65	48	1%	-17	-26%	-734	-94%	-	-
United Kingdom	3 860	39	43	1%	4	10%	-3 817	-99%	T3	CS
EU-28	**49 543**	**6 578**	**4 950**	**100%**	**-1 628**	**-25%**	**-44 594**	**-90%**		

Abbreviations explained in the Chapter 'Units and abbreviations'.

Table 4.13 shows information on methods applied, activity data, emission factors for N_2O emissions from 2B2 Nitric acid production for 1990 to 2013. The table shows that all MS report Nitric acid production as activity data; for some MS this information is confidential The decrease of the IEF between 1990 and 2013 is mainly due to the implementation of improved abatement technologies in the different MS and the closure of some older plants. The table also shows that almost all emissions are estimated with higher tier methods.

Table 4.13 2B2 Nitric acid production: Information on methods applied, activity data, emission factors for N_2O emissions

Member State	Method applied	Emission factor	1990 Activity data Description	1990 Activity data (kt)	1990 Implied emission factor (t/t)	1990 CO_2 emissions (Gg)	2013 Activity data Description	2013 Activity data (kt)	2013 Implied emission factor (t/t)	2013 CO_2 emissions (Gg)
Austria	-	-	Nitric Acid Production	530	0.01	877	Nitric Acid Production	475	0.0003	48
Belgium	T3	PS	Nitric Acid Production	1436	0.01	3424	Nitric Acid Production	1960	0.001	555
Bulgaria	T1,T3	D,PS	Nitric Acid Production	0	C	1647	Nitric Acid Production	0	C	123
Croatia	T2	PS	Nitric Acid Production	332	0.01	754	Nitric Acid Production	298	0.003	240
Cyprus	NA	NA	Nitric Acid Production	0	NO	NO	Nitric Acid Production	0	NO	NO
Czech Republic	T1	PS	Nitric Acid Production	530	0.01	1050	Nitric Acid Production	515	0.001	212
Denmark	T1	PS	Nitric Acid Production	450	0.01	1003	Nitric Acid Production	0	NO	NO
Estonia	NA	NA	Nitric Acid Production	0	NO	NO	Nitric Acid Production	0	NO	NO
Finland	T2	PS	Nitric Acid Production	549	0.01	1592	Nitric Acid Production	635	0.001	211
France	-	-	Nitric Acid Production	3200	0.01	6316	Nitric Acid Production	2386	0.001	444
Germany	T3	PS	Nitric Acid Production	1698	0.01	3258	Nitric Acid Production	2559	0.001	480
Greece	D	D	Nitric Acid Production	511	0.01	1066	Nitric Acid Production	174	0.0004	21
Hungary	CS	PS	Nitric Acid Production	732	0.01	3090	Nitric Acid Production	518	0.0002	38
Ireland	T1	PS	Nitric Acid Production	339	0.01	995	Nitric Acid Production	0	NO	NO
Italy	T2	D,PS	Nitric Acid Production	1037	0.01	2005	Nitric Acid Production	433	0.001	112
Latvia	NA	NA	Nitric Acid Production	0	NO	NO	Nitric Acid Production	0	NO	NO
Lithuania	T2	PS	Nitric Acid Production	355437	0.00	893	Nitric Acid Production	1049172	0.000001	336
Luxembourg	NA	NA	Nitric Acid Production	0	NO	NO	Nitric Acid Production	0	NO	NO
Malta	NA	NA	-	0	NO	NO	-	0	NO	NO
Netherlands	T2	PS	Nitric Acid Production	0	C	6085	Nitric Acid Production	0	C	274
Poland	T1	CS	Nitric Acid Production	1577	0.01	3041	Nitric Acid Production	2280	0.001	884
Portugal	D	PS	Nitric Acid Production	0	C	498	Nitric Acid Production	0	C	57
Romania	T2	D	Nitric Acid Production	1261	0.01	3473	Nitric Acid Production	950	0.002	508
Slovakia	T3	PS	Nitric Acid Production	401	0.01	1142	Nitric Acid Production	612	0.001	129
Slovenia	NA	NA	Nitric Acid Production	0	NO	NO	Nitric Acid Production	0	NO	NO
Spain	T2	CS,PS	Nitric Acid Production	1329	0.01	2692	Nitric Acid Production	664	0.001	186
Sweden	-	-	Nitric Acid Production	374	0.01	782	Nitric Acid Production	251	0.001	48
United Kingdom	T3	CS	Nitric Acid Production	2408	0.01	3860	Nitric Acid Production	1015	0.0001	43
EU-28			**EU-28**	**374131**	**0.13**	**49543**	**EU 28**	**1064895**	**0.005**	**4950**

Abbreviations explained in the Chapter 'Units and abbreviations'.

4.2.2.3 2B3 Adipic acid production

N_2O emissions from 2B3 Adipic acid production account for 0.01 % of total emissions in 2013. Between 1990 and 2013, N_2O emissions from this source decreased by 99 % (Figure 4.8). Only France, Germany and Italy produce adipic acid and all three countries were able to decrease emissions from this source category significantly due to the retrofitting of installations with abatement technologies.

Figure 4.8 2B3 Adipic acid production: EU-28 N_2O emissions

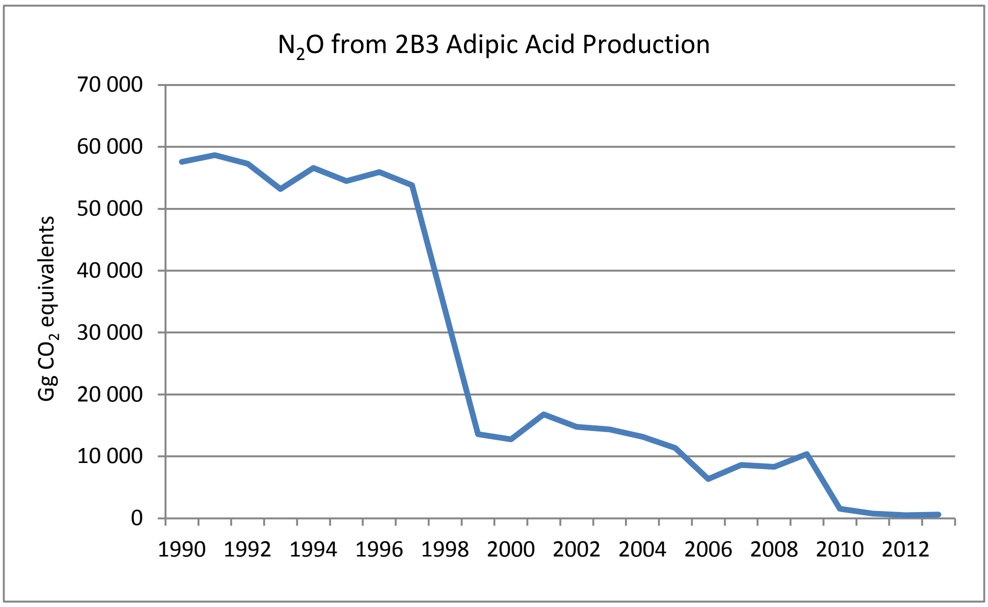


Table 4.14 2B3 Adipic acid production: Member States' contributions to N_2O emissions

Member State	N2O emissions in kt CO2 equiv.			Share in EU28 emissions in 2013	Change 2012-2013		Change 1990-2013		Method applied	Emission factor
	1990	2012	2013		kt CO2 equiv.	%	kt CO2 equiv.	%		
Austria	NO	NO	NO	-	-	-	-	-	NA	NA
Belgium	NO	NO	NO	-	-	-	-	-	NA	NA
Bulgaria	NO	NO	NO	-	-	-	-	-	NA	NA
Croatia	NO	NO	NO	-	-	-	-	-	NA	NA
Cyprus	NO	NO	NO	-	-	-	-	-	NA	NA
Czech Republic	NO	NO	NO	-	-	-	-	-	NA	NA
Denmark	NO	NO	NO	-	-	-	-	-	NA	NA
Estonia	NO	NO	NO	-	-	-	-	-	NA	NA
Finland	NO	NO	NO	-	-	-	-	-	NA	NA
France	14 232	70	157	26%	88	126%	-14 075	-99%	-	-
Germany	18 077	357	338	56%	-18	-5%	-17 738	-98%	T3	PS
Greece	NO	NO	NO	-	-	-	-	-	NA	NA
Hungary	NO	NO	NO	-	-	-	-	-	NA	NA
Ireland	NO	NO	NO	-	-	-	-	-	NA	NA
Italy	4 402	83	110	18%	27	33%	-4 292	-97%	T2	D,PS
Latvia	NO	NO	NO	-	-	-	-	-	NA	NA
Lithuania	NO	NO	NO	-	-	-	-	-	NA	NA
Luxembourg	NO	NO	NO	-	-	-	-	-	NA	NA
Malta	NO	NO	NO	-	-	-	-	-	NA	NA
Netherlands	NO	NO	NO	-	-	-	-	-	NA	NA
Poland	358	NO	NO	-	-	-	-358	-100%	T1	D
Portugal	NO	NO	NO	-	-	-	-	-	NA	NA
Romania	552	NO	NO	-	-	-	-552	-100%	D	D
Slovakia	NO	NO	NO	-	-	-	-	-	NA	NA
Slovenia	NO	NO	NO	-	-	-	-	-	NA	NA
Spain	NO	NO	NO	-	-	-	-	-	NA	NA
Sweden	NO	NO	NO	-	-	-	-	-	NA	NA
United Kingdom	19 935	NO	NO	-	-	-	-19 935	-100%	T3	CS
EU-28	**57 555**	**509**	**605**	**100%**	**97**	**19%**	**-56 949**	**-99%**		

Abbreviations explained in the Chapter 'Units and abbreviations'.

Table 4.15 shows information on methods applied, activity data, emission factors for N_2O emissions from 2B3 Adipic acid production for 1990 to 2013. The table shows that in 2013 adipic acid was produced in only three MS. Adipic acid production is used as activity data but the information is confidential in France and Germany. The implied emission factors per tonne of adipic acid produced is only provided by Italy with 0.3 t/t for 1990 and 0.005 t/t for 2013. The table shows that in 2013 100 % of EU-28 emissions are estimated with higher Tier methods.

Table 4.15 2B3 Adipic acid production: Information on methods applied, activity data, emission factors for N_2O emissions

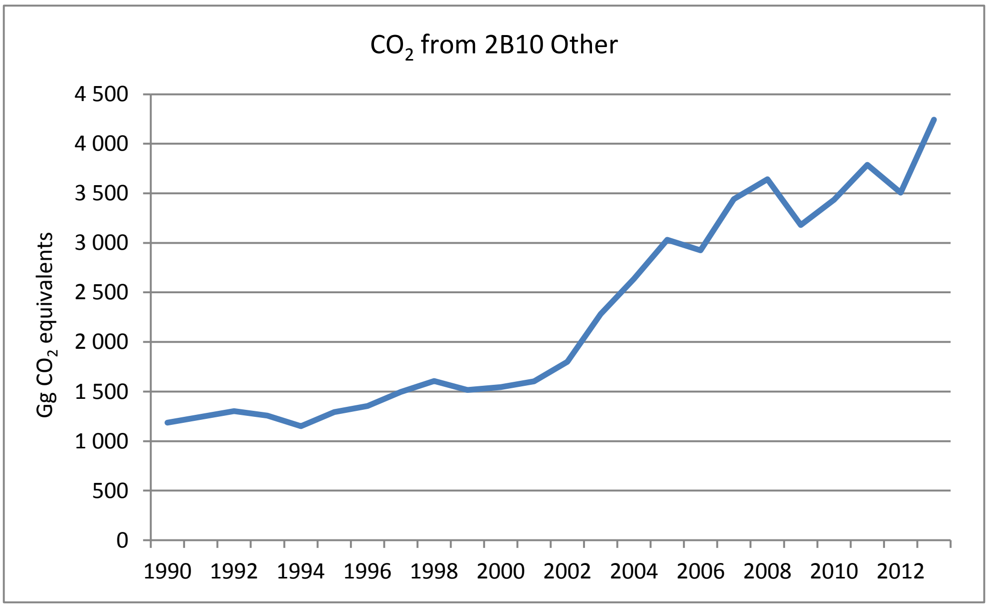
			1990				2013			
Member State	Method applied	Emission factor	Activity data		Implied emission factor	CO_2 emissions (Gg)	Activity data		Implied emission factor	CO_2 emissions (Gg)
			Description	(kt)	(t/t)		Description	(kt)	(t/t)	
Austria	NA	NA	Adipic Acid Production	0	NO,NA	NO	Adipic Acid Production	0	NO,NA	NO
Belgium	NA	NA	Adipic Acid Production	0	NO	NO	Adipic Acid Production	0	NO	NO
Bulgaria	NA	NA	Adipic Acid Production	0	NO	NO	Adipic Acid Production	0	NO	NO
Croatia	NA	NA	Adipic Acid Production	0	NO	NO	Adipic Acid Production	0	NO	NO
Cyprus	NA	NA	Adipic Acid Production	0	NO	NO	Adipic Acid Production	0	NO	NO
Czech Republic	NA	NA	Adipic Acid Production	0	NO	NO	Adipic Acid Production	0	NO	NO
Denmark	NA	NA	Adipic Acid Production	0	NO	NO	Adipic Acid Production	0	NO	NO
Estonia	NA	NA	Adipic Acid Production	0	NO	NO	Adipic Acid Production	0	NO	NO
Finland	NA	NA	Adipic Acid Production	0	NO	NO	Adipic Acid Production	0	NO	NO
France	-	-	Adipic Acid Production	0	C	14232	Adipic Acid Production	0	C	157
Germany	T3	PS	Adipic Acid Production	0	C	18077	Adipic Acid Production	0	C	338
Greece	NA	NA	Adipic Acid Production	0	NO	NO	Adipic Acid Production	0	NO	NO
Hungary	NA	NA	Adipic Acid Production	0	NO	NO	Adipic Acid Production	0	NO	NO
Ireland	NA	NA	Adipic Acid Production	0	NO	NO	Adipic Acid Production	0	NO	NO
Italy	T2	D,PS	Adipic Acid Production	49	0.30	4402	Adipic Acid Production	80	0.005	110
Latvia	NA	NA	Adipic Acid Production	0	NO	NO	Adipic Acid Production	0	NO	NO
Lithuania	NA	NA	Adipic Acid Production	0	NO	NO	Adipic Acid Production	0	NO	NO
Luxembourg	NA	NA	Adipic Acid Production	0	NO	NO	Adipic Acid Production	0	NO	NO
Malta	NA	NA	-	0	NO	NO	-	0	NO	NO
Netherlands	NA	NA	Adipic Acid Production	0	NA,NO	NO	Adipic Acid Production	0	NO	NO
Poland	T1	D	Adipic Acid Production	4	0.30	358	Adipic Acid Production	0	NO,NA	NO
Portugal	NA	NA	Adipic Acid Production	0	NO	NO	Adipic Acid Production	0	NO	NO
Romania	D	D	Adipic Acid Production	6	0.30	552	Adipic Acid Production	0	NO	NO
Slovakia	NA	NA	Adipic Acid Production	0	NO	NO	Adipic Acid Production	0	NO	NO
Slovenia	NA	NA	Adipic Acid Production	0	NO	NO	Adipic Acid Production	0	NO	NO
Spain	NA	NA	Adipic Acid Production	0	NO	NO	Adipic Acid Production	0	NO	NO
Sweden	NA	NA	Adipic Acid Production	0	NO	NO	Adipic Acid Production	0	NO	NO
United Kingdom	T3	CS	Adipic Acid Production	0	C	19935	Adipic Acid Production	0	NO	NO
EU-28			**EU-28**	**59**	**89.40**	**57555**	**EU 28**	**80**	**1.37**	**605**

Note: Some member states report AD and IEF as confidential. Only the data from countries which reported all data are being used for the calculation of the IEF. Therefore the IEF in this table is not necessarily an accurate representation of the IEF for this category.
Abbreviations explained in the Chapter 'Units and abbreviations'.

4.2.2.4 2B10 Other chemical industry

Eleven Member States report CO_2, CH_4 or N_2O emissions in this category (Table 4.16). This category contributed 4.2 Mt of CO_2 in 2013. Between 1990 and 2013, CO_2 emissions from this source increased significantly by 3.1 Mt or 258 % (Figure 4.9). Belgium is responsible for 37 % of these emissions, followed by Finland (21 %) and France (19 %). Between 1990 and 2013 Belgium had the largest growth of emissions in absolute terms. Between 2012 and 2013, CO_2 emissions from this source increased by 21 % with Belgium contributing the largest increase.

Figure 4.9 2B10 Other: CO_2 emissions



This category contains a wide heterogeneity of emissions and sources across Member States as shown in Table 4.16.

Table 4.16 2B10 Other: CO_2, CH_4 and N_2O emissions – emission trends between 1990 and 2013 and MS contribution

Member State	2.B.10 Other	CO_2 emissions [kt]	CO2 emissions [kt]	CH4 emissions [kt]	CH4 emissions [kt]	N2O emissions [kt]	N2O emissions [kt]
		1990	2013	1990	2013	1990	2013
AUT	Other	138.56	128.140101	0.29	0.2374	NA	NA
	CO2 from Nitric Acid Production	0.41	0.341	NA	NA	NA	NA
	Other chemical bulk production	138.15	127.799101	0.29	0.2374	NA	NA
BEL	Other	285.15	230.84979	NA	0.118548	0.03	0.03101588
	Other non-specified	285.15	230.84979	NA	0.118548	0.03	0.03101588
BGR	Other						
CYP	Other						
CZE	Other	IE	IE	IE	IE	NO	NO
DEU	Other	NA	NA	NA	NA	IE	IE
	production amount of dicarbonic acid	NA	NA	NA	NA	IE	IE
DNM	Other	0.85	1.3496	NA	NA	NA	NA
	Production of catalysts	0.85	1.3496	NA	NA	NA	NA
ESP	Other	NA	NA	0.71	0.583792	NA	NA
	Other No-Specify	NA	NA	0.71	0.583792	NA	NA
EST	Other	NO	NO	NO	NO	NO	NO
FIN	Other	176.18	909.902362	NO	NO	NO	NO
	Chemicals Production	NO	NO	NO	NO	NO	NO
	Phosphoric Acid Production	24.54	41.5566296	NO	NO	NO	NO
	Hydrogen Production	116.22	793.277578	NO	NO	NO	NO
	Limestone and Dolomite Use	35.42	75.0681547	NO	NO	NO	NO
FRK	Other	358.2	801.620525	0.02	0.0285257	1.76	0.3474408
GBE	Other	NO	NO	7.43	2.656844	0.01	0.005119
	Chemical industry - other	NO	NO	7.43	2.656844	0.01	0.005119
GRC	Other	NA,NO	304.781935	NA	NA	NA	NA
	Sulfuric acid	NA	NA	NA	NA	NA	NA
	Hydrogen production	NO	304.781935	NA	NA	NA	NA
HRV	Other	NO	NO	NO	NO	NO	NO
HUN	Other	NO	NO	NO	NO	NO	NO
IRL	Other						
ITA	Other	IE	IE	IE,NA	IE,NA	IE,NA	IE,NA
	other (indirect emissions)	IE	IE	IE	IE	IE	IE
	Soda Ash (CO emissions only)	IE	IE	NA	NA	NA	NA
LTU	Other	NO	NO	NO	NO	NO	NO
	Sulfuric acid production	NO	NO	NO	NO	NO	NO
LUX	Other	NO	NO	NO	NO	NO	NO
LVA	Other	NO	NO	NO	NO	NO	NO
MLT	Other	NO	NO	NO	NO	NO	NO
NLD	Other	NA	NA	NA	NA	NA	NA
	process emissions precursors chemical industry	NA	NA	NA	NA	NA	NA
POL	Other						
PRT	Other	19.78	21.2163749	NO	NO	NO	NO
	2.B.10.a Sulphuric Acid	NO	NO	NO	NO	NO	NO
	2.B.10.b Ammonium Sulphate	0.05	0.00507491	NO	NO	NO	NO
	2.B.10.c Explosives	NO	NO	NO	NO	NO	NO
	2.B.10.d Solvent use in plastic products manufacturi	19.73	21.2113	NO	NO	NO	NO
ROU	Other	NO	NO	NO	NO	NO	NO
	Other - non-specified	NO	NO	NO	NO	NO	NO
SVK	Other	116.99	369.29	0	0.00664478	0	0.00066448
	Hydrogen Production	116.99	369.29	0	0.00664478	0	0.00066448
SVN	Other	NO	NO	NO	NO	NO	NO
SWE	Other	90.08	118.775603	0.03	0.0315909	0.07	0.02219983
	Other inorganic chemical products	52.4	64.6010117	0	0.0025909	0.01	0.00218
	Other non-specified	NA	NA	NE	NE	NE	NE
	Other organic chemical products	37.68	54.1745913	0.03	0.029	NA	NA
	Pharmaceutical industry	NA	NA	NE	NE	0.05	0.02
	Sulphuric acid production	NA	NA	NA	NA	NA	NA
	Base chemicals for plastic industry	NA	NA	NE	NE	0.01	1.9833E-05

Table 4.16 provides an overview of change between 1990 and 2013 at a disaggregated level. Due to the heterogeneity of emission sources in this category, it is not possible to interpret trends in a meaningful way.

Table 4.17 2B10 Other: Member States' contributions to CO_2 emissions

Member State	CO2 emissions in kt			Share in EU28 emissions in 2013	Change 2012-2013		Change 1990-2013	
	1990	2012	2013		kt CO2	%	kt CO2	%
Austria	139	142	128	3%	-14	-10%	-10	-8%
Belgium	285	972	1 587	37%	614	63%	1 301	456%
Bulgaria	-	-	-	-	-	-	-	-
Croatia	NO	NO	NO	-	-	-	-	-
Cyprus	-	-	-	-	-	-	-	-
Czech Republic	IE	IE	IE	-	-	-	-	-
Denmark	1	1	1	0%	0	0%	0	58%
Estonia	NO	NO	NO	-	-	-	-	-
Finland	176	834	910	21%	76	9%	734	416%
France	358	743	802	19%	59	8%	443	124%
Germany	NA	NA	NA	-	-	-	-	-
Greece	NA,NO	323	305	7%	-19	-6%	305	100%
Hungary	NO	NO	NO	-	-	-	-	-
Ireland	-	-	-	-	-	-	-	-
Italy	IE	IE	IE	-	-	-	-	-
Latvia	NO	NO	NO	-	-	-	-	-
Lithuania	NO	NO	NO	-	-	-	-	-
Luxembourg	NO	NO	NO	-	-	-	-	-
Malta	NO	NO	NO	-	-	-	-	-
Netherlands	NA	NA	NA	-	-	-	-	-
Poland	-	-	-	-	-	-	-	-
Portugal	20	21	21	1%	0	0%	1	7%
Romania	NO	NO	NO	-	-	-	-	-
Slovakia	117	357	369	9%	12	3%	252	216%
Slovenia	NO	NO	NO	-	-	-	-	-
Spain	NA	NA	NA	-	-	-	-	-
Sweden	90	113	119	3%	6	5%	29	32%
United Kingdom	NO	NO	NO	-	-	-	-	-
EU-28	**1 186**	**3 507**	**4 242**	**100%**	**735**	**21%**	**3 056**	**258%**

Abbreviations explained in the Chapter 'Units and abbreviations'.

N_2O emissions from 2B10 Other account for 0.003 % of total emissions in 2013. Between 1990 and 2013, N_2O emissions from this source decreased by 77 % (Table 4.18). The Netherlands, Belgium and France are responsible for almost all of these emissions. Between 2012 and 2013, N_2O emissions from this source increased by 23 % with most of the increase in France.

Figure 4.10 2B10 Other: N_2O emissions

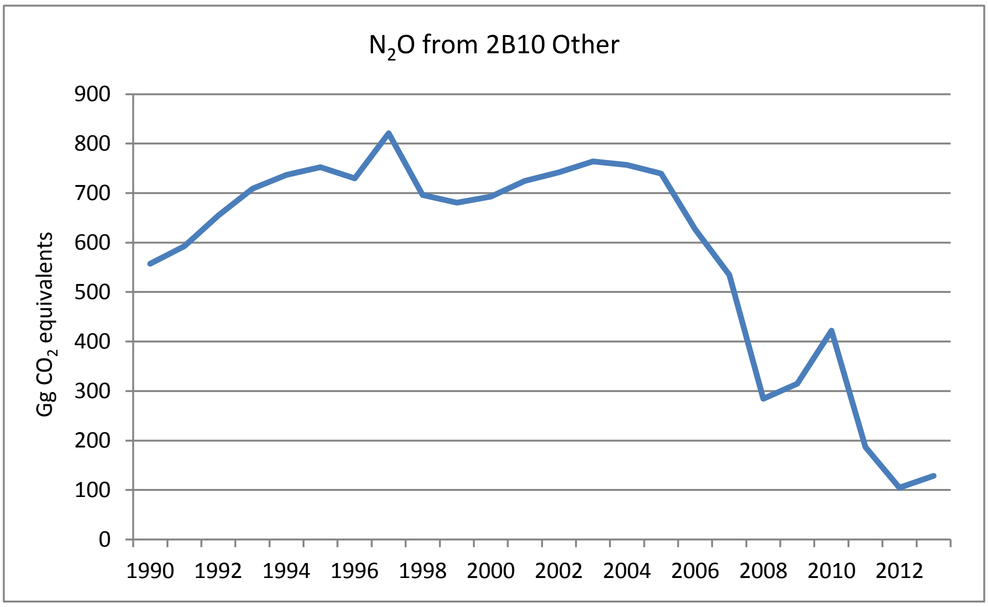


Table 4.18 2B10 Other: Member States' contributions to N_2O emissions

Member State	N2O emissions in kt CO2 equiv.			Share in EU28 emissions in 2013	Change 2012-2013		Change 1990-2013	
	1990	2012	2013		kt CO2 equiv.	%	kt CO2 equiv.	%
Austria	NA	NA	NA	-	-	-	-	-
Belgium	9	19	17	13%	-2	-11%	8	87%
Bulgaria	-	-	-	-	-	-	-	-
Croatia	NO	NO	NO	-	-	-	-	-
Cyprus	-	-	-	-	-	-	-	-
Czech Republic	NO	NO	NO	-	-	-	-	-
Denmark	NA	NA	NA	-	-	-	-	-
Estonia	NO	NO	NO	-	-	-	-	-
Finland	NO	NO	NO	-	-	-	-	-
France	526	78	104	81%	26	33%	-422	-80%
Germany	IE	IE	IE	-	-	-	-	-
Greece	NA	NA	NA	-	-	-	-	-
Hungary	NO	NO	NO	-	-	-	-	-
Ireland	-	-	-	-	-	-	-	-
Italy	IE,NA	IE,NA	IE,NA	-	-	-	-	-
Latvia	NO	NO	NO	-	-	-	-	-
Lithuania	NO	NO	NO	-	-	-	-	-
Luxembourg	NO	NO	NO	-	-	-	-	-
Malta	NO	NO	NO	-	-	-	-	-
Netherlands	NA	NA	NA	-	-	-	-	-
Poland	-	-	-	-	-	-	-	-
Portugal	NO	NO	NO	-	-	-	-	-
Romania	NO	NO	NO	-	-	-	-	-
Slovakia	0	0	0	0%	0	3%	0	224%
Slovenia	NO	NO	NO	-	-	-	-	-
Spain	NA	NA	NA	-	-	-	-	-
Sweden	21	6	7	5%	0	7%	-14	-68%
United Kingdom	2	2	2	1%	0	-10%	0	-15%
EU-28	**557**	**105**	**129**	**100%**	**24**	**23%**	**-429**	**-77%**

Abbreviations explained in the Chapter 'Units and abbreviations'.

Table 4.19 provides an overview of all sources reported under 2B10 Other Chemical Industry by EU-28 Member States for the year 2013 and for all gases. The largest contributors to the total EU-28 emissions are France and Finland.

Table 4.19 2B10 Other: Overview of sources reported under this source category for 2013

Member State	2.B.10 Other Chemical Industry	CO_2 emissions [Gg]	CH_4 emissions [Gg]	N_2O emissions [Gg]	Total emissions [Gg CO_2 equivalents]	Share in EU-28 Total
Austria	Other, CO2 from Nitric Acid Production, Other chemical bulk production	128	0.2	NA	134	4%
Belgium	Other, Other non-specified	231	0.1	0.03	243	8%
Bulgaria	Other				-	-
Croatia	Other	NO	NO	NO	-	-
Cyprus	Other				-	-
Czech Republic	Other	IE	IE	NO	-	-
Denmark	Other, Production of catalysts	1	NA	NA	1	0.04%
Estonia	Other	NO	NO	NO	-	-
Finland	Other, Chemicals Production, Phosphoric Acid Production, Hydrogen Production, Limestone and Dolomite Use	910	NO	NO	910	29%
France	Other	802	0.03	0.3	906	29%
Germany	Other, production amount of dicarbonic acid	NA	NA	IE	-	-
Greece	Other, Sulfuric acid, Hydrogen production	305	NA	NA	305	10%
Hungary	Other	NO	NO	NO	-	-
Ireland	Other				-	-
Italy	Other, other (indirect emissions), Soda Ash (CO emissions only)	IE	IE,NA	IE,NA	-	-
Latvia	Other	NO	NO	NO	-	-
Lithuania	Other, Sulfuric acid production	NO	NO	NO	-	-
Luxembourg	Other	NO	NO	NO	-	-
Malta	Other	NO	NO	NO	-	-
Netherlands	Other, process emissions precursors chemical industry	NA	NA	NA	-	-
Poland	Other				-	-
Portugal	Other, 2.B.10.a Sulphuric Acid, 2.B.10.b Ammonium Sulphate, 2.B.10.c Explosives, 2.B.10.d Solvent use in plastic products manufacturing	21	NO	NO	21	0.7%
Romania	Other, Other - non-specified	NO	NO	NO	-	-
Slovakia	Other, Hydrogen Production	369	0.01	0.0007	370	12%
Slovenia	Other	NO	NO	NO	-	-
Spain	Other, Other No-Specify	NA	0.6	NA	-	-
Sweden	Other, Other inorganic chemical products, Other non-specified, Other organic chemical products, Pharmaceutical industry, Sulphuric acid production, Base chemicals for plastic industry	119	0.03	0.02	126	4%
United Kingdom	Other, Chemical industry - other	NO	3	0.01	-	-
EU 28 - Total		**2886**	**3.66**	**0.41**	**3099**	**100%**

Abbreviations explained in the Chapter 'Units and abbreviations'.

4.2.2.5 Non-key sources

The following categories will be assessed and included in the 2016 NIR with a suitable level of detail as appropriate:

2B4 Caprolactam, glyoxal and glyoxylic acid production

2B5 Carbide production

2B6 Titanium dioxide production

2B7 Soda ash production

4.2.3 Metal Industry (CRF Source Category 2C)

This source category includes two key sources, namely CO_2 emissions from 2C1 Iron and Steel Production and PFC emissions from 2C3 Aluminium Production.

Table 4.20 summarises information by Member State on total GHG emissions, CO_2, SF_6 and PFC emissions from Metal Production. Between 1990 and 2013, CO_2 emission from 2C Metal Production decreased by approx. 39 %. The absolute decrease of CO_2 emissions was largest in Germany, Romania and Poland.

Table 4.20 2C Metal Industry: Member States' contributions to total GHG, CO_2, PFC and SF_6 emissions

Member State	GHG emissions in 1990 (kt CO2 equivalents)	GHG emissions in 2013 (kt CO2 equivalents)	CO2 emissions in 1990 (kt)	CO2 emissions in 2013 (kt)	PFC emissions in 1990 (kt CO2 equivalents)	PFC emissions in 2013 (kt CO2 equivalents)	SF6 emissions in 1990 (kt CO2 equivalents)	SF6 emissions in 2013 (kt CO2 equivalents)
Austria	8 177	10 232	6 787	10 223	1 149	NO	242	9
Belgium	10 400	3 965	10 400	3 949	-	-	-	-
Bulgaria	1 439	33	1 413	33	-	-	-	-
Croatia	1 583	17	339	17	1 240	NO	NO	NO
Cyprus	0	0	NO	NO	-	-	-	-
Czech Republic	9 668	7 058	9 653	6 625	NO	NO	NO	NO
Denmark	60	0	30	0	NO	NO	30	NO
Estonia	0	0	NO	NO	NO	NO	NO	NO
Finland	1 976	2 095	1 976	2 095	NO	NO	NO	C,NO
France	8 463	3 459	4 113	3 269	3 567	98	781	92
Germany	28 147	15 204	25 073	15 024	2 889	108	180	34
Greece	1 190	1 153	1 000	1 070	190	83	NO	NO
Hungary	3 699	728	3 316	725	376	NO	NO	NO
Ireland	0	0	NO	NO	-	-	-	-
Italy	5 921	1 244	3 878	1 192	1 975	NO	NO	NO
Latvia	13	1	13	1	NO	NO	NO	NO
Lithuania	15	2	15	2	NO	NO	NO	NO
Luxembourg	985	102	985	102	NO	NO	NO	NO
Malta	0	0	NO,NA	NO,NA	-	-	NO,NA	NO,NA
Netherlands	5 351	1 261	2 714	1 251	2 638	11	NO	NO
Poland	6 201	2 452	6 037	2 434	142	NA,NO	NA,NO	4
Portugal	128	82	122	66	-	-	-	-
Romania	13 848	3 318	11 372	3 308	2 455	6	NO,NE	NO,NE
Slovakia	4 901	4 204	4 586	4 194	315	10	NO	NO
Slovenia	551	223	343	208	208	15	-	-
Spain	4 443	2 946	3 397	2 883	1 021	44	NA,NO	NA,NO
Sweden	3 722	2 783	3 246	2 723	434	49	23	11
United Kingdom	9 431	5 235	7 392	5 013	1 553	7	387	146
EU-28	**130 311**	**67 798**	**108 198**	**66 406**	**20 151**	**431**	**1 642**	**296**

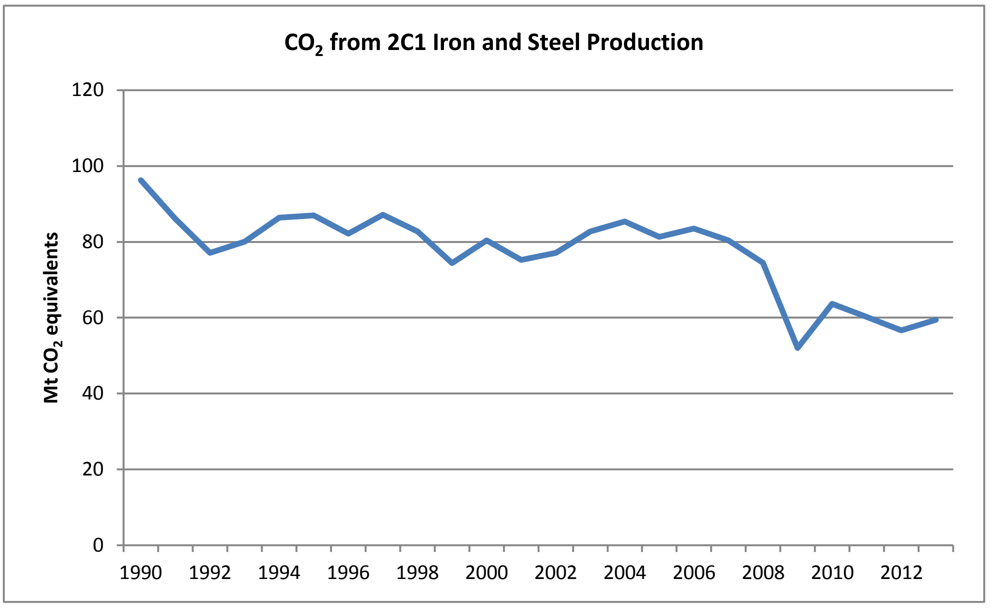
4.2.3.1 2C1 Iron and steel production

This source category includes emissions from the iron and steel industry. Crude iron is produced by the reduction of iron oxide ores mostly in blast furnaces, using coke or other forms of carbon as fuel and reducing agent. In most iron furnaces, the process is aided by the use of carbonate fluxes (limestone). Additional emissions occur as the limestone or dolomite flux releases CO_2 during reduction of pig iron in the blast furnace. Carbon plays the dual role of fuel and reducing agent. Member States use different methods for the allocation of emissions that are described in Table 4.22.

CO_2 emissions from 2C1 Iron and Steel Production amounted to approx. 2.2 % of total GHG emissions (without LULUCF) in 2013. Germany accounts for 23.5 % of these emissions in the EU-28. Germany had the largest decrease in absolute terms between 1990 and 2013 while increases were encountered in Austria, Finland and (on a small scale) Slovenia.

The overall emission trend between 1990 and 2013 roughly follows the trend of emissions from Germany that fluctuates due to varying production figures. Between 1990 and 2013, overall CO_2 emissions from iron and steel production decreased by 38 % (Table 4.21). Between 2012 and 2013 emissions increased by 5 %.

Figure 4.11 2C1 Iron and Steel Production: CO_2 emissions



CO_2 emissions from iron and steel industry are reported by all Member States except Cyprus, Estonia, Ireland and Malta. All follow higher-tier methods and most use country or plant specific methods (see Table **4.21**).

Table 4.21 2C1 Iron and Steel Production: Member States' contributions to CO_2 emissions and information on method applied, activity data and emission factor

Member State	CO2 emissions in kt			Share in EU28 emissions in 2013	Change 2012-2013		Change 1990-2013		Method applied	Emission factor
	1990	2012	2013		kt CO2	%	kt CO2	%		
Austria	6 610	9 850	10 191	17%	341	3%	3 581	54%	NA	NA
Belgium	10 278	3 627	3 799	6%	172	5%	-6 479	-63%	CS,T3	PS
Bulgaria	1 283	50	33	0%	-18	-35%	-1 251	-97%	T1,T2	CS,D
Croatia	46	2	17	0%	15	843%	-29	-64%	NA,T2	CS,NA
Cyprus	NO	NO	NO	-	-	-	-	-	NA	NA
Czech Republic	9 643	5 752	6 543	11%	791	14%	-3 099	-32%	CS,T2	D,PS
Denmark	30	NO	NO	-	-	-	-	-	T1,T2	D
Estonia	NO	NO	NO	-	-	-	-	-	NA	NA
Finland	1 967	2 264	2 073	3%	-191	-8%	107	5%	CS,T3	CS
France	2 877	1 925	2 337	4%	413	21%	-540	-19%	NA	NA
Germany	22 810	14 290	13 978	24%	-312	-2%	-8 832	-39%	NA,T2	CS,NA
Greece	93	83	66	0%	-17	-20%	-26	-28%	CS,NA	CS,NA
Hungary	3 153	1 200	725	1%	-475	-40%	-2 428	-77%	NA,T3	NA,PS
Ireland	NO	NO	NO	-	-	-	-	-	NA	NA
Italy	3 124	1 291	1 157	2%	-134	-10%	-1 967	-63%	T2	CR,CS,PS
Latvia	13	3	1	0%	-2	-67%	-12	-93%	NA,T2	D,NA,PS
Lithuania	15	3	2	0%	-1	-23%	-12	-84%	T2	D
Luxembourg	985	100	102	0%	1	1%	-883	-90%	CS,NA,T2	CS,NA
Malta	NO,NA	NO,NA	NO,NA	-	-	-	-	-	NA	NA
Netherlands	2 266	1 240	1 083	2%	-157	-13%	-1 183	-52%	NA,T2	CS,NA
Poland	5 343	1 683	1 862	3%	179	11%	-3 481	-65%	T1,T2	CS
Portugal	122	62	66	0%	4	6%	-56	-46%	T2	D,OTH,PS
Romania	10 781	2 852	2 933	5%	81	3%	-7 848	-73%	NA,T3	CS,NA
Slovakia	4 168	3 860	3 763	6%	-97	-3%	-405	-10%	T2	PS
Slovenia	44	48	49	0%	2	4%	6	13%	NA,T2	NA,PS
Spain	2 428	1 375	1 483	2%	108	8%	-945	-39%	T2	CS,PS
Sweden	2 632	2 179	2 249	4%	70	3%	-383	-15%	NA	NA
United Kingdom	5 583	2 918	4 945	8%	2 027	69%	-637	-11%	NA,T2	CS,NA
EU-28	**96 293**	**56 656**	**59 459**	**100%**	**2 803**	**5%**	**-36 805**	**-38%**		

For this category, it is not useful to give an average IEF across the Member States because of their varying emission allocation (the split between process and combustion related emissions for pig iron production, which is an important sub-category). Activity data, implied implied emission factors and CO_2 emissions for the various Member States and sub-categories are provided in Table 4.22.

Figure 4.12 2C1 Iron and Steel Production: Implied emission factors

1990					2013				
Member State	Activity data		Implied emission factor (t/t)	CO2 emissions (kt)	Member State	Activity data		Implied emission factor (t/t)	CO2 emissions (kt)
	Description	(kt)				Description	(kt)		
Austria	**Iron and steel production**			6610	Austria	**Iron and steel production**			10191
	Steel	3921	1.68	6591		Steel	7290	1	10151
	Pig Iron	3444	NA,IE	IE		Pig Iron	6144	NA,IE	IE
	Direct reduced iron	0	NO,NA	NO		Direct reduced iron	NO	NO,NA	NO
	Sinter	0	NO,NA	NO		Sinter	NO	NO,NA	NO
	Pellet	0	NO,NA	NO		Pellet	NO	NO,NA	NO
	Other			20		Other			40
	Electric Furnace Steel	370	0.05	20		Electric Furnace Steel	664	0.06	40
Belgium	**Iron and steel production**			10278	Belgium	**Iron and steel production**			3799
	Steel	11570	0.75	8689		Steel	6829	0.5	3731
	Pig Iron	9415	NA,IE	IE		Pig Iron	3892	NA,IE	IE
	Direct reduced iron	0	NO	NO		Direct reduced iron	NO	NO	NO
	Sinter	13075	0.12	1589		Sinter	5349	0.01	64
	Pellet	0	IE,NO	IE		Pellet	NO	NO	NO
	Other			IE		Other			4
	Use of electrodes	NA	NO, IE	IE		Use of electrodes	1178	0.004	4
Bulgaria	**Iron and steel production**			1283	Bulgaria	**Iron and steel production**			33
	Steel	2180	0.59	1283		Steel	541	0.06	33
	Pig Iron	1143	NO,IE	IE		Pig Iron	NO	NO	NO
	Direct reduced iron	IE	NO,IE	IE		Direct reduced iron	NO	NO	NO
	Sinter	C	NO,IE	IE		Sinter	NO	NO	NO
	Pellet	IE	NO,IE	IE		Pellet	NO	NO	NO
	Other					Other			
Croatia	**Iron and steel production**			46	Croatia	**Iron and steel production**			17
	Steel	171	0.27	46		Steel	58	0.3	17
	Pig Iron	209	IE,NO	IE		Pig Iron	NO	NO	NO
	Direct reduced iron	NO	NO	NO		Direct reduced iron	NO	NO	NO
	Sinter	NO	NO	NO		Sinter	NO	NO	NO
	Pellet	NO	NO	NO		Pellet	NO	NO	NO
	Other			NO		Other			NO
Cyprus	**Iron and steel production**			NO	Cyprus	**Iron and steel production**			NO
	Steel	NO	NO	NO		Steel	NO	NO	NO
	Pig Iron	NO	NO	NO		Pig Iron	NO	NO	NO
	Direct reduced iron	NO	NO	NO		Direct reduced iron	NO	NO	NO
	Sinter	NO	NO	NO		Sinter	NO	NO	NO
	Pellet	NO	NO	NO		Pellet	NO	NO	NO
	Other					Other			
Czech Republic	**Iron and steel production**			9643	Czech Republic	**Iron and steel production**			6543
	Steel	8190	NA,IE	IE		Steel	5222	NA,IE	IE
	Pig Iron	6106	NA,IE	IE		Pig Iron	4040	NA,IE	IE
	Direct reduced iron	NO	NO	NO		Direct reduced iron	NO	NO	NO
	Sinter	8469	NA,IE	IE		Sinter	5543	NA,IE	IE
	Pellet	NO	NO	NO		Pellet	NO	NO	NO
	Other			9643		Other			6543
	Metallurgical coke	7125	1.29	9180		Metallurgical coke	2489	2.27	5660
	Use of limestone and dolomite	891	0.52	462		Use of limestone and dolomite	1080	0.82	883
Denmark	**Iron and steel production**			30	Denmark	**Iron and steel production**			NO
	Steel	614	0.05	30		Steel	NO	NO	NO
	Pig Iron	NO	NO	NO		Pig Iron	NO	NO	NO
	Direct reduced iron	NO	NO	NO		Direct reduced iron	NO	NO	NO
	Sinter	NO	NO	NO		Sinter	NO	NO	NO
	Pellet	NO	NO	NO		Pellet	NO	NO	NO
	Other					Other			
Estonia	**Iron and steel production**			NO	Estonia	**Iron and steel production**			NO
	Steel	NO	NO	NO		Steel	NO	NO	NO
	Pig Iron	NO	NO	NO		Pig Iron	NO	NO	NO
	Direct reduced iron	NO	NO	NO		Direct reduced iron	NO	NO	NO
	Sinter	NO	NO	NO		Sinter	NO	NO	NO
	Pellet	NO	NO	NO		Pellet	NO	NO	NO
	Other			NO		Other			NO

1990					2013				
Member State	Activity data		Implied emission factor (t/t)	CO2 emissions (kt)	Member State	Activity data		Implied emission factor (t/t)	CO2 emissions (kt)
	Description	(kt)				Description	(kt)		
Finland	**Iron and steel production**			1967	Finland	**Iron and steel production**			2073
	Steel	2861	0.69	1967		Steel	3517	0.6	2073
	Pig Iron	NO	NO,IE	IE		Pig Iron	NO	NO,IE	IE
	Direct reduced iron	NO	NO	NO		Direct reduced iron	NO	NO	NO
	Sinter	NO	NO	NO		Sinter	NO	NO	NO
	Pellet	NO	NO	NO		Pellet	NO	NO	NO
	Other			NO		Other			NO
	Coke	487	NO	NO		Coke	878	NO	NO
France	**Iron and steel production**			2877	France	**Iron and steel production**			2337
	Steel	19073	0.09	1643		Steel	15692	0.09	1407
	Pig Iron	14088	0.09	1234		Pig Iron	10241	0.09	930
	Direct reduced iron	NO	NO	NO		Direct reduced iron	NO	NO	NO
	Sinter	IE	IE	IE		Sinter	IE	IE	IE
	Pellet	NO	NO	NO		Pellet	NO	NO	NO
	Other			NO		Other			NO
Germany	**Iron and steel production**			22810	Germany	**Iron and steel production**			13978
	Steel	43939	0.52	22810		Steel	42645	0.3	13978
	Pig Iron	32263	IE,NO	IE		Pig Iron	27176	IE,NO	IE
	Direct reduced iron	IE	IE	IE		Direct reduced iron	IE	IE	IE
	Sinter	IE	IE	IE		Sinter	IE	IE	IE
	Pellet	NO	NO	NO		Pellet	NO	NO	NO
	Other			NO		Other			NO
Greece	**Iron and steel production**			93	Greece	**Iron and steel production**			66
	Steel	999	0.09	93		Steel	1030	0.1	66
	Pig Iron	NO	NO	NO		Pig Iron	NO	NO	NO
	Direct reduced iron	NO	NO	NO		Direct reduced iron	NO	NO	NO
	Sinter	NO	NO	NO		Sinter	NO	NO	NO
	Pellet	NO	NO	NO		Pellet	NO	NO	NO
	Other			NO		Other			NO
Hungary	**Iron and steel production**			3153	Hungary	**Iron and steel production**			725
	Steel	2963	0.12	346		Steel	883	0.12	105
	Pig Iron	1697	1.65	2427		Pig Iron	628	2	429
	Direct reduced iron	NO	NO	NO		Direct reduced iron	NO	NO	NO
	Sinter	72	5.28	380		Sinter	36	5	191
	Pellet	IE	IE	IE		Pellet	IE	IE	IE
	Other			NO		Other			NO
Ireland	**Iron and steel production**			NO	Ireland	**Iron and steel production**			NO
	Steel	NO	NO	NO		Steel	NO	NO	NO
	Pig Iron	NO	NO	NO		Pig Iron	NO	NO	NO
	Direct reduced iron	NO	NO	NO		Direct reduced iron	NO	NO	NO
	Sinter	NO	NO	NO		Sinter	NO	NO	NO
	Pellet	NO	NO	NO		Pellet	NO	NO	NO
	Other			NO		Other			NO
Italy	**Iron and steel production**			3124	Italy	**Iron and steel production**			1157
	Steel	25467	0.05	1346		Steel	24080	0.03	604
	Pig Iron	11852	0.15	1778		Pig Iron	6933	0	553
	Direct reduced iron	NO	NO	NO		Direct reduced iron	NO	NO	NO
	Sinter	13577	NA	NA		Sinter	8175	NA	NA
	Pellet	NO	NO	NO		Pellet	NO	NO	NO
	Other			NO		Other			NO
Latvia	**Iron and steel production**			13	Latvia	**Iron and steel production**			1
	Steel	550	0.02	13		Steel	193	0	1
	Pig Iron	NO	NO	NO		Pig Iron	NO	NO	NO
	Direct reduced iron	NO	NO	NO		Direct reduced iron	NO	NO	NO
	Sinter	NO	NO	NO		Sinter	NO	NO	NO
	Pellet	NO	NO	NO		Pellet	NO	NO	NO
	Other			NO		Other			NO

Member State	1990 Activity data: Description	(kt)	Implied emission factor (t/t)	CO2 emissions (kt)	Member State	2013 Activity data: Description	(kt)	Implied emission factor (t/t)	CO2 emissions (kt)
Lithuania	**Iron and steel production**			15	**Lithuania**	**Iron and steel production**			2
	Steel	NO	NO	NO		Steel	NO	NO	NO
	Pig Iron	NO	NO	NO		Pig Iron	NO	NO	NO
	Direct reduced iron	NO	NO	NO		Direct reduced iron	NO	NO	NO
	Sinter	NO	NO	NO		Sinter	NO	NO	NO
	Pellet	NO	NO	NO		Pellet	NO	NO	NO
	Other			15		Other			2
	Cast Iron	106	0.14	15		Cast Iron	3	0.7	2
Luxembourg	**Iron and steel production**			985	**Luxembourg**	**Iron and steel production**			102
	Steel	3506	0.12	404		Steel	2089	0.05	102
	Pig Iron	2645	0.08	200		Pig Iron	NO	NO	NO
	Direct reduced iron	NO	NO	NO		Direct reduced iron	NO	NO	NO
	Sinter	4804	0.08	380		Sinter	NO	NO	NO
	Pellet	NO	NO	NO		Pellet	NO	NO	NO
	Other			NO		Other			NO
Malta	**Iron and steel production**			NO,NA	**Malta**	**Iron and steel production**			NO,NA
	Steel	NO	NO	NO		Steel	NO	NO	NO
	Pig Iron	NO	NO	NO		Pig Iron	NO	NO	NO
	Direct reduced iron	NO	NO	NO		Direct reduced iron	NO	NO	NO
	Sinter	NO	NO	NO		Sinter	NO	NO	NO
	Pellet	NO	NO	NO		Pellet	NO	NO	NO
	Other			NA		Other			NA
Netherlands	**Iron and steel production**			2266	**Netherlands**	**Iron and steel production**			1083
	Steel	5162	0.01	43		Steel	6800	0.00	15
	Pig Iron	0	IE,NO	IE		Pig Iron	NA	IE,NO	IE
	Direct reduced iron	0	NA	1		Direct reduced iron	NA	NA	0
	Sinter	0	IE,NO	IE		Sinter	NA	IE,NO	IE
	Pellet	0	IE,NO	IE		Pellet	NA	IE,NO	IE
	Other			2223		Other			1068
	Other non specified	11691	0.19	2223		Other non specified	NA	NA	1068
Poland	**Iron and steel production**			5343	**Poland**	**Iron and steel production**			1862
	Steel	0	IE	IE		Steel	IE	IE	IE
	Pig Iron	8657	0.16	1427		Pig Iron	4012	0	636
	Direct reduced iron	0	NO	NO		Direct reduced iron	NO	NO	NO
	Sinter	11779	0.07	841		Sinter	6854	0	355
	Pellet	0	NO	NO		Pellet	NO	NO	NO
	Other			3075		Other			870
	Open-hearth Steel	3945	0.52	2060		Open-hearth Steel	NO	NA,NO	NO
	Basic Oxygen Furnace Steel	7207	0.13	929		Basic Oxygen Furnace Steel	4520	0.14	645
	Electric Furnace Steel	2309	0.04	85		Electric Furnace Steel	3679	0.06	225
Portugal	**Iron and steel production**			122	**Portugal**	**Iron and steel production**			66
	Steel	621	0.07	42		Steel	1998	0.0	66
	Pig Iron	308	0.00004	0		Pig Iron	NO	NO	NO
	Direct reduced iron	NO	NO	NO		Direct reduced iron	NO	NO	NO
	Sinter	338	0.24	80		Sinter	NO	NO	NO
	Pellet	NO	NO	NO		Pellet	NO	NO	NO
	Other			NO		Other			NO
Romania	**Iron and steel production**			10781	**Romania**	**Iron and steel production**			2933
	Steel	9959	1.08	10781		Steel	3118	0.94	2933
	Pig Iron	5916	NO,IE	IE		Pig Iron	1604	NO,IE	IE
	Direct reduced iron	NO	NO	NO		Direct reduced iron	NO	NO	NO
	Sinter	11357	NO,IE	IE		Sinter	2111	NO,IE	IE
	Pellet	NO	NO	NO		Pellet	NO	NO	NO
	Other			NO		Other			NO
Slovakia	**Iron and steel production**			4168	**Slovakia**	**Iron and steel production**			3763
	Steel	3562	1.17	4150		Steel	4344	0.9	3709
	Pig Iron	17	NO,IE	IE		Pig Iron	14	NO,IE	IE
	Direct reduced iron	NO	NO	NO		Direct reduced iron	NO	NO	NO
	Sinter	IE	NO,IE	IE		Sinter	IE	NO,IE	IE
	Pellet	IE	NO,IE	IE		Pellet	IE	NO,IE	IE
	Other			18		Other			54
	EAF production of steel	311	0.06	18		EAF production of steel	711	0.08	54

1990					2013				
Member State	Activity data		Implied emission factor	CO2 emissions	Member State	Activity data		Implied emission factor	CO2 emissions
	Description	(kt)	(t/t)	(kt)		Description	(kt)	(t/t)	(kt)
Slovenia	**Iron and steel production**			44	**Slovenia**	**Iron and steel production**			49
	Steel	632	0.07	44		Steel	663	0.07	49
	Pig Iron	NO	NO,NA	NO		Pig Iron	NO	NO,NA	NO
	Direct reduced iron	NO	NO	NO		Direct reduced iron	NO	NO	NO
	Sinter	NO	NO	NO		Sinter	NO	NO	NO
	Pellet	NO	NO	NO		Pellet	NO	NO	NO
	Other			NO		Other			NO
Spain	**Iron and steel production**			2428	**Spain**	**Iron and steel production**			1483
	Steel	13163	0.07	979		Steel	14446	0.05	672
	Pig Iron	C	C	246		Pig Iron	C	C	295
	Direct reduced iron	IE	NA,IE	IE		Direct reduced iron	IE	NA,IE	IE
	Sinter	C	C	538		Sinter	C	C	190
	Pellet	IE	NA,IE	IE		Pellet	IE	NA,IE	IE
	Other			666		Other			326
	Flaring in iron and steel production	C	C	C		Flaring in iron and steel production	C	C	326
Sweden	**Iron and steel production**			2632	**Sweden**	**Iron and steel production**			2249
	Steel	1755	0.09	156		Steel	1446	0.12	167
	Pig Iron	2736	0.77	2094		Pig Iron	2896	0.63	1813
	Direct reduced iron	109	1.19	129		Direct reduced iron	113	1.45	164
	Sinter	1058	0.20	212		Sinter	NA	NA	NA
	Pellet	9919	0.004	41		Pellet	24115	0.004	106
	Other					Other			
United Kingdom	**Iron and steel production**			5583	**United Kingdom**	**Iron and steel production**			4945
	Steel	17485	0.01	224		Steel	11769	0.01	140
	Pig Iron	12463	0.15	1837		Pig Iron	9471	0.22	2115
	Direct reduced iron	NO	NO	NO		Direct reduced iron	NO	NO	NO
	Sinter	C	C	3522		Sinter	C	C	2690
	Pellet	NO	NO	NO		Pellet	NO	NO	NO
	Other			NO		Other			NO

It can be seen from the table that several Member States use IE for some categores. This can be explained by the fact that they make use of carbon balances and several processes occur within the same industrial site, which makes differentiation into the various subcategories difficult. For example, several countries include emissions from the production of pig iron (which occurs at integrated iron and steel production sites) under “steel production”.

According to the 2006 IPCC guidelines, all emissions from iron and steel production should be reported under category 2.C.1, irrespective of their role as reducing agent or fuel.

However, e. g. some Member States report emissions from blast furnace gas and from converter gas under 1A2a instead of 2C1 because this can be interpreted as emissions from energy supply.

Thus, for an overview of total emissions it seems to be more convenient to take into account all emissions covered by the combined category 1A2a + 2C1. Resulting emissions for this combined category are given in Table 4.22.

Table 4.22 CO_2 Emissions of from iron and steel production: 1A2a, 2C1 and combined (sum of both categories). The column "Share 2C1" denotes the ratio of emissions under 2C1 and combined emissions.

Member State	CO_2 emissions in Gg			Share in EU28 emissions in 2013	Share 2C1
	1A2a	2C1	Combined		
Austria	1,971	10,191	12,162	7%	84%
Belgium	1,128	3,799	4,927	3%	77%
Bulgaria	99	33	132	0%	25%
Croatia	58	17	75	0%	22%
Cyprus	NO,IE	NO	-	-	-
Czech Republic	2,812	6,543	9,355	6%	70%
Denmark	71	NO	71	0%	-
Estonia	NO	NO	-	-	-
Finland	2,154	2,073	4,227	3%	49%
France	13,976	2,337	16,314	10%	14%
Germany	34,081	13,978	48,059	29%	29%
Greece	173	66	239	0%	28%
Hungary	203	725	928	1%	78%
Ireland	NO	NO	-	-	-
Italy	10,597	1,157	11,754	7%	10%
Latvia	39	1	40	0%	2%
Lithuania	NO	2	2	0%	100%
Luxembourg	264	102	365	0%	28%
Malta	IE	NO,NA	-	-	-
Netherlands	3,496	1,083	4,579	3%	24%
Poland	5,818	1,862	7,680	5%	24%
Portugal	143	66	209	0%	31%
Romania	2,703	2,933	5,636	3%	52%
Slovakia	3,192	3,763	6,956	4%	54%
Slovenia	202	49	251	0%	20%
Spain	6,256	1,483	7,739	5%	19%
Sweden	1,261	2,249	3,511	2%	64%
United Kingdom	14,670	4,945	19,615	12%	25%
EU-28	**105368**	**59459**	**164826**	**100%**	**36%**

It can be seen that the ratio of emissions under 2C1 and combined emissions (see column "Share 2C1" in Table **4.22**) varies across Member States. This indicates that the boundary between 1A2a and 2C1 is not uniformly interpreted by Member States. The eight Member States with largest CO_2 emissions from iron and steel production allocate their emissions in the following ways:

- Germany: Approx. 29 % of emissions are reported under 2C1. This category comprises process-related CO_2 emissions (including emissions from carbonate use). However, emissions from energy-related use of top gas and converter gas are reported under the respective sub-categories of sector 1.
- United Kingdom: Major share of emissions (75 %) is reported under 1A2a. Emissions from sintering (coke breeze and carbonates), from flared blast furnace gas and from electric and ladle arc furnances are reported under 2C1.
- France: Major share of emissions (86 %) is reported under 1A2a. Emissions from sinter production are reported under 1A2a.
- Austria: 84 % of emissions are reported under 2C1. Generally, all emissions from iron and steel production are reported under this category, irrespective of their role as reducing agent or fuel,

but emissions related to the coke oven and to on-site power plants are reported under category 1A2a.

- Italy: Major share of emissions (90 %) is reported under 1A2a. CO_2 emissions due to the consumption of coke, coal and other reducing agents used in the iron and steel industry have been accounted for as fuel consumption and reported in the energy sector. In sector 2C1, emissions are reported from carbonates used in sinter plants and in basic oxygen furnaces, emissions related to steel and pig iron scraps and emissions from graphite electrodes consumed in electric arc furnaces.
- Czech Republic: 70 % of emissions are reported under category 2C1. It also includes emissions from limestone and dolomite use.
- Spain: Major share of emissions (81 %) is reported under 1A2a, including emissions from coke production.
- Poland: 76 % of emissions are reported under 1A2a. Generally, all fuels are reported under this category, but CO_2 emissions from coke in the blast furnace are reported under category 2C1.

4.2.3.2 2C3 Aluminium production

This category includes PFC emissions from aluminium production. Two PFCs, tetrafluoromethane (CF_4) and hexafluoroethane (C_2F_6), are known to be emitted from the process of primary aluminium smelting. These PFCs are formed during the phenomenon known as the anode effect, when the aluminium oxide concentration in the reduction cell electrolyte is low.

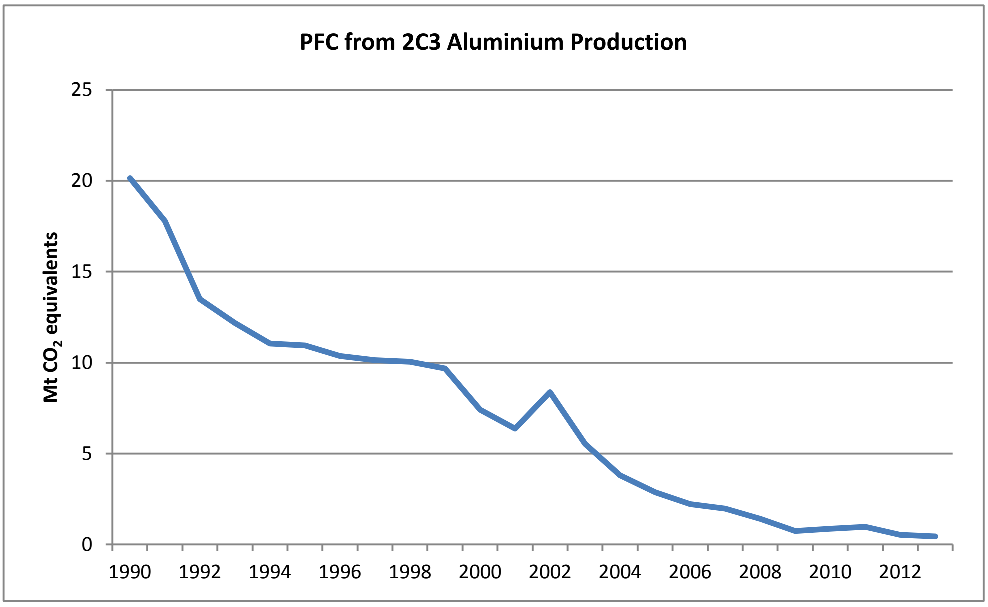
Table 4.23 summarises information by Member States on emission trends for the key source PFCs from 2C3 Aluminium Production. PFC emissions from 2C3 Aluminium production account for 0.01 % of total EU-28 GHG emissions (without LULUCF) in 2013. Between 1990 and 2013, PFC emissions from this source decreased by 98 %. In 2013, Germany contributed the highest share among the EU-28, amounting to 25 % of overall emissions. Of the ten Member States reporting PFC emissions under this category in 2013, seven use plant or country-specifc emission factors.

Table 4.23 2C3 Aluminium Production: Member States' contributions to PFC emissions and information on method applied and emission factor

Member State	PFCs emissions in kt CO2 equiv.			Share in EU28 emissions in 2013	Change 2012-2013		Change 1990-2013		Method applied	Emission factor
	1990	2012	2013		kt CO2 equiv.	%	kt CO2 equiv.	%		
Austria	1 149	NO	NO	-	-	-	-1 149	-100%	NA	NA
Belgium	-	-	-	-	-	-	-	-	-	-
Bulgaria	-	-	-	-	-	-	-	-	-	-
Croatia	1 240	NO	NO	-	-	-	-1 240	-100%	NA,T1	D,NA
Cyprus	-	-	-	-	-	-	-	-	-	-
Czech Republic	-	-	-	-	-	-	-	-	NA	NA
Denmark	NO	NO	NO	-	-	-	-	-	NA	NA
Estonia	NO	NO	NO	-	-	-	-	-	NA	NA
Finland	NO	NO	NO	-	-	-	-	-	NA	NA
France	3 567	134	98	23%	-36	-27%	-3 469	-97%	NA	NA
Germany	2 889	87	108	25%	20	23%	-2 781	-96%	CS,NA	CS,NA
Greece	190	58	83	19%	24	42%	-108	-57%	T3	PS
Hungary	376	NO	NO	-	-	-	-376	-100%	T2	D
Ireland	-	-	-	-	-	-	-	-	-	-
Italy	1 975	39	NO	-	-39	-100%	-1 975	-100%	T1	D
Latvia	NO	NO	NO	-	-	-	-	-	NA	NA
Lithuania	NO	NO	NO	-	-	-	-	-	NA	NA
Luxembourg	-	-	-	-	-	-	-	-	NA	NA
Malta	-	-	-	-	-	-	-	-	-	-
Netherlands	2 638	18	11	3%	-7	-39%	-2 627	-100%	NA	NA
Poland	142	NO	NO	-	-	-	-142	-100%	NA,T1c	CS,NA
Portugal	-	-	-	-	-	-	-	-	-	-
Romania	2 455	7	6	1%	-1	-17%	-2 449	-100%	T1,T1b	D
Slovakia	315	26	10	2%	-16	-62%	-305	-97%	T2	PS
Slovenia	208	18	15	4%	-3	-15%	-192	-93%	NA,T3	CS,D,NA
Spain	1 021	45	44	10%	-1	-2%	-976	-96%	NA,T3	NA,PS
Sweden	434	76	49	11%	-27	-35%	-384	-89%	-	-
United Kingdom	1 553	16	7	2%	-9	-58%	-1 546	-100%	CS	CS,PS
EU-28	**20 151**	**524**	**431**	**100%**	**-94**	**-18%**	**-19 720**	**-98%**		

All Member States reduced their emissions from this source between 1990 and 2013. France, Germany, the Netherlands and Romania had the largest decreases in absolute terms. The decreasing trend of PFC emissions from this key source between 1990 and 2013 is due to production stop or decline and due to process improvements.The emission peak in 2002 (see Figure 4.13) can be explained by technological changes and sub-optimal conditions of operation (in France and in the Netherlands).

Figure 4.13 2C3 Aluminium Production: PFC emissions



4.2.4 Electronics Industry (CRF Source Category 2.E)

2.E Electronics Industry comprises emissions which were formerly reported under 2.F.7 Semiconductor Manufacture,

4.2.5 Product uses as substitutes for ODS (CRF Source Category 2F) (EU-28)

This category is similar to the former category 2.F Consumption of Halocarbons and SF_6, except that the former subcategory 2.F.7 Electronics Industry is now reported under 2.E and the former subcategories 2.F.8 Electrical Equipment and 2.F.9 Other sources of SF_6 are now reported under 2.G. Emissions related to the consumption of Halocarbons (HFCs, PFCs) and Sulphur Hexafluoride (SF_6) are reported under this source category. HFCs are predominantly serving as alternatives to ozone depleting substances (ODS) that are being phased out under the Montreal Protocol, and have been introduced to the EU market first at the end of 1990. The main applications of halocarbons include refrigeration and air conditioning, foam blowing, fire protection, aerosols, solvents as well as some other applications. Primary uses of SF_6 include gas insulated switch gear for transportation and distribution of electric power and several other applications. Like SF_6, PFCs had been used already before 1990, especially in semiconductor manufacture.

For 2.F Product uses as substitutes for ODS, Table 4.24 summarizes information by Member States on emission trends of total GHG emissions as well as on HFCs, PFCs and SF_6 individually.

Table 4.24 2F Product uses as substitutes for ODS: Member States' and EU-28 total GHG, HFC, PFC, SF_6, NF_3 and Unspecified Mix of HFC and PFC emissions

Member State	GHG emissions in 1990 (kt CO2 equivalents)	GHG emissions in 2013 (kt CO2 equivalents)	HFC emissions in 1990 (kt CO2 equivalents)	HFC emissions in 2013 (kt CO2 equivalents)	PFC emissions in 1990 (kt CO2 equivalents)	PFC emissions in 2013 (kt CO2 equivalents)	NF3 emissions in 1990 (kt CO2 equivalents)	NF3 emissions in 2013 (kt CO2 equivalents)	SF6 emissions in 1990 (kt CO2 equivalents)	SF6 emissions in 2013 (kt CO2 equivalents)	Unspec. Mix of HFC and PFC emissions in 1990 (kt CO2 equivalents)	Unspec. Mix of HFC and PFC in 2013 (kt CO2 equivalents)
Austria	0	1 672	NO	1 672	NO	NO	-	-	-	-	-	-
Belgium	0	2 529	NO	2 527	NO	2	NO	NO	NO	NO	NO	NO
Bulgaria	0	898	NO	898	NO	0	NO	NO	NO	NO	NO	NO
Croatia	0	578	NO	578	NO	0	NO	NO	NO	NO	NO	NO
Cyprus	0	544	NE,NO	544	-	-	-	-	-	-	-	-
Czech Republic	0	2 673	NO	2 667	NO	6	NO	NO	NO	NO	NO	NO
Denmark	0	789	NO	782	NO	7	-	-	-	-	-	-
Estonia	0	204	NO	204	NO	NO	NO	NO	NO	NO	NO	NO
Finland	0	1 559	0	1 555	NO	4	NO	NO	NO	NO	NO	NO
France	0	19 569	NO	19 569	-	-	-	-	-	-	-	-
Germany	0	10 523	C,NA,NO	10 514	C,NA	9	-	-	-	-	NO	NO
Greece	0	5 734	NO	5 645	NO	90	-	-	-	-	-	-
Hungary	0	1 281	NO	1 279	NO	2	NO	NO	NO	NO	NO	NO
Ireland	0	1 273	NO	1 273	-	-	-	-	-	-	-	-
Italy	0	11 503	NO	11 503	-	-	-	-	-	-	-	-
Latvia	0	107	NO,NE	107	NO	NO	NO,NA	NO,NA	NO,NA	NO,NA	NO	NO
Lithuania	0	314	NO,NA	314	NO,NA	NO	NO,NA	NO	NO,NA	NO	NO	NO
Luxembourg	0	58	0	58	-	-	-	-	-	-	-	-
Malta	0	214	NO,NE,IE	214	NO	NO	-	-	-	-	-	-
Netherlands	0	2 015	IE,NA,NO	2 015	NO	NO	IE	IE	NO	NO	NO	NO
Poland	0	9 621	NO	9 607	NO	15	-	-	-	-	-	-
Portugal	0	1 728	NE,NA	1 728	NE	0	NO	NO	-	-	-	-
Romania	0	1 299	0	1 299	NO	NO	NO	NO	NO	NO	NO	NO
Slovakia	0	535	NO	535	NO	NO	NO	NO	NO	NO	-	-
Slovenia	0	278	NO	278	NO	NO	NO	NO	NO	NO	NO	NO
Spain	42	8 477	42	8 474	NO	3	NO	NA,NO	NO	NA,NO	NO	NO
Sweden	5	854	5	852	NO	2	-	-	-	-	-	-
United Kingdom	161	16 087	161	16 087	NO	NO	NO	NO	NO	NO	NO	NO
EU-28	**208**	**102 917**	**208**	**102 778**	**0**	**139**	**0**	**0**	**0**	**0**	**0**	**0**

Abbreviations explained in the Chapter 'Units and abbreviations'.

HFC emissions from 2.F Product uses as substitutes for ODS account for about 2% of total EU-28 GHG emissions (w/o LULUCF) in 2013. HFC emissions in 2013 were about 500 times higher than in 1990. The main reason for this is the phase-out of ODS such as chlorofluorocarbons (CFCs) under the Montreal Protocol and the replacement of these substances by HFCs (mainly in refrigeration, air conditioning, foam production, fire protection and as aerosol propellants).

Table 4.25 shows the sub-categories of HFC emissions from 2.F Product uses as substitutes for ODS by Member State. It shows that 2.F.1 Refrigeration and Air Conditioning is by far the largest sub-category accounting for 88% of HFC emissions in this source category; 2.F.4 Aerosols/Metered Dose Inhalers and 2.F.3 Fire Extinguishers account for 6% and 2% respectively.

Table 4.25 2F Consumption of Halocarbons and SF_6: Member States' sub-categories of HFC emissions for 2013 (Gg CO_2 equivalents)

Member State	**Product uses as substitutes for ODS**	Refrigeration and air conditioning	Foam blowing agents	Fire protection	Aerosols	Solvents	Other applications
Austria	**1 672**	1 619	17	13	24	NO	-
Belgium	**2 527**	2 371	61	12	83	NO	NO
Bulgaria	**898**	863	20	5	11	-	-
Croatia	**578**	564	NO	4	9	-	-
Cyprus	**544**	537	4	4	-	-	-
Czech Republic	**2 667**	2 607	3	41	12	4	-
Denmark	**782**	704	61	-	18	-	-
Estonia	**204**	195	2	3	3	NO	NO
Finland	**1 555**	1 477	12	C,NA,NO	66	NO	NO
France	**19 569**	16 516	616	166	1 910	121	241
Germany	**10 514**	9 301	597	49	567	C	-
Greece	**5 645**	5 373	191	36	45	-	-
Hungary	**1 279**	1 072	146	7	55	NO	NO
Ireland	**1 273**	1 124	-	35	115	-	-
Italy	**11 503**	10 172	594	225	512	-	-
Latvia	**107**	103	0	0	4	NO	NO
Lithuania	**314**	292	13	2	7	NO	NO
Luxembourg	**58**	55	1	-	2	-	-
Malta	**214**	209	0	2	3	NO	NO
Netherlands	**2 015**	1 805	IE,NA,NO	IE,NO	IE,NO	IE,NO	211
Poland	**9 607**	9 279	141	61	125	0	-
Portugal	**1 728**	1 673	41	7	7	-	-
Romania	**1 299**	1 265	0	4	29	NO	NO
Slovakia	**535**	505	2	19	9	NO	-
Slovenia	**278**	269	2	1	5	-	-
Spain	**8 474**	7 081	112	1 248	33	NO	NO
Sweden	**852**	769	35	17	31	-	-
United Kingdom	**16 087**	13 048	493	268	2 146	22	110
EU-28	**102 778**	**90 847**	**3 164**	**2 230**	**5 828**	**147**	**562**

Abbreviations explained in the Chapter 'Units and abbreviations'.

Table 4.26 to Table 4.29 show the contribution of each MS to EU-28 HFC emissions from the most important sub-sources 2F1, 2F2, 2F3 and 2F4 respectively.

Table 4.26 2F1 Refrigeration and Air conditioning: Member States' contributions to HFC emissions and information on method applied, activity data and emission factor

Member State	HFCs emissions in kt CO2 equiv.				Share in EU28 emissions in 2013	Change 2012-2013		Change 1990-2013		Method applied	Emission factor
	1990	1995	2012	2013		kt CO2 equiv.	%	kt CO2 equiv.	%		
Austria	NO	38	1 603	1 619	2%	16	1%	1 619	100%	NA	NA
Belgium	NO	99	2 349	2 371	3%	22	1%	2 371	100%	NA	NA
Bulgaria	NO	3	713	863	1%	150	21%	863	100%	NO	NO
Croatia	NO	57	557	564	1%	7	1%	564	100%	NA	NA
Cyprus	NO	NO	554	537	1%	-17	-3%	537	100%	NA	NA
Czech Republic	NO	0	2 369	2 607	3%	238	10%	2 607	100%	NA	NA
Denmark	NO	43	707	704	1%	-3	0%	704	100%	NA	NA
Estonia	NO	10	185	195	0%	11	6%	195	100%	NA	NA
Finland	0	24	1 401	1 477	2%	76	5%	1 477	10833183%	T2	D
France	NO	568	15 939	16 516	18%	577	4%	16 516	100%	NA	NA
Germany	NA	572	9 152	9 301	10%	149	2%	9 301	100%	NA	NA
Greece	NO	42	4 807	5 373	6%	566	12%	5 373	100%	IE	IE
Hungary	NO	26	987	1 072	1%	85	9%	1 072	100%	NA	NA
Ireland	NO	12	975	1 124	1%	149	15%	1 124	100%	NA	NA
Italy	NO	265	9 665	10 172	11%	508	5%	10 172	100%	NA	NA
Latvia	NO,NE	0	86	103	0%	17	20%	103	100%	NA	NA
Lithuania	NO	2	265	292	0%	27	10%	292	100%	NA	NA
Luxembourg	0	3	54	55	0%	1	2%	55	76967291%	T2	CS
Malta	NO,IE	0	192	209	0%	17	9%	209	100%	NA	NA
Netherlands	NA,NO	72	1 776	1 805	2%	29	2%	1 805	100%	NA	NA
Poland	NO	80	8 950	9 279	10%	329	4%	9 279	100%	NA	NA
Portugal	NE,NA	13	1 682	1 673	2%	-9	-1%	1 673	100%	NA	NA
Romania	NO	2	1 146	1 265	1%	120	10%	1 265	100%	NA	NA
Slovakia	NO	8	500	505	1%	6	1%	505	100%	NA	NA
Slovenia	NO	5	269	269	0%	0	0%	269	100%	NA	NA
Spain	42	269	7 081	7 081	8%	0	0%	7 039	16848%	NA	NA
Sweden	3	141	802	769	1%	-33	-4%	766	24151%	NA	NA
United Kingdom	NO	850	12 982	13 048	14%	67	1%	13 048	100%	NA	NA
EU-28	**45**	**3 205**	**87 745**	**90 847**	**100%**	**3 102**	**4%**	**90 802**	**201935%**		

Abbreviations explained in the Chapter 'Units and abbreviations'.

In 2013, HFC emissions from 2F1 were about 28 times higher than in 1995 (Figure 4.14). France, Germany, Italy and the UK are responsible for 53% of total EU-28 emissions from this source. Between 2012 and 2013 EU-28 emissions increased by 3.5%. The largest increase of HFC emissions from 2F1 between these years was in Bulgaria (21%). Cyprus, Portugal and Sweden reported in 2013 decreasing emissions compared to the previous year.

Figure 4.14 2F1 Refrigeration and Air conditioning: EU-28 HFC emissions

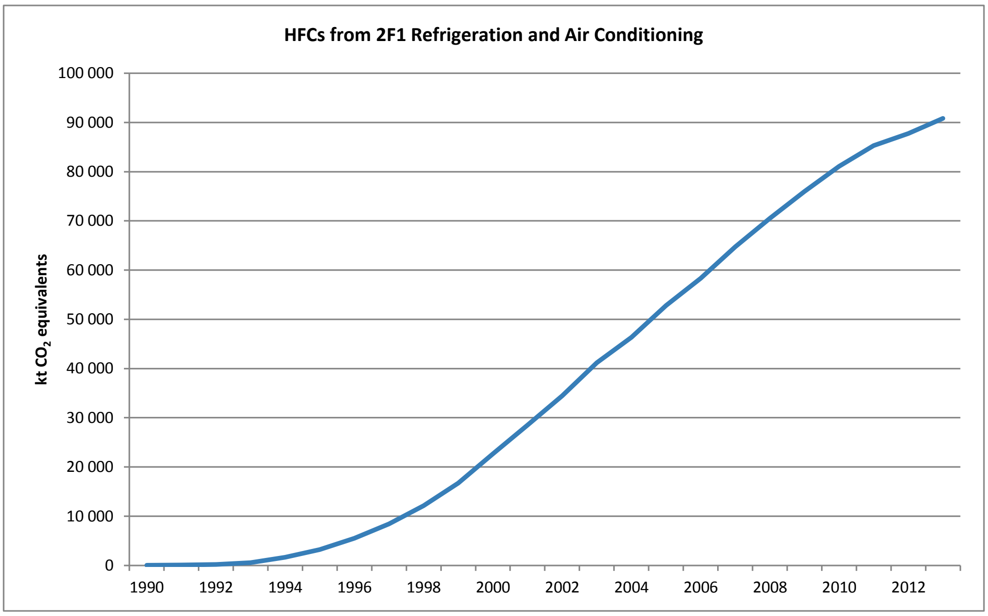


Table 4.27 2F2 Foam Blowing: Member States' contributions to HFC emissions and information on method applied, activity data and emission factor

Member State	HFCs emissions in kt CO2 equiv.				Share in EU28 emissions in 2013	Change 2012-2013		Change 1990-2013		Method applied	Emission factor
	1990	1995	2012	2013		kt CO2 equiv.	%	kt CO2 equiv.	%		
Austria	NO	301	17	17	1%	0	-1%	17	100%	NA	NA
Belgium	NO	357	90	61	2%	-29	-32%	61	100%	NA	NA
Bulgaria	NO	NO	24	20	1%	-4	-18%	20	100%	NO	NO
Croatia	NO	NO	NO	NO	-	-	-	-	-	NA	NA
Cyprus	NO,NE	NO,NE	4	4	0%	0	-1%	4	100%	NA	NA
Czech Republic	NO	0	3	3	0%	0	-5%	3	100%	NA	NA
Denmark	NO	200	73	61	2%	-12	-16%	61	100%	NA	NA
Estonia	NO	18	2	2	0%	0	-10%	2	100%	NA	NA
Finland	NO	1	16	12	0%	-4	-25%	12	100%	NA	NA
France	NO	NO	611	616	19%	5	1%	616	100%	NA	NA
Germany	C,NA	1 666	721	597	19%	-124	-17%	597	100%	NA	NA
Greece	NO	NO	169	191	6%	23	14%	191	100%	NA	NA
Hungary	NO	NO	138	146	5%	8	5%	146	100%	NA	NA
Ireland	-	-	-	-	-	-	-	-	-	NA	NA
Italy	NO	NO	577	594	19%	17	3%	594	100%	NA	NA
Latvia	NO	NO,NE	0	0	0%	0	0%	0	100%	NA	NA
Lithuania	NO	NO	12	13	0%	1	10%	13	100%	NA	NA
Luxembourg	NO	13	1	1	0%	0	8%	1	100%	NA	NA
Malta	NO,NE	NO,NE	0	0	0%	0	7%	0	100%	NA	NA
Netherlands	IE,NA,NO	IE,NA,NO	IE,NA,NO	IE,NA,NO	-	-	-	-	-	NA	NA
Poland	NO	NO	101	141	4%	40	39%	141	100%	NA	NA
Portugal	NE	1	42	41	1%	-1	-2%	41	100%	NA	NA
Romania	NO	NO	16	0	0%	-16	-99%	0	100%	NA	NA
Slovakia	NO	NO	3	2	0%	0	-15%	2	100%	NA	NA
Slovenia	NO	30	2	2	0%	0	-4%	2	100%	NA	NA
Spain	NO	NO	166	112	4%	-54	-32%	112	100%	NA	NA
Sweden	NO	NO	33	35	1%	2	6%	35	100%	NA	NA
United Kingdom	NO	184	489	493	16%	4	1%	493	100%	NA	NA
EU-28	**0**	**2 769**	**3 310**	**3 164**	**100%**	**-145**	**-4%**	**3 164**	**-**		

In 2013, HFC emissions from 2F2 (Table 4.27) decreased by 4% compared to 2012 – and slightly increased by 14% compared to 1995. The biggest contributors to this sector are Germany (19%), France (19%), Italy (19%) and UK (16%), those four countries account for 73% of the share in EU-28 emissions in this sector. France, Greece, Hungary, Italy, Lithuania, Luxembourg, Malta, Poland, Sweden and the UK reported an increase in emissions compared to 2012.

Table 4.28 2F3 Fire extinguishers: Member States' contributions to HFC emissions and information on method applied, activity data and emission factor

Member State	HFCs emissions in kt CO2 equiv.				Share in EU28 emissions in 2013	Change 2012-2013		Change 1990-2013		Method applied	Emission factor
	1990	1995	2012	2013		kt CO2 equiv.	%	kt CO2 equiv.	%		
Austria	NO	NO	13	13	1%	0	0%	13	100%	NA	NA
Belgium	NO	1	12	12	1%	0	4%	12	100%	NA	NA
Bulgaria	NO	NO	5	5	0%	1	13%	5	100%	NA	NA
Croatia	NO	0	4	4	0%	1	17%	4	100%	NA	NA
Cyprus	NO,NE	NO,NE	4	4	0%	0	-1%	4	100%	NA	NA
Czech Republic	NO	NO	37	41	2%	4	10%	41	100%	NA	NA
Denmark	-	-	-	-	-	-	-	-	-	-	-
Estonia	NO	NO	3	3	0%	0	2%	3	100%	NA	NA
Finland	NO	NO	C,NA,NO	C,NA,NO	-	-	-	-	-	NA	NA
France	NO	5	162	166	7%	4	2%	166	100%	NA	NA
Germany	NO	NO	44	49	2%	5	12%	49	100%	NA	NA
Greece	NO	NO	34	36	2%	2	6%	36	100%	NA	NA
Hungary	NO	NO	8	7	0%	-1	-7%	7	100%	NA	NA
Ireland	NO	NO	35	35	2%	0	0%	35	100%	NA	NA
Italy	NO	NO	212	225	10%	14	6%	225	100%	NA	NA
Latvia	NO,NE	NO,NE	0	0	0%	0	15%	0	100%	NA	NA
Lithuania	NO	NO	2	2	0%	0	5%	2	100%	NA	NA
Luxembourg	-	-	-	-	-	-	-	-	-	-	-
Malta	NE	NE	3	2	0%	-1	-21%	2	100%	NA	NA
Netherlands	IE,NO	IE,NO	IE,NO	IE,NO	-	-	-	-	-	NA	NA
Poland	NO	NO	55	61	3%	7	13%	61	100%	NA	NA
Portugal	NE	NO	7	7	0%	0	-2%	7	100%	NA	NA
Romania	NO	NO	4	4	0%	0	5%	4	100%	NA	NA
Slovakia	NO	2	19	19	1%	0	-2%	19	100%	NA	NA
Slovenia	NO	NO	1	1	0%	0	1%	1	100%	NA	NA
Spain	NO	3	1 265	1 248	56%	-17	-1%	1 248	100%	NA	NA
Sweden	NO	NO	16	17	1%	1	4%	17	100%	NA	NA
United Kingdom	NO	1	264	268	12%	3	1%	268	100%	NA	NA
EU-28	**0**	**12**	**2 207**	**2 230**	**100%**	**23**	**1%**	**2 230**	**-**		

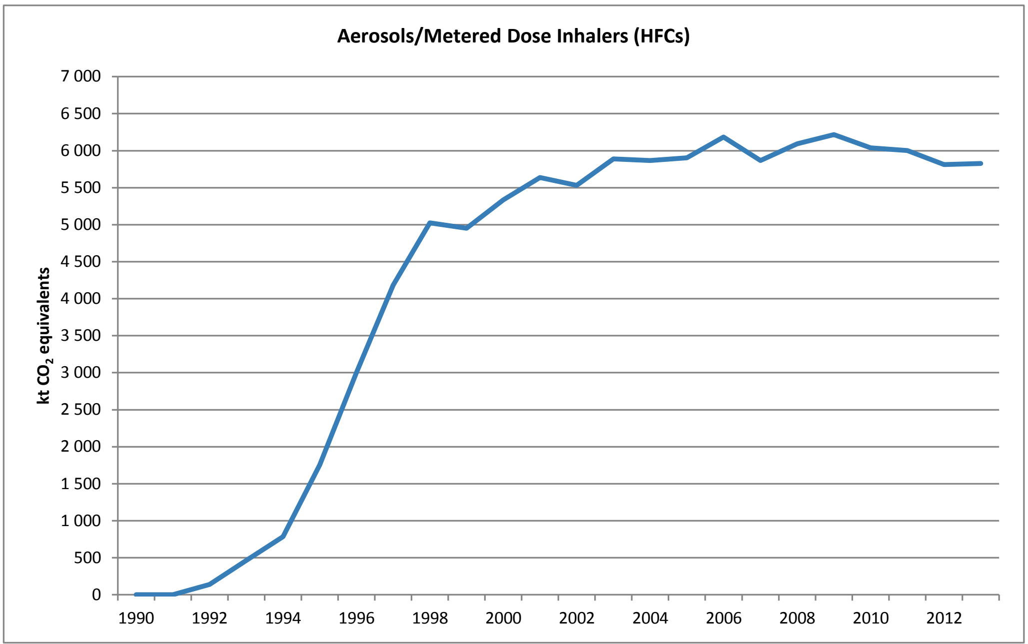
In 2013, HFC emissions from 2F3 (Table 4.28) increased by 1% compared to 2012 – and by 18583% compared to 1995. The biggest contributors to this sector are Spain (56%), UK (12%), and Italy (10%), those three countries account for 78% of the share in EU-28 emissions in this sector. Cyprus, Hungary, Malta, Portugal, Slovakia and Spain reported a decrease in emissions compared to 2012.

Table 4.29 2F4 Aerosols/ Metered Dose Inhalers: Member States' contributions to HFC emissions and information on method applied, activity data and emission factor

Member State	HFCs emissions in kt CO2 equiv.				Share in EU28 emissions in 2013	Change 2012-2013		Change 1990-2013		Method applied	Emission factor
	1990	1995	2012	2013		kt CO2 equiv.	%	kt CO2 equiv.	%		
Austria	NO	9	20	24	0%	3	16%	24	100%	NA	NA
Belgium	NO	41	87	83	1%	-4	-5%	83	100%	NA	NA
Bulgaria	NO	NO	10	11	0%	0	5%	11	100%	NO	NO
Croatia	NO	NO	4	9	0%	5	104%	9	100%	NA	NA
Cyprus	-	-	-	-	-	-	-	-	-	-	-
Czech Republic	NO	NO	17	12	0%	-5	-28%	12	100%	NA	NA
Denmark	NO	NO	17	18	0%	0	1%	18	100%	NA	NA
Estonia	NO	0	3	3	0%	0	5%	3	100%	NA	NA
Finland	NO	2	53	66	1%	13	24%	66	100%	NA	NA
France	NO	610	2 027	1 910	33%	-116	-6%	1 910	100%	NA	NA
Germany	C,NA,NO	342	552	567	10%	14	3%	567	100%	NA	NA
Greece	NO	0	48	45	1%	-4	-8%	45	100%	NA	NA
Hungary	NO	15	51	55	1%	4	7%	55	100%	NA	NA
Ireland	NO	27	123	115	2%	-8	-7%	115	100%	NA	NA
Italy	NO	NO	390	512	9%	122	31%	512	100%	NA	NA
Latvia	NO,NE	NO,NE	3	4	0%	1	38%	4	100%	NO	NO
Lithuania	NO	1	6	7	0%	1	14%	7	100%	NA	NA
Luxembourg	NO	2	2	2	0%	0	-2%	2	100%	NA	NA
Malta	NE,NO	NE,NO	4	3	0%	-1	-26%	3	100%	NA	NA
Netherlands	IE,NO	IE,NO	IE,NO	IE,NO	-	-	-	-	-	NA	NA
Poland	NO	18	126	125	2%	-1	-1%	125	100%	NA	NA
Portugal	NE	17	7	7	0%	0	-2%	7	100%	NA	NA
Romania	0	1	31	29	0%	-2	-7%	29	15959%	NA,T2	D,NA
Slovakia	NO	NO	8	9	0%	0	5%	9	100%	NA	NA
Slovenia	NO	NO	5	5	0%	0	6%	5	100%	NA	NA
Spain	NO	2	33	33	1%	0	-1%	33	100%	NA	NA
Sweden	1	7	30	31	1%	0	1%	29	2050%	NA	NA
United Kingdom	IE,NO	660	2 155	2 146	37%	-9	0%	2 146	100%	NA	NA
EU-28	**2**	**1 754**	**5 814**	**5 828**	**100%**	**14**	**0%**	**5 826**	**361620%**		

In 2013, HFC emissions from 2F4 were 3.3 times higher than in 1995 (Figure 4.15). France and UK are responsible for 68% of total EU-28 emissions from this source. Between 2012 and 2013 EU-28 emissions increased by 2.4%. The relative decrease between these years was largest in Czech Republic; the biggest increase was reported in Croatia (Table 4.29).

Figure 4.15 2F4 Aerosols/Metered Dose Inhalers: EU-28 HFC emissions



4.3 Other product manufacture and use (CRF Source Category 2G) (EU-28)

The former subcategories 2.F.8 Electrical Equipment and 2.F.9 Other sources of SF_6 are now reported under 2.G.Other product manufacture and use.

Table 4.32 shows that all Member States report GHG emissions in 2G Other product manufacture and use for the year 2013. SF_6 emissions from electrical equipment (2.G.1) are reported by Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Portugal, Spain, Sweden, Great Britain, Bulgaria, Cyprus, Czech Republic, Estonia, Croatia, Hungary, Latvia, Lithuania, Malta, Poland, Romania, Slovakia, Slovenia. Other subcategories included in 2.G. comprise soundproof windows (SF_6), Accelerators (SF_6), adiabatic properties: Shoes and tyres (SF_6, PFCs), military applications (SF_6), Unspecified mix of PFCs, Other (SF_6; HFCs).

Table 4.30 2G Other: Overview of sources reported under this source category for 2013

Member State	2.G Other product manufacture and use	HFC emissions [kt CO_2 equivalents]	PFC emissions [kt CO_2 equivalents]	SF_6 emissions [kt CO2 equivalents]	NF_3 emissions [kt CO2 equivalents]	Unspecified mix of HFCs and PFCs [kt CO2 equivalents]	Total emissions [kt CO_2 equivalents]	Share in EU-28 Total
AUT	Electrical equipment (SF6); Soundproof windows (SF6); Other (SF6)		NO	266.11			266.11	4.19%
BEL	Electrical equipment (SF6); Soundproof windows (SF6); Other (C6F14)	NO	0.22	113.44	NO	NO	113.66	1.79%
DNM	Electrical equipment (SF6); Soundproof windows (SF6); Other (SF6)			130.58			130.58	2.06%
FIN	Electrical equipment (SF6)	NO	NO	10.02	NO	NO	10.02	0.16%
FRK	Electrical equipment (SF6); Accelerators (SF6); Other (SF6, Unspecified mix of PFCs)	0.11	478.03	483.01	NA	NO	961.15	15.14%
DEU	Electrical equipment (SF6); Military applications (SF6 => Notation Key C); Accelerators (SF6); Soundproof windows (SF6); Adiabatic properties: shoes and tyres (SF6; C3F8 => Notation Key C); Other (SF6, C10F18)	7.12	C,NA	3107.63			3114.75	49.07%
GRC	Electrical equipment (SF6)		NO	5.15			5.15	0.08%
IRL	Electrical equipment (SF6); Soundproof windows (SF6); Adiabatic properties: shoes and tyres (SF6); Other (SF6)	NO	NO	21.52	NO	NO	21.52	0.34%
ITA	Electrical equipment (SF6); Accelerators (SF6)	NO	NO	372.85	NO	NA	372.85	5.87%
LUX	Electrical equipment (SF6); Soundproof windows (SF6), Other (HFC-43-10mee)	2.56		8.05			10.61	0.17%
NLD	Other (SF6)	NO	NA,NO	132.26	IE	NO	132.26	2.08%
PRT	Electrical equipment (SF6)		NO	55.25	NO		55.25	0.87%
ESP	Electrical equipment (SF6)	NA,NO	NA,NO	212.62	NA,NO	NO	212.62	3.35%
SWE	Electrical equipment (SF6); Soundproof windows (SF6); Adiabatic properties: shoes and tyres (C3F8; SF6)		2.43	40.12			42.55	0.67%
GBE	Electrical equipment (SF6); Military applications (SF6); Accelerators (SF6); Other (CF4, C2F6, C3F8, c-C4F8, SF6)	NO	134.27	455.37	NO	NO	589.64	9.29%
BGR	Electrical equipment (SF6)		NO	19.72			19.72	0.31%
CYP	Electrical equipment (SF6)			0.03			0.03	0.00%
CZE	Electrical equipment (SF6); Soundproof windows (SF6)			16.42			16.42	0.26%
EST	Electrical equipment (SF6); Soundproof windows (SF6)	NO	NO	2.00	NO	NO	2.00	0.03%
HRV	Electrical equipment (SF6)	NO	NO	6.58	NO	NO	6.58	0.10%
HUN	Electrical equipment (SF6)	NO	NO	122.92	NO	NO	122.92	1.94%
LVA	Electrical equipment (SF6), Other (HFC-134a)	1.84	NO,NA	8.50	NO,NA	NO	10.34	0.16%
LTU	Electrical equipment (SF6); Accelerators (SF6)	NO	NO	0.39	NO	NO	0.39	0.01%
MLT	Electrical equipment (SF6), Other (SF6, C3F8)		0.00	2.68			2.68	0.04%
POL	Electrical equipment (SF6)			35.01			35.01	0.55%
ROU	Electrical equipment (SF6)	NO	NO	57.08	NO	NO	57.08	0.90%
SVK	Electrical equipment (SF6)	NO	NO	22.30	NO		22.30	0.35%
SVN	Electrical equipment (SF6)	NO	NO	13.28	NO	NO	13.28	0.21%
EU-28	**TOTAL**	**11.63**	**614.95**	**5 720.91**	**0.00**	**0.00**	**6347.49**	**100.00%**

Abbreviations explained in the Chapter 'Units and abbreviations'.

Table 4.31 summarizes information by Member State on emissions for the key source SF_6 from 2G Other sources of SF_6. The emission trend is mainly driven by the emission trend in Germany.

Figure 4.16 2G Other: EU-28 SF_6 emissions

Table 4.31 2G Other: Member States' contributions to SF_6 emissions

Member State	SF6 emissions in kt CO2 equiv.				Share in EU28 emissions in 2013	Change 2012-2013		Change 1990-2013	
	1990	1995	2012	2013		kt CO2 equiv.	%	kt CO2 equiv.	%
Austria	132	268	268	266	5%	-1	-1%	135	102%
Belgium	88	134	109	113	2%	5	5%	26	30%
Bulgaria	4	5	19	20	0%	0	2%	16	434%
Croatia	10	11	9	7	0%	-3	-29%	-4	-37%
Cyprus	NO,NE	NO,NE	0	0	0%	0	-1%	0	100%
Czech Republic	16	16	25	16	0%	-9	-35%	1	5%
Denmark	14	68	112	131	2%	19	17%	117	847%
Estonia	NO	3	2	2	0%	0	7%	2	100%
Finland	45	27	10	10	0%	0	3%	-35	-78%
France	1 252	1 482	541	483	8%	-58	-11%	-769	-61%
Germany	4 050	6 072	2 987	3 108	54%	121	4%	-942	-23%
Greece	3	3	5	5	0%	0	2%	2	76%
Hungary	11	52	120	123	2%	3	2%	112	1029%
Ireland	33	38	19	22	0%	3	13%	-12	-36%
Italy	294	550	396	373	7%	-23	-6%	79	27%
Latvia	NO,NA,NE	0	8	9	0%	1	9%	9	100%
Lithuania	NO	0	0	0	0%	0	-9%	0	100%
Luxembourg	1	1	8	8	0%	0	5%	7	819%
Malta	0	1	0	3	0%	2	493%	3	25094%
Netherlands	208	274	187	132	2%	-55	-29%	-76	-36%
Poland	NO	13	36	35	1%	-1	-3%	35	100%
Portugal	NE,NO	15	53	55	1%	3	5%	55	100%
Romania	0	1	51	57	1%	6	12%	57	11917%
Slovakia	0	10	21	22	0%	1	5%	22	38112%
Slovenia	10	12	14	13	0%	-1	-7%	3	35%
Spain	64	101	218	213	4%	-6	-3%	149	235%
Sweden	80	93	36	40	1%	5	13%	-40	-50%
United Kingdom	892	877	479	455	8%	-23	-5%	-437	-49%
EU-28	**7 204**	**10 128**	**5 733**	**5 721**	**100%**	**-12**	**0%**	**-1 483**	**-21%**

Abbreviations explained in the Chapter 'Units and abbreviations'.

4.3.1 Other (CRF Source Category 2H)

Table 4.32 shows that eight Member States report GHG emissions under 2H Other for the year 2013. Under this category, Belgium reports CO_2 emissions from the Flemish region, which were included in the inventory to reflect the extended scope of the EU ETS. Bulgaria includes emissions from the domestic use of pharmaceutical products and the production of vegetable oil. Finland reports emissions of fluorinated gases, which were grouped in this category for reasons of confidentiality. Lithuania includes CO_2 emission from carbonates use in flue gas desulphurisation and CO_2 from the pulp and paper as well as food and beverage industry.

The Netherlands report CO_2 emissions from the food and beverage industry. Portugal includes CO_2 from the food and beverage industry and from wood chipboard production. Sweden reports CO_2 emissions from the use of limestone and dolomite in mineral wool production. In addition, CH_4 and N_2O emissions from the combustion of spent cooking liquor from the pulp and paper industry are reported under category 2.H. The UK reports CH_4 emissions from the manufacture of fletton bricks (a type of brick using Lower Oxford Clay).

Table 4.32 2H Other: Overview of sources reported under this source category for 2013

Member State	Type of source	CO2 emissions in 2013 (kt)	N2O emissions in 2013 (kt CO2 equivalents)	CH4 emissions in 2013 (kt CO2 equivalents)	HFC emissions in 2013 (kt CO2 equivalents)	PFC emissions in 2013 (kt CO2 equivalents)	SF6 emissions in 2013 (kt CO2 equivalents)	GHG emissions in 2013 (kt CO2 equivalents)	Share in EU28 emissions in 2013
Austria	NA	NA	NA	NA	-	-	-	-	-
Belgium	2.H.3 Other	172	NO,NA	NO,NA	NO	NO	NO	172	46%
Bulgaria	Domestic Use of Pharmaceutical Products, Vegetable Oil	5	NO,NA,IE	NO,NA,IE	-	-	-	5	1%
Croatia	NA	NA	NA	NA	-	-	-	-	-
Cyprus		-	-	-	-	-	-	-	-
Czech Republic	NO	NO	NO	NO	NO	NO	NO	-	-
Denmark	NA	NA	NA	NA	-	-	-	-	-
Estonia	NO	NO	NO	NO	NO	NO	NO	-	-
Finland	2.H.3 Other	NO	NO	NO	2	3	21	25	7%
France	NA	NA	NA	NA	-	-	-	-	-
Germany	NA	NA	NA	NA	-	-	-	-	-
Greece	NA	NA	NA	NA	-	-	-	-	-
Hungary	NO	NO	NO	NO	NO	NO	NO	-	-
Ireland	NO	NO	NO	NO	NO	NO	NO	-	-
Italy	NO	NO	NO	NO	-	-	-	-	-
Latvia	NO,NA	NO,NA	NO,NA	NO,NA	NA	NA	NA	-	-
Lithuania	2.H.2 Food and beverages industry, Consumption of carbonates in flue gas desulphurisation	12	NO	NO	NO	NO	NO	12	3%
Luxembourg	NO	NO	NO	NO	NO	NO	NO	-	-
Malta		-	-	-	-	-	-	-	-
Netherlands	2.H.2 Food and beverages	27	NO	NO	NO	NO	NO	27	7%
Poland	NO	NO	NO	NO	NO	NO	NO	-	-
Portugal	2.H.2 Food and beverages industry, 2.H.3.a Chipboard	31	NO	NO	-	-	-	31	8%
Romania	NO,NE	NO,NE	NO,NE	NO,NE	NO	NO	NO	-	-
Slovakia	NO,NA	NO	NO,NA	NO,NA	NO	NO	NO	-	-
Slovenia	NA	NA	NA	NA	-	-	-	-	-
Spain	NA	NA	NA	NA	NA	NA	NA	-	-
Sweden	Mineral wool production	11	81	8	-	-	-	99	26%
United Kingdom	Mineral Industry CH4 emissions (fletton bricks)	IE,NE,NO	NO	5	-	-	-	5	1%
EU-28		**257**	**81**	**12**	**2**	**3**	**21**	**376**	**100%**

Abbreviations explained in the Chapter 'Units and abbreviations'.

4.4 Uncertainties

For information on uncertainties please refer to chapter 1.6.

4.5 Sector-specific quality assurance and quality control

There are two main activities for improving the quality of GHG emissions from industrial processes: (1) Before and during the compilation of the EU GHG inventory several checks are made of the Member States data in particular for time series consistency of emissions and implied emission factors, comparisons of implied emission factors across Member States and checks of internal consistency. (2) In the second half of the year the EU internal review is carried out for selected source categories. In 2006 the following source categories were reviewed by Member States experts: 2A Mineral Products, 2B Chemical Industry, 2C Iron and Steel Production and Fluorinated Gases, 2E Production of Halocarbons and SF_6 and 2F Consumption of Halocarbons and SF_6. In 2008, completeness and allocation issues were reviewed by Member States experts for all source categories in Industrial Processes. In 2012 a comprehensive review was carried out for all sectors and all EU Member States in order to fix the base year 2020 under the EU Effort Sharing Decision. (ESD review 2012).

For the inventory 2005 plant-specific data was available from the EU Emission Trading Scheme (EU ETS) for the first time. This information was used by EU Member States for quality checks and as an input for calculating total CO_2 emissions for the sectors Energy and Industrial Processes in the 2005 report (see Section 1.4.2). During the ESD review 2012 consistency checks were carried out between EU ETS data and the inventory estimates.

In 2013 two workshops were organized in the context of the MS assistance project with the aim of supporting Member States in improving their inventories related to the use of EU ETS data and related to F-gases. Both workshops were very well attended.

In 2014, the initial checks for F-gases were extended: (1) the time series of HFC emissions of the EU Member States was checked at 3-digit level (2.F.1, 2.F.2,…) and at 4-digit level for 2.F.1 (i.e. 2.F.1.1, 2.F.1.2,…); (2) time series and comparability across EU Member States was checked for per capita HFC emissions of category 2-F.1 and its subcategories (2.F.1.1, 2.F.1.2, …). As a result of the checks, 74 issues were clarified with EU Member States. Furthermore, in 2014 additional quality checks of the EU NIR chapter waste were carried out in order to improve the consistency between the CRF tables and the EU NIR and consistency of tables and figures with text in the EU NIR.

4.6 Sector-specific recalculations

For information on recalculations please refer to chapter 10.

5 AGRICULTURE (CRF SECTOR 3)

Half the European Union's land is farmed. This fact alone highlights the importance of farming for the EU's natural environment. Farming and nature exercise a profound influence over each other. Farming has contributed over the centuries to creating and maintaining a variety of valuable semi-natural habitats. Today these shape the majority of the EU's landscapes and are home to many of the EU's richest wildlife. Farming also supports a diverse rural community that is not only a fundamental asset of European culture, but also plays an essential role in maintaining the environment in a healthy state[19].

The links between the richness of the natural environment and farming practices are complex. While many valuable habitats in Europe are maintained by extensive farming, and a wide range of wild species rely on this for their survival, agricultural practices can also have an adverse impact on natural resources. Pollution of soil, water and air, fragmentation of habitats and loss of wildlife can be the result of inappropriate agricultural practices and land use.

Agriculture in Europe is determined by the Common Agricultural Policy (CAP) of the European Union. The CAP dates from 1957, and its foundations are entrenched in the Treaty of Rome. Initially, the emphasis of the CAP was to increase agricultural productivity, partly for food security reasons, but also to ensure that the EU had a viable agricultural sector and that consumers had a stable supply of affordable food (Gay et al., 2005). With the MacSharry reform of 1992 several steps were taken by the EU to shift CAP subsidies away from price and market support towards direct support for farmers. This was further pursued with the Agenda 2000 reform, as signified by the shift in focus towards the maintenance and enhancement of the rural environment and the growing recognition of agriculture as a multifunctional activity. In environmental terms, the focus is on * less-favoured areas and areas with environmental restrictions, and * on agricultural production methods designed to protect the environment and to maintain the countryside.

However price support and income payments, together with milk quotas, remained the dominant support measures. The 2003 CAP reform made further progress in the direction initiated by the Agenda 2000 reform, by aiming to make European agriculture more market oriented and giving a stronger focus to environmental protection. With the CAP reform, cross-compliance became an obligatory element of the CAP. Cross-compliance establishes a link between the granting of income support to the farmers and the compliance by the beneficiary with specified requirements of public interest (Oenema, 2008). These are given in

19 http://ec.europa.eu/agriculture/envir/index_en.htm

- "Statutory management requirements" (SMR, (Annex III of Regulation (EC) No 1782/2003) which are set in 19 community legislative acts on environment, food safety, animal health and welfare, as well as
- the obligation to maintaining land in good agricultural and environmental conditions (GAECs) and maintaining permanent pasture at level at 1.5.2004. Definitions of GAEC are specified at national or regional level and should warrant appropriate soil protection, ensure a minimum level of maintenance of soil organic matter and soil structure and avoid the deterioration of habitats.

In 2013, the Council of the EU Agriculture Ministers adopted four Basic Regulations for a reformed CAP following a CAP Health Check[20] in 2008 and a Commission Communication on the CAP towards 2020[21] in 2011. The four legislative texts that regulate the post-2013 CAP are:

- Rural Development: Regulation 1305/2013[22]
- "Horizontal" issues such as funding and controls: Regulation 1306/2013[23]
- Direct payments for farmers: Regulation 1307/2013[24]
- Market measures: Regulation 1308/2013[25]

The Nitrates Directive (Council Directive 91/676/EEC) is the SMR with the largest impact on greenhouse gas emissions from agriculture. The directive aims at reducing and preventing water pollution caused by nitrates from agricultural sources with the goal that nitrate concentrations in groundwater will not exceed 50 mg NO3 L-1 and listing codes of good practice (Annex II A) to be implemented by the farmers on a voluntary basis. Nitrate vulnerable zones must be designated on the basis of monitoring results which indicate that the groundwater and surface waters in these zones are or could be affected by nitrate pollution from agriculture. The action program must contain mandatory measures relating to: (i) periods when application of animal manure and fertilizers is prohibited; (ii) capacity of and facilities for storage of animal manure; and (iii) limits to the amounts of animal manure and fertilizers applied to land.

This has affected emissions in most countries, for example in Belgium, manure Action Plans (based on the Nitrate directive) in Flanders affected NH_3 volatilization from manure application. The first action plan in 1991 regulated the reduced in which manure can be spread and foresees low-emission techniques for the application of manure on land. The MAP2bis in 2000 focuses on the reduction of the manure surplus and manure processing in order to reduce the NH_3 emissions from manure application on land. Other MAP's followed.

In Denmark, the environmental policy has introduced a series of measures to prevent loss of nitrogen from agricultural soils to the aquatic environment. The measures include improvements to the utilisation of nitrogen in manure, a ban on manure application during autumn and winter, increasing area with winter-green fields to catch nitrogen, a maximum number of animals per hectare and maximum nitrogen application rates for agricultural crops. All farmers are obliged to do N-mineral accounting at farm and field level with the N-excretion data from FAS (Faculty of Agricultural Sciences). The N figures also include the quantities of mineral fertilizers bought and sold. Suppliers of

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20 http://ec.europa.eu/agriculture/healthcheck/index_en.htm

21 http://ec.europa.eu/agriculture/cap-post-2013/communication/index_en.htm

22 http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2013:347:0487:0548:en:PDF

23 http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2013:347:0549:0607:en:PDF

24 http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2013:347:0608:0670:en:PDF

25 http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2013:347:0671:0854:en:PDF

mineral fertilizers are required to report all N sales to commercial farmers to the Plant Directorate. An active environmental policy has brought about a decrease in the N-excretion and a decrease of emission per produced animal, because of more efficient feeding. As a result of increasing requirements to reduce the nitrogen loss to the environment, the consumption of nitrogen in synthetic fertilizer has more than halved since 1990.

In the Netherlands, manure and fertilizer policy influences livestock numbers. Especially young cattle, pigs and poultry numbers decreased by the introduction of measures like buying up part of the so-called pig and poultry production rights (ceilings for total animal numbers) by the government and lowering the maximum nutrient application standards for manure and fertilizer. However, greater compliance to standards and requirements for animal welfare and the housing of animals may contribute to increasing emissions (so-called pollution swapping).

Beside the environmentally-targeted directives, also the so-called first pillar of the CAP (dealing with market support in contrast to pillar two covering rural development measures) had a strong impact on the greenhouse gas emissions from agriculture in Europe, namely through the milk quota system, which lead to a strong reduction of animal numbers in the dairy sector to compensate for the increasing animal performance during the last decades.

Other important policies affecting greenhouse gas emissions from agriculture, particularly by addressing the abatement of air pollution through the control of NO_X and NH_3 emissions include, under others,

- the 1999 Gothenburg Protocol under the Convention on Long Range Transboundary Air Pollution (CLRTAP[26]) to 'Abate Acidification, Eutrophication and Ground-level Ozone', which entered into force on 22 June 2006;
- the National Emission Ceilings Directive (NEC - Directive 2001/81/EC[27]), which sets upper limits for each Member State for the total emissions in 2010 of the four pollutants responsible for acidification, eutrophication and ground-level ozone pollution;
- the Integrated Pollution Prevention and Control (IPPC) Directive (Directive 2008/1/EC[28]), which was established in 1996, and aims at minimizing pollution from point sources, i. e., intensive animal production facilities (pig and poultry farms, with > 2 000 fattening pigs; more than750 sows or more than 40,000 head of poultry). These are required under the directive to apply control techniques for preventing NH_3 emissions according to Best Available Technology (BAT).

Structural changes are caused also by the general development of countries. For example, in Finland, the membership in the EU resulted in changes in the economic structure followed by an increase in the average farm size and a decrease in the number of small farms (Pipatti 2001), causing also a decrease in the livestock numbers for most animal types. Swedish agriculture has undergone radical structural changes and rationalizations over the past 50 years. One fifth of the Swedish arable land cultivated in the 1950s is no longer farmed. Closures have mainly affected smallholdings and those remaining are growing larger. In 1999, some 31,000 agricultural holdings were livestock farms, 14,000 were purely crop husbandry farms, and only 5,000 were a combination of the two. Livestock farmers predominately engage in milk production and the main crops grown in Sweden are grain and fodder crops. The decrease of agricultural land area has continued since Sweden joined the European

26 http://www.unece.org/env/lrtap/multi_h1.html

27 http://ec.europa.eu/environment/air/pollutants/ceilings.htm

28 http://ec.europa.eu/environment/air/pollutants/stationary/ippc/summary.htm

Union in 1995 and the acreages of land for hay and silage has increased. Organic farming increased from 3% of the arable land area in 1995 to 17% in 2007.

5.1 Overview of sector

In the year 2013, CH_4, N_2O and CO_2 emissions from source category 3 Agriculture were 50.8%, 78.5%, and 0.24% of total EU28 CH_4, N_2O, and CO_2 emissions, respectively. Total emissions from agriculture were 441 Mt CO_2-eq with contributions from CH_4, N_2O, and CO_2 of 235 Mt CO_2-eq, 197 Mt CO_2-eq and 8.9 Mt CO_2-eq, respectively.

Thus, CH_4, N_2O, and CO_2 contributed with 0.2 %, 5.3 % and 4.4 % on total EU28 GHG emissions. They make 53.3%, 44.7% and 2% of total agricultural emissions.

Figure 5.1 shows the development of total GHG emissions from agriculture from 1990 to 2013 and the considerably decrease in EU28. The decrease was most pronounced for CO_2 with a decrease of 34.8%, followed by CH_4 with a decrease of 24% and CO_2 with a decrease of 20.2%

Figure 5.2 shows that largest reductions occurred in the largest key sources CH_4 from 3.A.1: Cattle and N_2O from 3.D.1: Direct emissions from managed soils. The main reasons for this are decreasing use of fertiliser and manure and declining cattle numbers in most Member States.

Figure 5.1: EU-28 GHG emissions for 1990-2013 from CRF Sector 3: 'Agriculture' in CO_2 equivalents (Mt)

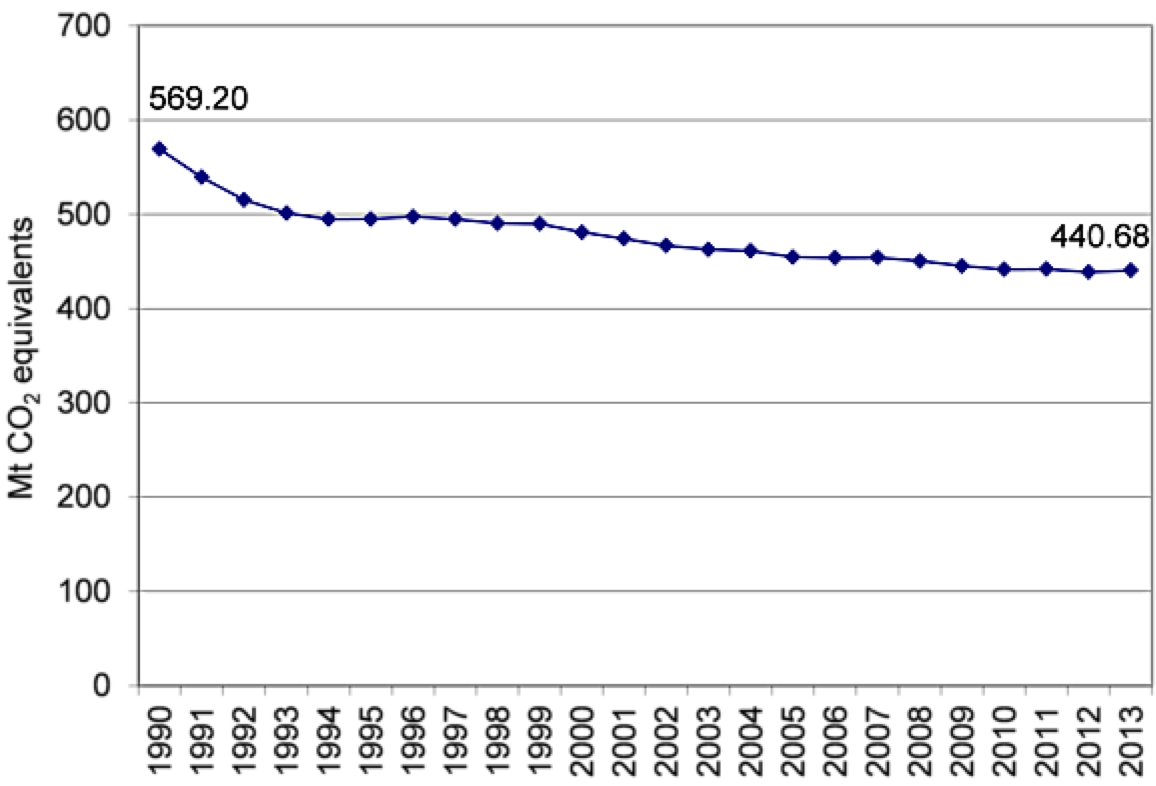
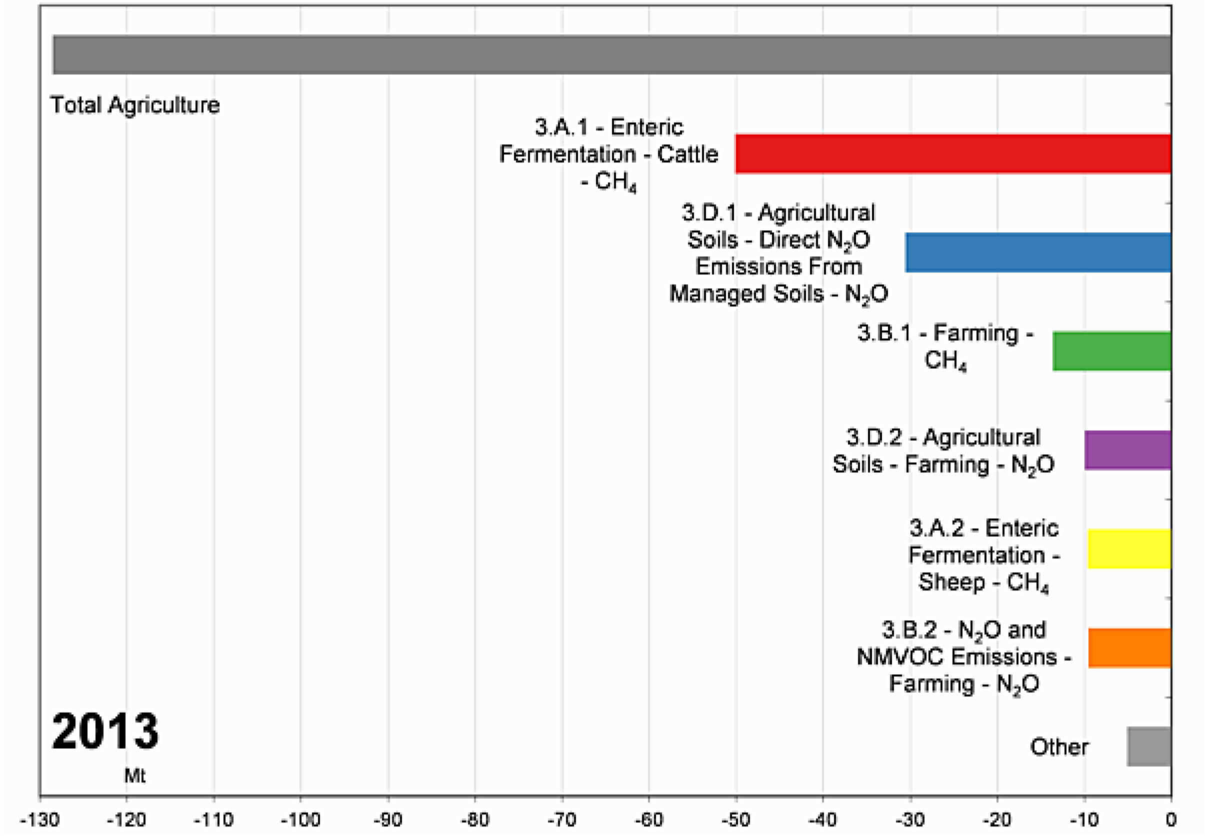
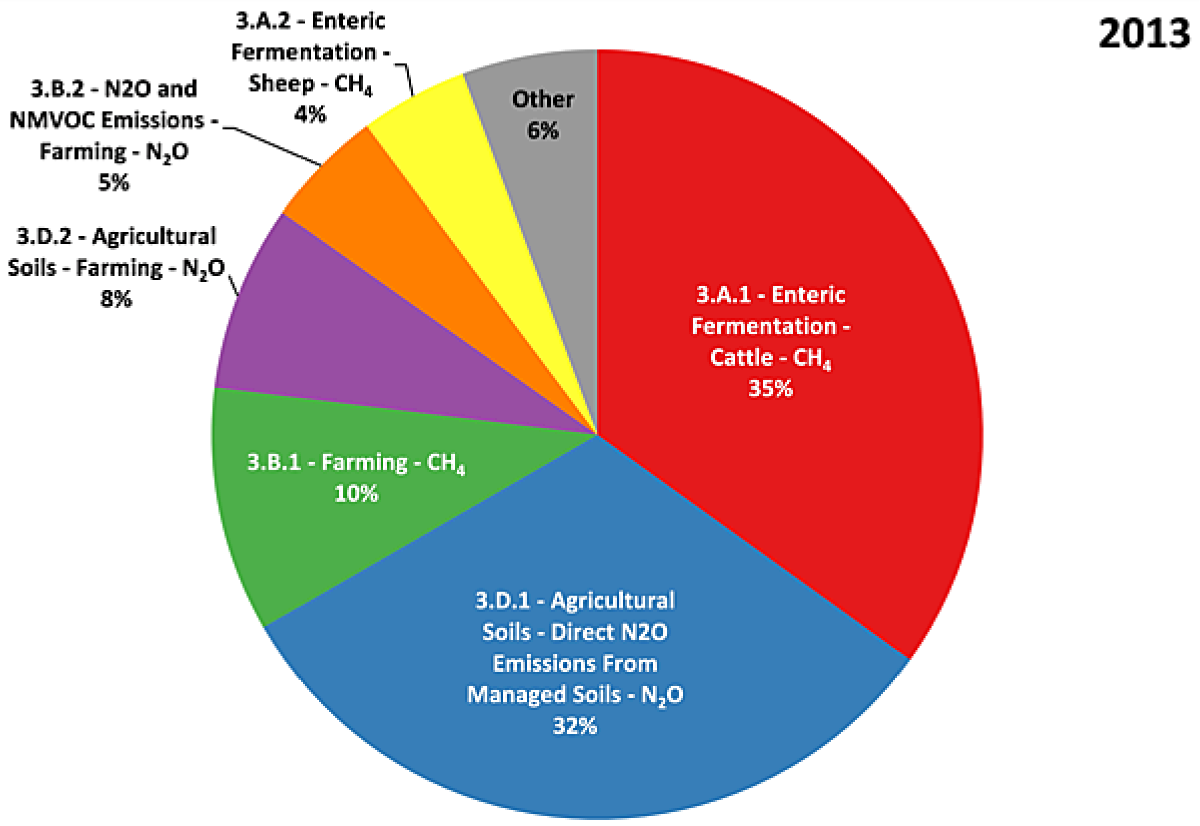


Figure 5.2: Absolute change of GHG emissions by large key source categories 1990-2013 in CO_2 equivalents (Mt) in CRF Sector 3: 'Agriculture' and share of largest key source categories in 2013





5.2 Source categories and methodological issues

In this section we present the information relevant for EU28 key source categories in the sector 3 Agriculture.

Sources categories considered are:

- CH_4 emissions from source category 3A1 - Cattle
- CH_4 emissions from source category 3A2 - Sheep
- CH_4 emissions from source category 3B11 - Cattle
- CH_4 emissions from source category 3B13 - Swine
- N_2O emissions from source category 3B11 - Cattle
- N_2O emissions from source category 3B15 - Indirect emissions
- N_2O emissions from source category 3B14 - Other Livestock (mainly Poultry)
- N_2O emissions from source category 3D11 - Direct N_2O emissions from managed soils from inorganic N fertilizers
- N_2O emissions from source category 3D12 - Direct N_2O emissions from managed soils from organic N fertilizers
- N_2O emissions from source category 3D21 - Indirect Emissions from Managed Soils, Atmospheric Deposition
- N_2O emissions from source category 3D22 - Indirect Emissions from Managed Soils, Nitrogen leaching and run-off

Other source categories are not contributing to a key source analysis at EU28 level and are therefore not further discussed here.

For each of the above-mentioned source categories, data on the countries contributing most to EU28 emissions and to EU28 emissions trend are provided, as well as information on relevant activity data and IEFs and other parameters, if relevant.

Many countries recognize that in the agriculture sector the emissions from the different categories are inherently linked and are best estimated in a comprehensive model that covers not only greenhouse gases (CH_4 and N_2O) in a consistent manner, but also ammonia. Estimations of ammonia emissions are required for reporting under the Convention on Long-Range Transboundary Air Pollution and are needed to estimate indirect N_2O emissions. Hence, some countries have developed comprehensive models covering consistently different source categories and different gases.

- Austria: For the calculation of the losses of gaseous N species the mass-flow procedure pursuant to EMEP/CORINAIR is used. A detailed emission model for NH_3, NMVOC and NO_X has been integrated into the national inventory.
- Germany: Germany uses the emission inventory model GAS-EM (see Figure 6.3) to calculate consistently emissions of CH_4, NH_3, N_2O, and NO from agricultural sources. It is based on IPCC methodologies and has been developed in recent years with a comprehensive description found in Roesemann et al. (2013). Basis of the model is the feed intake which determine emissions in category 3.A and which determines N and C excretion rates relevant for category 3.B and also 3.D. Data are available at district (Landkreis, livestock characterisation, housing systems, manure management systems) and regional (Bundesland) level. N-emissions are considered within an N-flow concept (Daemmgen and Hutchings, 2005). In the N-flow concept, only remaining N in manure is transferred to storage systems, after subtraction of emissions in housing systems. Emissions are subtracted from the total N-pool.
- Denmark: The emissions from the agricultural sector are calculated in a comprehensive agricultural model complex called IDA (Integrated Database model for Agricultural emissions). The model complex is designed in a relational data-base system (MS Access). Input data are stored in tables in one database called IDA_Backend and the calculations are carried out as queries in another linked database called IDA. This model complex is implemented in great detail and is used to cover emissions of NH_3, particulate matter and greenhouse gases. Thus, there is a direct coherence between the NH_3 emission and the emission of N_2O. Finland: Finland uses a nitrogen mass flow model (except for N-fixing, crop residue and sewage sludge) accounts for nitrogen losses as ammonia and nitrous oxide emissions during manure management in animal houses, during storage and application; the calculation method was developed in order to avoid double-counting.

5.2.1 Enteric fermentation (CRF Source Category 3A)

CH_4 emissions from source category 3.A Enteric Fermentation are 4.1% of total EU28 GHG emissions and 40% of total EU28 CH_4 emissions. They make 41.9% of total agricultural emissions. It is thus the largest GHG source in agriculture and the largest source of CH_4 emissions. The main sub-categories are 3.A.1 (Cattle) and 3.A.2 (Sheep) as shown in Figure 5.4. Total GHG and CH_4 emissions by Member States from 3.A Enteric Fermentation are shown in Table 5.2. Between 1990 and 2013, CH_4 emission from Enteric Fermentation decreased by 25% or 61.1 Mt CO_2-eq. The decrease was largest in Croatia in relative terms (66%) and in Germany in absolute terms (29% or 9.9 Mt CO_2-eq). From 2012 to 2013 emissions increased by 0.3%.

Figure 5.4: Share of source category 3.A on total EU28 agricultural emissions (left panel) and decomposition into its sub-categories (right panel). The percentages refer to the emission in the year 2013.

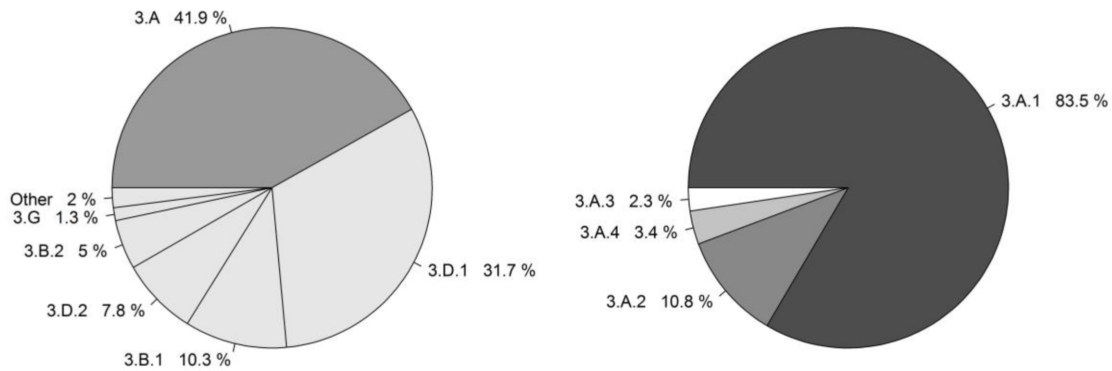


Table 5.2 3.A - Enteric Fermentation: Member States' contributions to total GHG and CH_4 emissions

Member State	GHG emissions in 1990 (kt CO2 equivalents)	GHG emissions in 2013 (kt CO2 equivalents)	CH4 emissions in 1990 (kt CO2 equivalents)	CH4 emissions in 2013 (kt CO2 equivalents)
Austria	4 821	4 103	4 821	4 103
Belgium	5 535	4 589	5 535	4 589
Bulgaria	5 475	1 865	5 475	1 865
Croatia	2 501	840	2 501	840
Cyprus	242	264	242	264
Czech Republic	5 023	2 412	5 023	2 412
Denmark	3 799	3 467	3 799	3 467
Estonia	1 250	555	1 250	555
Finland	2 425	2 063	2 425	2 063
France	36 561	33 189	36 561	33 189
Germany	34 652	24 713	34 652	24 713
Greece	4 017	4 067	4 017	4 067
Hungary	3 579	1 848	3 579	1 848
Ireland	11 357	10 554	11 357	10 554
Italy	15 743	13 849	15 743	13 849
Latvia	2 282	804	2 282	804
Lithuania	4 236	1 544	4 236	1 544
Luxembourg	433	406	433	406
Malta	22	33	22	33
Netherlands	9 227	8 139	9 227	8 139
Poland	21 554	11 712	21 554	11 712
Portugal	3 343	3 338	3 343	3 338
Romania	19 299	9 679	19 299	9 679
Slovakia	2 398	1 047	2 398	1 047
Slovenia	936	889	936	889
Spain	13 238	11 921	13 238	11 921
Sweden	3 629	3 122	3 629	3 122
United Kingdom	27 932	23 416	27 932	23 416
EU-28	**245 509**	**184 426**	**245 509**	**184 426**

Total GHG and CH_4 emissions by Member States from 3.A.1 - Cattle Enteric Fermentation are shown in Table 5.3. Between 1990 and 2013, CH_4 emission from Cattle decreased by 25% or 50.1 Mt CO_2-eq. The decrease was largest in Croatia in relative terms (71%) and in Germany in absolute terms (29% or 9.7 Mt CO_2-eq). From 2012 to 2013 emissions increased by 0.3%.

Table 5.3 3.A.1 - Cattle: Member States' contributions to total GHG and CH_4 emissions

Member State	CH4 emissions in kt CO2 equiv.			Share in EU28 emissions in 2013	Change 2012-2013		Change 1990-2013		Method applied	Emission factor
	1990	2012	2013		kt CO2 equiv.	%	kt CO2 equiv.	%		
Austria	4 579	3 850	3 861	3%	11	0%	-719	-16%	-	-
Belgium	5 234	4 333	4 288	3%	-45	-1%	-946	-18%	T2	CS
Bulgaria	3 519	1 458	1 489	1%	31	2%	-2 030	-58%	T2	CS
Croatia	2 344	739	686	0%	-52	-7%	-1 658	-71%	T2	CS
Cyprus	144	156	153	0%	-2	-2%	9	7%	T1,T2	CS,D
Czech Republic	4 740	2 292	2 290	1%	-1	0%	-2 450	-52%	T2	CS
Denmark	3 422	2 973	3 001	2%	28	1%	-421	-12%	T2	CS,D
Estonia	1 193	496	526	0%	30	6%	-667	-56%	T2	CS,D
Finland	2 226	1 862	1 864	1%	2	0%	-362	-16%	T2	CS
France	33 079	30 364	30 502	20%	138	0%	-2 577	-8%	-	-
Germany	33 252	23 162	23 557	15%	395	2%	-9 696	-29%	T2,T3	CS,D
Greece	1 178	1 239	1 273	1%	35	3%	96	8%	T2	CS,D
Hungary	2 788	1 385	1 430	1%	46	3%	-1 357	-49%	T2	CS
Ireland	10 101	9 589	9 758	6%	169	2%	-343	-3%	CS,T2	CS
Italy	13 167	10 925	10 982	7%	57	1%	-2 185	-17%	T2	CS
Latvia	2 178	738	765	0%	27	4%	-1 413	-65%	T2	CS
Lithuania	4 118	1 506	1 481	1%	-26	-2%	-2 637	-64%	T2	CS
Luxembourg	428	389	398	0%	10	3%	-30	-7%	T2	CS
Malta	14	26	26	0%	-1	-2%	11	77%	T2	D
Netherlands	8 191	6 959	7 229	5%	269	4%	-962	-12%	T2	CS
Poland	19 547	11 474	11 152	7%	-322	-3%	-8 394	-43%	T2	CS
Portugal	2 335	2 745	2 730	2%	-15	-1%	395	17%	T2	CS
Romania	11 019	4 119	4 134	3%	14	0%	-6 886	-62%	T2	CS
Slovakia	2 145	919	919	1%	0	0%	-1 226	-57%	T2	CS
Slovenia	904	857	850	1%	-7	-1%	-54	-6%	T2	CS
Spain	7 173	7 448	7 296	5%	-152	-2%	122	2%	CS,T2	CS,D
Sweden	3 236	2 706	2 713	2%	7	0%	-523	-16%	T2	CS
United Kingdom	21 806	18 853	18 610	12%	-243	-1%	-3 196	-15%	T2	D
EU-28	**204 063**	**153 562**	**153 965**	**100%**	**403**	**0%**	**-50 098**	**-25%**		

Total GHG and CH_4 emissions by Member States from 3.A.2 - Sheep Enteric Fermentation are shown in Table 5.4. Between 1990 and 2013, CH_4 emission from Sheep decreased by 33% or 9.9 Mt CO_2-eq. The decrease was largest in Poland in relative terms (95%) and in Romania in absolute terms (36% or 2.4 Mt CO_2-eq). From 2012 to 2013 emissions increased by 0.4%.

Table 5.4 3.A.2 - Sheep: Member States' contributions to total GHG and CH_4 emissions

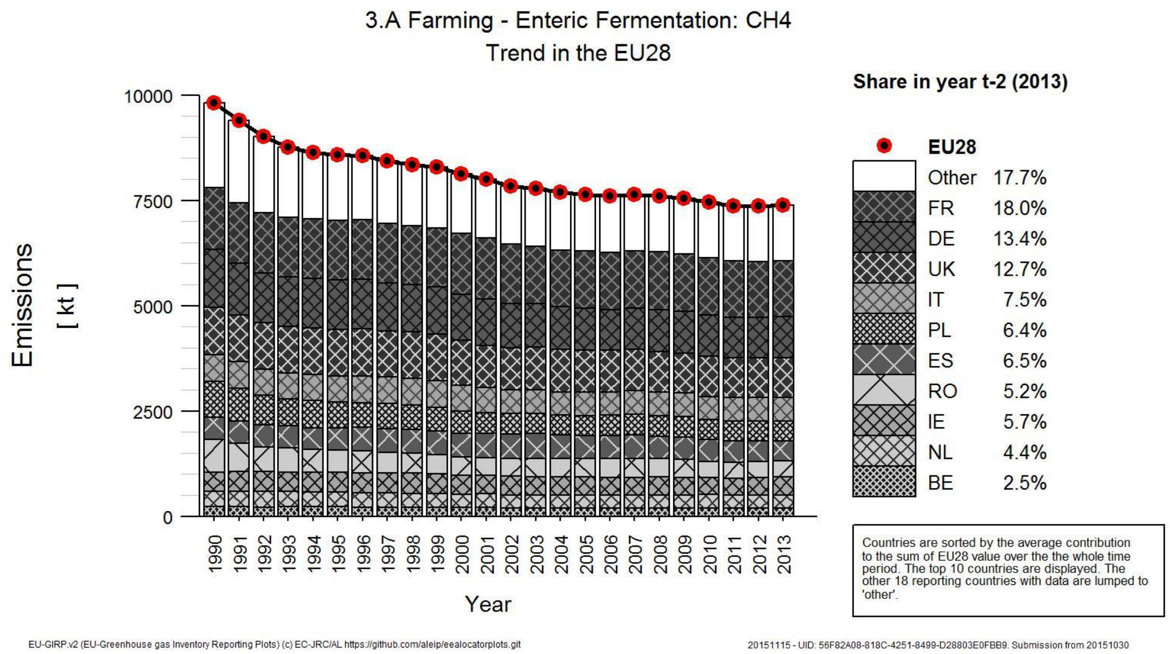
Member State	CH4 emissions in kt CO2 equiv.			Share in EU28 emissions in 2013	Change 2012-2013		Change 1990-2013		Method applied	Emission factor
	1990	2012	2013		kt CO2 equiv.	%	kt CO2 equiv.	%		
Austria	62	73	71	0%	-1	-2%	10	15%	-	-
Belgium	38	21	21	0%	0	0%	-17	-45%	T1	D
Bulgaria	1 569	261	258	1%	-3	-1%	-1 311	-84%	T2	CS
Croatia	94	130	120	1%	-9	-7%	26	28%	T2	CS
Cyprus	58	69	63	0%	-7	-10%	5	8%	T1	D
Czech Republic	86	44	44	0%	0	0%	-42	-49%	T1	D
Denmark	39	38	37	0%	-1	-2%	-1	-4%	T2	D
Estonia	32	18	17	0%	-2	-9%	-15	-48%	D,T1	D
Finland	18	27	28	0%	1	4%	11	62%	CS	CS
France	2 580	1 772	1 717	9%	-55	-3%	-863	-33%	-	-
Germany	506	305	292	1%	-14	-5%	-214	-42%	T1	CS,D
Greece	2 054	2 087	2 086	10%	-1	0%	32	2%	T2	CS,D
Hungary	392	228	242	1%	14	6%	-150	-38%	T1	D
Ireland	1 176	695	696	3%	1	0%	-480	-41%	T1	D
Italy	1 748	1 403	1 436	7%	33	2%	-311	-18%	T1	D
Latvia	33	17	17	0%	0	1%	-16	-48%	T1	D
Lithuania	17	24	29	0%	5	20%	13	76%	T2	CS
Luxembourg	1	1	1	0%	0	5%	0	18%	T2	CS
Malta	0	2	2	0%	0	-7%	2	424%	T1	D
Netherlands	340	209	207	1%	-2	-1%	-134	-39%	T1	D
Poland	832	53	45	0%	-9	-16%	-787	-95%	T1	D
Portugal	737	491	456	2%	-36	-7%	-282	-38%	T2	CS
Romania	6 587	4 071	4 212	21%	141	3%	-2 375	-36%	T2	CS
Slovakia	148	100	96	0%	-4	-4%	-52	-35%	T2	CS
Slovenia	4	17	16	0%	-1	-5%	12	290%	T1	D
Spain	5 082	3 529	3 468	17%	-61	-2%	-1 614	-32%	CS,T2	CS,D
Sweden	81	122	115	1%	-7	-6%	34	42%	-	-
United Kingdom	5 550	4 040	4 134	21%	94	2%	-1 416	-26%	T1	CS,D
EU-28	**29 864**	**19 850**	**19 927**	**100%**	**77**	**0%**	**-9 937**	**-33%**		

Trends in Emissions and Activity Data

3.A - Enteric Fermentation - Emissions

Emissions in source category 3.A - Enteric Fermentation decreased considerably in EU28 by 25% or 61.1 Mt CO_2-eq. Figure 5.5 shows the trend of emissions indicating the countries contributing most to EU28 total. The ten countries with highest emissions together accounted for 82.3% of enteric Fermentation CH_4 emissions. Emissions decreased in 25 countries and increased in three countries. The three countries with the largest decreases were Germany, Poland and Romania with a total absolute decrease of 29.4 Mt CO_2-eq. Emissions increased in Malta, Cyprus and Greece with a total absolute increase of 82 kt CO_2-eq.

Figure 5.5: 3.A: Trend in emissions in the EU28 and the countries contributing most to EU28 values including their share to EU28 emissions in 2013



3.A.1 - Cattle - Emissions

Emissions in source category 3.A.1 - Cattle decreased considerably in EU28 by 25% or 50.1 Mt CO_2-eq. Figure 5.6 shows the trend of emissions indicating the countries contributing most to EU28 total. The ten countries with highest emissions together accounted for 82.8% of cattle CH_4 emissions. Emissions decreased in 23 countries and increased in five countries. The three countries with the largest decreases were Germany, Poland and Romania with a total absolute decrease of 25 Mt CO_2-eq. The three countries with the largest increases were Greece, Spain and Portugal with a total absolute increase of 613 kt CO_2-eq.

3.A.1 - Cattle - Population

The main driver for the decrease was the decrease in animal numbers shown in Figure 5.7[29].

Cattle population decreased strongly in EU28 by 28% or 30.5 mio heads. Figure 5.7 shows the trend of cattle population indicating the countries contributing most to EU28 total. The ten countries with highest population together accounted for 84.7% of Cattle population. Population decreased in 21 countries and increased in six countries. The three countries with the largest decreases were Germany, Poland and Romania with a total absolute decrease of 14.6 mio heads. Largest increases occurred in Portugal and Spain with a total absolute increase of 801 thousand heads.

[29] No population data were reported from the UK

Figure 5.6: 3.A.1: Trend in emissions in the EU28 and the countries contributing most to EU28 values including their share to EU28 emissions in 2013

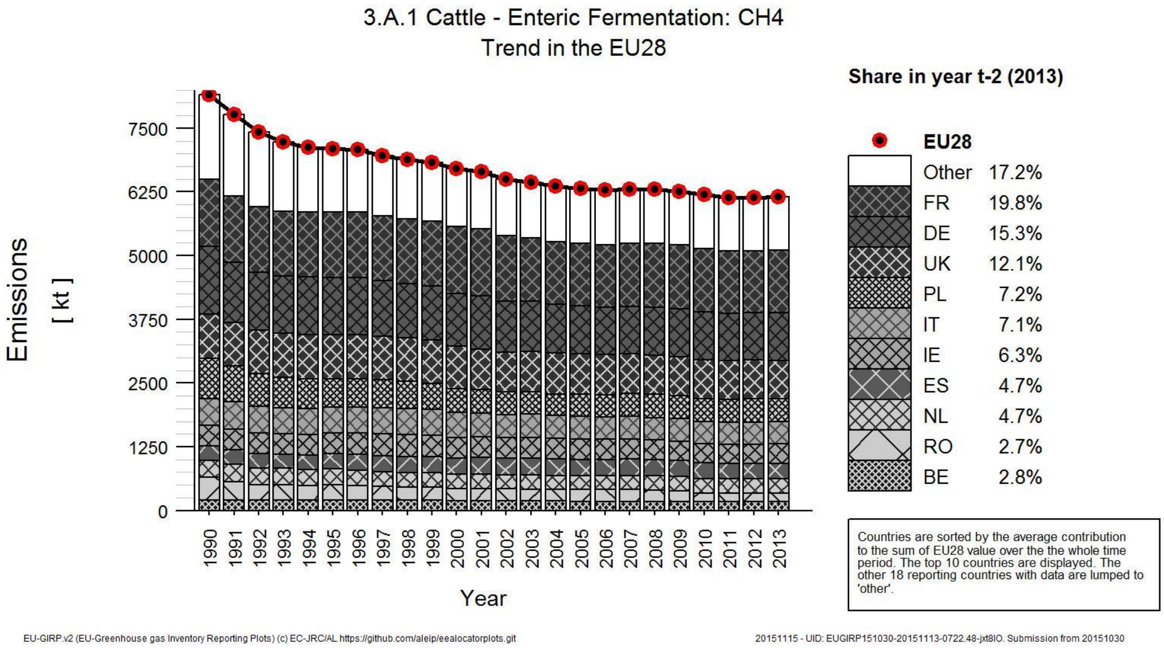
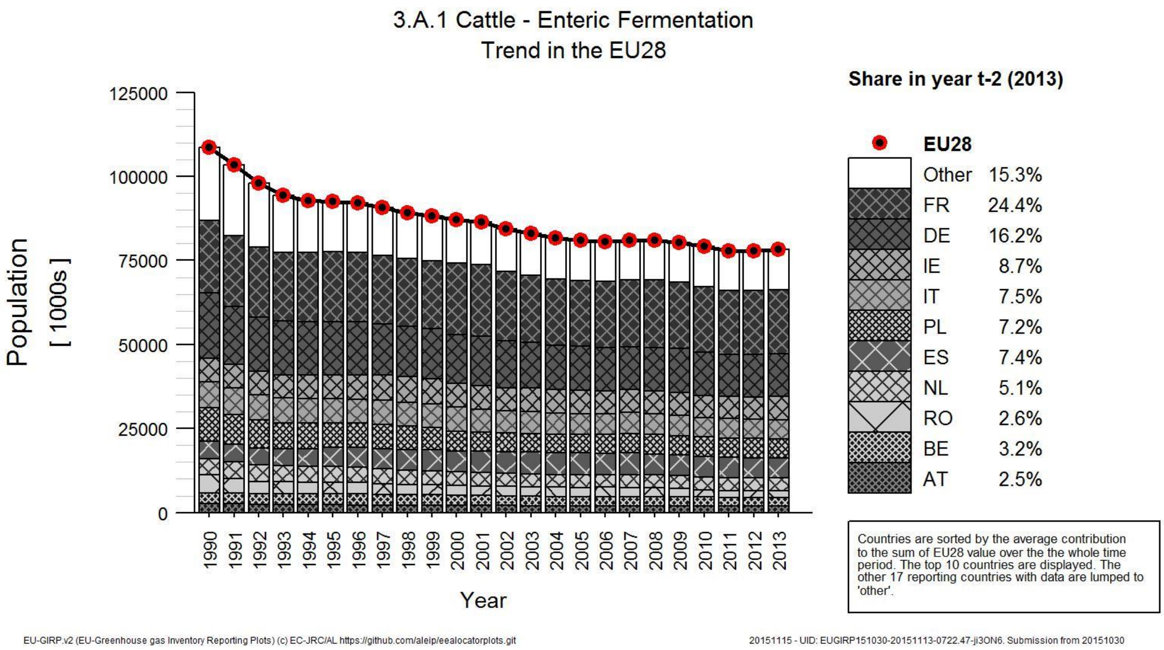


Figure 5.7: 3.A.1: Trend in emissions in the EU28 and the countries contributing most to EU28 values including their share to EU28 emissions in 2013



3.A.2 - Sheep - Emissions

Emissions in source category 3.A.2 - Sheep decreased strongly in EU28 by 33% or 9.9 Mt CO_2-eq. Figure 5.8 shows the trend of emissions indicating the countries contributing most to EU28 total. The ten countries with highest emissions together accounted for 94.1% of sheep CH_4 emissions. Emissions decreased in 18 countries and increased in ten countries. The four countries with the largest decreases were Romania, Spain, United Kingdom and Bulgaria with a total absolute decrease of 6.7 Mt CO_2-eq. The three countries with the largest increases were Croatia, Greece and Sweden with a total absolute increase of 93 kt CO_2-eq.

3.A.2 - Sheep - Population

The main driver for the decrease was the decrease in animal numbers shown in Figure 5.9.

Sheep population decreased strongly in EU28 by 33% or 48.4 mio heads. Figure 5.9 shows the trend of sheep population indicating the countries contributing most to EU28 total. The ten countries with highest population together accounted for 94.1% of Sheep population. Population decreased in 19 countries and increased in nine countries. The four countries with the largest decreases were United Kingdom, Spain, Bulgaria and Romania with a total absolute decrease of 31.5 mio heads. The three countries with the largest increases were Slovenia, Greece and Sweden with a total absolute increase of 377 thousand heads.

Figure 5.8: 3.A.2: Trend in emissions in the EU28 and the countries contributing most to EU28 values including their share to EU28 emissions in 2013

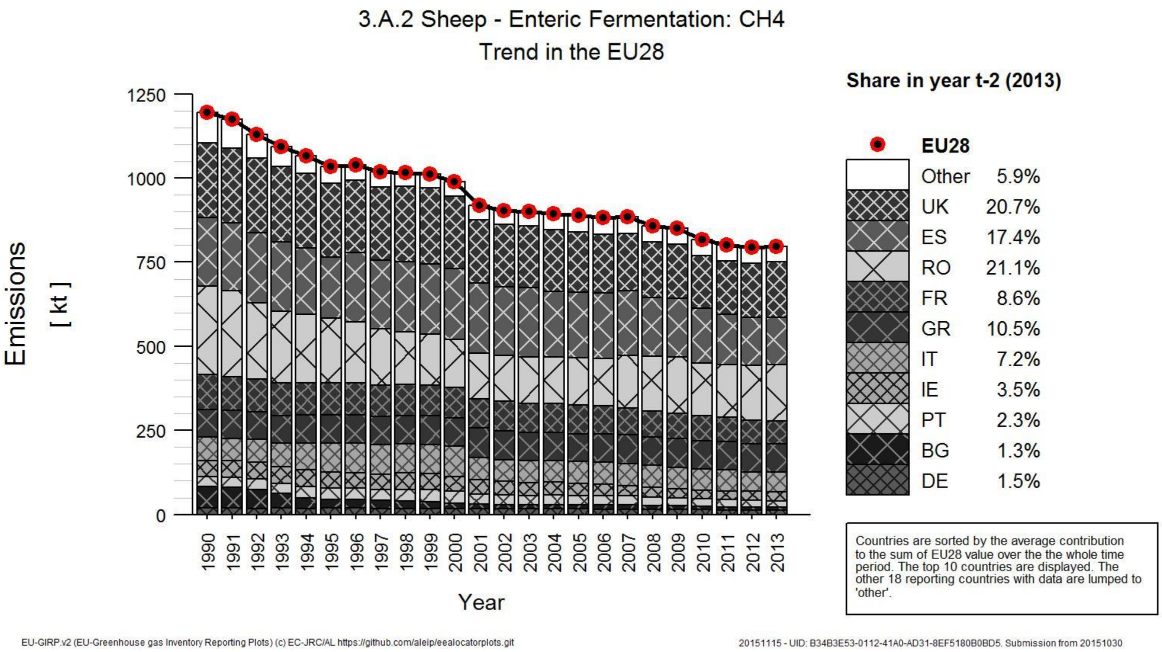
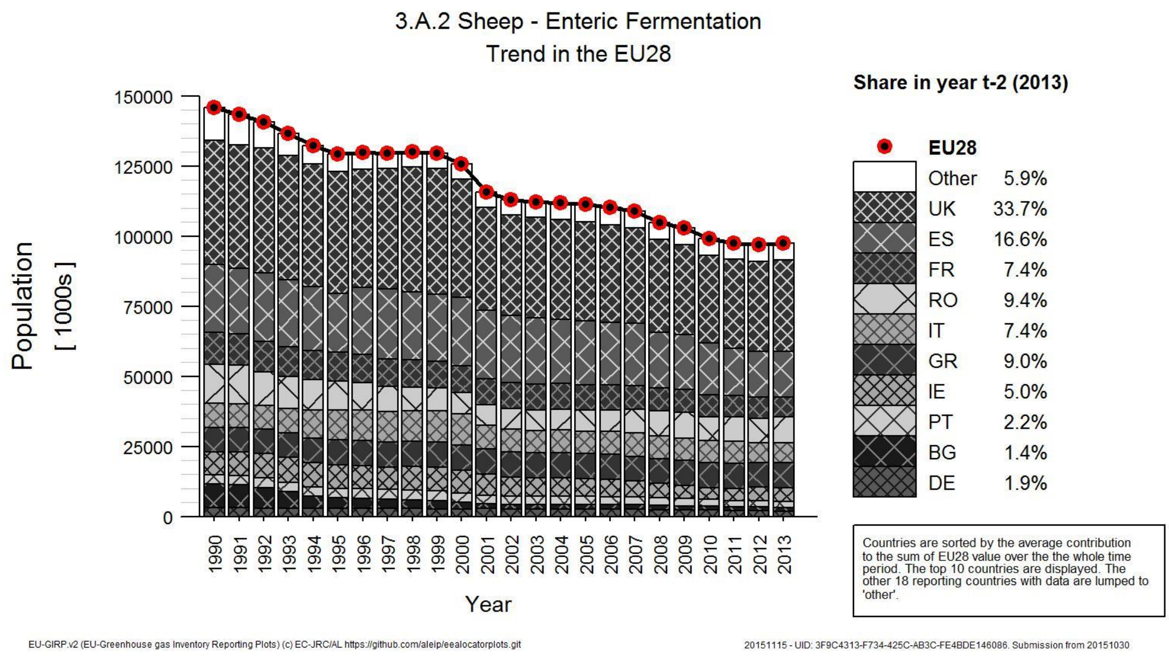


Figure 5.9: 3.A.2: Trend in population in the EU28 and the countries contributing most to EU28 values including their share to EU28 emissions in 2013



Implied EFs and Methodological Issues

Information for cattle, sheep and swine are reported using national classification of the animals. For example, it is possible to report Cattle numbers using one of three options.

- Option A distinguishes 'Dairy Cattle' and 'Non-Dairy Cattle'.
- Option B distinguished 'Mature Dairy Cattle', 'Other Mature Cattle' and 'Growing Cattle'.
- Option C allows for any national classification.

To obtain values that can be aggregated to EU28 level, data reported under Option B and Option C were converted to Option A categories. 'Mature Dairy Cattle' is taken for 'Dairy Cattle' and the other two categories under Option B are used for 'Non-Dairy Cattle'. Also in Option C, dairy cattle can be identified (e.g. 'Dairy Cows', 'Other dairy cattle' etc.) and all other cattle category have been grouped to the animal type 'Non-Dairy Cattle'.

In case data were aggregated, this was done on the basis of a weighted average using population data as weighting factors.

No population data were available for the United Kingdom, and therefore data could not be aggregated or used.

In the cases for 'Sheep' and 'Swine', all animal types reported by countries are aggregated to one single parent category using the same approach.

In this section we discuss the Implied Emission Factor for the main animal types. Furthermore, we present data on the Average Gross Energy Intake and - for Dairy Cattle - also the Milk Yield.

3.A.1 - Cattle - Implied emission factor

The implied emission factor for CH_4 emissions in source category 3.A.1 - Cattle increased in EU28 slightly by 3.2% or 2.17 kg/head/year between 1990 and 2013. Figure 5.10 shows the trend of the IEF in EU28 indicating also the range of values used by the countries. Table 5.5 shows the implied emission factor for CH_4 emissions in source category 3.A.1 - Cattle for the years 1990 and 2013 for all Member States and EU28. The IEF decreased in five countries and increased in 22 countries. The largest decrease occurred in Croatia with an absolute decrease of 50 kg/head/year. The three countries with the largest increases were Slovakia, Estonia and Czech Republic with a mean absolute increase of 18 kg/head/year.

Figure 5.10: 3.A.1 - Cattle: Trend in implied emission factor in the EU28 and range of values reported by countries

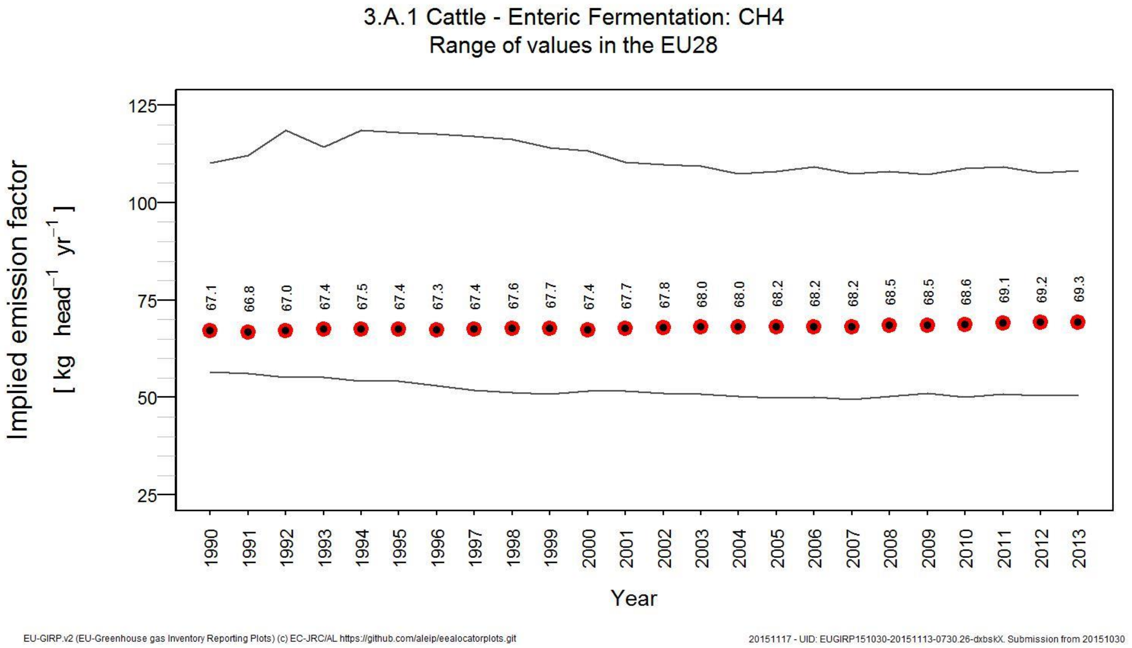


Table 5.5 3.A.1 - Cattle: Member States' and EU28 Implied emission factor (kg/head/year)

Member State	1990	2013	Member State	1990	2013
Austria	71	79	Italy	68	75
Belgium	64	69	Lithuania	71	83
Bulgaria	88	108	Luxembourg	78	82
Cyprus	105	107	Latvia	61	75
Czech Republic	54	68	Malta	56	67
Germany	68	74	Netherlands	67	72
Denmark	61	74	Poland	78	80
Estonia	63	80	Portugal	68	73
Spain	56	51	Romania	83	83
Finland	65	82	Sweden	75	73
France	61	64	Slovenia	68	74
Greece	68	72	Slovakia	55	79
Croatia	110	60	United Kingdom		
Hungary	69	75	**EU28**	**67**	**69**
Ireland	59	57			

3.A.1 - Dairy Cattle - Implied emission factor

The implied emission factor for CH_4 emissions in source category 3.A.1 - Dairy Cattle increased in EU28 considerably by 16.4% or 17.5 kg/head/year between 1990 and 2013. Figure 5.11 shows the trend of the IEF in EU28 indicating also the range of values used by the countries. Table 5.6 shows the implied emission factor for CH_4 emissions in source category 3.A.1 - Dairy Cattle for the years 1990 and 2013 for all Member States and EU28. The IEF decreased in two countries and increased in 24 countries. It was in 2013 at the level of 1990 in one country. No data were available for one country. The largest decrease occurred in Croatia with an absolute decrease of 56 kg/head/year. The four countries with the largest increases were Slovakia, Czech Republic, Estonia and Portugal with a mean absolute increase of 36 kg/head/year.

Figure 5.11: 3.A.1 - Dairy Cattle: Trend in implied emission factor in the EU28 and range of values reported by countries

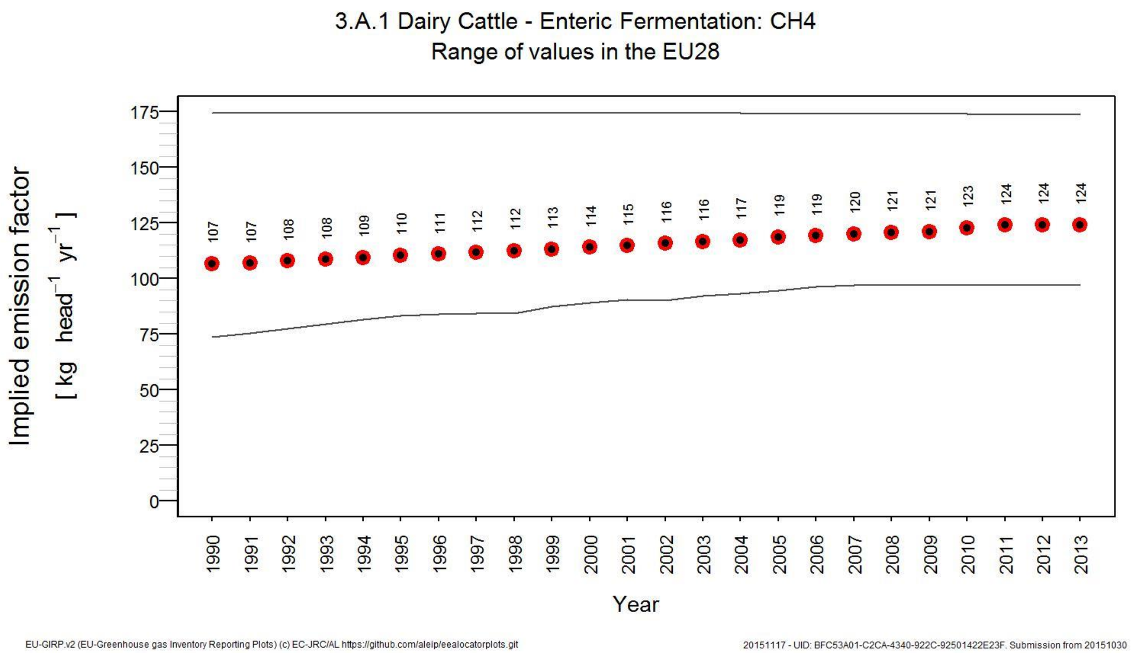


Table 5.6 3.A.1 - Dairy Cattle: Member States' and EU28 Implied emission factor (kg/head/year)

Member State	1990	2013	Member State	1990	2013
Austria	105	129	Italy	111	134
Belgium	114	143	Lithuania	101	120
Bulgaria	148	148	Luxembourg	120	136
Cyprus	174	174	Latvia	99	125
Czech Republic	82	119	Malta	93	118
Germany	120	135	Netherlands	110	128
Denmark	116	136	Poland	108	117
Estonia	102	141	Portugal	97	130
Spain	77	103	Romania	97	97
Finland	112	146	Sweden	120	132
France	99	118	Slovenia	92	119
Greece	93	121	Slovakia	74	108
Croatia	159	104	United Kingdom	0	0
Hungary	106	123	**EU28**	**107**	**124**
Ireland	101	112			

3.A.1 - Dairy Cattle - Average gross energy intake

The average gross energy intake, a parameter used for calculating CH_4 emissions in source category 3.A.1 - Dairy Cattle, increased in EU28 considerably by 20.2% or 50.6 MJ/head/day between 1990 and 2013. Figure 5.12 shows the trend of the Average gross energy intake in EU28 indicating also the range of values used by the countries. Table 5.7 shows the average gross energy intake in source category 3.A.1 - Dairy Cattle for the years 1990 and 2013 for all Member States and EU28. Average gross energy intake decreased in two countries and increased in 25 countries. It was in 2013 at the level of 1990 in one country. Decreases occurred in Croatia and Cyprus with a mean absolute decrease of 39 MJ/head/day. The four countries with the largest increases were Czech Republic, Slovakia, Estonia and Spain with a mean absolute increase of 91 MJ/head/day.

Figure 5.12: 3.A.1 - Dairy Cattle: Trend in average gross energy intake in the EU28 and range of values reported by countries

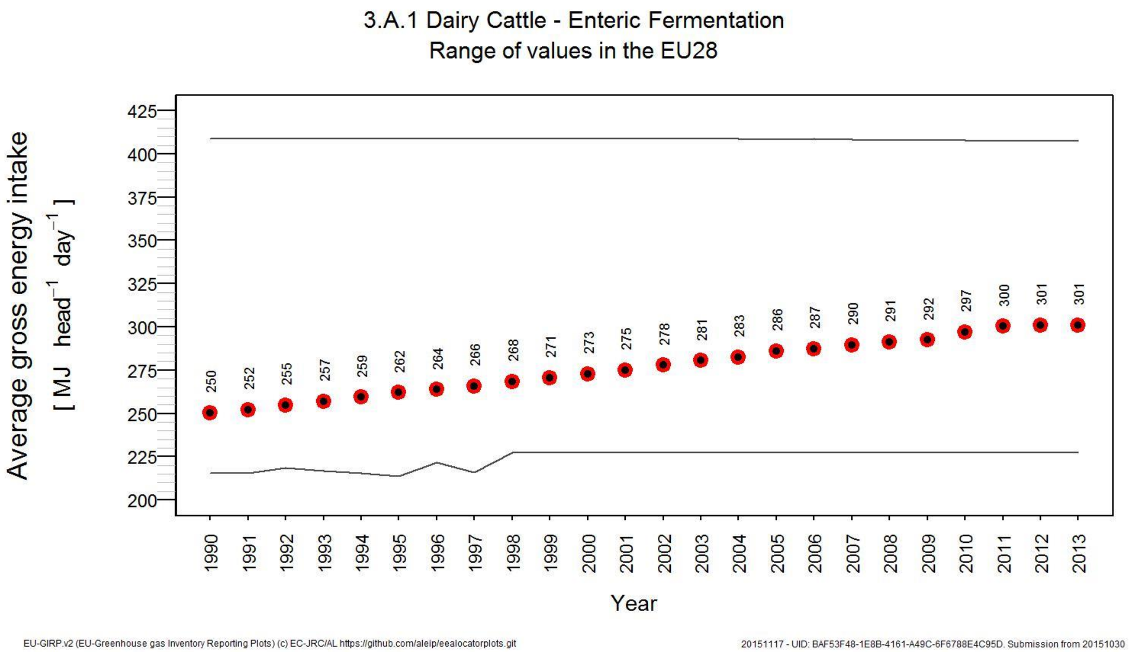


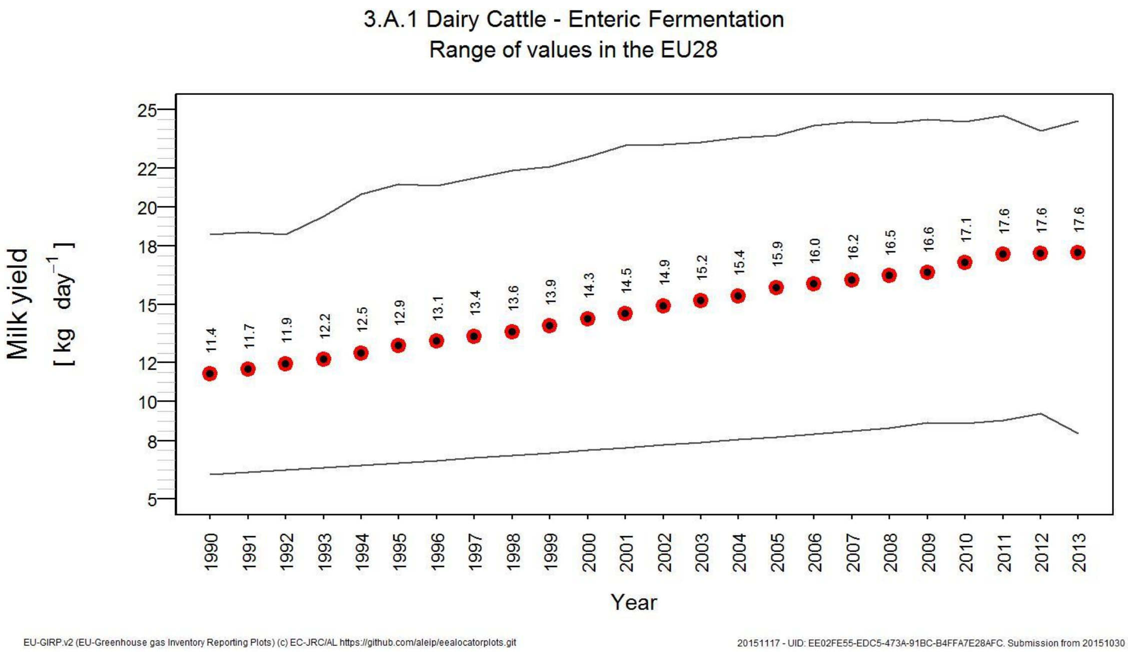
Table 5.7 3.A.1 - Dairy Cattle: Member States' and EU28 Average gross energy intake (MJ/head/day)

Member State	1990	2013		Member State	1990	2013
Austria	247	303	|	Italy	261	315
Belgium	279	350	|	Lithuania	238	281
Bulgaria	321	322	|	Luxembourg	280	318
Cyprus	409	407	|	Latvia	232	293
Czech Republic	209	304	|	Malta	215	276
Germany	260	322	|	Netherlands	280	334
Denmark	278	346	|	Poland	254	275
Estonia	241	332	|	Portugal	227	300
Spain	225	310	|	Romania	227	227
Finland	264	343	|	Sweden	276	326
France	242	293	|	Slovenia	215	280
Greece	217	283	|	Slovakia	211	306
Croatia	324	247	|	United Kingdom	237	296
Hungary	255	299	|	**EU28**	**250**	**301**
Ireland	222	247	|			

3.A.1 - Dairy Cattle - Milk yield

The milk yield, a parameter used for calculating CH_4 emissions in source category 3.A.1 - Dairy Cattle, increased in EU28 very strongly by 54.2% or 6.19 kg/head/day between 1990 and 2013. Figure 5.13 shows the trend of the Milk yield in EU28 indicating also the range of values used by the countries. Table 5.8 shows the milk yield in source category 3.A.1 - Dairy Cattle for the years 1990 and 2013 for all Member States and EU28. Milk yield decreased in one country and increased in 24 countries. It was in 2013 at the level of 1990 in one country. No data were available for one country. Decreases occurred in Bulgaria with an absolute decrease of 0.014 kg/head/day. The four countries with the largest increases were Slovakia, Spain, Greece and Slovenia with a mean absolute increase of 9 kg/head/day.

Figure 5.13: 3.A.1 - Dairy Cattle: Trend in milk yield in the EU28 and range of values reported by countries[30]



30 Note that data from Luxembourg are not included in the plot as they are reported in a different unit.

Table 5.8 3.A.1 - Dairy Cattle: Member States' and EU28 Milk yield (kg/head/day)

Member State	1990	2013	Member State	1990	2013
Austria	10.4	17.7	Ireland	11.5	14.4
Belgium	11.2	20.6	Italy	11.5	17.4
Bulgaria	11.9	11.9	Lithuania	10.2	14.6
Cyprus	12.2	17.0	Luxembourg		
Czech Republic	10.7	20.4	Latvia	9.4	15.1
Germany	12.9	20.1	Malta	12.1	18.1
Denmark	16.5	23.7	Poland	8.9	14.0
Estonia	11.4	21.9	Portugal	12.2	21.9
Spain	9.9	21.4	Romania	10.0	10.0
Finland	15.7	22.5	Sweden	18.6	24.4
France	13.1	18.1	Slovenia	7.6	14.9
Greece	7.6	15.5	Slovakia	6.3	16.1
Croatia	6.3	8.4	United Kingdom	14.1	20.6
Hungary	13.8	19.5	**EU28**	**11.4**	**17.6**

3.A.1 - Non-Dairy Cattle - Implied emission factor

The implied emission factor for CH_4 emissions in source category 3.A.1 - Non-Dairy Cattle increased in EU28 slightly by 2.9% or 1.36 kg/head/year between 1990 and 2013. Figure 5.14 shows the trend of the IEF in EU28 indicating also the range of values used by the countries. Table 5.9 shows the implied emission factor for CH_4 emissions in source category 3.A.1 - Non-Dairy Cattle for the years 1990 and 2013 for all Member States and EU28. The IEF decreased in five countries and increased in 22 countries. No data were available for one country. The largest decrease occurred in Croatia with an absolute decrease of 13 kg/head/year. The largest increases occurred in Finland and Slovakia with a mean absolute increase of 13 kg/head/year.

Figure 5.14: 3.A.1 - Non-Dairy Cattle: Trend in implied emission factor in the EU28 and range of values reported by countries

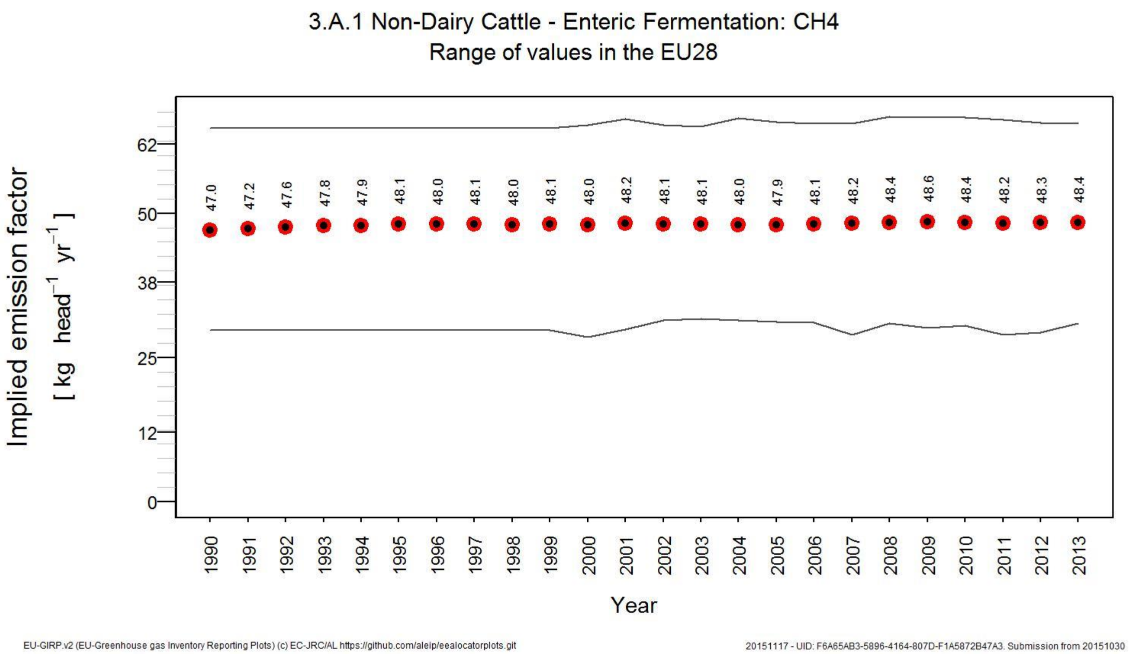


Table 5.9 3.A.1 - Non-Dairy Cattle: Member States' and EU28 Implied emission factor (kg/head/year)

Member State	1990	2013	Member State	1990	2013
Austria	52	60	Italy	46	48
Belgium	47	52	Lithuania	54	54
Bulgaria	51	62	Luxembourg	63	65
Cyprus	57	57	Latvia	38	41
Czech Republic	39	48	Malta	30	31
Germany	43	44	Netherlands	40	37
Denmark	33	39	Poland	49	51
Estonia	40	44	Portugal	56	62
Spain	47	42	Romania	65	64
Finland	39	53	Sweden	53	55
France	49	51	Slovenia	50	60
Greece	57	61	Slovakia	45	56
Croatia	44	31	United Kingdom	0	0
Hungary	49	51	**EU28**	**47**	**48**
Ireland	49	46			

3.A.1 - Non-Dairy Cattle - Average gross energy intake

The average gross energy intake, a parameter used for calculating CH_4 emissions in source category 3.A.1 - Non-Dairy Cattle, increased in EU28 slightly by 3.5% or 4.15 MJ/head/day between 1990 and 2013. Figure 5.15 shows the trend of the Average gross energy intake in EU28 indicating also the range of values used by the countries. Table 5.10 shows the average gross energy intake in source category 3.A.1 - Non-Dairy Cattle for the years 1990 and 2013 for all Member States and EU28. Average gross energy intake decreased in four countries and increased in nineteen countries. It was in 2013 at the level of 1990 in two countries. No data were available for three countries. The three countries with the largest decreases were Croatia, Netherlands and Ireland with a mean absolute decrease of 7 MJ/head/day. The largest increase occurred in Finland with an absolute increase of 32 MJ/head/day.

Figure 5.15: 3.A.1 - Non-Dairy Cattle: Trend in average gross energy intake in the EU28 and range of values reported by countries

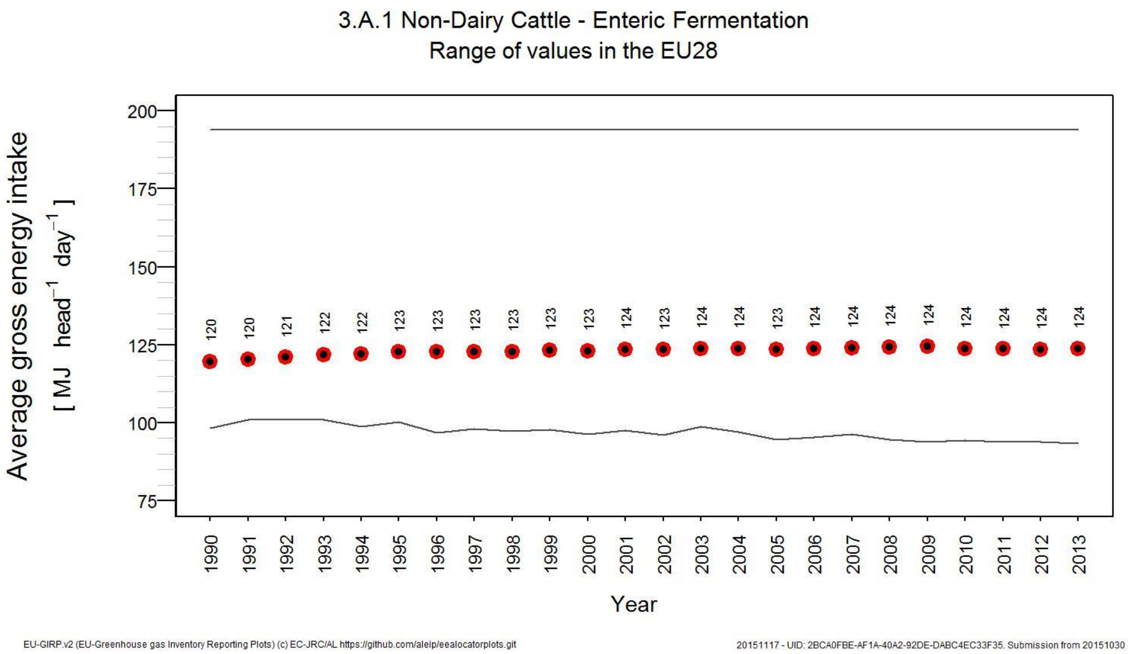


Table 5.10 3.A.1 - Non-Dairy Cattle: Member States' and EU28 Average gross energy intake (MJ/head/day)

Member State	1990	2013		Member State	1990	2013
Austria	123	141	|	Ireland	132	126
Belgium	119	132	|	Italy	141	142
Bulgaria	115	138	|	Lithuania	127	127
Czech Republic	100	123	|	Luxembourg	146	153
Germany	103	104	|	Latvia	101	107
Denmark	107	130	|	Netherlands	98	93
Estonia	105	107	|	Poland	114	119
Spain	124	123	|	Portugal	139	153
Finland	92	124	|	Romania	194	194
France	116	120	|	Sweden	181	181
Greece	134	142	|	Slovenia	111	132
Croatia	112	101	|	Slovakia	122	145
Hungary	134	138	|	**EU28**	**120**	**124**

3.A.2 - Sheep - Implied emission factor

The implied emission factor for CH_4 emissions in source category 3.A.2 - Sheep decreased in EU28 barely by 0.099% or 0.0081 kg/head/year between 1990 and 2013. Figure 5.16 shows the trend of the IEF in EU28 indicating also the range of values used by the countries. Table 5.11 shows the implied emission factor for CH_4 emissions in source category 3.A.2 - Sheep for the years 1990 and 2013 for all Member States and EU28. The IEF decreased in nine countries and increased in nine countries. It was in 2013 at the level of 1990 in ten countries. The three countries with the largest decreases were Portugal, Ireland and Slovakia with a mean absolute decrease of 0.3 kg/head/year. The largest increase occurred in Croatia with an absolute increase of 3 kg/head/year.

Figure 5.16: 3.A.2 - Sheep: Trend in implied emission factor in the EU28 and range of values reported by countries

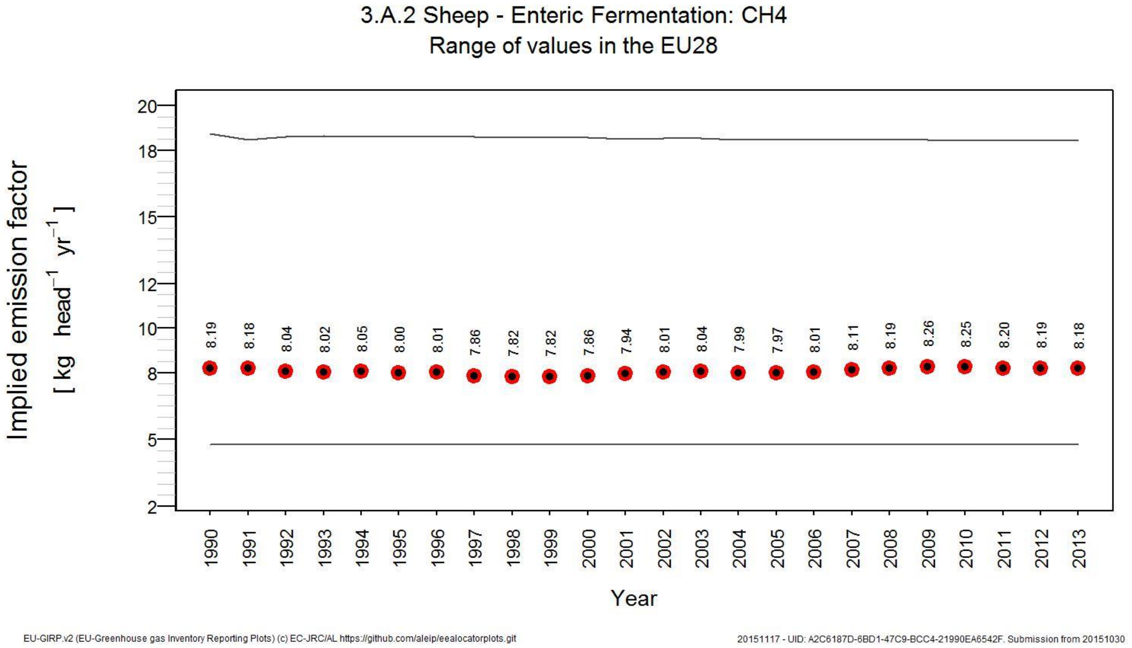


Table 5.11 3.A.2 - Sheep: Member States' and EU28 Implied emission factor (kg/head/year)

Member State	1990	2013		Member State	1990	2013
Austria	8.0	8.0	|	Italy	8.0	8.0
Belgium	8.0	8.0	|	Lithuania	11.8	11.8
Bulgaria	7.5	7.6	|	Luxembourg	4.8	4.8
Cyprus	8.0	8.0	|	Latvia	8.0	8.0
Czech Republic	8.0	8.0	|	Malta	8.0	8.0
Germany	6.2	6.2	|	Netherlands	8.0	8.0
Denmark	6.7	6.7	|	Poland	8.0	8.0
Estonia	8.0	8.0	|	Portugal	9.0	8.6
Spain	8.5	8.6	|	Romania	18.7	18.4
Finland	6.8	8.4	|	Sweden	8.0	8.0
France	9.1	9.5	|	Slovenia	8.0	8.0
Greece	9.5	9.5	|	Slovakia	9.9	9.6
Croatia	5.0	7.8	|	United Kingdom	5.0	5.0
Hungary	8.0	8.0	|	**EU28**	**8.2**	**8.2**
Ireland	5.9	5.7	|			

3.A.2 - Sheep - Average gross energy intake

The average gross energy intake, a parameter used for calculating CH_4 emissions in source category 3.A.2 - Sheep, increased in EU28 slightly by 2.6% or 0.66 MJ/head/day between 1990 and 2013. Figure 5.17 shows the trend of the Average gross energy intake in EU28 indicating also the range of values used by the countries. Table 5.12 shows the average gross energy intake in source category 3.A.2 - Sheep for the years 1990 and 2013 for all Member States and EU28. Average gross energy intake decreased in three countries and increased in two countries. It was in 2013 at the level of 1990 in six countries. No data were available for seventeen countries. Decreases occurred in Portugal, Greece and Ireland with a mean absolute decrease of 0.3 MJ/head/day. Increases in Spain and Bulgaria with a mean absolute increase of 0.2 MJ/head/day.

Figure 5.17: 3.A.2 - Sheep: Trend in average gross energy intake in the EU28 and range of values reported by countries

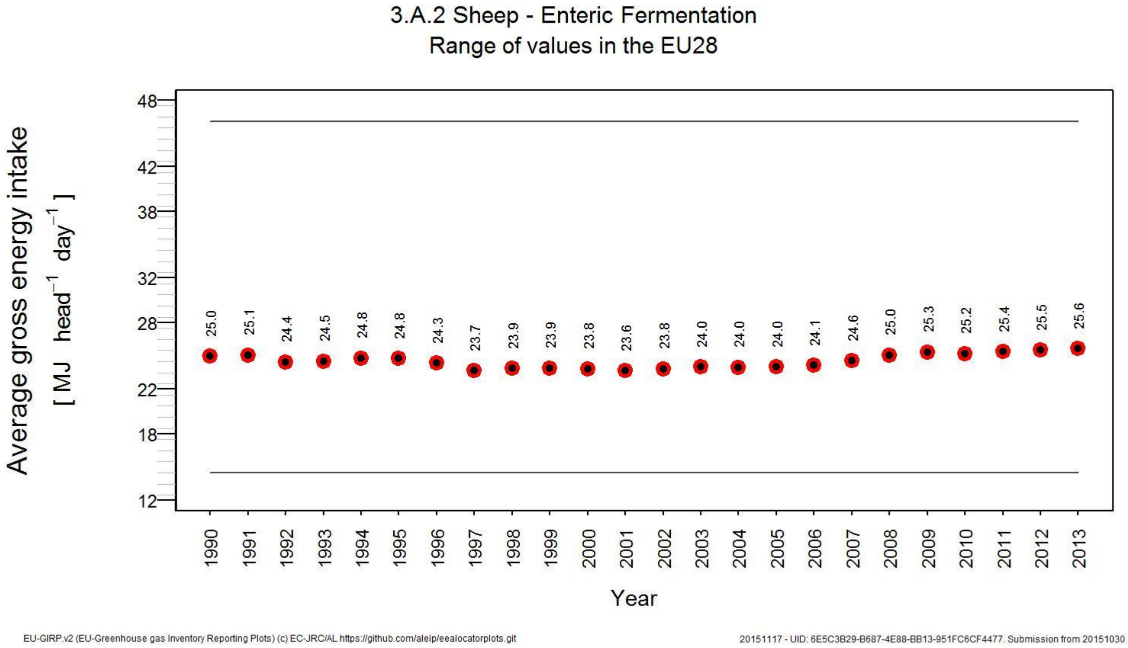


Table 5.12 3.A.2 - Sheep: Member States' and EU28 Average gross energy intake (MJ/head/day)

Member State	1990	2013		Member State	1990	2013
Bulgaria	17	17	|	Lithuania	29	29
Germany	20	20	|	Luxembourg	14	14
Denmark	20	20	|	Portugal	22	21
Spain	19	19	|	Romania	46	46
Greece	23	23	|	Sweden	20	20
Ireland	20	20	|	**EU28**	**25**	**26**

Manure Management - CH_4 (CRF Source Category 3B1)

CH_4 emissions from source category 3.B.1 Manure Management are 1% of total EU28 GHG emissions and 9.8% of total EU28 CH_4 emissions. They make 10.3% of total agricultural emissions. The main sub-categories are 3.B.1.1 (Cattle) and 3.B.1.3 (Swine) as shown in Figure 5.18. Total GHG and CH_4 emissions by Member States from 3.B.1 Manure Management are shown in Table 5.13. Between 1990 and 2013, CH_4 emission from Manure Management decreased by 23% or 13.6 Mt CO_2-eq. The decrease was largest in Bulgaria in relative terms (87%) and also in absolute terms (87% or 3.4 Mt CO_2-eq). From 2012 to 2013 emissions decreased by 1.9%.

Figure 5.18: Share of source category 3.B.1 on total EU28 agricultural emissions (left panel) and decomposition into its sub-categories (right panel). The percentages refer to the emission in the year 2013.

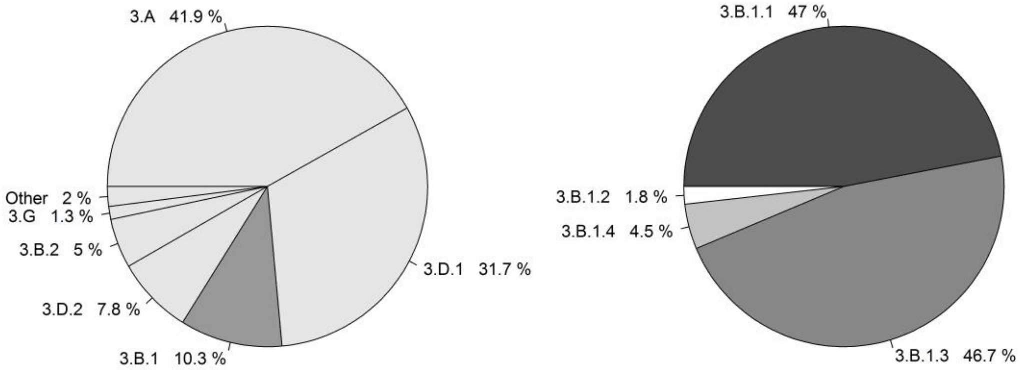


Table 5.13 3.B.1 - Manure Management: Member States' contributions to total GHG and CH_4 emissions

Member State	GHG emissions in 1990 (kt CO2 equivalents)	GHG emissions in 2013 (kt CO2 equivalents)	N2O emissions in 1990 (kt CO2 equivalents)	N2O emissions in 2013 (kt CO2 equivalents)	CH4 emissions in 1990 (kt CO2 equivalents)	CH4 emissions in 2013 (kt CO2 equivalents)
Austria	991	842	453	445	537	397
Belgium	2 827	2 598	979	730	1 849	1 868
Bulgaria	4 751	870	883	358	3 868	511
Croatia	677	318	324	141	353	178
Cyprus	454	410	325	253	129	157
Czech Republic	4 261	1 759	2 981	1 195	1 280	564
Denmark	2 707	2 673	978	755	1 729	1 918
Estonia	265	142	157	73	107	69
Finland	652	740	284	285	368	455
France	8 490	8 135	3 178	2 602	5 312	5 533
Germany	13 188	10 255	5 114	3 912	8 073	6 344
Greece	1 190	1 152	305	329	884	824
Hungary	2 634	1 361	819	405	1 816	958
Ireland	1 838	1 760	496	518	1 342	1 242
Italy	6 798	5 348	2 864	2 198	3 934	3 149
Latvia	714	248	305	111	409	137
Lithuania	1 229	441	544	167	685	274
Luxembourg	97	99	45	39	52	60
Malta	34	33	6	7	28	27
Netherlands	6 351	4 751	530	419	5 821	4 332
Poland	5 960	3 845	3 163	1 994	2 797	1 851
Portugal	1 664	1 380	249	208	1 415	1 172
Romania	5 854	2 382	1 400	762	4 454	1 620
Slovakia	1 807	626	1 246	447	561	179
Slovenia	587	359	164	96	423	263
Spain	7 451	9 173	1 293	1 511	6 157	7 662
Sweden	507	510	262	249	246	261
United Kingdom	6 757	5 271	2 317	1 822	4 440	3 449
EU-28	**90 735**	**67 481**	**31 665**	**22 025**	**59 070**	**45 456**

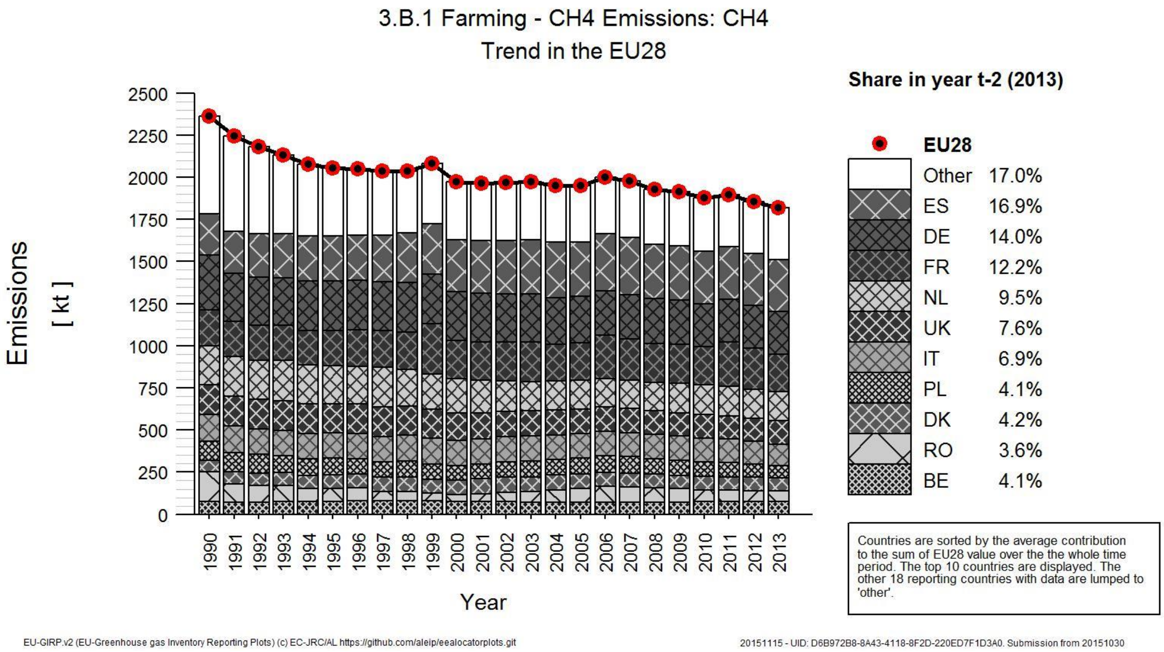
Trends in Emissions and Activity Data

3.B.1 - Manure Management - Emissions

Emissions in source category 3.B.1 - Manure Management decreased considerably in EU28 by 23% or 13.6 Mt CO_2-eq. Figure 5.19 shows the trend of emissions indicating the countries contributing most to EU28 total. The ten countries with highest emissions together accounted for 83% of manure

Management CH_4 emissions. Emissions decreased in 20 countries and increased in eight countries. The three countries with the largest decreases were Bulgaria, Romania and Germany with a total absolute decrease of 7.9 Mt CO_2-eq. Largest increases occurred in France and Spain with a total absolute increase of 1.7 Mt CO_2-eq.

Figure 5.19: 3.B.1: Trend in emissions in the EU28 and the countries contributing most to EU28 values including their share to EU28 emissions in 2013



3.B.1.1 - Cattle - Emissions

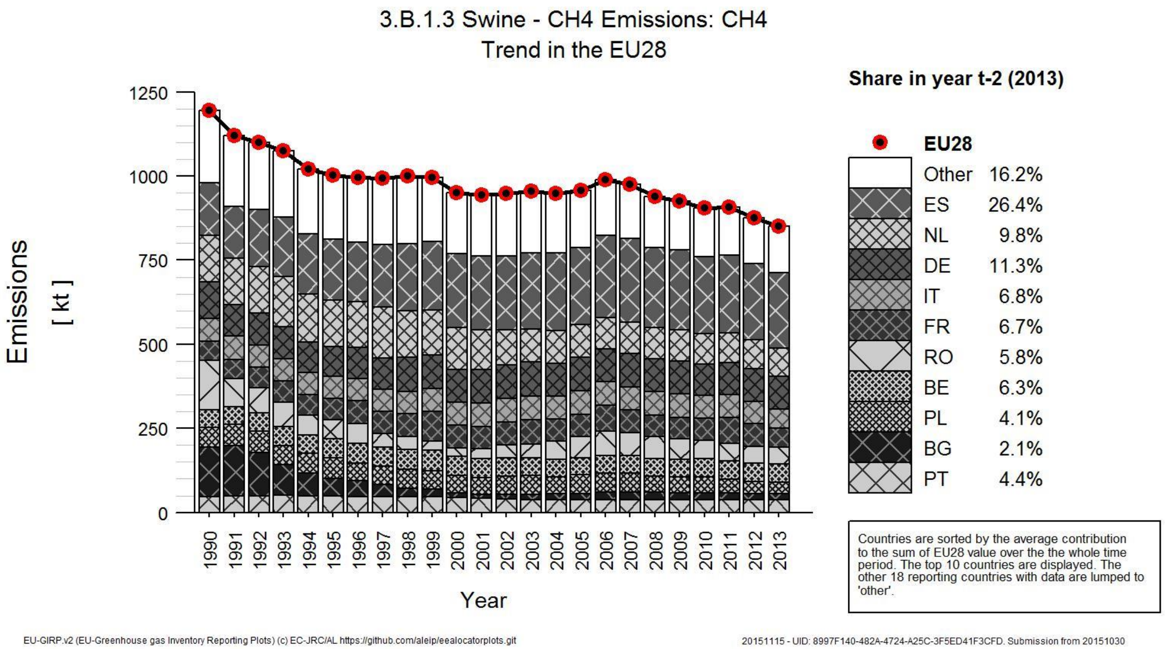
CH_4 emissions in source category 3.B.1.1 - Cattle are 0.48% of total EU28 GHG emissions and 4.6% of total EU28 CH_4 emissions. They make 4.8% of total agricultural emissions.

Total GHG and CH_4 emissions by Member States from 3.B.1.1 Manure Management are shown in Table 5.14. Between 1990 and 2013, CH_4 emission from Cattle decreased by 17% or 4.3 Mt CO_2-eq. The decrease was largest in Romania in relative terms (68%) and in Germany in absolute terms (28% or 1.5 Mt CO_2-eq). From 2012 to 2013 emissions decreased by 1.1%. Figure 5.20 shows the trend of emissions indicating the countries contributing most to EU28 total. The ten countries with highest emissions together accounted for 87.3% of cattle CH_4 emissions. Emissions decreased in 15 countries and increased in thirteen countries. The three countries with the largest decreases were Germany, Italy and United Kingdom with a total absolute decrease of 2.6 Mt CO_2-eq. The three countries with the largest increases were Denmark, France and Netherlands with a total absolute increase of 610 kt CO_2-eq.

Table 5.14 3.B.1.1 - Cattle: Member States' contributions to total GHG and CH_4 emissions

Member State	CH4 emissions in kt CO2 equiv.			Share in EU28 emissions in 2013	Change 2012-2013		Change 1990-2013		Method applied	Emission factor
	1990	2012	2013		kt CO2 equiv.	%	kt CO2 equiv.	%		
Austria	149	89	87	0%	-2	-3%	-62	-42%	-	-
Belgium	1 346	1 348	1 348	6%	0	0%	2	0%	T2	CS
Bulgaria	3 664	450	441	2%	-9	-2%	-3 223	-88%	T2	CS
Croatia	59	39	39	0%	-1	-2%	-20	-35%	T2	CS
Cyprus	96	135	123	1%	-12	-9%	26	27%	T1	D
Czech Republic	359	118	119	1%	1	0%	-240	-67%	T1	D
Denmark	798	882	868	4%	-14	-2%	70	9%	CS,T2	D
Estonia	56	21	21	0%	0	-1%	-34	-62%	T2	CS,D
Finland	66	106	108	1%	1	1%	42	63%	T2	CS
France	1 416	1 734	1 431	7%	-303	-17%	15	1%	-	-
Germany	2 685	2 426	2 403	11%	-23	-1%	-282	-10%	T2	CS,D
Greece	398	346	346	2%	0	0%	-52	-13%	T1	D
Hungary	1 034	550	551	3%	1	0%	-483	-47%	T2	CS
Ireland	160	193	190	1%	-3	-1%	30	19%	T2	CS,D
Italy	1 705	1 645	1 444	7%	-202	-12%	-261	-15%	T2	CS
Latvia	224	57	58	0%	2	3%	-166	-74%	T1	D
Lithuania	355	127	120	1%	-8	-6%	-236	-66%	T2	CS
Luxembourg	11	12	11	0%	0	-3%	1	5%	T2	CS
Malta	15	11	12	0%	1	9%	-3	-20%	T1	D
Netherlands	3 489	2 156	2 086	10%	-70	-3%	-1 403	-40%	T2	CS
Poland	1 436	911	866	4%	-45	-5%	-570	-40%	T2	CS
Portugal	1 196	930	938	4%	9	1%	-257	-22%	T2	CS
Romania	3 661	1 253	1 235	6%	-19	-2%	-2 426	-66%	T2	CS
Slovakia	252	63	64	0%	1	1%	-188	-75%	T1	D
Slovenia	197	45	44	0%	-1	-2%	-153	-78%	T1	D
Spain	3 886	5 640	5 612	26%	-28	0%	1 727	44%	-	-
Sweden	59	44	44	0%	1	1%	-15	-25%	-	-
United Kingdom	1 090	583	633	3%	50	9%	-457	-42%	T2	CS,D
EU-28	**29 863**	**21 916**	**21 242**	**100%**	**-674**	**-3%**	**-8 621**	**-29%**		

Figure 5.20: 3.B.1.1: Trend in emissions in the EU28 and the countries contributing most to EU28 values including their share to EU28 emissions in 2013



3.B.1.1 - Cattle - Activity Data

The main Activity Data for CH_4 emissions from Manure Management - Cattle are the animal numbers. Cattle numbers are already discussed under source category 3.A Enteric Fermentation and therefore not further discussed here.

Other relevant activity data are:

- Allocation by Climate Region (Tier 1)
- Allocation by MMS.

3.B.1.3 - Swine - Emissions

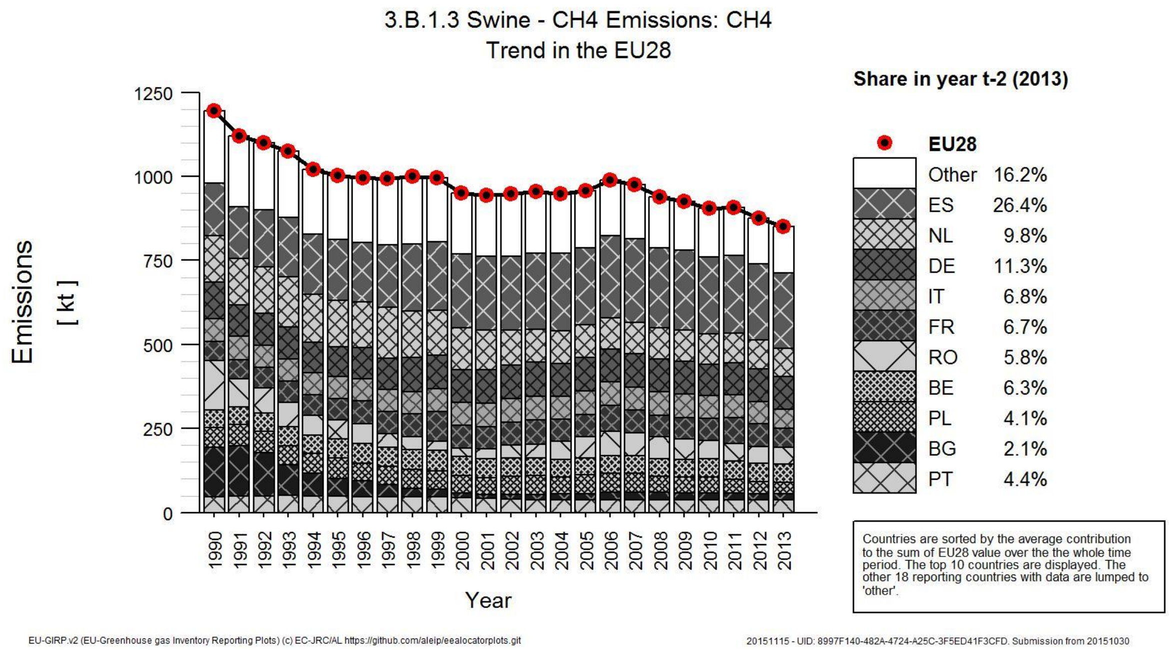
CH_4 emissions in source category 3.B.1.3 - Swine are 0.47% of total EU28 GHG emissions and 4.6% of total EU28 CH_4 emissions. They make 4.8% of total agricultural emissions.

Total GHG and CH_4 emissions by Member States from 3.B.1.3 Manure Management are shown in Table 5.15. Between 1990 and 2013, CH_4 emission from Swine decreased by 29% or 8.6 Mt CO_2-eq. The decrease was largest in Bulgaria in relative terms (88%) and also in absolute terms (88% or 3.2 Mt CO_2-eq). From 2012 to 2013 emissions decreased by 3.1%. Figure 5.21 shows the trend of emissions indicating the countries contributing most to EU28 total. The ten countries with highest emissions together accounted for 85.8% of Swine emissions. Emissions decreased in 20 countries and increased in eight countries. The three countries with the largest decreases were Bulgaria, Romania and Netherlands with a total absolute decrease of 7.1 Mt CO_2-eq. Largest increases occurred in Spain with a total absolute increase of 1.7 Mt CO_2-eq.

Table 5.15 3.B.1.3 - Swine: Member States' contributions to total GHG and CH_4 emissions

Member State	CH4 emissions in kt CO2 equiv.			Share in EU28 emissions in 2013	Change 2012-2013		Change 1990-2013		Method applied	Emission factor
	1990	2012	2013		kt CO2 equiv.	%	kt CO2 equiv.	%		
Austria	149	89	87	0%	-2	-3%	-62	-42%	-	-
Belgium	1 346	1 348	1 348	6%	0	0%	2	0%	T2	CS
Bulgaria	3 664	450	441	2%	-9	-2%	-3 223	-88%	T2	CS
Croatia	59	39	39	0%	-1	-2%	-20	-35%	T2	CS
Cyprus	96	135	123	1%	-12	-9%	26	27%	T1	D
Czech Republic	359	118	119	1%	1	0%	-240	-67%	T1	D
Denmark	798	882	868	4%	-14	-2%	70	9%	CS,T2	D
Estonia	56	21	21	0%	0	-1%	-34	-62%	T2	CS,D
Finland	66	106	108	1%	1	1%	42	63%	T2	CS
France	1 416	1 734	1 431	7%	-303	-17%	15	1%	-	-
Germany	2 685	2 426	2 403	11%	-23	-1%	-282	-10%	T2	CS,D
Greece	398	346	346	2%	0	0%	-52	-13%	T1	D
Hungary	1 034	550	551	3%	1	0%	-483	-47%	T2	CS
Ireland	160	193	190	1%	-3	-1%	30	19%	T2	CS,D
Italy	1 705	1 645	1 444	7%	-202	-12%	-261	-15%	T2	CS
Latvia	224	57	58	0%	2	3%	-166	-74%	T1	D
Lithuania	355	127	120	1%	-8	-6%	-236	-66%	T2	CS
Luxembourg	11	12	11	0%	0	-3%	1	5%	T2	CS
Malta	15	11	12	0%	1	9%	-3	-20%	T1	D
Netherlands	3 489	2 156	2 086	10%	-70	-3%	-1 403	-40%	T2	CS
Poland	1 436	911	866	4%	-45	-5%	-570	-40%	T2	CS
Portugal	1 196	930	938	4%	9	1%	-257	-22%	T2	CS
Romania	3 661	1 253	1 235	6%	-19	-2%	-2 426	-66%	T2	CS
Slovakia	252	63	64	0%	1	1%	-188	-75%	T1	D
Slovenia	197	45	44	0%	-1	-2%	-153	-78%	T1	D
Spain	3 886	5 640	5 612	26%	-28	0%	1 727	44%	-	-
Sweden	59	44	44	0%	1	1%	-15	-25%	-	-
United Kingdom	1 090	583	633	3%	50	9%	-457	-42%	T2	CS,D
EU-28	**29 863**	**21 916**	**21 242**	**100%**	**-674**	**-3%**	**-8 621**	**-29%**		

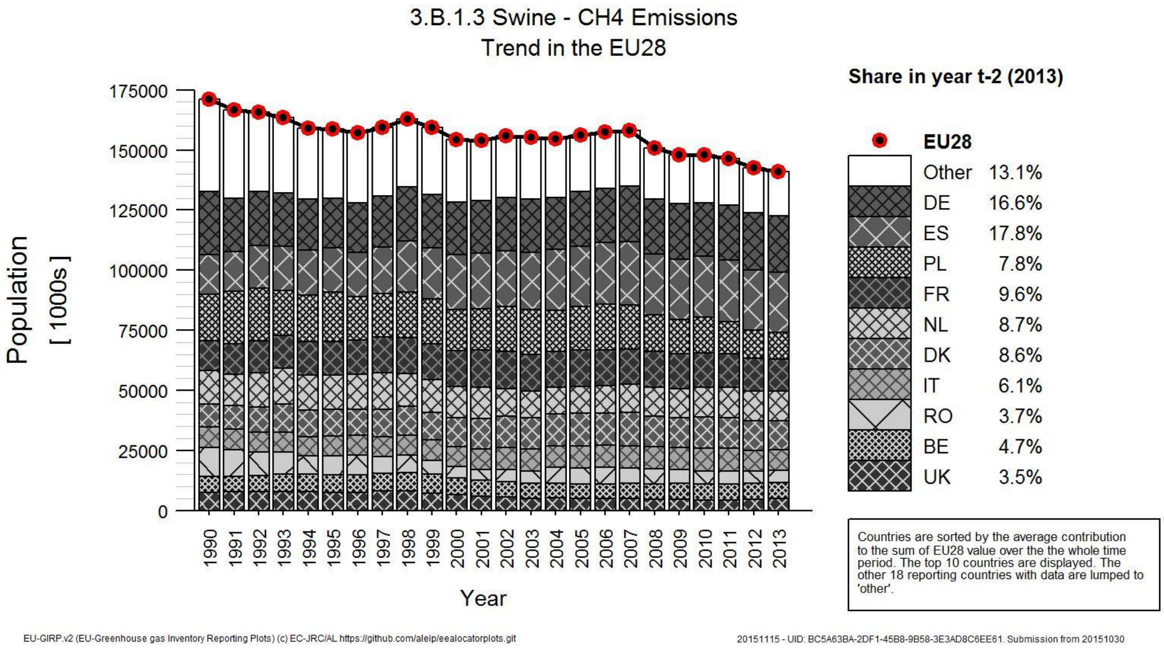
Figure 5.21: 3.B.1.3: Trend in emissions in the EU28 and the countries contributing most to EU28 values including their share to EU28 emissions in 2013



3.B.1.3 - Swine - Population

Main Activity Data for CH_4 emissions from Manure Management - Swine are the animal numbers. As Swine are not a main animal type in the source category 3.A Enteric Fermentation their population data are discussed here. Swine population decreased considerably in EU28 by 18% or 30.2 mio heads. Figure 5.22 shows the trend of swine population indicating the countries contributing most to EU28 total. The ten countries with highest population together accounted for 86.9% of Swine population. Population decreased in 21 countries and increased in seven countries. The three countries with the largest decreases were Poland, Romania and Hungary with a total absolute decrease of 21.1 mio heads. Largest increases occurred in Denmark and Spain with a total absolute increase of 11.3 mio heads.

Figure 5.22: 3.B.1.3: Trend in population in the EU28 and the countries contributing most to EU28 values including their share to EU28 emissions in 2013



Implied EFs and Methodological Issues

In this section we discuss the Implied Emission Factor for the main animal types. Furthermore, we present data on the Typical Animal Mass as reported in CRF Tables 3B(a)s1 and average VS daily excretion.

3.B.1.1 - Cattle - Implied emission factor

The implied emission factor for CH_4 emissions in source category 3.B.1.1 - Cattle increased in EU28 considerably by 15.9% or 1.32 kg/head/year between 1990 and 2013. Figure 5.23 shows the trend of the IEF in EU28 indicating also the range of values used by the countries. Table 5.16 shows the implied emission factor for CH_4 emissions in source category 3.B.1.1 - Cattle for the years 1990 and 2013 for all Member States and EU28. The IEF decreased in seven countries and increased in twenty countries. The three countries with the largest decreases were Spain, Romania and Croatia with a mean absolute decrease of 2 kg/head/year. The four countries with the largest increases were Estonia, Latvia, Finland and Lithuania with a mean absolute increase of 4 kg/head/year.

Figure 5.23: 3.B.1.1 - Cattle: Trend in implied emission factor in the EU28 and range of values reported by countries

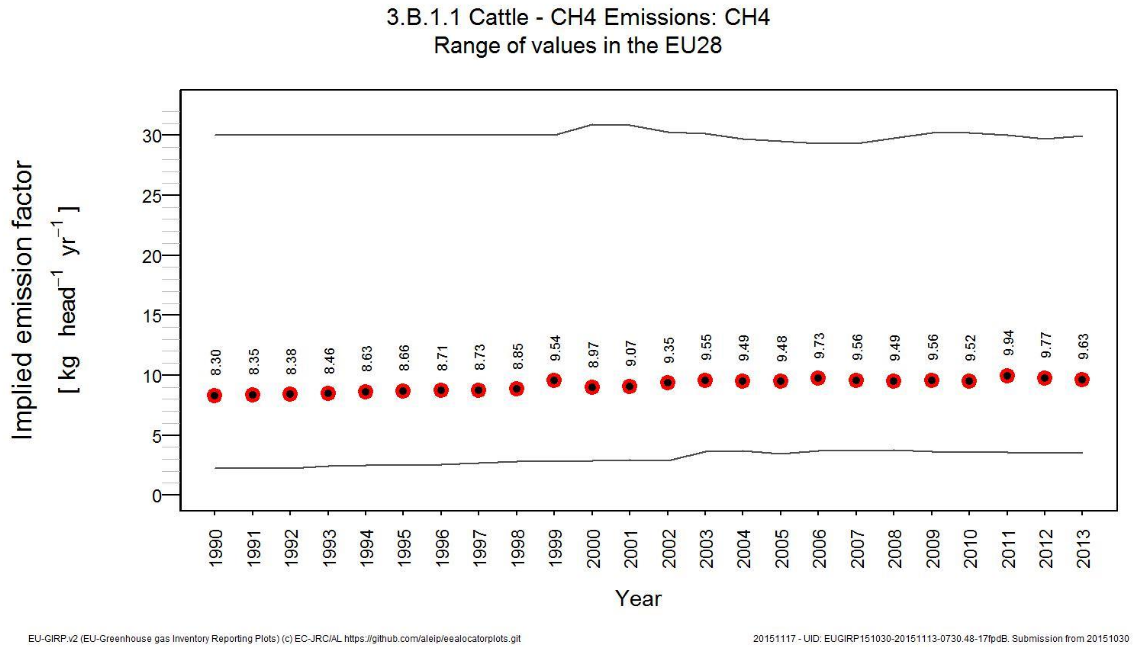


Table 5.16 3.B.1.1 - Cattle: Member States' and EU28 Implied emission factor (kg/head/year)

Member State	1990	2013		Member State	1990	2013
Austria	5.8	6.0	|	Italy	10.0	9.0
Belgium	6.0	8.0	|	Lithuania	4.4	7.1
Bulgaria	3.0	3.6	|	Luxembourg	7.4	9.9
Cyprus	19.8	20.0	|	Latvia	2.8	6.9
Czech Republic	9.8	11.8	|	Malta	30.0	30.0
Germany	10.8	11.8	|	Netherlands	14.9	21.4
Denmark	15.0	22.8	|	Poland	4.6	6.3
Estonia	2.2	6.7	|	Portugal	3.0	3.6
Spain	16.1	12.9	|	Romania	4.2	3.5
Finland	6.9	12.0	|	Sweden	3.6	4.9
France	6.7	8.0	|	Slovenia	13.2	16.8
Greece	5.5	5.4	|	Slovakia	7.0	7.9
Croatia	13.1	11.6	|	United Kingdom		
Hungary	17.0	18.9	|	**EU28**	**8.3**	**9.6**
Ireland	6.1	5.4	|			

3.B.1.1 - Dairy Cattle - Implied emission factor

The implied emission factor for CH_4 emissions in source category 3.B.1.1 - Dairy Cattle increased in EU28 strongly by 47.8% or 6.8 kg/head/year between 1990 and 2013. Figure 5.24 shows the trend of the IEF in EU28 indicating also the range of values used by the countries. Table 5.17 shows the implied emission factor for CH_4 emissions in source category 3.B.1.1 - Dairy Cattle for the years 1990 and 2013 for all Member States and EU28. The IEF decreased in five countries and increased in twenty countries. It was in 2013 at the level of 1990 in two countries. No data were available for one country. The three countries with the largest decreases were Romania, Italy and Bulgaria with a mean absolute decrease of 1 kg/head/year. The four countries with the largest increases were Estonia, Latvia, Portugal and Finland with a mean absolute increase of 9 kg/head/year.

Figure 5.24: 3.B.1.1 - Dairy Cattle: Trend in implied emission factor in the EU28 and range of values reported by countries

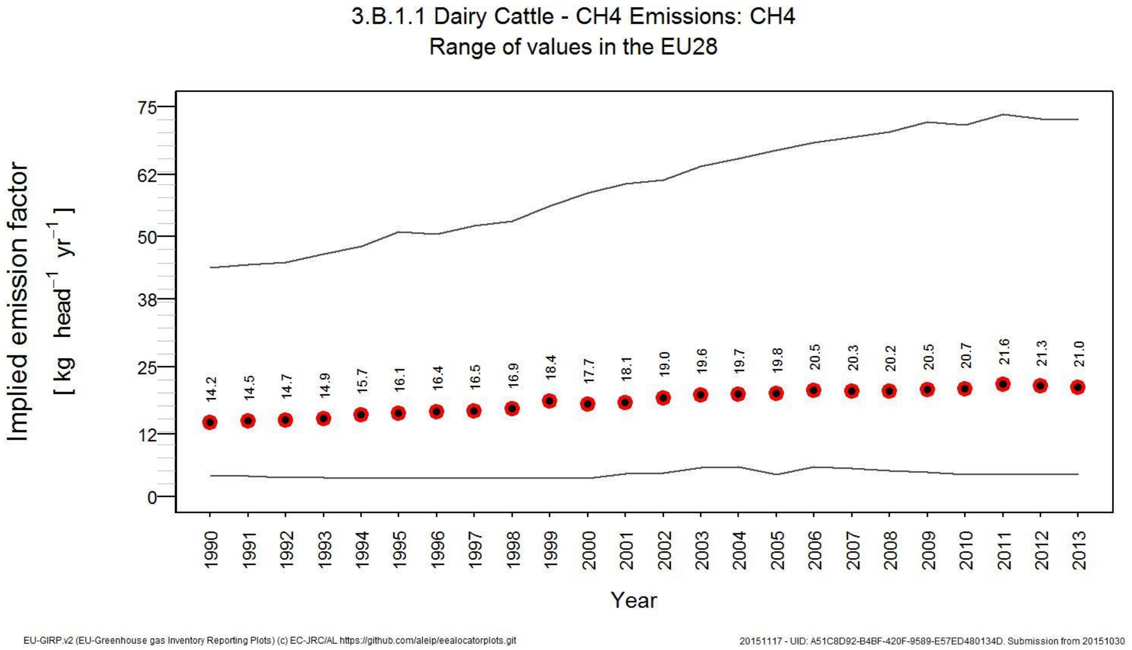


Table 5.17 3.B.1.1 - Dairy Cattle: Member States' and EU28 Implied emission factor (kg/head/year)

Member State	1990	2013		Member State	1990	2013
Austria	9.9	10.4	|	Italy	15.0	13.4
Belgium	14.1	27.6	|	Lithuania	6.1	9.2
Bulgaria	5.5	5.2	|	Luxembourg	14.5	24.8
Cyprus	28.1	28.0	|	Latvia	5.0	13.2
Czech Republic	13.1	20.0	|	Malta	44.0	44.0
Germany	16.7	21.2	|	Netherlands	26.4	41.5
Denmark	26.2	39.4	|	Poland	7.3	11.4
Estonia	4.0	12.8	|	Portugal	5.1	11.1
Spain	41.7	72.5	|	Romania	5.2	4.3
Finland	12.5	26.0	|	Sweden	6.6	8.8
France	14.1	21.2	|	Slovenia	21.0	32.3
Greece	10.4	13.5	|	Slovakia	12.5	13.0
Croatia	16.9	16.9	|	United Kingdom	0.0	0.0
Hungary	24.5	29.8	|	**EU28**	**14.2**	**21.0**
Ireland	10.6	10.2	|			

3.B.1.1 - Dairy Cattle - Typical animal mass

The typical animal mass, a parameter used for calculating CH_4 emissions in source category 3.B.1.1 - Dairy Cattle, increased in EU28 slightly by 3.1% or 17.9 kg between 1990 and 2013. Figure 5.25 shows the trend of the Typical animal mass in EU28 indicating also the range of values used by the countries. Table 5.18 shows the typical animal mass in source category 3.B.1.1 - Dairy Cattle for the years 1990 and 2013 for all Member States and EU28. The reported typical animal mass in 2013 was at the level of 1990 in fourteen countries and increased in all other ten countries. The three countries with the largest increases were Finland, Slovenia and United Kingdom with a mean absolute increase of 91 kg.

Figure 5.25: 3.B.1.1 - Dairy Cattle: Trend in typical animal mass in the EU28 and range of values reported by countries

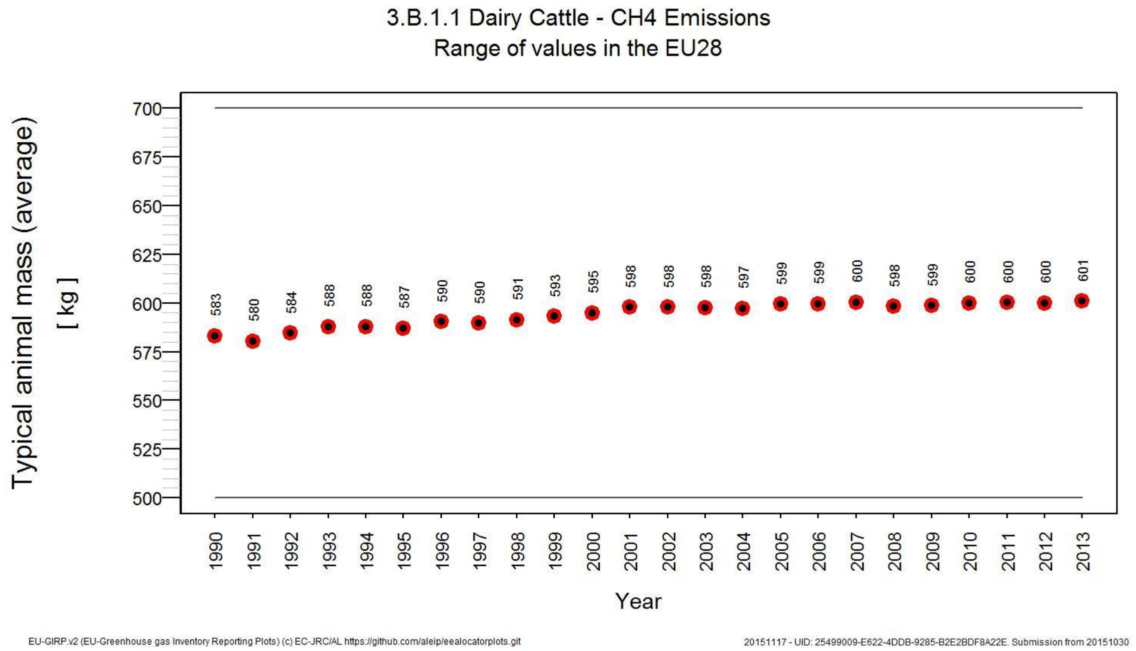


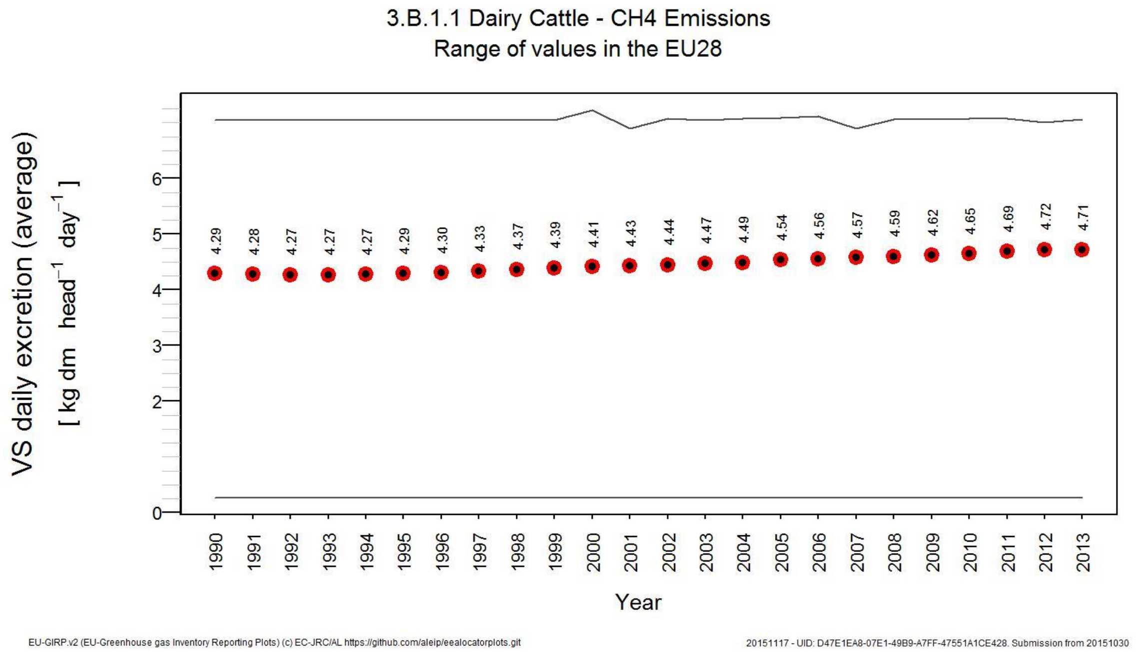
Table 5.18 3.B.1.1 - Dairy Cattle: Member States' and EU28 Typical animal mass (kg)

Member State	1990	2013	Member State	1990	2013
Austria	700	700	Italy	603	603
Belgium	600	600	Lithuania	575	596
Bulgaria	588	588	Luxembourg	650	650
Cyprus	550	550	Latvia	550	580
Germany	608	646	Poland	500	500
Denmark	550	580	Portugal	600	600
Estonia	545	548	Romania	650	650
Spain	598	647	Sweden	600	600
Finland	520	647	Slovenia	510	599
Greece	600	600	Slovakia	550	550
Croatia	563	563	United Kingdom	564	620
Hungary	633	641	**EU28**	**583**	**601**
Ireland	535	535			

3.B.1.1 - Dairy Cattle - VS daily excretion

The VS daily excretion, a parameter used for calculating CH_4 emissions in source category 3.B.1.1 - Dairy Cattle, increased in EU28 moderately by 9.9% or 0.425 kg dm/head/day between 1990 and 2013. Figure 5.26 shows the trend of the VS daily excretion in EU28 indicating also the range of values used by the countries. Table 5.19 shows the VS daily excretion in source category 3.B.1.1 - Dairy Cattle for the years 1990 and 2013 for all Member States and EU28. VS daily excretion decreased in one country and increased in 22 countries. It was in 2013 at the level of 1990 in three countries. No data were available for two countries. Decreases occurred in Poland with an absolute decrease of 0.1 kg dm/head/day. The four countries with the largest increases were Czech Republic, Estonia, Portugal and Spain with a mean absolute increase of 1 kg dm/head/day.

Figure 5.26: 3.B.1.1 - Dairy Cattle: Trend in VS daily excretion in the EU28 and range of values reported by countries[31]



31 Note that data from Sweden are not included in the plot as they are reported in a different unit.

Table 5.19 3.B.1.1 - Dairy Cattle: Member States' and EU28 VS daily excretion (kg dm/head/day)

Member State	1990	2013	Member State	1990	2013
Austria	4.03	4.31	Italy	6.37	6.37
Belgium	4.01	5.02	Lithuania	4.63	5.47
Bulgaria	7.05	7.06	Luxembourg	4.75	5.40
Czech Republic	3.95	5.69	Latvia	4.51	5.70
Germany	3.47	4.01	Netherlands	3.84	4.69
Denmark	5.66	6.43	Poland	5.69	5.59
Estonia	4.44	6.12	Portugal	3.47	4.67
Spain	3.90	5.14	Romania	4.09	4.09
Finland	4.47	5.81	Sweden	1865.87	1944.92
France	3.46	4.04	Slovenia	4.51	5.17
Greece	3.68	4.80	Slovakia	6.40	6.82
Croatia	0.27	0.27	United Kingdom	3.48	4.35
Hungary	4.41	5.10	**EU28**	**4.29**	**4.71**
Ireland	2.76	2.99			

3.B.1.1 - Non-Dairy Cattle - Implied emission factor

The implied emission factor for CH_4 emissions in source category 3.B.1.1 - Non-Dairy Cattle decreased in EU28 barely by 0.19% or 0.0102 kg/head/year between 1990 and 2013. Figure 5.27 shows the trend of the IEF in EU28 indicating also the range of values used by the countries. Table 5.20 shows the implied emission factor for CH_4 emissions in source category 3.B.1.1 - Non-Dairy Cattle for the years 1990 and 2013 for all Member States and EU28. The IEF decreased in seven countries and increased in nineteen countries. It was in 2013 at the level of 1990 in one country. No data were available for one country. The largest decrease occurred in Spain with an absolute decrease of 2 kg/head/year. The four countries with the largest increases were Estonia, Latvia, Sweden and Lithuania with a mean absolute increase of 2 kg/head/year.

Figure 5.27: 3.B.1.1 - Non-Dairy Cattle: Trend in implied emission factor in the EU28 and range of values reported by countries

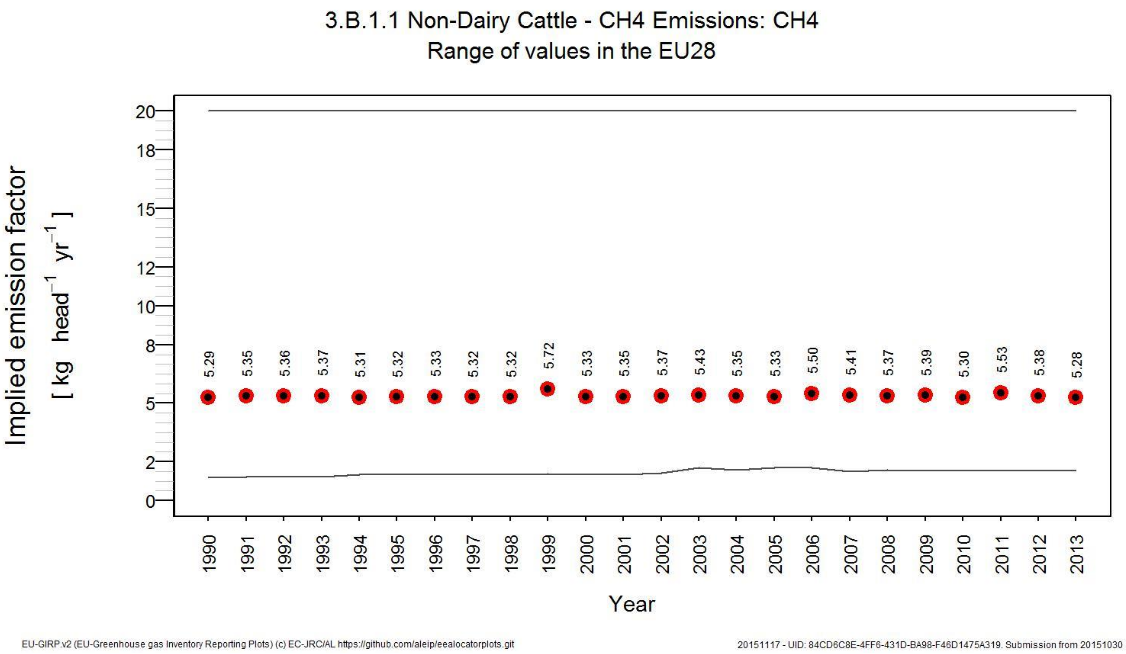


Table 5.20 3.B.1.1 - Non-Dairy Cattle: Member States' and EU28 Implied emission factor (kg/head/year)

Member State	1990	2013		Member State	1990	2013
Austria	3.6	4.4	|	Italy	7.5	7.0
Belgium	3.1	3.5	|	Lithuania	3.4	5.5
Bulgaria	1.4	1.6	|	Luxembourg	4.9	5.2
Cyprus	13.9	13.9	|	Latvia	1.5	2.7
Czech Republic	8.0	8.7	|	Malta	20.0	20.0
Germany	7.9	7.1	|	Netherlands	7.8	8.6
Denmark	9.4	13.5	|	Poland	2.0	2.3
Estonia	1.2	3.0	|	Portugal	2.1	2.2
Spain	4.2	2.7	|	Romania	2.9	2.5
Finland	3.7	5.7	|	Sweden	2.1	3.7
France	4.2	4.8	|	Slovenia	7.4	11.9
Greece	3.3	3.5	|	Slovakia	4.0	4.1
Croatia	8.1	8.1	|	United Kingdom	0.0	0.0
Hungary	13.0	13.6	|	**EU28**	**5.3**	**5.3**
Ireland	5.0	4.4	|			

3.B.1.1 - Non-Dairy Cattle - Typical animal mass

The typical animal mass, a parameter used for calculating CH_4 emissions in source category 3.B.1.1 - Non-Dairy Cattle, increased in EU28 moderately by 6.7% or 24.9 kg between 1990 and 2013. Figure 5.28 shows the trend of the Typical animal mass in EU28 indicating also the range of values used by the countries. Table 5.21 shows the typical animal mass in source category 3.B.1.1 - Non-Dairy Cattle for the years 1990 and 2013 for all Member States and EU28. Typical animal mass decreased in one country and increased in twenty countries. It was in 2013 at the level of 1990 in three countries. No data were available for four countries. Decreases occurred in Ireland with an absolute decrease of 10 kg. The largest increase occurred in Finland with an absolute increase of 111 kg.

Figure 5.28: 3.B.1.1 - Non-Dairy Cattle: Trend in typical animal mass in the EU28 and range of values reported by countries

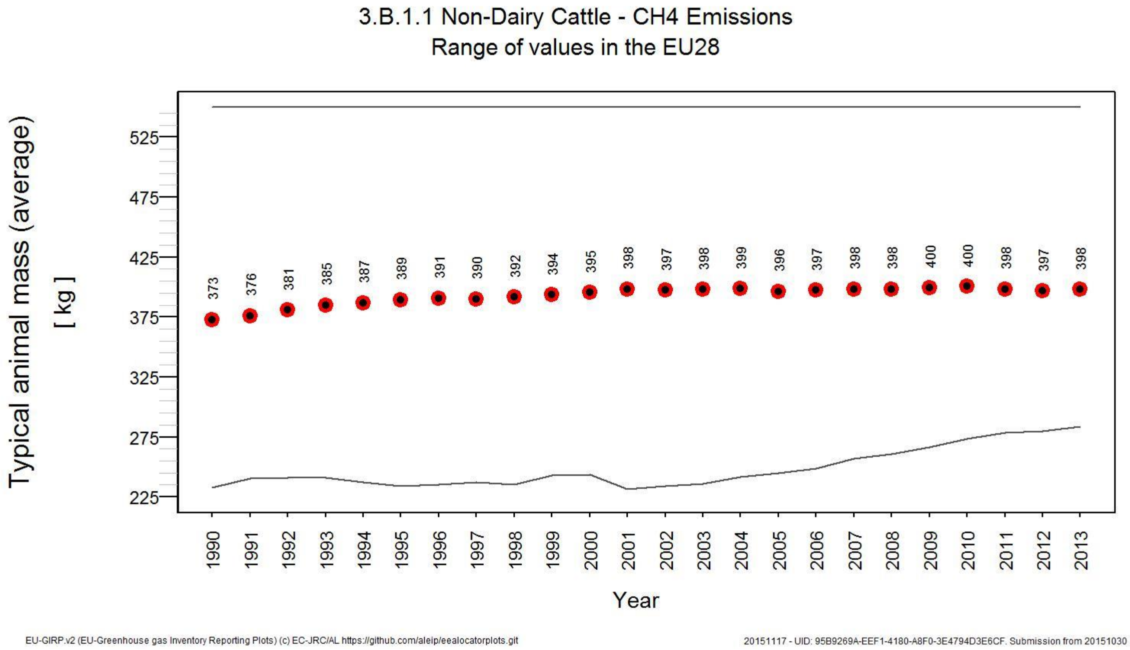


Table 5.21 3.B.1.1 - Non-Dairy Cattle: Member States' and EU28 Typical animal mass (kg)

Member State	1990	2013		Member State	1990	2013
Austria	364	420	|	Ireland	349	339
Belgium	381	410	|	Italy	376	385
Bulgaria	314	390	|	Lithuania	326	330
Cyprus	350	350	|	Luxembourg	405	417
Germany	339	367	|	Latvia	387	422
Denmark	290	320	|	Poland	311	329
Estonia	233	283	|	Portugal	355	407
Spain	395	433	|	Romania	482	482
Finland	278	390	|	Sweden	550	550
France	428	435	|	Slovenia	289	346
Greece	374	411	|	Slovakia	313	328
Croatia	331	334	|	**EU28**	**373**	**398**
Hungary	327	352	|			

3.B.1.1 - Non-Dairy Cattle - VS daily excretion

The VS daily excretion, a parameter used for calculating CH_4 emissions in source category 3.B.1.1 - Non-Dairy Cattle, increased in EU28 barely by 0.28% or 0.00556 kg dm/head/day between 1990 and 2013. Figure 5.29 shows the trend of the VS daily excretion in EU28 indicating also the range of values used by the countries. Table 5.22 shows the VS daily excretion in source category 3.B.1.1 -

Non-Dairy Cattle for the years 1990 and 2013 for all Member States and EU28. VS daily excretion decreased in four countries and increased in twenty countries. It was in 2013 at the level of 1990 in two countries. No data were available for two countries. The three countries with the largest decreases were Spain, Ireland and Netherlands with a mean absolute decrease of 0.2 kg dm/head/day. The largest increases occurred in Finland and Denmark with a mean absolute increase of 1 kg dm/head/day.

Figure 5.29: 3.B.1.1 - Non-Dairy Cattle: Trend in VS daily excretion in the EU28 and range of values reported by countries[32]

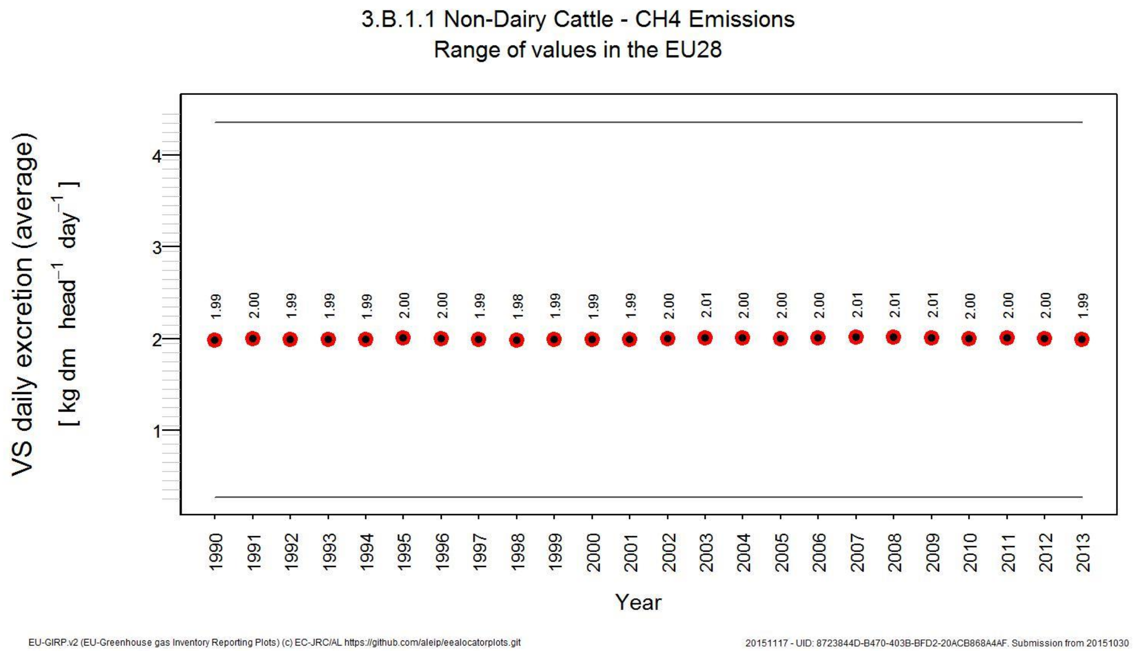


Table 5.22 3.B.1.1 - Non-Dairy Cattle: Member States' and EU28 VS daily excretion (kg dm/head/day)

Member State	1990	2013	Member State	1990	2013
Austria	1.55	1.92	Italy	2.80	2.93
Belgium	1.69	1.87	Lithuania	2.47	2.47
Bulgaria	2.52	3.04	Luxembourg	2.48	2.60
Czech Republic	2.28	2.67	Latvia	1.96	2.07
Germany	1.37	1.38	Netherlands	1.37	1.26
Denmark	2.37	3.26	Poland	2.04	2.09
Estonia	1.94	2.21	Portugal	2.89	3.17
Spain	2.53	2.28	Romania	4.36	4.36
Finland	1.55	2.15	Sweden	547.16	532.75
France	1.87	1.91	Slovenia	2.14	2.53
Greece	2.61	2.77	Slovakia	3.05	3.12
Croatia	0.27	0.27	United Kingdom	2.78	2.85
Hungary	2.54	2.64	**EU28**	**1.99**	**1.99**
Ireland	1.43	1.31			

32 Note that data from Sweden are not included in the plot as they are reported in a different unit.

3.B.1.3 - Swine - Implied emission factor

The implied emission factor for CH_4 emissions in source category 3.B.1.3 - Swine decreased in EU28 clearly by 13.6% or 0.952 kg/head/year between 1990 and 2013. Figure 5.30 shows the trend of the IEF in EU28 indicating also the range of values used by the countries. Table 5.23 shows the implied emission factor for CH_4 emissions in source category 3.B.1.3 - Swine for the years 1990 and 2013 for all Member States and EU28. The IEF decreased in eighteen countries and increased in seven countries. It was in 2013 at the level of 1990 in three countries. The three countries with the largest decreases were Slovenia, Netherlands and Austria with a mean absolute decrease of 4 kg/head/year. The largest increases occurred in Finland and Hungary with a mean absolute increase of 2 kg/head/year.

Figure 5.30: 3.B.1.3 - Swine: Trend in implied emission factor in the EU28 and range of values reported by countries

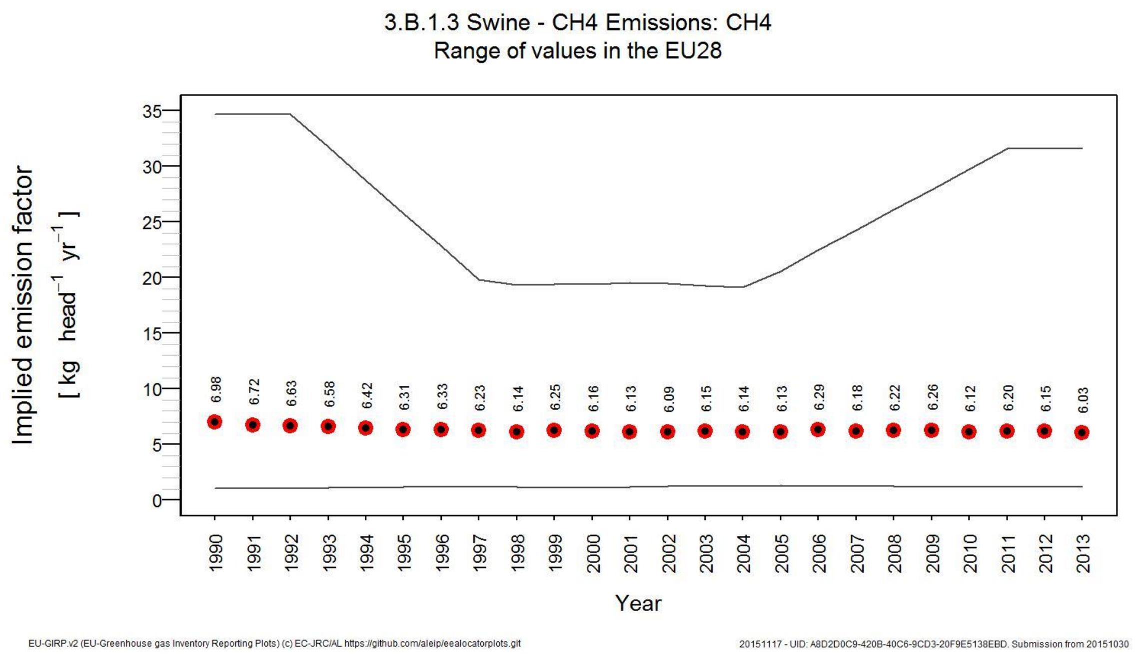


Table 5.23 3.B.1.3 - Swine: Member States' and EU28 Implied emission factor (kg/head/year)

Member State	1990	2013	Member State	1990	2013
Austria	1.6	1.2	Italy	8.1	6.7
Belgium	8.0	8.1	Lithuania	5.8	6.3
Bulgaria	34.7	31.6	Luxembourg	5.8	5.2
Cyprus	13.9	13.7	Latvia	6.4	6.4
Czech Republic	3.0	3.0	Malta	10.0	10.0
Germany	4.1	4.1	Netherlands	10.0	6.8
Denmark	3.4	2.9	Poland	3.0	3.1
Estonia	2.6	2.4	Portugal	18.9	18.7
Spain	9.5	8.9	Romania	12.2	9.5
Finland	1.9	3.3	Sweden	1.0	1.3
France	4.6	4.2	Slovenia	13.4	6.1
Greece	16.0	16.0	Slovakia	5.0	4.0
Croatia	3.0	2.9	United Kingdom	5.8	5.2
Hungary	4.8	7.5	**EU28**	**7.0**	**6.0**
Ireland	5.2	5.0			

3.B.1.3 - Swine - Typical animal mass

The typical animal mass, a parameter used for calculating CH_4 emissions in source category 3.B.1.3 - Swine, decreased in EU28 slightly by 3.8% or 2.87 kg between 1990 and 2013. Figure 5.31 shows the trend of the Typical animal mass in EU28 indicating also the range of values used by the countries. Table 5.24 shows the typical animal mass in source category 3.B.1.3 - Swine for the years 1990 and 2013 for all Member States and EU28. Typical animal mass decreased in nine countries and increased in five countries. It was in 2013 at the level of 1990 in three countries. No data were available for eleven countries. The three countries with the largest decreases were Ireland, Belgium and Croatia with a mean absolute decrease of 6 kg. The three countries with the largest increases were Denmark, Estonia and Italy with a mean absolute increase of 4 kg.

Figure 5.31: 3.B.1.3 - Swine: Trend in typical animal mass in the EU28 and range of values reported by countries

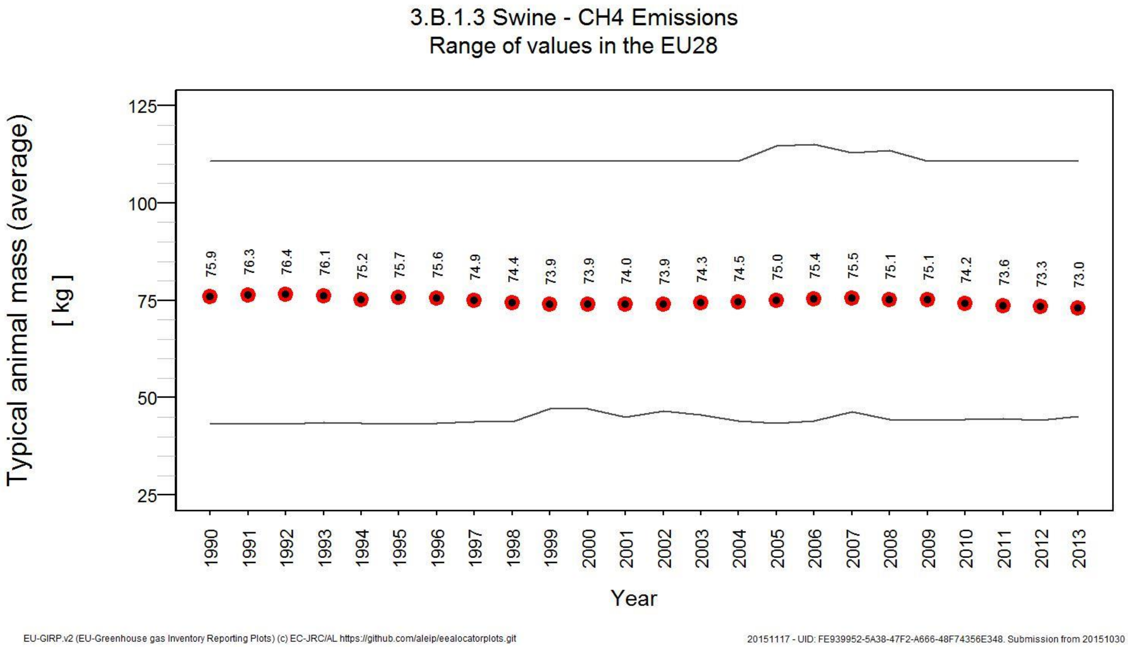


Table 5.24 3.B.1.3 - Swine: Member States' and EU28 Typical animal mass (kg)

Member State	1990	2013	Member State	1990	2013
Belgium	69	64	Hungary	63	65
Bulgaria	109	104	Ireland	63	58
Cyprus	68	65	Italy	79	81
Germany	67	63	Lithuania	63	60
Denmark	98	107	Luxembourg	92	86
Estonia	43	45	Portugal	62	58
Spain	62	63	Romania	111	111
Greece	50	50	Sweden	52	52
Croatia	88	81	**EU28**	**76**	**73**

3.B.1.3 - Swine - VS daily excretion

The VS daily excretion, a parameter used for calculating CH_4 emissions in source category 3.B.1.3 - Swine, decreased in EU28 clearly by 11.7% or 0.0406 kg dm/head/day between 1990 and 2013. Figure 5.32 shows the trend of the VS daily excretion in EU28 indicating also the range of values used by the countries. Table 5.25 shows the VS daily excretion in source category 3.B.1.3 - Swine for the years 1990 and 2013 for all Member States and EU28. VS daily excretion decreased in eleven countries and increased in five countries. It was in 2013 at the level of 1990 in three countries. No data were available for nine countries. The largest decrease occurred in Netherlands with an absolute decrease of 0.2 kg dm/head/day. The three countries with the largest increases were Germany, Sweden and Estonia with a mean absolute increase of 3 kg dm/head/day.

Figure 5.32: 3.B.1.3 - Swine: Trend in VS daily excretion in the EU28 and range of values reported by countries[33]

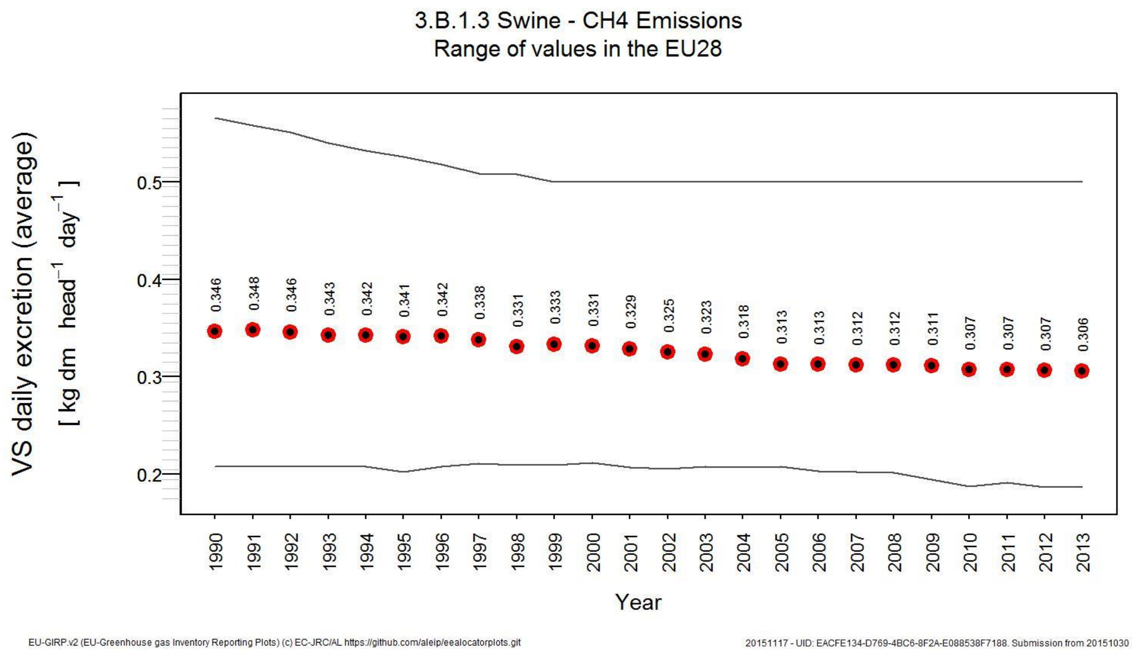


Table 5.25 3.B.1.3 - Swine: Member States' and EU28 VS daily excretion (kg dm/head/day)

Member State	1990	2013		Member State	1990	2013
Austria	0.27	0.27	|	Ireland	0.28	0.27
Belgium	0.39	0.40	|	Italy	0.37	0.34
Bulgaria	0.49	0.49	|	Lithuania	0.38	0.38
Germany	0.26	0.30	|	Luxembourg	0.32	0.31
Denmark	0.24	0.19	|	Netherlands	0.57	0.37
Estonia	0.26	0.27	|	Portugal	0.28	0.27
Spain	0.30	0.29	|	Romania	0.28	0.28
Finland	0.21	0.21	|	Sweden	104.07	112.21
Croatia	0.36	0.35	|	Slovenia	0.32	0.31
Hungary	0.50	0.50	|	**EU28**	**0.35**	**0.31**

33 Note that data from Sweden are not included in the plot as they are reported in a different unit.

5.2.2 Manure Management - N_2O (CRF Source Category 3B2)

N_2O emissions from source category 3.B.2 - Manure Management are 0.49% of total EU28 GHG emissions and 8.8% of total EU28 N_2O emissions. They make 5% of total agricultural emissions. The main sub-categories are 3.B.2.1 (Cattle), 3.B.2.5 (Indirect Emissions) and 3.B.2.4 (Other Livestock) as shown in Figure 5.33.

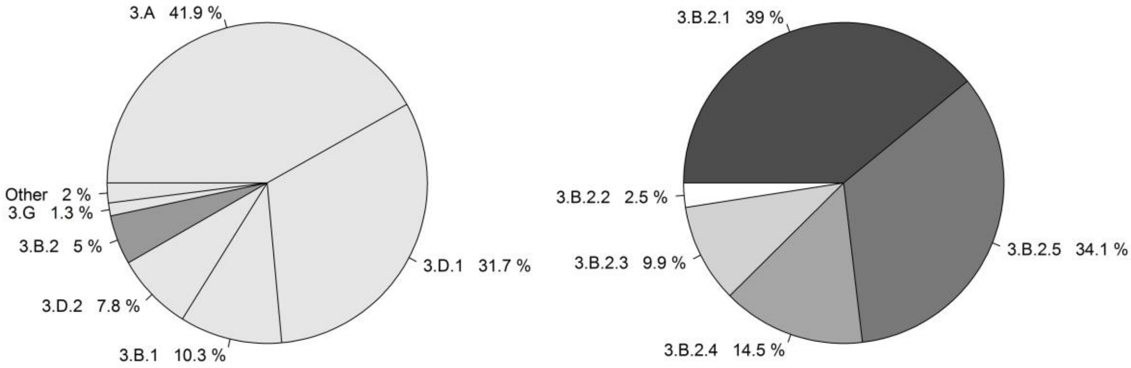


Figure 5.33: Share of source category 3.B.2 on total EU28 agricultural emissions (left panel) and decomposition into its sub-categories (right panel). The percentages refer to the emission in the year 2013.

Total GHG and N_2O emissions by Member States from 3.B.2 Manure Management are shown in Table 5.26. Between 1990 and 2013, N_2O emission from Manure Management decreased by 30% or 9.6 Mt CO_2-eq. The decrease was largest in Lithuania in relative terms (69%) and in Czech Republic in absolute terms (60% or 1.8 Mt CO_2-eq). From 2012 to 2013 emissions decreased by 0.4%.

Table 5.26 3.B.2 - Manure Management: Member States' contributions to total GHG and N_2O emissions

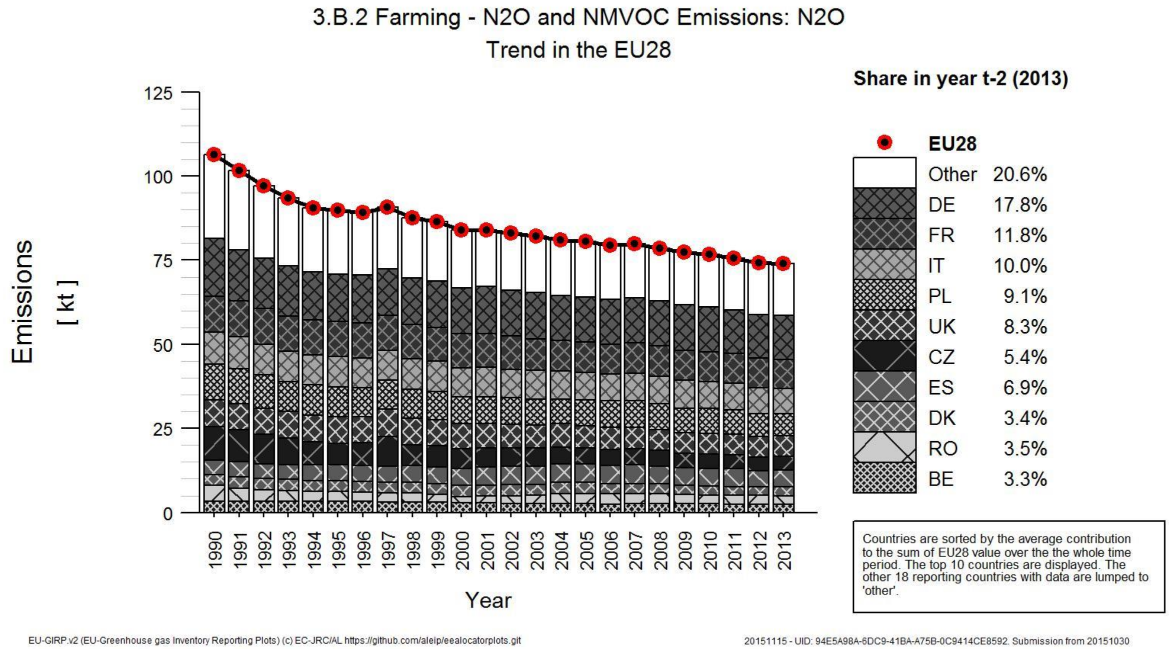
Member State	GHG emissions in 1990 (kt CO2 equivalents)	GHG emissions in 2013 (kt CO2 equivalents)	N2O emissions in 1990 (kt CO2 equivalents)	N2O emissions in 2013 (kt CO2 equivalents)	CH4 emissions in 1990 (kt CO2 equivalents)	CH4 emissions in 2013 (kt CO2 equivalents)
Austria	991	842	453	445	537	397
Belgium	2 827	2 598	979	730	1 849	1 868
Bulgaria	4 751	870	883	358	3 868	511
Croatia	677	318	324	141	353	178
Cyprus	454	410	325	253	129	157
Czech Republic	4 261	1 759	2 981	1 195	1 280	564
Denmark	2 707	2 673	978	755	1 729	1 918
Estonia	265	142	157	73	107	69
Finland	652	740	284	285	368	455
France	8 490	8 135	3 178	2 602	5 312	5 533
Germany	13 188	10 255	5 114	3 912	8 073	6 344
Greece	1 190	1 152	305	329	884	824
Hungary	2 634	1 361	819	403	1 816	958
Ireland	1 838	1 760	496	518	1 342	1 242
Italy	6 798	5 348	2 864	2 198	3 934	3 149
Latvia	714	248	305	111	409	137
Lithuania	1 229	441	544	167	685	274
Luxembourg	97	99	45	39	52	60
Malta	34	33	6	7	28	27
Netherlands	6 351	4 751	530	419	5 821	4 332
Poland	5 960	3 845	3 163	1 994	2 797	1 851
Portugal	1 664	1 380	249	208	1 415	1 172
Romania	5 854	2 382	1 400	762	4 454	1 620
Slovakia	1 807	626	1 246	447	561	179
Slovenia	587	359	164	96	423	263
Spain	7 451	9 173	1 293	1 511	6 157	7 662
Sweden	507	510	262	249	246	261
United Kingdom	6 757	5 271	2 317	1 822	4 440	3 449
EU-28	**90 735**	**67 481**	**31 665**	**22 025**	**59 070**	**45 456**

Trends in Emissions and Activity Data

3.B.2 - Manure Management - Emissions

Emissions in source category 3.B.2 - Manure Management decreased strongly in EU28 by 30% or 9.6 Mt CO_2-eq. Figure 5.34 shows the trend of emissions indicating the countries contributing most to EU28 total. The ten countries with highest emissions together accounted for 79.4% of manure Management N_2O emissions. Emissions decreased in 23 countries and increased in five countries. The three countries with the largest decreases were Czech Republic, Germany and Poland with a total absolute decrease of 4.2 Mt CO_2-eq. Largest increases occurred in Spain with a total absolute increase of 218 kt CO_2-eq.

Figure 5.34: 3.B.2 Manure Management: Trend in emissions in the EU28 and the countries contributing most to EU28 values including their share to EU28 emissions in 2013



3.B.2.1 - Cattle - Emissions

N_2O emissions in source category 3.B.2.1 - Cattle are 0.19% of total EU28 GHG emissions and 3.4% of total EU28 N_2O emissions. They make 2% of total agricultural emissions.

Total GHG and N_2O emissions by Member States from 3.B.2.1 Manure Management are shown in Table 5.27. Between 1990 and 2013, N_2O emission from Cattle decreased by 37% or 5 Mt CO_2-eq. The decrease was largest in Slovakia in relative terms (69%) and in Germany in absolute terms (33% or 1 Mt CO_2-eq). From 2012 to 2013 emissions decreased by 0.9%. Figure 5.35 shows the trend of emissions indicating the countries contributing most to EU28 total. The ten countries with highest emissions together accounted for 80.2% of cattle N_2O emissions. Emissions decreased in 20 countries and increased in seven countries. The four countries with the largest decreases were Germany, Czech Republic, Slovakia and Italy with a total absolute decrease of 3.2 Mt CO_2-eq. The four countries with the largest increases were Finland, Ireland, Greece and Spain with a total absolute increase of 95 kt CO_2-eq.

Main Activity Data for N_2O emissions from Manure Management - Cattle are the animal numbers. Cattle numbers are already discussed under source category 3.A Enteric Fermentation and therefore not further discussed here.

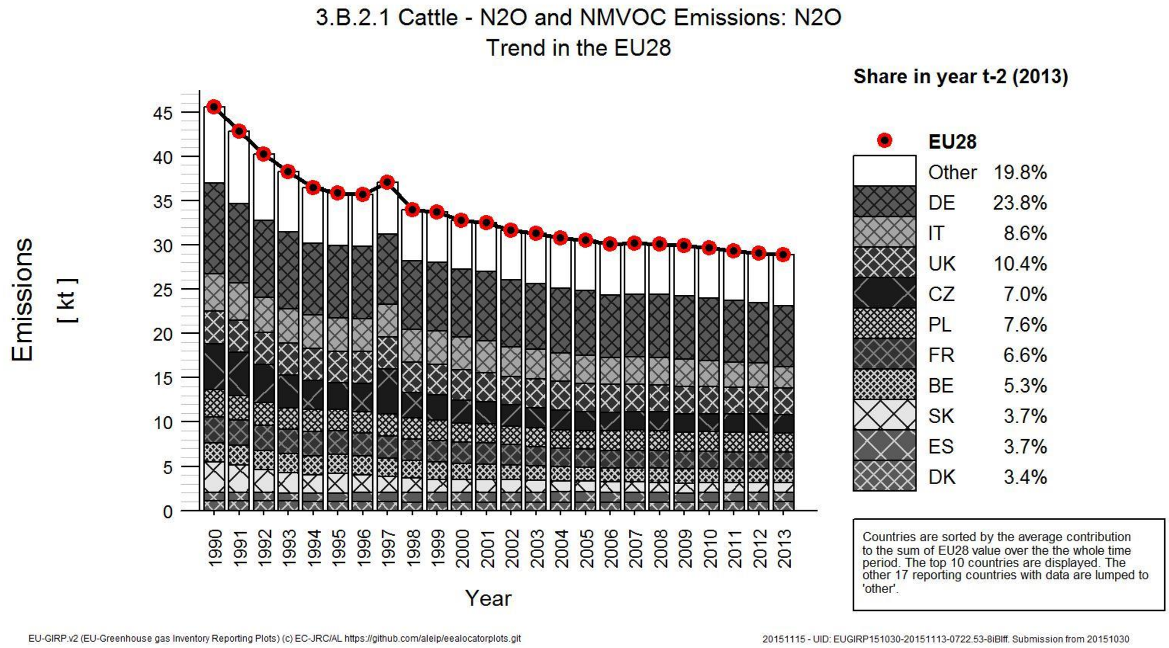
Other activity Data is:

- N-allocation by MMS.

Table 5.27 3.B.2.1 - Cattle: Member States' contributions to total GHG and N_2O emissions

Member State	N2O emissions in kt CO2 equiv.			Share in EU28 emissions in 2013	Change 2012-2013		Change 1990-2013	
	1990	2012	2013		kt CO2 equiv.	%	kt CO2 equiv.	%
Austria	258	264	264	3%	1	0%	6	2%
Belgium	651	457	457	5%	0	0%	-194	-30%
Bulgaria	572	257	260	3%	3	1%	-312	-55%
Croatia	92	34	34	0%	0	-1%	-58	-63%
Cyprus	9	9	9	0%	0	-2%	0	3%
Czech Republic	1 525	606	602	7%	-3	-1%	-922	-60%
Denmark	326	292	295	3%	2	1%	-32	-10%
Estonia	55	26	27	0%	1	5%	-28	-51%
Finland	128	142	140	2%	-1	-1%	12	9%
France	877	563	564	7%	1	0%	-313	-36%
Germany	3 052	2 015	2 042	24%	27	1%	-1 009	-33%
Greece	57	73	74	1%	2	2%	17	31%
Hungary	281	146	150	2%	5	3%	-130	-46%
Ireland	241	253	258	3%	5	2%	17	7%
Italy	1 267	826	738	9%	-88	-11%	-529	-42%
Latvia	125	47	49	1%	2	5%	-75	-60%
Lithuania	204	74	74	1%	0	0%	-131	-64%
Luxembourg	22	17	18	0%	1	3%	-4	-16%
Malta	2	2	2	0%	0	-1%	1	44%
Netherlands	IE	IE	IE	-	-	-	-	-
Poland	918	680	655	8%	-25	-4%	-263	-29%
Portugal	62	54	53	1%	-1	-2%	-9	-15%
Romania	214	101	102	1%	1	1%	-112	-52%
Slovakia	1 032	324	321	4%	-3	-1%	-711	-69%
Slovenia	48	23	22	0%	-1	-2%	-26	-54%
Spain	271	321	320	4%	-1	0%	49	18%
Sweden	179	161	168	2%	6	4%	-11	-6%
United Kingdom	1 107	905	898	10%	-7	-1%	-209	-19%
EU-28	**13 573**	**8 671**	**8 596**	**100%**	**-75**	**-1%**	**-4 976**	**-37%**

Figure 5.35: 3.B.2.1 - Cattle: Trend in emissions in the EU28 and the countries contributing most to EU28 values including their share to EU28 emissions in 2013



3.B.2.1 - Cattle - Emissions

Main Activity Data for N_2O emissions from Manure Management - Cattle are the animal numbers. Cattle numbers are already discussed under source category 3.A Enteric Fermentation and therefore not further discussed here.

Other activity Data:

- N-allocation by MMS.

3.B.2.5 - Manure Management - Indirect Emissions - Emissions

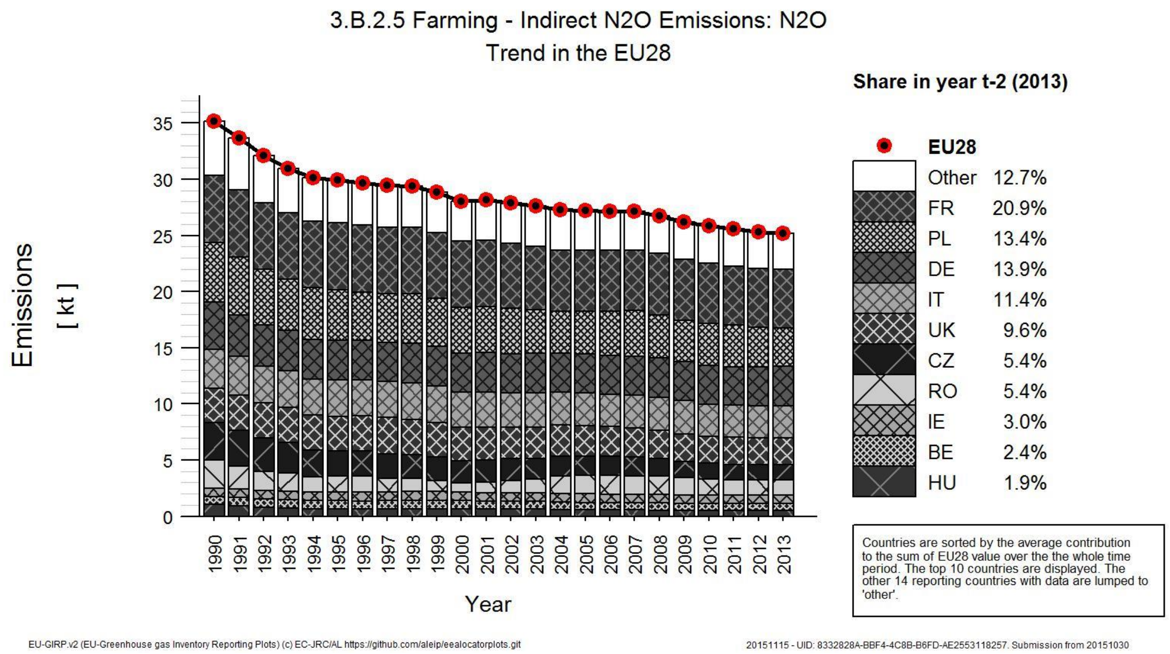
N_2O emissions in source category 3.B.2.5 - Manure Management - Indirect Emissions are 0.17% of total EU28 GHG emissions and 3% of total EU28 N_2O emissions. They make 1.7% of total agricultural emissions.

Total GHG and N_2O emissions by Member States from 3.B.2.5 Manure Management - Indirect Emissions are shown in Table 5.28. Between 1990 and 2013, N_2O emission from Manure Management - Indirect Emissions decreased by 28% or 3 Mt CO_2-eq. The decrease was largest in Bulgaria in relative terms (72%) and in Czech Republic in absolute terms (59% or 583 kt CO_2-eq). From 2012 to 2013 emissions decreased by 0.4%. Figure 5.36 shows the trend of emissions indicating the countries contributing most to EU28 total. The ten countries with highest emissions together accounted for 87.6% of indirect N_2O emissions. Emissions decreased in 20 countries and increased in four countries. The three countries with the largest decreases were Czech Republic, Poland and Romania with a total absolute decrease of 1.5 Mt CO_2-eq. The three countries with the largest increases were Austria, Ireland and Greece with a total absolute increase of 23 kt CO_2-eq. Note that Figure 5.36 shows the then countries contributing most to EU28 total over the whole time period with Hungary contributing with 1.9% while the number above refers to the year 2013 with Greece contributing with 2.2% explaining the slight deviation in the presented numbers.

Table 5.28 3.B.2.5 - Manure Management - Indirect Emissions: Member States' contributions to total GHG and N_2O emissions

Member State	N2O emissions in kt CO2 equiv.			Share in EU28 emissions in 2013	Change 2012-2013		Change 1990-2013	
	1990	2012	2013		kt CO2 equiv.	%	kt CO2 equiv.	%
Austria	107	111	111	1%	0	0%	4	4%
Belgium	218	187	181	2%	-5	-3%	-37	-17%
Bulgaria	3	1	1	0%	0	0%	-2	-72%
Croatia	192	93	94	1%	1	1%	-97	-51%
Cyprus	61	54	49	1%	-5	-10%	-13	-20%
Czech Republic	985	398	402	5%	4	1%	-583	-59%
Denmark	197	152	140	2%	-11	-8%	-57	-29%
Estonia	68	29	30	0%	1	2%	-38	-56%
Finland	99	91	91	1%	0	0%	-8	-8%
France	1 797	1 565	1 568	21%	3	0%	-229	-13%
Germany	1 242	1 035	1 044	14%	9	1%	-199	-16%
Greece	157	166	167	2%	2	1%	10	6%
Hungary	309	145	145	2%	0	0%	-164	-53%
Ireland	216	223	225	3%	3	1%	9	4%
Italy	1 035	852	856	11%	4	0%	-179	-17%
Latvia	142	46	48	1%	2	4%	-95	-67%
Lithuania	230	83	82	1%	-2	-2%	-148	-65%
Luxembourg	21	17	18	0%	0	2%	-3	-14%
Malta	3	3	3	0%	0	-2%	0	14%
Netherlands	NO	NO	NO	-	-	-	-	-
Poland	1 579	1 045	1 008	13%	-37	-4%	-571	-36%
Portugal	110	91	91	1%	-1	-1%	-20	-18%
Romania	745	408	405	5%	-3	-1%	-340	-46%
Slovakia	IE	IE	IE	-	-	-	-	-
Slovenia	43	28	28	0%	0	-1%	-15	-35%
Spain	NE	NE	NE	-	-	-	-	-
Sweden	IE	IE	IE	-	-	-	-	-
United Kingdom	923	716	723	10%	8	1%	-200	-22%
EU-28	**10 483**	**7 538**	**7 509**	**100%**	**-29**	**0%**	**-2 973**	**-28%**

Figure 5.36: 3.B.2.5 - Manure Management - Indirect Emissions: Trend in emissions in the EU28 and the countries contributing most to EU28 values including their share to EU28 emissions in 2013



3.B.2.4 - Other Livestock - Emissions

N_2O emissions in source category 3.B.2.4 - Other Livestock are 0.071% of total EU28 GHG emissions and 1.3% of total EU28 N_2O emissions. They make 0.72% of total agricultural emissions.

Total GHG and N_2O emissions by Member States from 3.B.2.4 Manure Management are shown in Table 5.29. Between 1990 and 2013, N_2O emission from Other Livestock decreased by 8% or 289 kt CO_2-eq. The decrease was largest in Croatia in relative terms (63%) and in Bulgaria in absolute terms (62% or 125 kt CO_2-eq). From 2012 to 2013 emissions increased by 2.8%. Figure 5.37 shows the trend of emissions indicating the countries contributing most to EU28 total. The ten countries with highest emissions together accounted for 85.7% of other Livestock N_2O emissions. Emissions decreased in 17 countries and increased in eleven countries. The four countries with the largest decreases were Bulgaria, Romania, Netherlands and Poland with a total absolute decrease of 450 kt CO_2-eq. Largest increases occurred in Italy and Spain with a total absolute increase of 231 kt CO_2-eq.

Table 5.29 3.B.2.4 - Other Livestock: Member States' contributions to total GHG and N_2O emissions

Member State	N2O emissions in kt CO2 equiv.			Share in EU28 emissions in 2013	Change 2012-2013		Change 1990-2013	
	1990	2012	2013		kt CO2 equiv.	%	kt CO2 equiv.	%
Austria	24	26	26	1%	0	0%	2	7%
Belgium	10	15	15	0%	0	1%	5	49%
Bulgaria	202	82	77	2%	-5	-6%	-125	-62%
Croatia	21	9	8	0%	-1	-12%	-13	-63%
Cyprus	246	212	188	6%	-24	-11%	-58	-23%
Czech Republic	83	54	61	2%	7	12%	-23	-27%
Denmark	46	57	62	2%	5	9%	17	36%
Estonia	12	5	6	0%	1	13%	-6	-51%
Finland	29	38	38	1%	1	1%	10	33%
France	354	371	376	12%	5	1%	22	6%
Germany	198	215	218	7%	3	1%	21	10%
Greece	30	29	29	1%	0	0%	-1	-3%
Hungary	34	26	24	1%	-1	-5%	-10	-29%
Ireland	10	12	12	0%	-1	-5%	1	13%
Italy	292	378	380	12%	2	0%	88	30%
Latvia	22	9	10	0%	1	9%	-12	-57%
Lithuania	8	7	7	0%	0	5%	-1	-7%
Luxembourg	0	1	1	0%	0	-4%	0	32%
Malta	0	0	0	0%	0	-5%	0	-40%
Netherlands	530	411	419	13%	8	2%	-111	-21%
Poland	157	61	58	2%	-3	-6%	-99	-63%
Portugal	60	55	54	2%	0	0%	-6	-9%
Romania	264	143	149	5%	6	4%	-115	-44%
Slovakia	66	54	51	2%	-3	-5%	-15	-23%
Slovenia	34	26	26	1%	0	0%	-8	-23%
Spain	660	718	803	25%	85	12%	143	22%
Sweden	40	45	46	1%	1	2%	6	16%
United Kingdom	45	43	44	1%	1	2%	0	-1%
EU-28	**3 477**	**3 102**	**3 188**	**100%**	**86**	**3%**	**-289**	**-8%**

3.B.2.4.7 - Poultry - Emissions

Largest contribution to emissions comes from sub-category Poultry with 52% of total N_2O emissions. Other animal types with high emissions are Other Other Livestock with a share of 32% and Horses with a share of 11%. Here only the most important animal type Poultry is discussed.

Emissions in source category 3.B.2.4.7 - Poultry decreased clearly in EU28 by 12% or 224 kt CO_2-eq. Figure 5.38 shows the trend of emissions indicating the countries contributing most to EU28 total. The ten countries with highest emissions together accounted for 91.1% of poultry N_2O emissions. Emissions decreased in 17 countries and increased in nine countries. The three countries with the largest decreases were Bulgaria, Romania and Cyprus with a total absolute decrease of 279 kt CO_2-eq. The three countries with the largest increases were Italy, Germany and Spain with a total absolute increase of 157 kt CO_2-eq.

3.A.4.7 - Poultry - Population

As population data for Poultry have not yet been discussed, this will be done here. Poultry population decreased slightly in EU28 by 3.9% or 51.8 mio heads. Figure 5.39 shows the trend of poultry population indicating the countries contributing most to EU28 total. The ten countries with highest population together accounted for 85.5% of Poultry population. Population decreased in 13 countries and increased in fourteen countries. The four countries with the largest decreases were Poland, Romania, Hungary and Bulgaria with a total absolute decrease of 184 mio heads. The four countries with the largest increases were Italy, Spain, United Kingdom and Germany with a total absolute increase of 146 mio heads.

Other activity Data:

- N on MMS

Figure 5.37: 3.B.2.4 - Other Livestock: Trend in emissions in the EU28 and the countries contributing most to EU28 values including their share to EU28 emissions in 2013

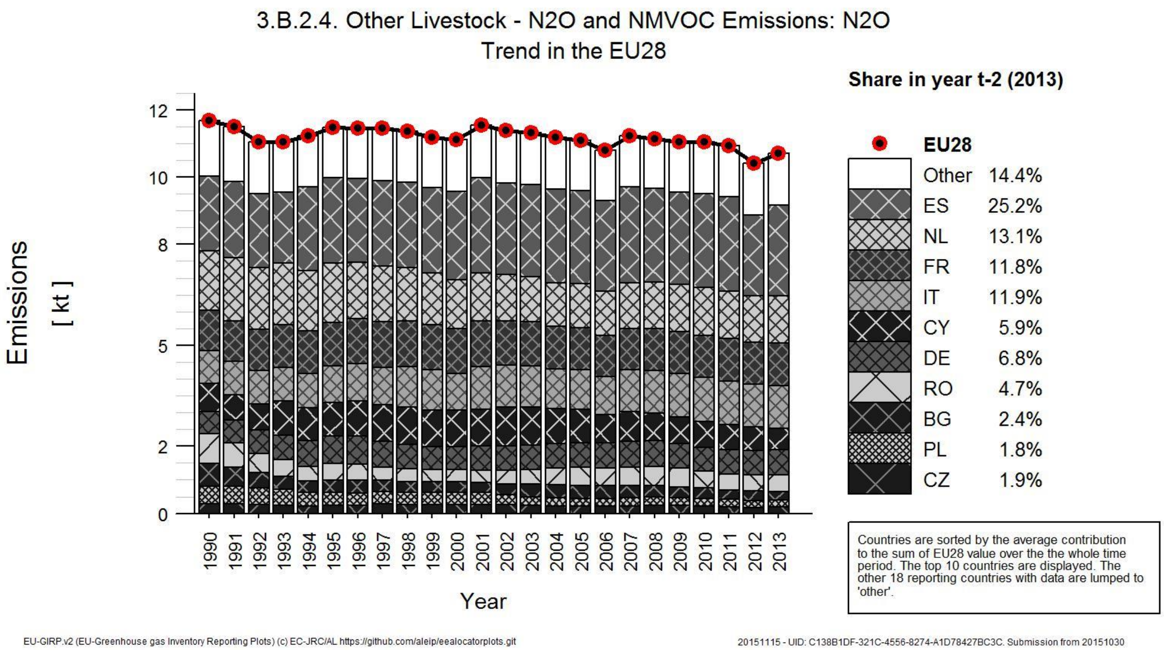


Figure 5.38: 3.B.2.4.7 - Poultry: Trend in emissions in the EU28 and the countries contributing most to EU28 values including their share to EU28 emissions in 2013

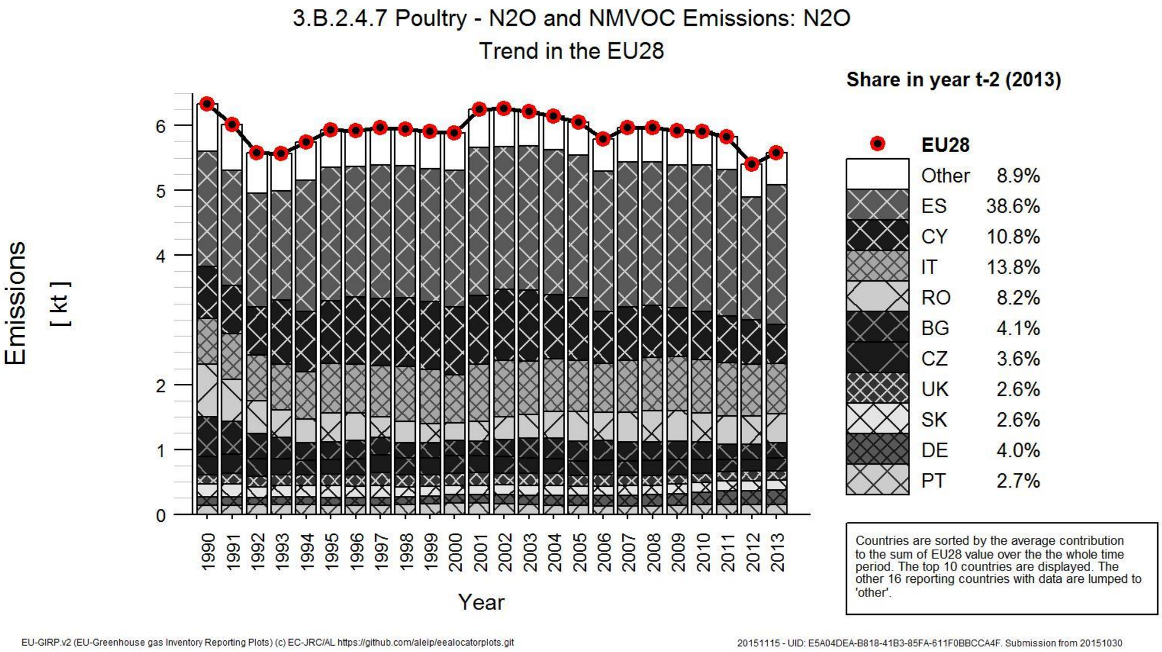
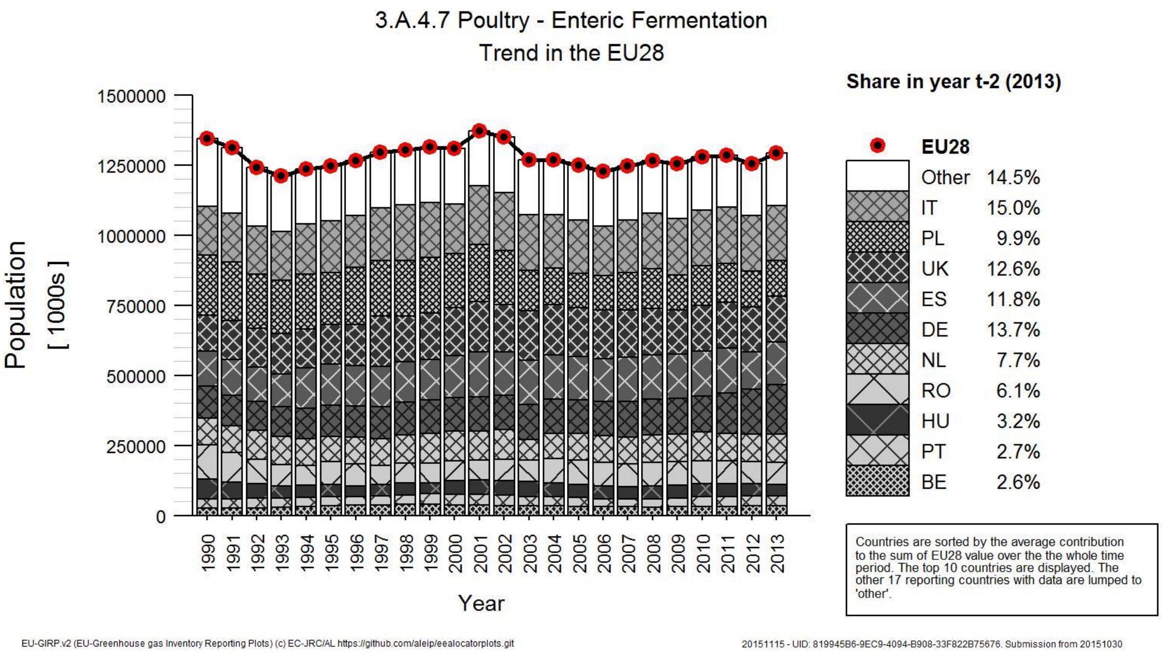


Figure 5.39: 3.A.4.7 - Poultry: Trend in population in the EU28 and the countries contributing most to EU28 values including their share to EU28 emissions in 2013



Implied EFs and Methodological Issues

In this section we discuss the Implied Emission Factor for the main animal types. Furthermore, we present data on the Nitrogen Excretion Rate.

3.B.2.1 - Cattle - Implied emission factor

The implied emission factor for N_2O emissions in source category 3.B.2.1 - Cattle decreased in EU28 clearly by 13.6% or 0.0549 kg/head/year between 1990 and 2013. Figure 5.40 shows the trend of the IEF in EU28 indicating also the range of values used by the countries. Table 5.30 shows the implied emission factor for N_2O emissions in source category 3.B.2.1 - Cattle for the years 1990 and 2013 for all Member States and EU28. The IEF decreased in nine countries and increased in seventeen countries. No data were available for one country. The three countries with the largest decreases were Slovenia, Croatia and France with a mean absolute decrease of 0.1 kg/head/year. The four countries with the largest increases were Finland, Latvia, Estonia and Austria with a mean absolute increase of 0.1 kg/head/year.

Figure 5.40: 3.B.2.1 - Cattle: Trend in implied emission factor in the EU28 and range of values reported by countries

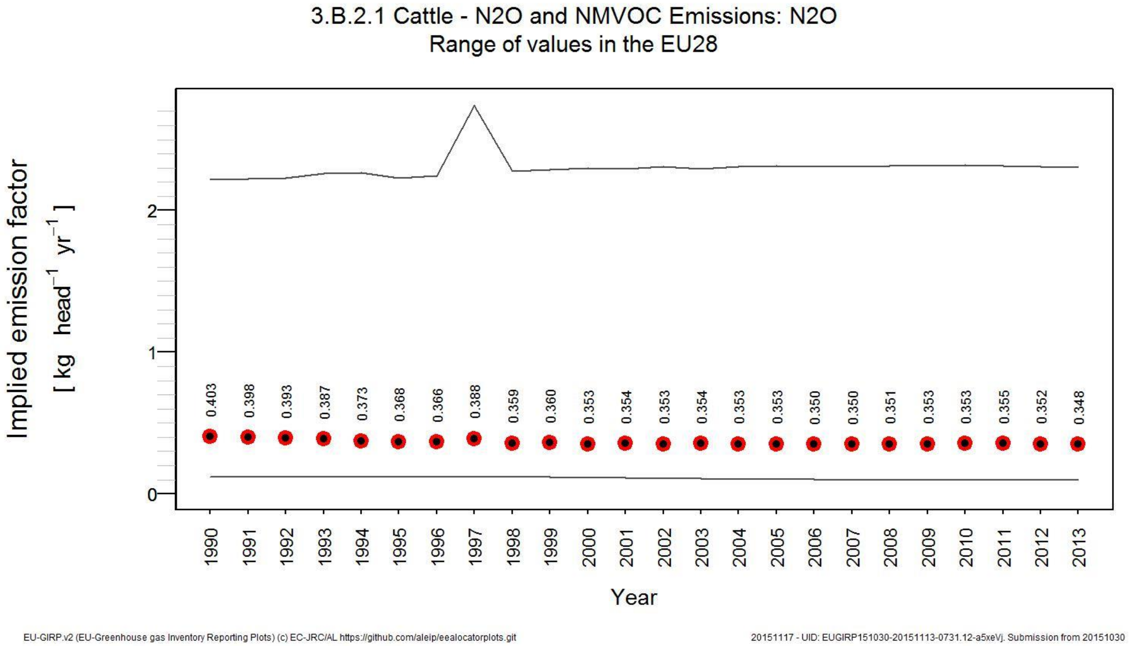


Table 5.30 3.B.2.1 - Cattle: Member States' and EU28 Implied emission factor (kg/head/year)

Member State	1990	2013	Member State	1990	2013
Austria	0.34	0.453	Ireland	0.12	0.126
Belgium	0.67	0.620	Italy	0.55	0.424
Bulgaria	1.20	1.585	Lithuania	0.30	0.346
Cyprus	0.54	0.538	Luxembourg	0.33	0.312
Czech Republic	1.46	1.494	Latvia	0.29	0.409
Germany	0.53	0.540	Malta	0.86	0.844
Denmark	0.49	0.612	Poland	0.31	0.393
Estonia	0.25	0.344	Portugal	0.15	0.118
Spain	0.18	0.187	Romania	0.14	0.171
Finland	0.32	0.516	Sweden	0.35	0.376
France	0.14	0.099	Slovenia	0.30	0.161
Greece	0.28	0.352	Slovakia	2.22	2.305
Croatia	0.36	0.247	United Kingdom		
Hungary	0.58	0.659	**EU28**	**0.40**	**0.348**

3.B.2.1 - Dairy Cattle - Implied emission factor

The implied emission factor for N_2O emissions in source category 3.B.2.1 - Dairy Cattle increased in EU28 slightly by 1.6% or 0.01 kg/head/year between 1990 and 2013. Figure 5.41 shows the trend of the IEF in EU28 indicating also the range of values used by the countries. Table 5.31 shows the implied emission factor for N_2O emissions in source category 3.B.2.1 - Dairy Cattle for the years 1990 and 2013 for all Member States and EU28. The IEF decreased in eight countries and increased in seventeen countries. No data were available for three countries. The largest decreases occurred in France and Croatia with a mean absolute decrease of 0.1 kg/head/year. The four countries with the largest increases were Spain, Greece, Portugal and Finland with a mean absolute increase of 0.3 kg/head/year.

Figure 5.41: 3.B.2.1 - Dairy Cattle: Trend in implied emission factor in the EU28 and range of values reported by countries

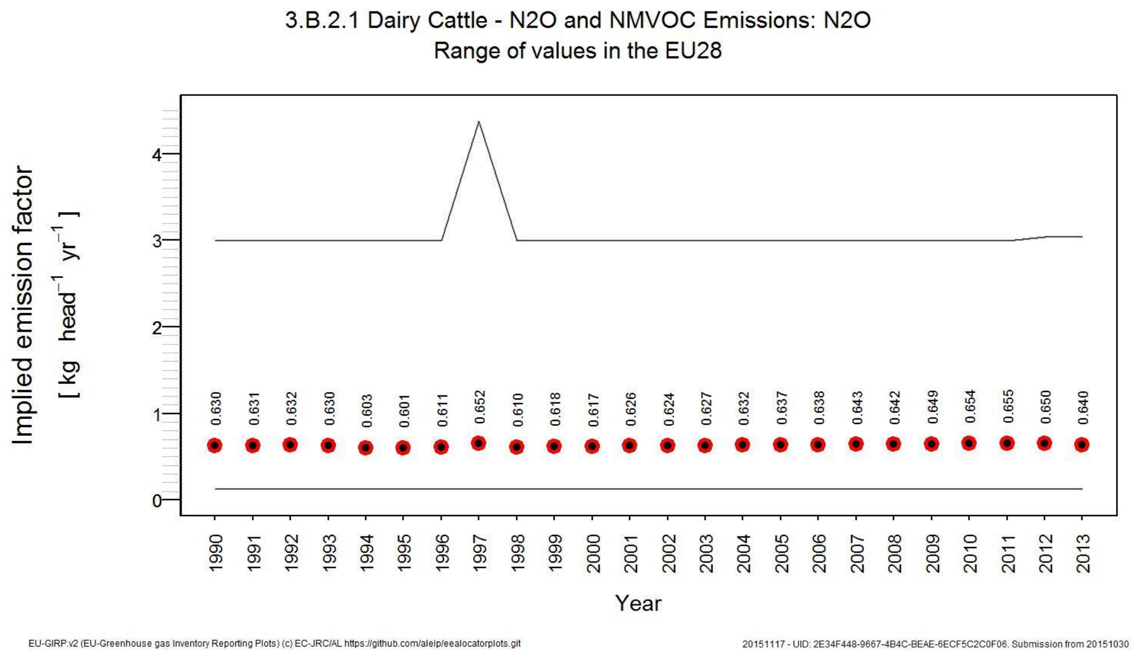


Table 5.31 3.B.2.1 - Dairy Cattle: Member States' and EU28 Implied emission factor (kg/head/year)

Member State	1990	2013	Member State	1990	2013
Austria	0.44	0.69	Ireland	0.13	0.12
Belgium	0.93	0.75	Italy	0.87	0.68
Bulgaria	1.74	1.98	Lithuania	0.39	0.48
Cyprus	0.82	0.79	Luxembourg	0.65	0.68
Czech Republic	2.38	3.04	Latvia	0.47	0.71
Germany	0.83	0.80	Poland	0.40	0.58
Denmark	0.88	1.03	Portugal	0.33	0.53
Estonia	0.38	0.55	Romania	0.17	0.21
Spain	0.41	0.90	Sweden	0.63	0.75
Finland	0.48	0.77	Slovenia	0.32	0.32
France	0.23	0.15	Slovakia	2.99	2.99
Greece	0.36	0.73	United Kingdom	0.00	0.00
Croatia	0.39	0.28	**EU28**	**0.63**	**0.64**
Hungary	0.88	1.06			

3.B.2.1 - Dairy Cattle - Nitrogen excretion rate

The nitrogen excretion rate, a parameter used for calculating N_2O emissions in source category 3.B.2.1 - Dairy Cattle, increased in EU28 considerably by 17.1% or 15.7 kg/head/year between 1990 and 2013. Figure 5.42 shows the trend of the Nitrogen excretion rate in EU28 indicating also the range of values used by the countries. Table 5.32 shows the nitrogen excretion rate in source category 3.B.2.1 - Dairy Cattle for the years 1990 and 2013 for all Member States and EU28. Nitrogen excretion rate decreased in one country and increased in 21 countries. It was in 2013 at the level of 1990 in five countries. No data were available for one country. Decreases occurred in Netherlands with an absolute decrease of 25 kg/head/year. The four countries with the largest increases were Greece, Spain, Finland and Portugal with a mean absolute increase of 40 kg/head/year.

Figure 5.42: *3.B.2.1 - Dairy Cattle: Trend in nitrogen excretion rate in the EU28 and range of values reported by countries*

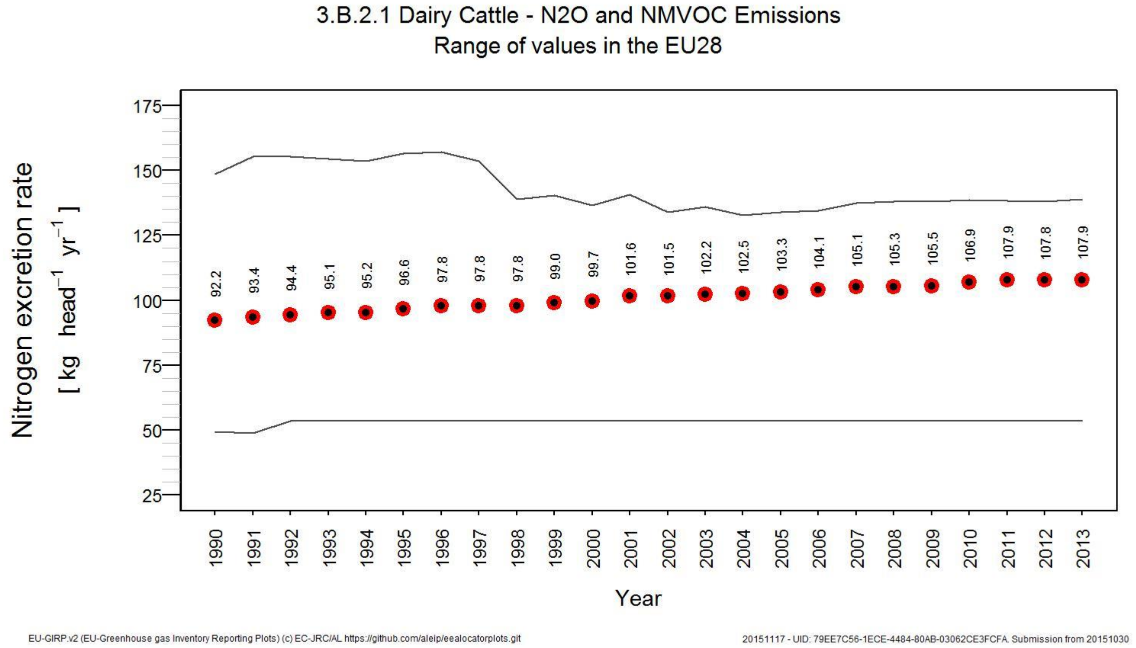


Table 5.32 *3.B.2.1 - Dairy Cattle: Member States' and EU28 Nitrogen excretion rate (kg/head/year)*

Member State	1990	2013		Member State	1990	2013
Austria	77	101	|	Ireland	96	101
Belgium	114	118	|	Italy	116	116
Bulgaria	100	100	|	Lithuania	82	101
Cyprus	96	96	|	Luxembourg	110	126
Czech Republic	102	136	|	Latvia	100	118
Germany	98	117	|	Netherlands	149	123
Denmark	129	139	|	Poland	65	83
Estonia	85	115	|	Portugal	86	117
Spain	69	110	|	Romania	54	54
Finland	91	129	|	Sweden	105	126
France	102	112	|	Slovenia	82	110
Greece	49	101	|	Slovakia	100	100
Croatia	70	88	|	United Kingdom	97	124
Hungary	83	102	|	**EU28**	**92**	**108**

3.B.2.1 - Non-Dairy Cattle - Implied emission factor

The implied emission factor for N_2O emissions in source category 3.B.2.1 - Non-Dairy Cattle decreased in EU28 considerably by 16.8% or 0.0486 kg/head/year between 1990 and 2013. Figure 5.43 shows the trend of the IEF in EU28 indicating also the range of values used by the countries. Table 5.33 shows the implied emission factor for N_2O emissions in source category 3.B.2.1 - Non-Dairy Cattle for the years 1990 and 2013 for all Member States and EU28. The IEF decreased in eleven countries and increased in fourteen countries. It was in 2013 at the level of 1990 in one country. No data were available for two countries. The three countries with the largest decreases were Slovenia, Portugal and Croatia with a mean absolute decrease of 0.1 kg/head/year. The four countries with the largest increases were Finland, Estonia, Austria and Bulgaria with a mean absolute increase of 0.1 kg/head/year.

Figure 5.43: 3.B.2.1 - Non-Dairy Cattle: Trend in implied emission factor in the EU28 and range of values reported by countries

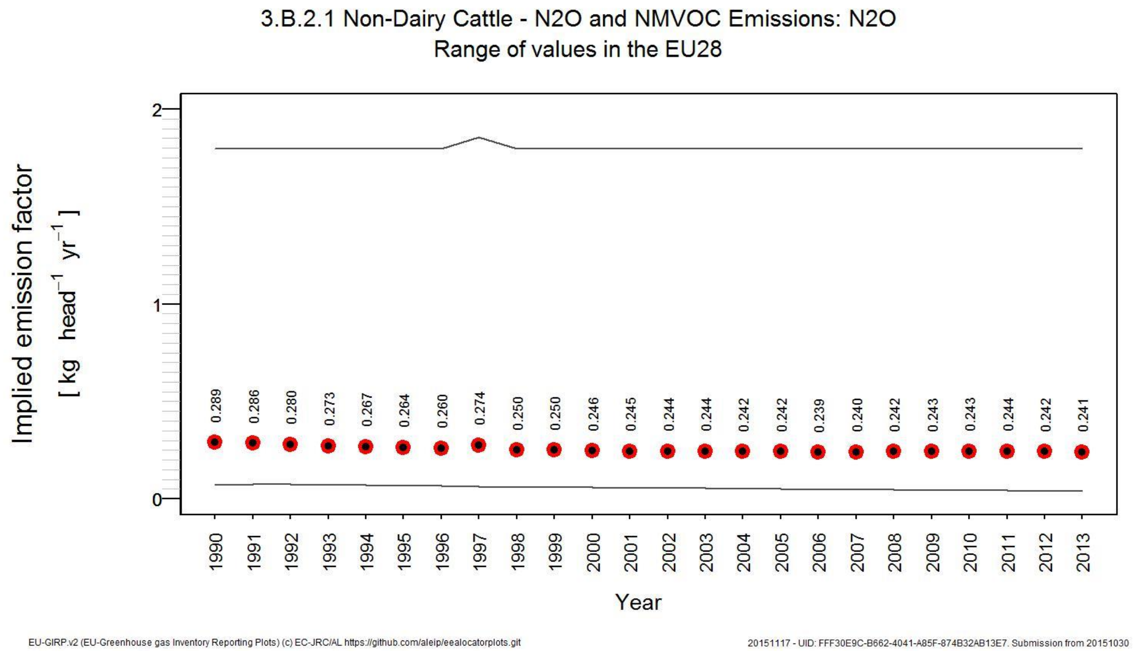


Table 5.33 3.B.2.1 - Non-Dairy Cattle: Member States' and EU28 Implied emission factor (kg/head/year)

Member State	1990	2013		Member State	1990	2013
Austria	0.277	0.363	|	Ireland	0.116	0.127
Belgium	0.581	0.589	|	Italy	0.384	0.306
Bulgaria	0.865	1.126	|	Lithuania	0.243	0.243
Cyprus	0.356	0.345	|	Luxembourg	0.211	0.199
Czech Republic	0.976	0.917	|	Latvia	0.184	0.203
Germany	0.377	0.410	|	Malta	0.861	0.844
Denmark	0.292	0.378	|	Poland	0.215	0.244
Estonia	0.169	0.224	|	Portugal	0.078	0.041
Spain	0.071	0.065	|	Romania	0.092	0.117
Finland	0.223	0.402	|	Sweden	0.209	0.264
France	0.105	0.087	|	Slovenia	0.290	0.112
Greece	0.240	0.264	|	Slovakia	1.796	1.796
Croatia	0.323	0.227	|	United Kingdom	0.000	0.000
Hungary	0.422	0.468	|	**EU28**	**0.289**	**0.241**

3.B.2.1 - Non-Dairy Cattle - Nitrogen excretion rate

The nitrogen excretion rate, a parameter used for calculating N_2O emissions in source category 3.B.2.1 - Non-Dairy Cattle, increased in EU28 slightly by 4.8% or 2.25 kg/head/year between 1990 and 2013. Figure 5.44 shows the trend of the Nitrogen excretion rate in EU28 indicating also the range of values used by the countries. Table 5.34 shows the nitrogen excretion rate in source category 3.B.2.1 - Non-Dairy Cattle for the years 1990 and 2013 for all Member States and EU28. Nitrogen excretion rate decreased in four countries and increased in twenty countries. It was in 2013 at the level of 1990 in four countries. The largest decrease occurred in Netherlands with an absolute decrease of 17 kg/head/year. The largest increase occurred in Finland with an absolute increase of 16 kg/head/year.

Figure 5.44: 3.B.2.1 - Non-Dairy Cattle: Trend in nitrogen excretion rate in the EU28 and range of values reported by countries

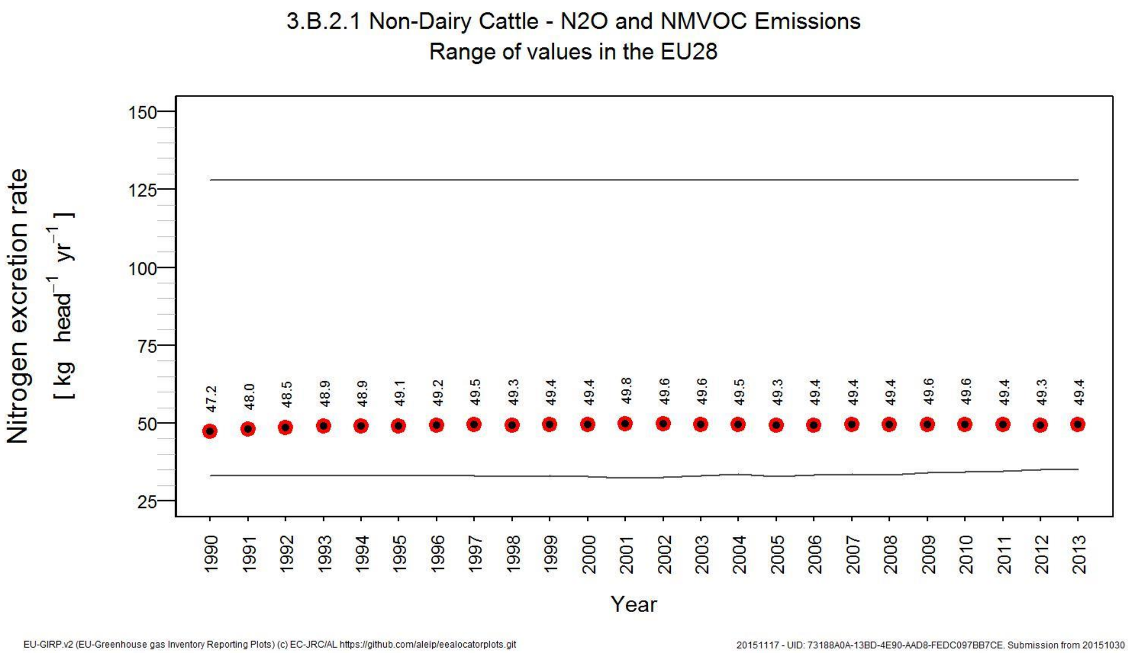


Table 5.34 3.B.2.1 - Non-Dairy Cattle: Member States' and EU28 Nitrogen excretion rate (kg/head/year)

Member State	1990	2013		Member State	1990	2013
Austria	40	46	|	Italy	50	51
Belgium	54	54	|	Lithuania	41	41
Bulgaria	50	57	|	Luxembourg	47	50
Cyprus	42	42	|	Latvia	43	46
Czech Republic	59	69	|	Malta	128	128
Germany	41	43	|	Netherlands	57	40
Denmark	36	44	|	Poland	33	35
Estonia	38	41	|	Portugal	44	50
Spain	43	43	|	Romania	38	38
Finland	34	51	|	Sweden	39	42
France	57	59	|	Slovenia	35	42
Greece	48	53	|	Slovakia	60	60
Croatia	55	50	|	United Kingdom	53	54
Hungary	44	50	|	**EU28**	**47**	**49**
Ireland	49	51	|			

3.B.2.5 - Atmospheric deposition from Manure Management - Implied emission factor

The implied emission factor for N_2O emissions in source category 3.B.2.5 - Atmospheric deposition from Manure Management decreased in EU28 barely by 0.22% or 3.53e-05 kg N_2O/kg N between 1990 and 2013. Figure 5.45 shows the trend of the IEF in EU28 indicating also the range of values used by the countries. Table 5.35 shows the implied emission factor for N_2O emissions in source category 3.B.2.5 - Atmospheric deposition from Manure Management for the years 1990 and 2013 for all Member States and EU28. The IEF decreased in three countries and increased in five countries. It was in 2013 at the level of 1990 in sixteen countries. No data were available for four countries. Decreases occurred in Poland, Germany and Bulgaria with a mean absolute decrease of 2.3e-06 kg N_2O/kg N. The largest increase occurred in Malta with an absolute increase of 0.0037 kg N_2O/kg N.

Figure 5.45: 3.B.2.5 - Atmospheric deposition from Manure Management: Trend in implied emission factor in the EU28 and range of values reported by countries

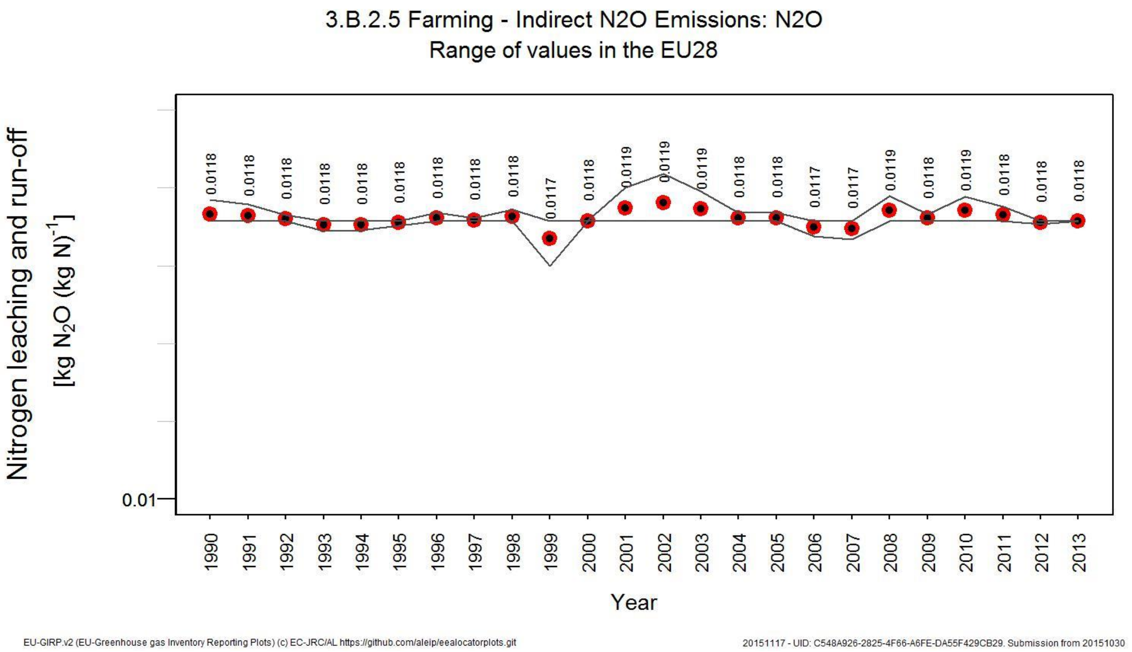


Table 5.35 3.B.2.5 - Atmospheric deposition from Manure Management: Member States' and EU28 Implied emission factor (kg N_2O/kg N)

Member State	1990	2013	Member State	1990	2013
Austria	0.016	0.016	Ireland	0.016	0.016
Belgium	0.016	0.016	Italy	0.016	0.016
Bulgaria	0.016	0.016	Lithuania	0.016	0.016
Cyprus	0.016	0.016	Luxembourg	0.016	0.016
Czech Republic	0.016	0.016	Latvia	0.016	0.016
Germany	0.016	0.016	Malta	0.012	0.016
Denmark	0.016	0.016	Poland	0.016	0.016
Estonia	0.016	0.016	Portugal	0.016	0.016
Finland	0.016	0.016	Romania	0.016	0.016
France	0.016	0.016	Slovenia	0.016	0.016
Greece	0.016	0.016	United Kingdom	0.016	0.016
Croatia	0.025	0.025	**EU28**	**0.016**	**0.016**
Hungary	0.016	0.016			

3.B.2.4.7 - Poultry - Implied emission factor

The implied emission factor for N_2O emissions in source category 3.B.2.4.7 - Poultry decreased in EU28 moderately by 7.7% or 0.000392 kg/head/year between 1990 and 2013. Figure 5.46 shows the trend of the IEF in EU28 indicating also the range of values used by the countries. Table 5.36 shows the implied emission factor for N_2O emissions in source category 3.B.2.4.7 - Poultry for the years 1990 and 2013 for all Member States and EU28. The IEF decreased in seventeen countries and increased in eight countries. It was in 2013 at the level of 1990 in one country. No data were available for two countries. The three countries with the largest decreases were Finland, Latvia and Denmark with a mean absolute decrease of 0.00096 kg/head/year. The largest increase occurred in Luxembourg with an absolute increase of 0.0013 kg/head/year.

Figure 5.46: 3.B.2.4.7 - Poultry: Trend in implied emission factor in the EU28 and range of values reported by countries

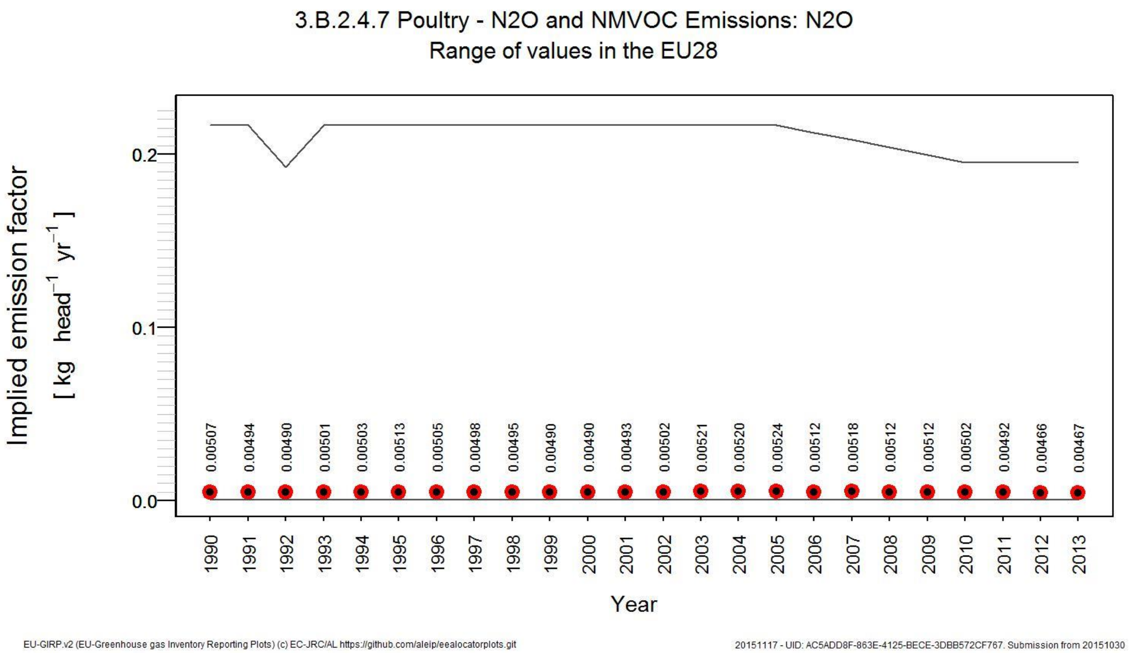


Table 5.36 3.B.2.4.7 - Poultry: Member States' and EU28 Implied emission factor (kg/head/year)

Member State	1990	2013		Member State	1990	2013
Austria	0.00462	0.00393	|	Italy	0.00409	0.00397
Belgium	0.00094	0.00095	|	Lithuania	0.00053	0.00060
Bulgaria	0.01585	0.01605	|	Luxembourg	0.00431	0.00560
Cyprus	0.21681	0.19515	|	Latvia	0.00377	0.00233
Czech Republic	0.00872	0.00872	|	Malta	0.00107	0.00106
Germany	0.00110	0.00125	|	Poland	0.00078	0.00076
Denmark	0.00112	0.00082	|	Portugal	0.00435	0.00432
Estonia	0.00337	0.00332	|	Romania	0.00662	0.00574
Spain	0.01424	0.01410	|	Sweden	0.00435	0.00399
Finland	0.00288	0.00173	|	Slovenia	0.00999	0.01091
Greece	0.00085	0.00085	|	Slovakia	0.01205	0.01344
Croatia	0.00507	0.00438	|	United Kingdom	0.00113	0.00089
Hungary	0.00135	0.00142	|	**EU28**	**0.00507**	**0.00467**
Ireland	0.00109	0.00102	|			

3.B.2.4.7 - Poultry - Nitrogen excretion rate

The nitrogen excretion rate, a parameter used for calculating N_2O emissions in source category 3.B.2.4.7 - Poultry, decreased in EU28 slightly by 4.9% or 0.031 kg/head/year between 1990 and 2013. Figure 5.47 shows the trend of the Nitrogen excretion rate in EU28 indicating also the range of values used by the countries. Table 5.37 shows the nitrogen excretion rate in source category 3.B.2.4.7 - Poultry for the years 1990 and 2013 for all Member States and EU28. Nitrogen excretion rate decreased in ten countries and increased in ten countries. It was in 2013 at the level of 1990 in seven countries. No data were available for one country. The three countries with the largest decreases were Denmark, United Kingdom and Netherlands with a mean absolute decrease of 0.1

kg/head/year. The largest increase occurred in Luxembourg with an absolute increase of 0.2 kg/head/year.

Figure 5.47: 3.B.2.4.7 - Poultry: Trend in nitrogen excretion rate in the EU28 and range of values reported by countries

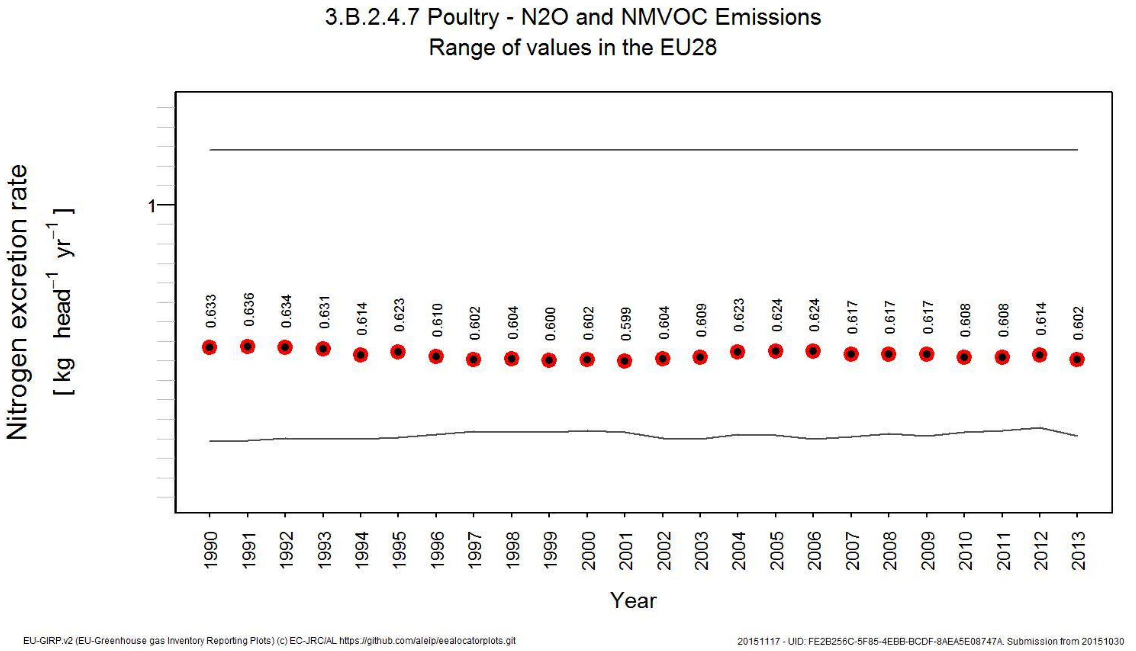


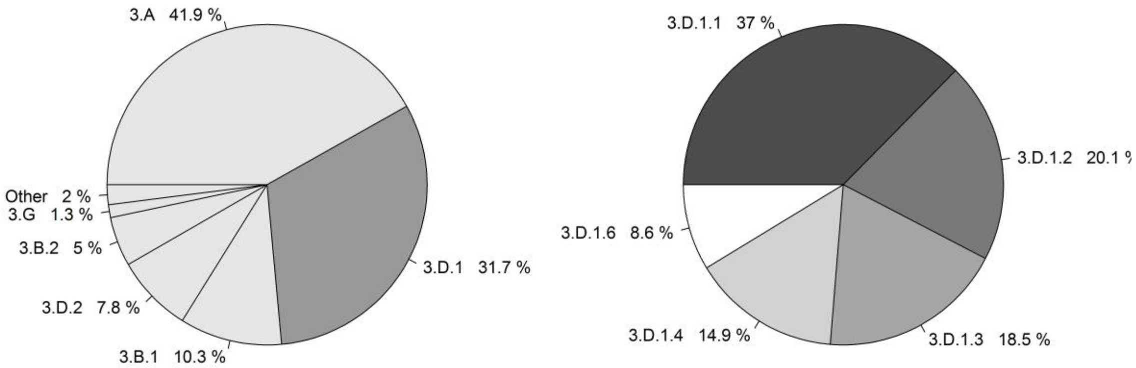
Table 5.37 3.B.2.4.7 - Poultry: Member States' and EU28 Nitrogen excretion rate (kg/head/year)

Member State	1990	2013	Member State	1990	2013
Austria	0.59	0.54	Italy	0.52	0.51
Belgium	0.60	0.60	Lithuania	0.39	0.41
Bulgaria	0.94	0.93	Luxembourg	0.55	0.71
Cyprus	0.91	0.91	Latvia	0.60	0.60
Czech Republic	0.60	0.60	Malta	0.87	0.87
Germany	0.69	0.71	Netherlands	0.68	0.61
Denmark	0.63	0.50	Poland	0.50	0.53
Estonia	0.44	0.43	Portugal	0.55	0.56
Spain	0.45	0.45	Romania	1.14	1.14
Finland	0.50	0.55	Sweden	0.46	0.42
Greece	0.50	0.50	Slovenia	0.47	0.51
Croatia	0.85	0.85	Slovakia	0.74	0.76
Hungary	0.48	0.56	United Kingdom	0.73	0.58
Ireland	0.60	0.54	**EU28**	**0.63**	**0.60**

5.2.3 Direct Emissions from Managed Soils - N_2O (CRF Source Category 3D1)

N_2O emissions from source category 3.D.1 Direct N_2O Emissions From Managed Soils are 3.1% of total EU28 GHG emissions and 56% of total EU28 N_2O emissions. They make 31.7% of total agricultural emissions. The main sub-categories are 3.D.1.1 (Inorganic N Fertilizers), 3.D.1.2 (Organic N Fertilizers) and 3.D.1.3 (Urine and Dung Deposited by Grazing Animals) as shown in Figure 5.48.

Figure 5.48: Share of source category 3.D.1 on total EU28 agricultural emissions (left panel) and decomposition into its sub-categories (right panel). The percentages refer to the emission in the year 2013.



Total GHG and N_2O emissions by Member States from 3.D.1 Direct N_2O Emissions From Managed Soils are shown in Table 5.38. Between 1990 and 2013, N_2O emission from Direct N_2O Emissions From Managed Soils decreased by 18% or 30.6 Mt CO_2-eq. The decrease was largest in Cyprus in relative terms (70%) and in Netherlands in absolute terms (40% or 3 Mt CO_2-eq). From 2012 to 2013 emissions increased by 1.3%.

Table 5.38 3.D.1 - Direct N_2O Emissions From Managed Soils : Member States' contributions to total GHG and N_2O emissions

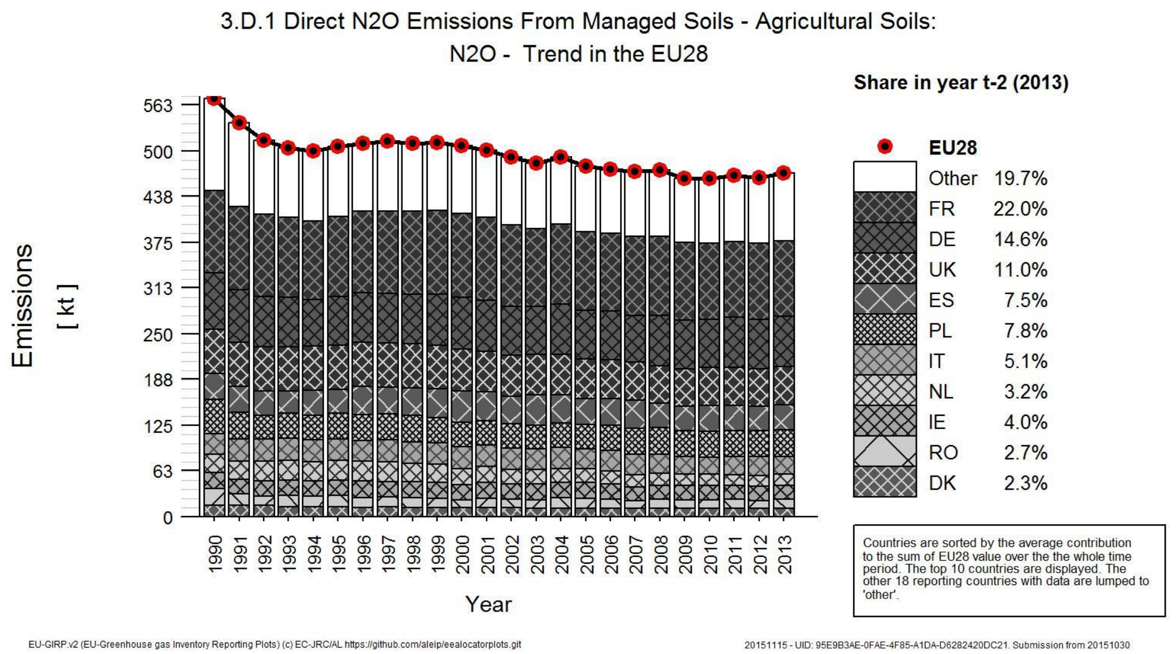
Member State	N2O emissions in kt CO2 equiv.			Share in EU28 emissions in 2013	Change 2012-2013		Change 1990-2013		Method applied	Emission factor
	1990	2012	2013		kt CO2 equiv.	%	kt CO2 equiv.	%		
Austria	1 717	1 472	1 452	1%	-19	-1%	-265	-15%	NA	NA
Belgium	3 332	2 527	2 552	2%	25	1%	-780	-23%	T1	D
Bulgaria	4 214	2 112	2 368	2%	257	12%	-1 846	-44%	T1	D
Croatia	1 162	901	828	1%	-73	-8%	-334	-29%	T1	D
Cyprus	63	27	19	0%	-8	-31%	-44	-70%	T1	D
Czech Republic	3 852	2 124	2 220	2%	97	5%	-1 631	-42%	T1,T2	CS,D
Denmark	4 500	3 175	3 277	2%	102	3%	-1 223	-27%	CS,D,T1,T2	D
Estonia	854	454	439	0%	-16	-3%	-415	-49%	CS,T1,T2	D
Finland	3 277	2 947	2 958	2%	12	0%	-319	-10%	T1,T2	CS,D
France	33 678	31 006	30 755	22%	-252	-1%	-2 923	-9%	NA	NA
Germany	22 927	20 279	20 422	15%	143	1%	-2 505	-11%	T1	D
Greece	3 554	2 430	2 468	2%	38	2%	-1 086	-31%	T1	D
Hungary	3 253	2 493	2 769	2%	276	11%	-484	-15%	T1	D
Ireland	6 581	5 872	5 633	4%	-238	-4%	-948	-14%	T1	D
Italy	8 482	7 627	7 088	5%	-539	-7%	-1 394	-16%	CS,T1	CS,D
Latvia	1 794	1 043	1 059	1%	16	1%	-735	-41%	T1	D
Lithuania	2 486	2 023	2 001	1%	-22	-1%	-484	-19%	T1	D
Luxembourg	148	118	120	0%	2	2%	-28	-19%	T1	D
Malta	14	14	14	0%	0	1%	0	-1%	T1	D
Netherlands	7 479	4 498	4 518	3%	20	0%	-2 961	-40%	T1,T1b,T2	CS,D
Poland	13 795	10 653	10 950	8%	298	3%	-2 845	-21%	T1	CS,D
Portugal	1 833	1 649	1 735	1%	86	5%	-98	-5%	T1	D
Romania	6 715	3 110	3 760	3%	649	21%	-2 955	-44%	T1	D
Slovakia	2 569	1 357	1 425	1%	68	5%	-1 144	-45%	T1b,T2	CS,D
Slovenia	324	314	312	0%	-2	-1%	-12	-4%	T1	D
Spain	10 546	9 843	10 419	7%	575	6%	-127	-1%	CS,T1a,T1b	D
Sweden	3 109	2 550	2 819	2%	269	11%	-290	-9%	NA	NA
United Kingdom	18 077	15 287	15 368	11%	81	1%	-2 708	-15%	T1,T1a	D
EU-28	**170 332**	**137 906**	**139 750**	**100%**	**1 844**	**1%**	**-30 583**	**-18%**		

Trends in Emissions and Activity Data

3.D.1 - Direct N_2O Emissions From Managed Soils - Emissions

Emissions in source category 3.D.1 - Direct N_2O Emissions From Managed Soils decreased considerably in EU28 by 18% or 30.6 Mt CO_2-eq. Figure 5.49 shows the trend of emissions indicating the countries contributing most to EU28 total. The ten countries with highest emissions together accounted for 80.3% of direct N_2O emissions. Emissions decreased in all 28 countries. The three countries with the largest decreases were Netherlands, Romania and France with a total absolute decrease of 8.8 Mt CO_2-eq.

Figure 5.49: 3.D.1 Direct N_2O Emissions From Managed Soils: Trend in emissions in the EU28 and the countries contributing most to EU28 values including their share to EU28 emissions in 2013



The main driving force of direct N_2O emissions from agricultural soils is the use of nitrogen fertiliser and animal manure, which were 25% and 16% below 1990 levels in 2013, respectively. N_2O emissions from agricultural land can be decreased by overall efficiency improvements of nitrogen uptake by crops, which should lead to lower fertiliser consumption on agricultural land. The decrease of fertiliser use is partly due to the effects of the 1992 reform of the common agricultural policy and the resulting shift from production-based support mechanisms to direct area payments in arable production. This has tended to lead to an optimisation and overall reduction in fertiliser use. In addition, reduction in fertiliser use is also due to directives such as the nitrate directive and to the extensification measures included in the agro-environment programmes (EC, 2001).

3.D.1.1 - Direct N_2O Emissions From Managed Soils Inorganic N Fertilizers - Emissions

Emissions in source category 3.D.1.1 - Direct N_2O Emissions From Managed Soils Inorganic N Fertilizers decreased strongly in EU28 by 26% or 17.7 Mt CO_2-eq. Figure 5.50 shows the trend of emissions indicating the countries contributing most to EU28 total. The ten countries with highest emissions together accounted for 81.4% of direct N_2O emissions. Emissions decreased in 26 countries and increased in two countries. The three countries with the largest decreases were Germany, France and United Kingdom with a total absolute decrease of 6.8 Mt CO_2-eq. Emissions increased in Slovenia and Malta with a total absolute increase of 2 kt CO_2-eq.

3.D.1.1 - Direct N_2O Emissions From Inorganic N Fertilizers - N input from application of inorganic fertilizers to cropland and grassland

N input from application of inorganic fertilizers to cropland and grassland decreased strongly in EU28 by 25% or 3.7 kt N/year. Figure 5.51 shows the trend of N input from application of inorganic fertilizers to cropland and grassland indicating the countries contributing most to EU28 total. The ten countries with highest N input from application of inorganic fertilizers to cropland and grassland together accounted for 81.5% of Direct N_2O Emissions From Managed Soils N input from application of inorganic fertilizers to cropland and grassland. N input from application of inorganic fertilizers to cropland and grassland decreased in 26 countries and increased in two countries. The three countries with the largest decreases were Germany, France and United Kingdom with a total absolute decrease of 1.4 kt N/year. N input from application of inorganic fertilizers to cropland and grassland increased in Slovenia and Malta with a total absolute increase of 0.4 kt N/year.

Figure 5.50: 3.D.1.1 - Direct N_2O Emissions From Managed Soils Inorganic N Fertilizers: Trend in emissions in the EU28 and the countries contributing most to EU28 values including their share to EU28 emissions in 2013

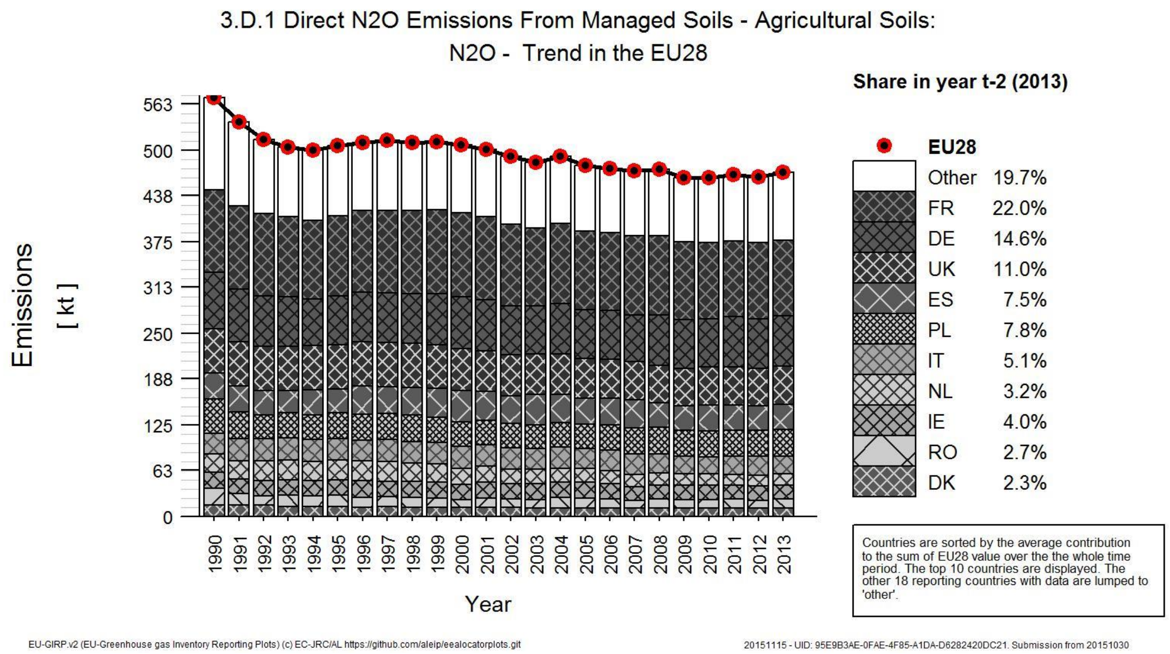
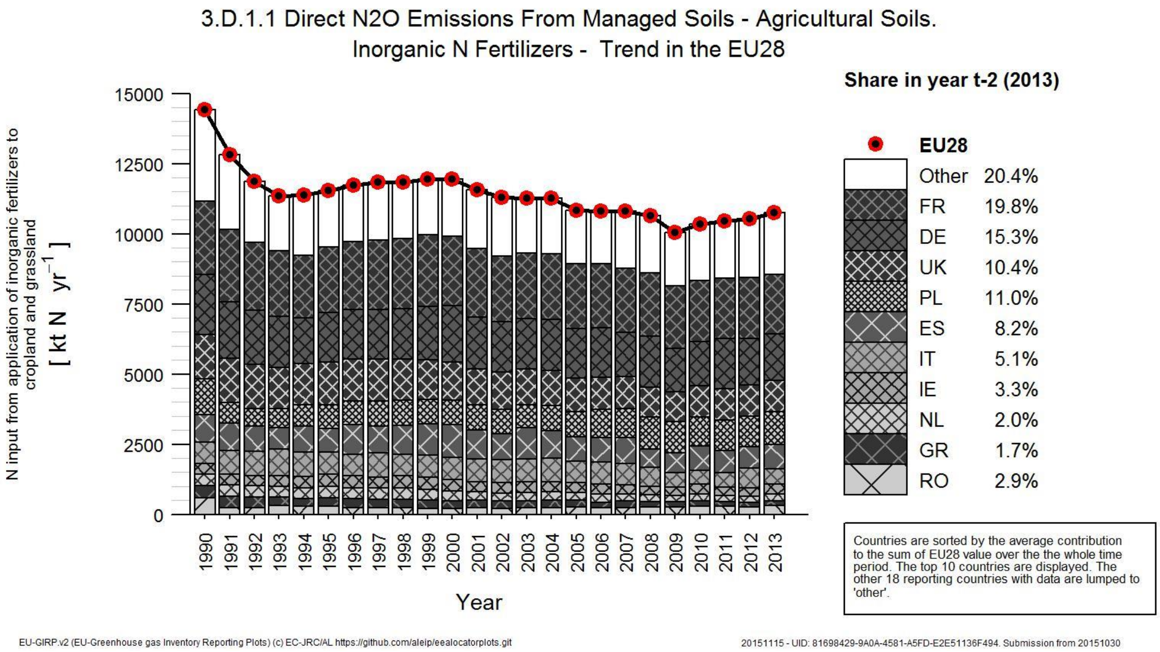


Figure 5.51: 3.D.1.1 - Direct N_2O Emissions From Inorganic N Fertilizers: Trend in N input from application of inorganic fertilizers to cropland and grassland in the EU28 and the countries contributing most to EU28 values including their share to EU28 emissions in 2013



3.D.1.2 - Direct N_2O Emissions From Managed Soils Organic N Fertilizers - Emissions

Emissions in source category 3.D.1.2 - Direct N_2O Emissions From Managed Soils Organic N Fertilizers decreased clearly in EU28 by 13% or 4.3 Mt CO_2-eq. Figure 5.52 shows the trend of emissions indicating the countries contributing most to EU28 total. The ten countries with highest emissions together accounted for 84.7% of direct N_2O emissions. Emissions decreased in 21 countries and increased in six countries. The five countries with the largest decreases were Romania, Poland, France, Bulgaria and Czech Republic with a total absolute decrease of 3.5 Mt CO_2-eq. The three countries with the largest increases were Germany, Netherlands and Spain with a total absolute increase of 1.2 Mt CO_2-eq.

3.D.1.2 - Direct N_2O Emissions From Organic N Fertilizers - N input from organic N fertilizers to cropland and grassland

N input from organic N fertilizers to cropland and grassland decreased considerably in EU28 by 16% or 988 kt N/year. Figure 5.52 shows the trend of N input from organic N fertilizers to cropland and grassland indicating the countries contributing most to EU28 total. The ten countries with highest N input from organic N fertilizers to cropland and grassland together accounted for 81.1% of Direct N_2O Emissions From Managed Soils N input from organic N fertilizers to cropland and grassland. N input from organic N fertilizers to cropland and grassland decreased in 22 countries and increased in five countries. The four countries with the largest decreases were Romania, Poland, Netherlands and Bulgaria with a total absolute decrease of 604 kt N/year. Largest increases occurred in Germany and Spain with a total absolute increase of 141 kt N/year.

Figure 5.52: 3.D.1.2 - Direct N2O Emissions From Managed Soils Organic N Fertilizers: Trend in emissions in the EU28 and the countries contributing most to EU28 values including their share to EU28 emissions in 2013

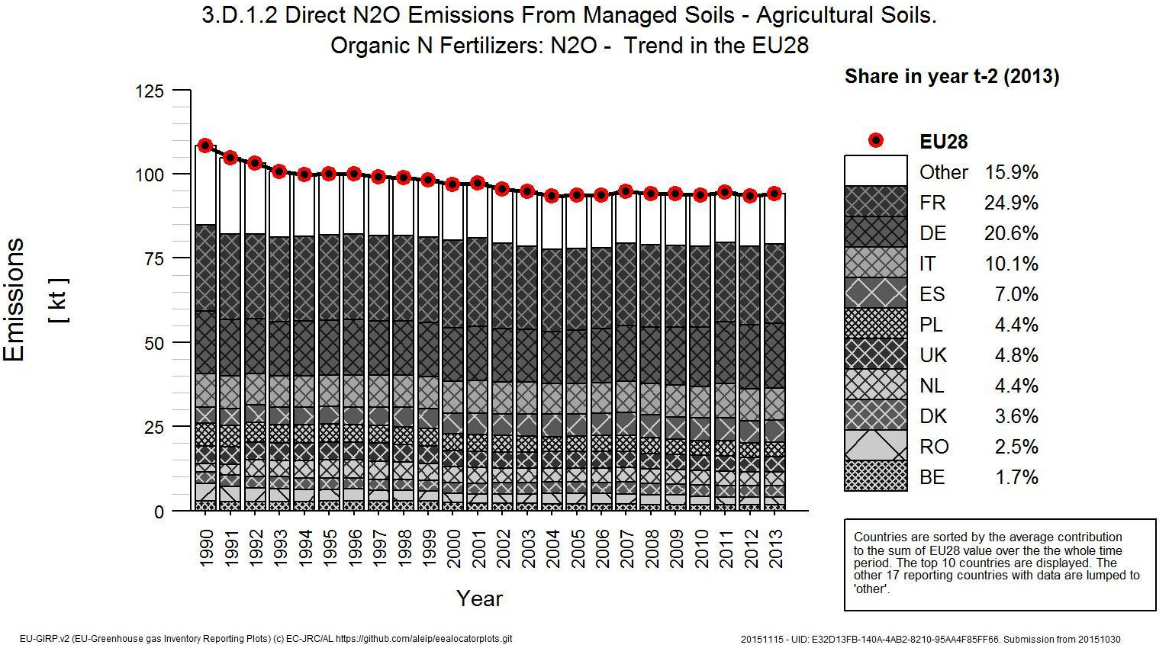
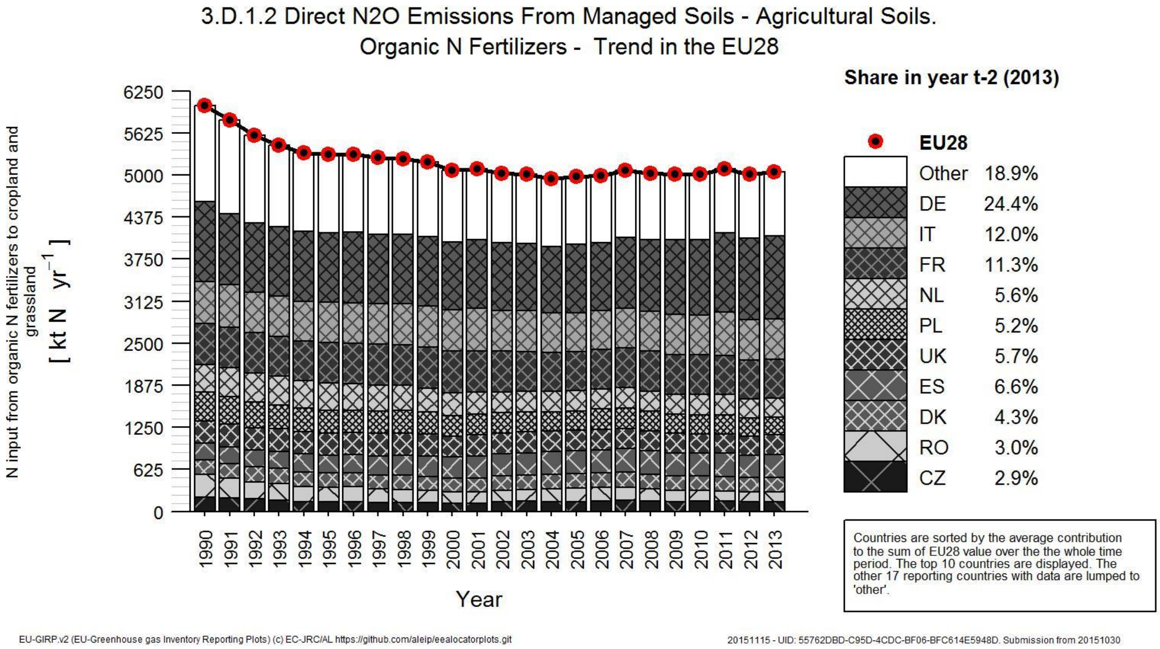


Figure 5.53: 3.D.1.2 - Direct N2O Emissions From Managed Soils Organic N Fertilizers: Trend in emissions in the EU28 and the countries contributing most to EU28 values including their share to EU28 emissions in 2013



3.D.1.3 - Urine and Dung Deposited by Grazing Animals Grazing Animals - Emissions

N_2O emissions in source category 3.D.1.3 - Urine and Dung Deposited by Grazing Animals Grazing Animals are 0.58% of total EU28 GHG emissions and 10% of total EU28 N_2O emissions. They make 5.9% of total agricultural emissions.

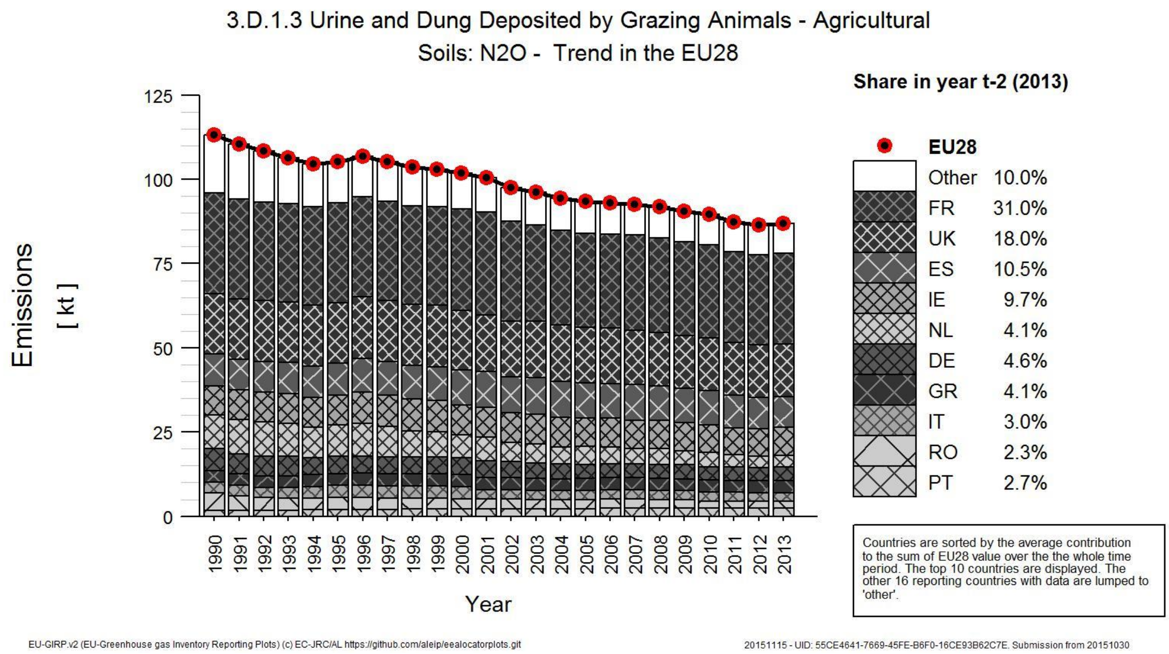
Total GHG and N_2O emissions by Member States from 3.D.1.3 Grazing Animals are shown in Table 5.39. Between 1990 and 2013, N_2O emission from Urine and Dung Deposited by Grazing Animals decreased by 23% or 7.8 Mt CO_2-eq. The decrease was largest in Latvia in relative terms (76%) and in Netherlands in absolute terms (65% or 2 Mt CO_2-eq). From 2012 to 2013 emissions increased by

0.4%. Figure 5.54 shows the trend of emissions indicating the countries contributing most to EU28 total. The ten countries with highest emissions together accounted for 90% of urine and Dung Deposited by Grazing Animals N_2O emissions. Emissions decreased in 23 countries and increased in three countries. The three countries with the largest decreases were Netherlands, Romania and France with a total absolute decrease of 3.7 Mt CO_2-eq. Largest increases occurred in Slovenia and Portugal with a total absolute increase of 178 kt CO_2-eq.

Table 5.39 3.D.1.3 - Urine and Dung Deposited by Grazing Animals Grazing Animals: Member States' contributions to total GHG and N_2O emissions

Member State	N2O emissions in kt CO2 equiv.			Share in EU28 emissions in 2013	Change 2012-2013		Change 1990-2013		Change 1995-2013		Method applied	Emission factor
	1990	2012	2013		kt CO2 equiv.	%	kt CO2 equiv.	%	kt CO2 equiv.	%		
Austria	149	73	72	0%	-1	-1%	-77	-52%	-59	-45%	-	-
Belgium	711	508	495	2%	-13	-3%	-216	-30%	-237	-32%	T1	D
Bulgaria	585	150	148	1%	-2	-1%	-436	-75%	-159	-52%	T1	D
Croatia	155	85	77	0%	-8	-10%	-78	-51%	-16	-17%	T1	D
Cyprus	NE	NE	NE	-	-	-	-	-	-	-	NA	NA
Czech Republic	262	224	227	1%	3	1%	-36	-14%	8	4%	T1	D
Denmark	299	182	185	1%	3	2%	-114	-38%	-128	-41%	T1	D
Estonia	182	69	72	0%	3	5%	-110	-60%	-19	-21%	CS,T2	D
Finland	151	110	109	0%	-1	-1%	-42	-28%	-18	-14%	T1	D
France	8 866	7 983	8 032	31%	49	1%	-834	-9%	-763	-9%	-	-
Germany	1 909	1 176	1 192	5%	16	1%	-717	-38%	-322	-21%	T1	D
Greece	1 049	1 048	1 051	4%	3	0%	2	0%	-11	-1%	T1	D
Hungary	193	103	108	0%	5	5%	-86	-44%	0	0%	T1	D
Ireland	2 540	2 433	2 501	10%	68	3%	-39	-2%	-136	-5%	T1	D
Italy	934	767	786	3%	19	2%	-148	-16%	-260	-25%	T1	CS,D
Latvia	368	92	87	0%	-4	-5%	-281	-76%	-69	-44%	T1	D
Lithuania	422	179	174	1%	-4	-2%	-248	-59%	-55	-24%	T1	D
Luxembourg	23	23	23	0%	0	1%	-1	-2%	0	1%	T1	D
Malta	NO	NO	NO	-	-	-	-	-	-	-	NA	NA
Netherlands	3 028	1 005	1 052	4%	47	5%	-1 976	-65%	-1 729	-62%	T1	D
Poland	1 048	351	338	1%	-14	-4%	-710	-68%	-270	-44%	T1	CS,D
Portugal	538	701	696	3%	-5	-1%	158	29%	125	22%	T1	D
Romania	1 522	602	607	2%	4	1%	-915	-60%	-489	-45%	T1	D
Slovakia	213	91	89	0%	-1	-2%	-124	-58%	-51	-36%	T1b	D
Slovenia	19	39	39	0%	0	-1%	20	110%	13	51%	T1	D
Spain	2 809	2 795	2 715	10%	-80	-3%	-94	-3%	-98	-3%	CS,T1a,T1b	D
Sweden	366	356	350	1%	-6	-2%	-16	-4%	-38	-10%	-	-
United Kingdom	5 383	4 645	4 655	18%	10	0%	-727	-14%	-714	-13%	T1	D
EU-28	**33 724**	**25 787**	**25 878**	**100%**	**91**	**0%**	**-7 846**	**-23%**	**-5 496**	**-21%**		

Figure 5.54: 3.D.1.3 - Urine and Dung Deposited by Grazing Animals Grazing Animals: Trend in emissions in the EU28 and the countries contributing most to EU28 values including their share to EU28 emissions in 2013



Implied EFs and Methodological Issues

In this section we discuss the Implied Emission Factor for the main N sources contributing to direct N_2O emissions from managed soils.

3.D.1.1 - Direct N_2O Emissions From Inorganic N Fertilizers - Implied emission factor

The implied emission factor for N_2O emissions in source category 3.D.1.1 - Direct N_2O Emissions From Inorganic N Fertilizers decreased in EU28 barely by 0.029% or 3.03e-06 kg N_2O-N/kg N between 1990 and 2013. Figure 5.55 shows the trend of the IEF in EU28 indicating also the range of values used by the countries. Table 5.40 shows the implied emission factor for N_2O emissions in source category 3.D.1.1 - Direct N_2O Emissions From Inorganic N Fertilizers for the years 1990 and 2013 for all Member States and EU28. The IEF decreased in six countries and increased in four countries. It was in 2013 at the level of 1990 in eighteen countries. The three countries with the largest decreases were Netherlands, Cyprus and France with a mean absolute decrease of 1e-04 kg N_2O-N/kg N. The three countries with the largest increases were Romania, Belgium and Spain with a mean absolute increase of 3.3e-06 kg N_2O-N/kg N.

Figure 5.55: 3.D.1.1 - Direct N_2O Emissions From Inorganic N Fertilizers: Trend in implied emission factor in the EU28 and range of values reported by countries

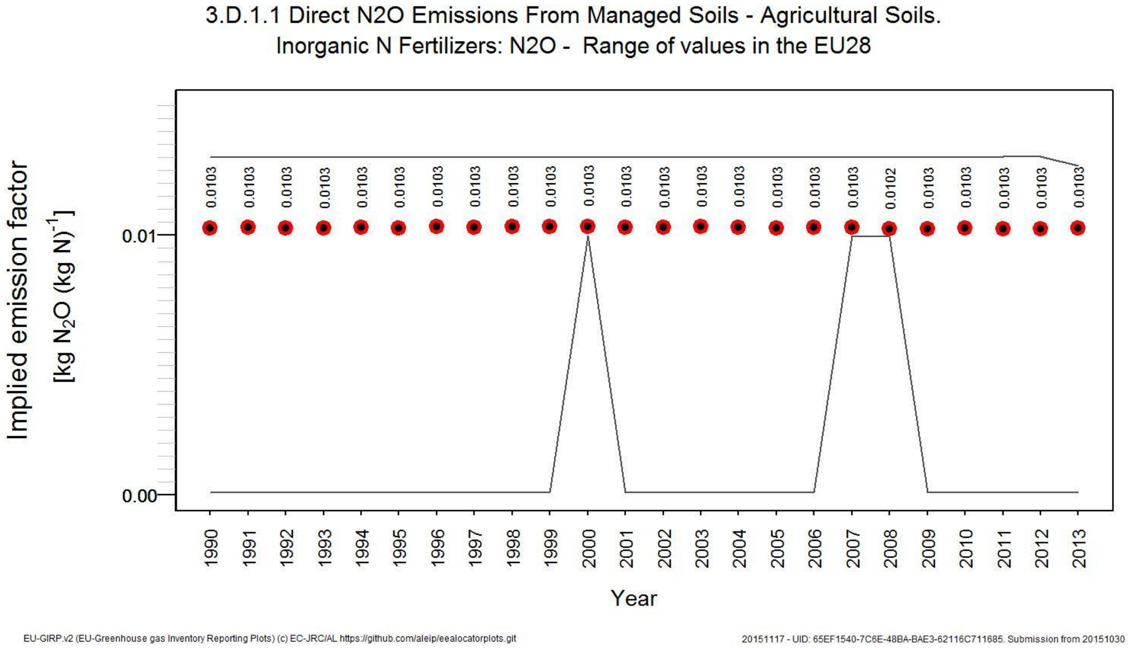


Table 5.40 3.D.1.1 - Direct N_2O Emissions From Inorganic N Fertilizers: Member States' and EU28 Implied emission factor (kg N_2O-N/kg N)

Member State	1990	2013		Member State	1990	2013
Austria	0.0100	1.0e-02	|	Italy	0.0100	1.0e-02
Belgium	0.0100	1.0e-02	|	Lithuania	0.0100	1.0e-02
Bulgaria	0.0100	1.0e-02	|	Luxembourg	0.0100	1.0e-02
Cyprus	0.0001	9.9e-05	|	Latvia	0.0100	1.0e-02
Czech Republic	0.0100	1.0e-02	|	Malta	0.0100	1.0e-02
Germany	0.0100	1.0e-02	|	Netherlands	0.0130	1.3e-02
Denmark	0.0100	1.0e-02	|	Poland	0.0100	1.0e-02
Estonia	0.0100	1.0e-02	|	Portugal	0.0100	1.0e-02
Spain	0.0125	1.3e-02	|	Romania	0.0100	1.0e-02
Finland	0.0100	1.0e-02	|	Sweden	0.0100	1.0e-02
France	0.0100	1.0e-02	|	Slovenia	0.0100	1.0e-02
Greece	0.0100	1.0e-02	|	Slovakia	0.0125	1.2e-02
Croatia	0.0100	1.0e-02	|	United Kingdom	0.0100	1.0e-02
Hungary	0.0100	1.0e-02	|	**EU28**	**0.0103**	**1.0e-02**
Ireland	0.0100	1.0e-02	|			

3.D.1.2 - Direct N_2O Emissions From Organic N Fertilizers - Implied emission factor

The implied emission factor for N_2O emissions in source category 3.D.1.2 - Direct N_2O Emissions From Organic N Fertilizers increased in EU28 slightly by 3.8% or 0.000434 kg N_2O-N/kg N between 1990 and 2013. Figure 5.56 shows the trend of the IEF in EU28 indicating also the range of values used by the countries. Table 5.41 shows the implied emission factor for N_2O emissions in source category 3.D.1.2 - Direct N_2O Emissions From Organic N Fertilizers for the years 1990 and 2013 for all Member States and EU28. The IEF decreased in six countries and increased in four countries. It was in 2013 at the level of 1990 in seventeen countries. No data were available for one country. The largest decrease occurred in Czech Republic with an absolute decrease of 0.0036 kg N_2O-N/kg N. The largest increase occurred in Netherlands with an absolute increase of 0.0054 kg N_2O-N/kg N.

Figure 5.56: 3.D.1.2 - Direct N_2O Emissions From Organic N Fertilizers: Trend in implied emission factor in the EU28 and range of values reported by countries

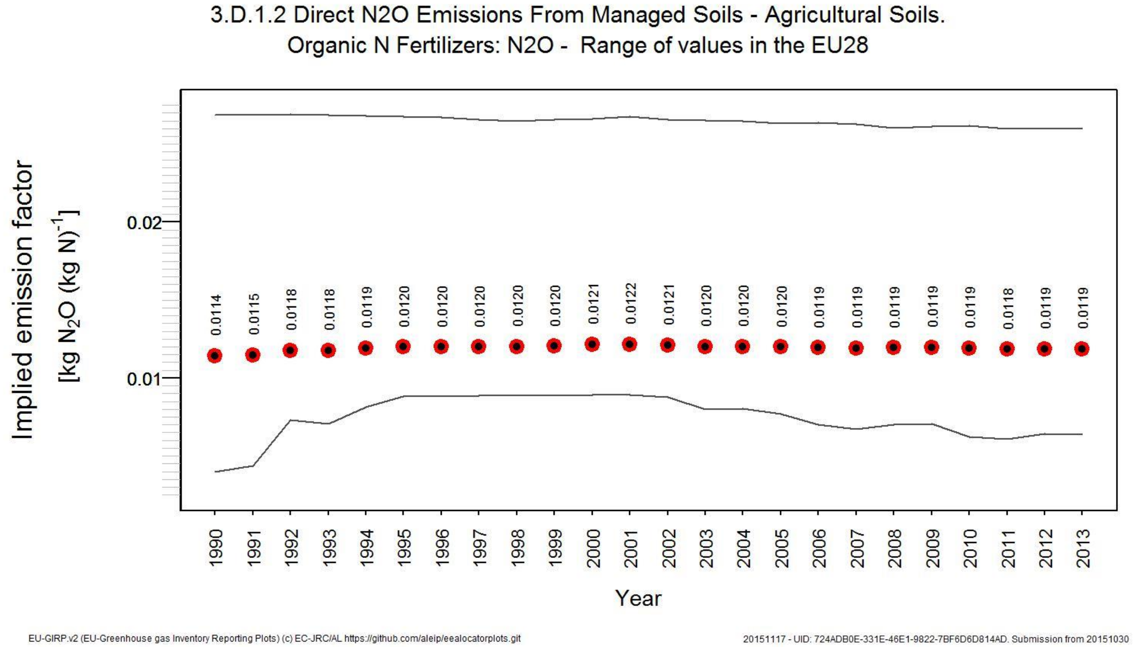


Table 5.41 3.D.1.2 - Direct N_2O Emissions From Organic N Fertilizers: Member States' and EU28 Implied emission factor (kg N_2O-N/kg N)

Member State	1990	2013		Member State	1990	2013
Austria	0.010	0.0100	|	Italy	0.010	0.0100
Belgium	0.010	0.0100	|	Lithuania	0.010	0.0100
Bulgaria	0.010	0.0100	|	Luxembourg	0.010	0.0100
Czech Republic	0.010	0.0064	|	Latvia	0.010	0.0100
Germany	0.010	0.0100	|	Malta	0.010	0.0100
Denmark	0.010	0.0100	|	Netherlands	0.004	0.0094
Estonia	0.010	0.0100	|	Poland	0.010	0.0100
Spain	0.013	0.0125	|	Portugal	0.010	0.0100
Finland	0.010	0.0100	|	Romania	0.010	0.0100
France	0.027	0.0260	|	Sweden	0.010	0.0100
Greece	0.010	0.0100	|	Slovenia	0.010	0.0100
Croatia	0.010	0.0100	|	Slovakia	0.012	0.0125
Hungary	0.010	0.0100	|	United Kingdom	0.010	0.0100
Ireland	0.010	0.0100	|	**EU28**	**0.011**	**0.0119**

3.D.1.3 - Urine and Dung Deposited by Grazing Animals - Implied emission factor

The implied emission factor for N_2O emissions in source category 3.D.1.3 - Urine and Dung Deposited by Grazing Animals could not be evaluated at EU28 level. Table 5.42 shows the implied emission factor for N_2O emissions in source category 3.D.1.3 - Urine and Dung Deposited by Grazing Animals for the years 1990 and 2013 for all Member States and EU28. The IEF decreased in thirteen countries and increased in ten countries. It was in 2013 at the level of 1990 in two countries. No data were available for three countries. The three countries with the largest decreases were Romania, Austria and Slovenia with a mean absolute decrease of 0.002 kg N_2O-N/kg N. The three countries with the largest increases were Portugal, Bulgaria and Poland with a mean absolute increase of 0.0013 kg N_2O-N/kg N.

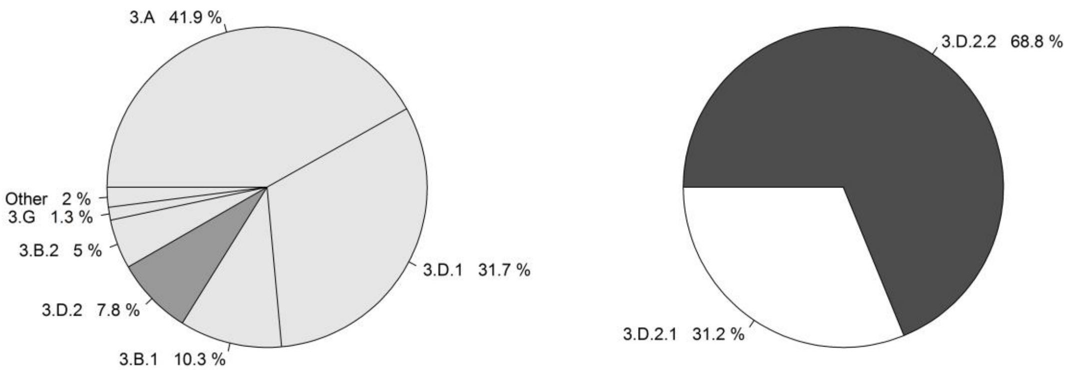
Table 5.42 3.D.1.3 - Urine and Dung Deposited by Grazing Animals: Member States' and EU28 Implied emission factor (kg N_2O-N/kg N)

Member State	1990	2013	Member State	1990	2013
Austria	0.018	0.016	Ireland	0.018	0.019
Belgium	0.020	0.020	Italy	0.011	0.011
Bulgaria	0.011	0.012	Lithuania	0.019	0.019
Czech Republic	0.017	0.018	Luxembourg	0.010	0.010
Germany	0.019	0.019	Latvia	0.020	0.019
Denmark	0.019	0.018	Netherlands	0.000	0.000
Estonia	0.019	0.019	Poland	0.018	0.019
Spain	0.020	0.020	Portugal	0.016	0.018
Finland	0.018	0.017	Romania	0.017	0.015
France	0.018	0.019	Sweden	0.017	0.017
Greece	0.010	0.011	Slovenia	0.018	0.017
Croatia	0.016	0.015	Slovakia	0.020	0.020
Hungary	0.014	0.014	United Kingdom	0.016	0.016

5.2.4 Indirect Emissions from Managed Soils - N_2O (CRF Source Category 3D2)

N_2O emissions from source category 3.D.2 Indirect Emissions from Managed Soils are 0.77% of total EU28 GHG emissions and 14% of total EU28 N_2O emissions. They make 7.8% of total agricultural emissions. The main sub-categories are 3.D.2.2 (Nitrogen Leaching and Run-off), and 3.D.2.1 (Atmospheric Deposition) as shown in Figure 5.58.

Figure 5.58: Share of source category 3.D.2 on total EU28 agricultural emissions (left panel) and decomposition into its sub-categories (right panel). The percentages refer to the emission in the year 2013.



Total GHG and N_2O emissions by Member States from 3.D.2 Indirect Emissions from Managed Soils are shown in Table 5.43. Between 1990 and 2013, N_2O emission from Indirect Emissions from Managed Soils decreased by 22% or 9.6 Mt CO_2-eq. The decrease was largest in Cyprus in relative terms (71%) and in Netherlands in absolute terms (61% or 1.2 Mt CO_2-eq). From 2012 to 2013 emissions increased by 1.9%.

Table 5.43 3.D.2 - Indirect Emissions from Managed Soils: Member States' contributions to total GHG and N_2O emissions

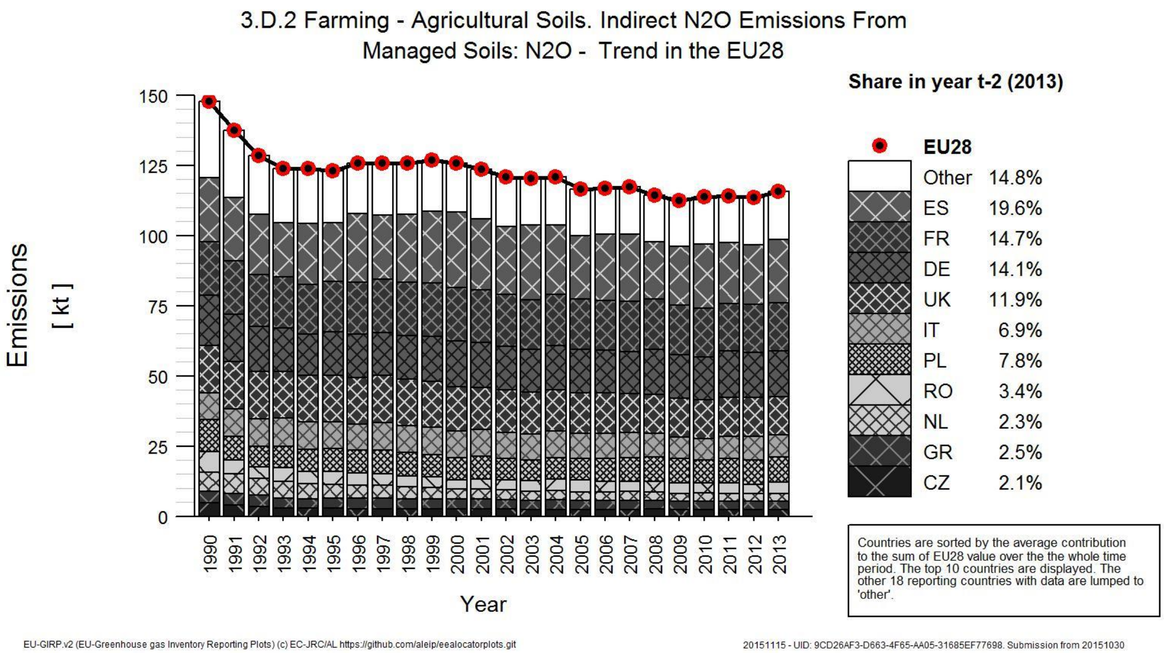
Member State	N2O emissions in kt CO2 equiv.			Share in EU28 emissions in 2013	Change 2012-2013		Change 1990-2013		Change 1995-2013		Method applied	Emission factor
	1990	2012	2013		kt CO2 equiv.	%	kt CO2 equiv.	%	kt CO2 equiv.	%		
Austria	334	303	301	1%	-3	-1%	-33	-10%	-41	-12%	NA	NA
Belgium	470	250	251	1%	1	0%	-219	-47%	-203	-45%	T1	D
Bulgaria	1 422	647	713	2%	66	10%	-710	-50%	80	13%	T1	D
Croatia	377	288	262	1%	-27	-9%	-115	-31%	-20	-7%	T1	D
Cyprus	20	8	6	0%	-3	-31%	-14	-71%	-17	-75%	T1	D
Czech Republic	1 398	712	736	2%	23	3%	-663	-47%	-122	-14%	T1	D
Denmark	862	493	481	1%	-12	-2%	-381	-44%	-281	-37%	T2	D
Estonia	228	111	109	0%	-2	-2%	-119	-52%	17	18%	D,T1	D
Finland	479	378	379	1%	0	0%	-100	-21%	-78	-17%	T1	D
France	5 685	5 129	5 069	15%	-60	-1%	-615	-11%	-292	-5%	-	-
Germany	5 366	4 777	4 857	14%	79	2%	-510	-9%	259	6%	T1	D
Greece	1 238	866	878	3%	12	1%	-360	-29%	-209	-19%	T1	D
Hungary	272	153	168	0%	15	10%	-104	-38%	0	0%	T1	D
Ireland	559	496	480	1%	-16	-3%	-79	-14%	-59	-11%	T1	CS,D
Italy	2 813	2 542	2 363	7%	-178	-7%	-450	-16%	-491	-17%	T1	CS,D
Latvia	389	175	182	1%	7	4%	-208	-53%	78	75%	T1	D
Lithuania	615	415	411	1%	-3	-1%	-204	-33%	172	72%	T1	D
Luxembourg	54	44	45	0%	1	2%	-9	-17%	-6	-12%	T1	D
Malta	2	3	3	0%	0	-2%	0	16%	-2	-45%	T1	D
Netherlands	2 039	804	800	2%	-4	-1%	-1 239	-61%	-625	-44%	T1	D
Poland	3 438	2 567	2 674	8%	107	4%	-764	-22%	251	10%	T1	D
Portugal	508	417	439	1%	21	5%	-69	-14%	-48	-10%	T1,T2	CS,D
Romania	2 151	991	1 160	3%	169	17%	-991	-46%	-222	-16%	T1	D
Slovakia	957	420	399	1%	-21	-5%	-558	-58%	39	11%	T1	D
Slovenia	111	105	104	0%	-1	-1%	-7	-6%	-10	-9%	T1	D
Spain	6 776	6 308	6 756	20%	448	7%	-20	0%	570	9%	CS,T1a,T1b	D
Sweden	470	357	360	1%	3	1%	-110	-23%	-71	-17%	-	-
United Kingdom	5 025	4 087	4 109	12%	22	1%	-915	-18%	-841	-17%	T1	D
EU-28	**44 057**	**33 849**	**34 493**	**100%**	**644**	**2%**	**-9 565**	**-22%**	**-2 175**	**-6%**		

Trends in Emissions and Activity Data

3.D.2 - Indirect Emissions from Managed Soils - Emissions

Emissions in source category 3.D.2 - Indirect Emissions from Managed Soils decreased considerably in EU28 by 22% or 9.6 Mt CO_2-eq. Figure 5.59 shows the trend of emissions indicating the countries contributing most to EU28 total. The ten countries with highest emissions together accounted for 85.2% of indirect N_2O emissions. Emissions decreased in 27 countries and increased in one country. Largest decreases occurred in Netherlands and Romania with a total absolute decrease of 2.2 Mt CO_2-eq. Emissions increased in Malta with a total absolute increase of 0.4 kt CO_2-eq.

Figure 5.59: 3.D.2 Indirect Emissions from Managed Soils: Trend in emissions in the EU28 and the countries contributing most to EU28 values including their share to EU28 emissions in 2013



3.D.2.1 - Atmospheric Deposition - Emissions

Emissions in source category 3.D.2.1 - Atmospheric Deposition decreased strongly in EU28 by 28% or 4.1 Mt CO_2-eq. Figure 5.60 shows the trend of emissions indicating the countries contributing most to EU28 total. The ten countries with highest emissions together accounted for 83% of atmospheric Deposition N_2O emissions. Emissions decreased in 26 countries and increased in two countries. Largest decreases occurred in Netherlands with a total absolute decrease of 944 kt CO_2-eq. Largest increases occurred in Spain with a total absolute increase of 44 kt CO_2-eq.

3.D.2.1 - Indirect N_2O Emissions From Atmospheric Deposition - Volatilized N from agricultural inputs of N

Volatilized N from agricultural inputs of N decreased strongly in EU28 by 28% or 872 kt N/year. Figure 5.61 shows the trend of volatilized N from agricultural inputs of N indicating the countries contributing most to EU28 total. The ten countries with highest volatilized N from agricultural inputs of N together accounted for 83% of Atmospheric Deposition volatilized N from agricultural inputs of N. Volatilized N from agricultural inputs of N decreased in 26 countries and increased in two countries. Largest decreases occurred in Netherlands with a total absolute decrease of 199 kt N/year. Largest increases occurred in Spain with a total absolute increase of 9 kt N/year.

Figure 5.60: 3.D.2.1 - Atmospheric Deposition: Trend in emissions in the EU28 and the countries contributing most to EU28 values including their share to EU28 emissions in 2013

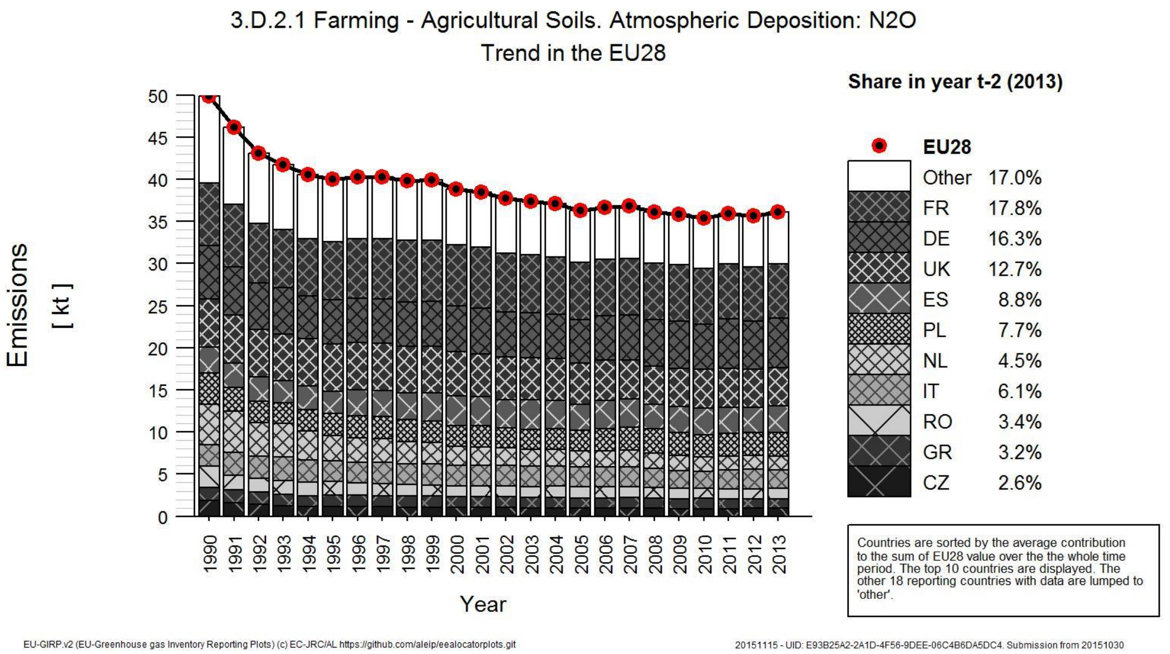
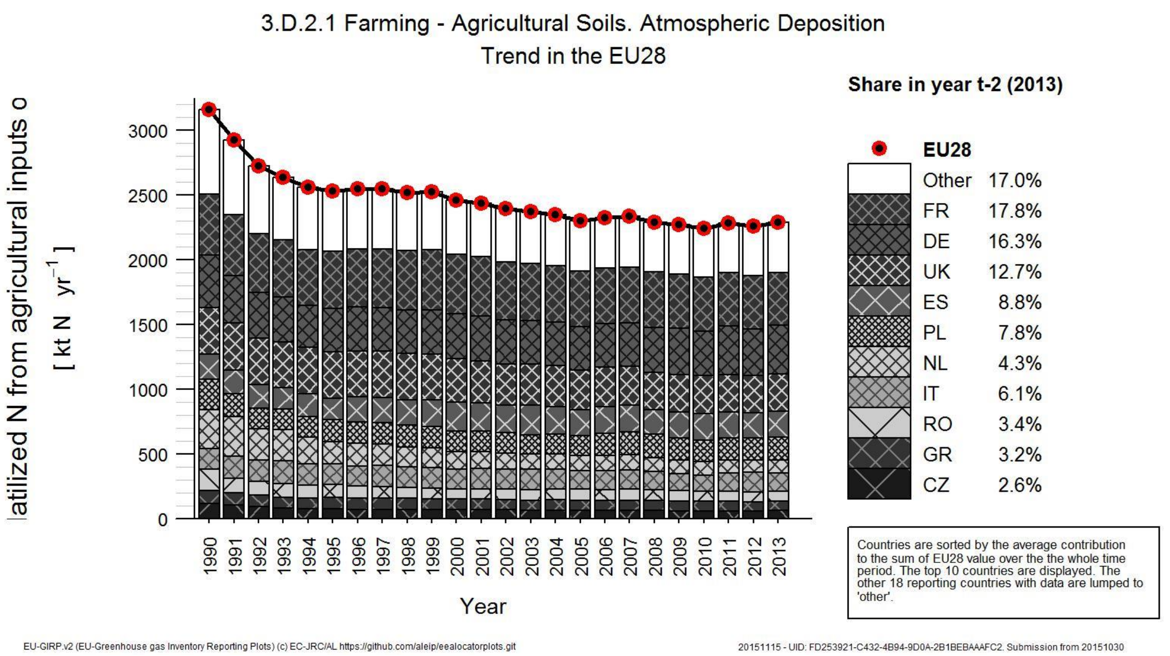


Figure 5.61: 3.D.2.1 - Atmospheric Deposition: Trend in emissions in the EU28 and the countries contributing most to EU28 values including their share to EU28 emissions in 2013



3.D.2.2 - Nitrogen leaching and run-off - Emissions

Emissions in source category 3.D.2.2 - Nitrogen leaching and run-off decreased considerably in EU28 by 19% or 5.5 Mt CO_2-eq. Figure 5.62 shows the trend of emissions indicating the countries contributing most to EU28 total. The ten countries with highest emissions together accounted for 87.1% of nitrogen leaching and run-off N_2O emissions. Emissions decreased in 27 countries and increased in one country. Largest decreases occurred in Romania and United Kingdom with a total absolute decrease of 1.2 Mt CO_2-eq. Emissions increased in Malta with a total absolute increase of 0.3 kt CO_2-eq.

3.D.2.2 - Indirect N_2O Emissions From Nitrogen leaching and run-off - N from fertilizers and other agricultural inputs that is lost through leaching and run-off

N from fertilizers and other agricultural inputs that is lost through leaching and run-off decreased considerably in EU28 by 21% or 1.6 kt N/year. Figure 5.63 shows the trend of N from fertilizers and other agricultural inputs that is lost through leaching and run-off indicating the countries contributing most to EU28 total. The ten countries with highest N from fertilizers and other agricultural inputs that is lost through leaching and run-off together accounted for 84.1% of Nitrogen leaching and run-off N from fertilizers and other agricultural inputs that is lost through leaching and run-off. N from fertilizers and other agricultural inputs that is lost through leaching and run-off decreased in 27 countries and increased in one country. Largest decreases occurred in Romania and United Kingdom with a total absolute decrease of 333 kt N/year. N from fertilizers and other agricultural inputs that is lost through leaching and run-off increased in Malta with a total absolute increase of 0.1 kt N/year.

Figure 5.62: 3.D.2.2 - Nitrogen leaching and run-off: Trend in emissions in the EU28 and the countries contributing most to EU28 values including their share to EU28 emissions in 2013

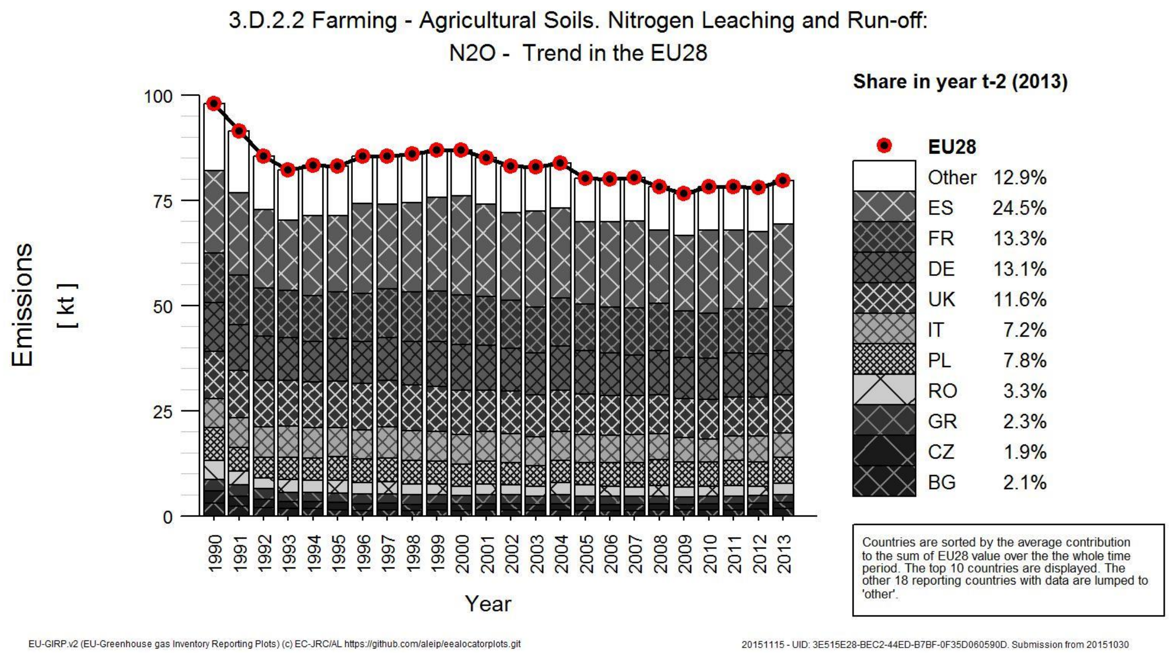
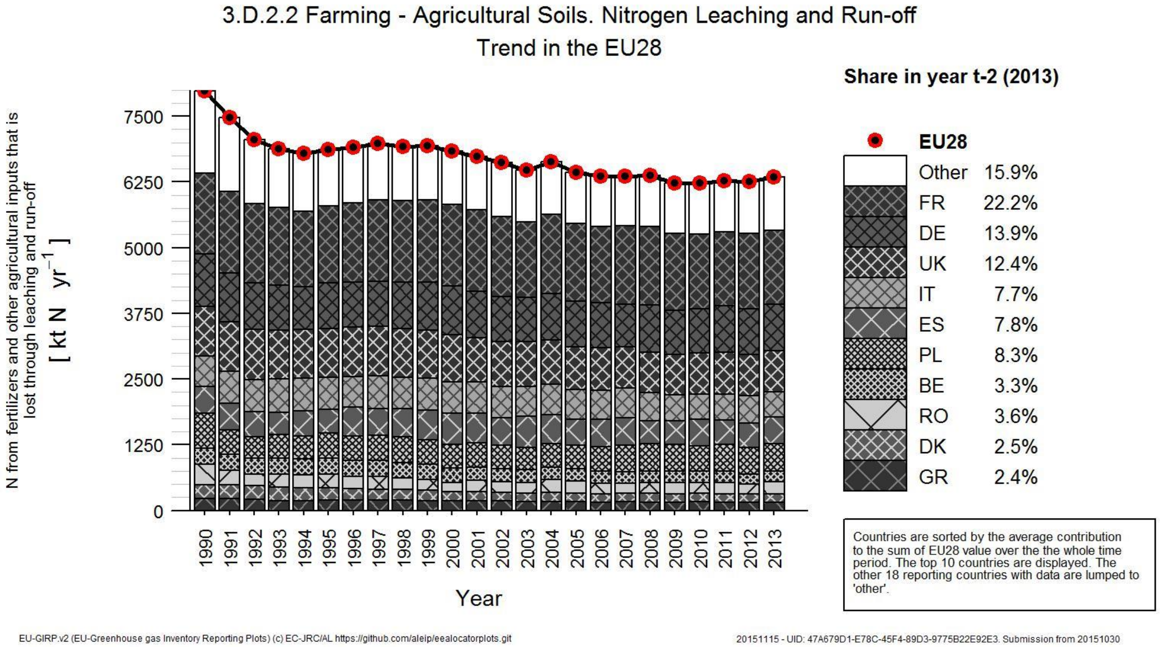


Figure 5.63: 3.D.2.2 - Nitrogen leaching and run-off: Trend in emissions in the EU28 and the countries contributing most to EU28 values including their share to EU28 emissions in 2013



Implied EFs and Methodological Issues

In this section we discuss the Implied Emission Factor for the main N sources contributing to indirect N_2O emissions from managed soils. Furthermore, we present data on the relevant fractions:

- $Frac_{GASF}$: Fraction of synthetic fertilizer N applied to soils that volatilises as NH_3 and NO_X
- $Frac_{GASM}$: Fraction of livestock N excretion that volatilises as NH_3 and NO_X
- $Frac_{LEACH}$: Fraction of N input to managed soils that is lost through leaching and run-off.

3.D.2.1 - Indirect N_2O Emissions From Atmospheric Deposition

The implied emission factor for N_2O emissions in source category 3.D.2.1 - Indirect N_2O Emissions From Atmospheric Deposition decreased in EU28 barely by 0.042% or 4.24e-06 kg N_2O-N/kg N between 1990 and 2013. Figure 5.64 shows the trend of the IEF in EU28 indicating also the range of values used by the countries. Table 5.44 shows the implied emission factor for N_2O emissions in source category 3.D.2.1 - Indirect N_2O Emissions From Atmospheric Deposition for the years 1990 and 2013 for all Member States and EU28. The IEF decreased in six countries and increased in four countries. It was in 2013 at the level of 1990 in eighteen countries. The three countries with the largest decreases were Lithuania, Cyprus and Portugal with a mean absolute decrease of 9.6e-05 kg N_2O-N/kg N. The three countries with the largest increases were Netherlands, Malta and Slovenia with a mean absolute increase of 9.1e-05 kg N_2O-N/kg N.

Figure 5.64: 3.D.2.1 - Indirect N_2O Emissions From Atmospheric Deposition: Trend in implied emission factor in the EU28 and range of values reported by countries

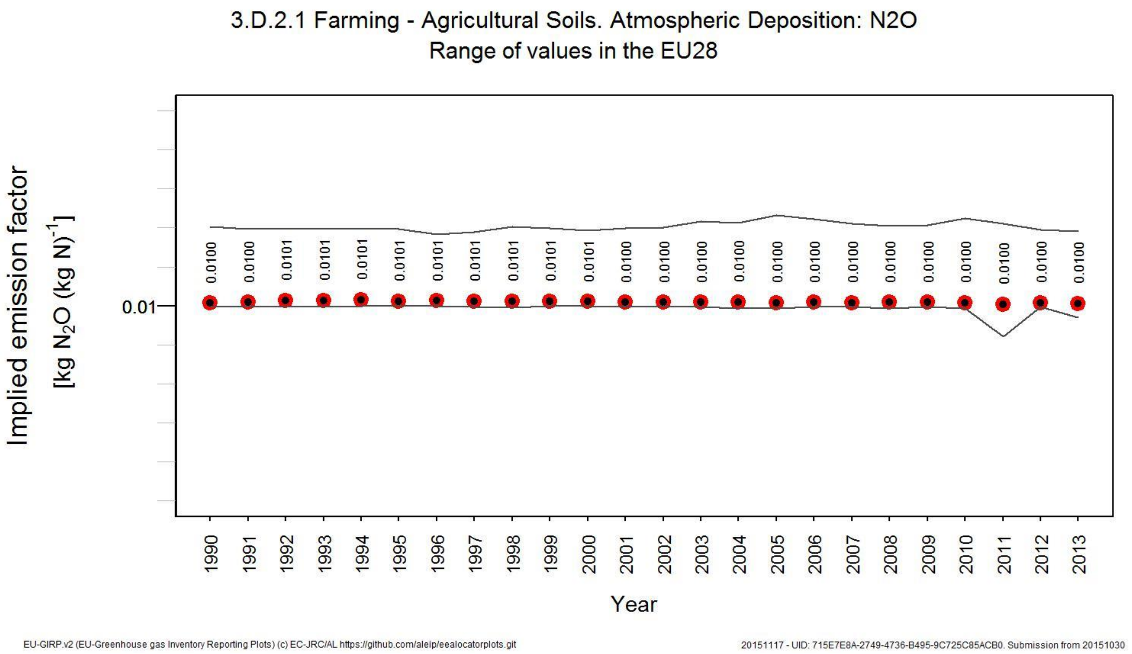


Table 5.44 3.D.2.1 - Indirect N_2O Emissions From Atmospheric Deposition: Member States' and EU28 Implied emission factor (kg N_2O-N/kg N)

Member State	1990	2013		Member State	1990	2013
Austria	0.010	0.0100	|	Italy	0.010	0.0100
Belgium	0.010	0.0100	|	Lithuania	0.010	0.0098
Bulgaria	0.010	0.0100	|	Luxembourg	0.010	0.0100
Cyprus	0.010	0.0099	|	Latvia	0.010	0.0100
Czech Republic	0.010	0.0100	|	Malta	0.010	0.0100
Germany	0.010	0.0100	|	Netherlands	0.010	0.0106
Denmark	0.010	0.0100	|	Poland	0.010	0.0100
Estonia	0.010	0.0100	|	Portugal	0.011	0.0110
Spain	0.010	0.0100	|	Romania	0.010	0.0100
Finland	0.010	0.0100	|	Sweden	0.010	0.0100
France	0.010	0.0100	|	Slovenia	0.010	0.0100
Greece	0.010	0.0100	|	Slovakia	0.010	0.0100
Croatia	0.010	0.0100	|	United Kingdom	0.010	0.0100
Hungary	0.010	0.0100	|	**EU28**	**0.010**	**0.0100**
Ireland	0.010	0.0100	|			

3.D.2.1 - Indirect emissions from atmospheric deposition - Fraction of synthetic fertilizer N applied to soils that volatilises as NH_3 and NO_X

The fraction of synthetic fertilizer N applied to soils that volatilises as NH_3 and NO_X, a parameter used for calculating N_2O emissions in source category 3.D.2.1 - Indirect emissions from atmospheric deposition, could not be evaluated at EU28 level. Table 5.45 shows the fraction of synthetic fertilizer N applied to soils that volatilises as NH_3 and NO_X in source category 3.D.2.1 - Indirect emissions from atmospheric deposition for the years 1990 and 2013 for all Member States and EU28. Fraction of synthetic fertilizer N applied to soils that volatilises as NH_3 and NO_X decreased in four countries and increased in seven countries. It was in 2013 at the level of 1990 in fifteen countries. No data were available for two countries. The largest decreases occurred in Ireland and Hungary with a mean absolute decrease of 0.018. The largest increases occurred in Austria and Germany with a mean absolute increase of 0.019.

Table 5.45 3.D.2.1 - Indirect emissions from atmospheric deposition: Member States' and EU28 Fraction of synthetic fertilizer N applied to soils that volatilises as NH_3 and NO_X (-)

Member State	1990	2013		Member State	1990	2013
Austria	0.026	0.0400	|	Hungary	0.093	0.0659
Belgium	0.065	0.0783	|	Ireland	0.028	0.0188
Bulgaria	0.100	0.1000	|	Italy	0.087	0.1026
Cyprus	0.100	0.1000	|	Lithuania	0.100	0.1000
Czech Republic	0.100	0.1000	|	Luxembourg	0.100	0.1000
Germany	0.061	0.0851	|	Latvia	0.100	0.1000
Denmark	0.047	0.0431	|	Poland	0.100	0.1000
Estonia	0.100	0.1000	|	Portugal	0.071	0.0746
Spain	0.086	0.0881	|	Romania	0.100	0.1000
Finland	0.015	0.0146	|	Sweden	0.011	0.0095
France	0.100	0.1000	|	Slovenia	0.072	0.0780
Greece	0.100	0.1000	|	Slovakia	0.100	0.1000
Croatia	0.100	0.1000	|	United Kingdom	0.100	0.1000

3.D.2.2 - Indirect emissions from atmospheric deposition - Fraction of livestock N excretion that volatilises as NH_3 and NO_X

The fraction of livestock N excretion that volatilises as NH_3 and NO_X, a parameter used for calculating N_2O emissions in source category 3.D.2.2 - Indirect emissions from atmospheric deposition, could not be evaluated at EU28 level. Table 5.46 shows the fraction of livestock N excretion that volatilises as NH_3 and NO_X in source category 3.D.2.2 - Indirect emissions from atmospheric deposition for the years 1990 and 2013 for all Member States and EU28. Fraction of livestock N excretion that volatilises as NH_3 and NO_X decreased in six countries and increased in six countries. It was in 2013 at the level of 1990 in thirteen countries. No data were available for three countries. The largest decreases occurred in Denmark and Belgium with a mean absolute decrease of 0.1. The largest increase occurred in Hungary with an absolute increase of 0.025.

Table 5.46 3.D.2.2 - Indirect emissions from atmospheric deposition: Member States' and EU28 Fraction of livestock N excretion that volatilises as NH_3 and NO_X (-)

Member State	1990	2013		Member State	1990	2013
Austria	0.269	0.288	|	Ireland	0.076	0.078
Belgium	0.266	0.162	|	Italy	0.230	0.219
Bulgaria	0.200	0.200	|	Lithuania	0.200	0.200
Czech Republic	0.200	0.200	|	Luxembourg	0.200	0.200
Germany	0.195	0.171	|	Latvia	0.200	0.200
Denmark	0.137	0.083	|	Poland	0.200	0.200
Estonia	0.200	0.200	|	Portugal	0.146	0.127
Spain	0.353	0.360	|	Romania	0.200	0.200
Finland	0.075	0.088	|	Sweden	0.329	0.331
France	0.200	0.200	|	Slovenia	0.393	0.355
Greece	0.200	0.200	|	Slovakia	0.200	0.200
Croatia	0.200	0.200	|	United Kingdom	0.200	0.200
Hungary	0.101	0.126	|			

3.D.2.2 - Indirect N_2O Emissions From Nitrogen leaching and run-off

The implied emission factor for N_2O emissions in source category 3.D.2.2 - Indirect N_2O Emissions From Nitrogen leaching and run-off increased in EU28 slightly by 2.3% or 0.00018 kg N_2O-N/kg N between 1990 and 2013. Figure 5.67 shows the trend of the IEF in EU28 indicating also the range of values used by the countries. Table 5.47 shows the implied emission factor for N_2O emissions in source category 3.D.2.2 - Indirect N_2O Emissions From Nitrogen leaching and run-off for the years 1990 and 2013 for all Member States and EU28. The IEF decreased in five countries and increased in seven countries. It was in 2013 at the level of 1990 in sixteen countries. The largest decrease occurred in Hungary with an absolute decrease of 0.0075 kg N_2O-N/kg N. The three countries with the largest increases were Belgium, Netherlands and Cyprus with a mean absolute increase of 0.00016 kg N_2O-N/kg N.

Figure 5.67: 3.D.2.2 - Indirect N_2O Emissions From Nitrogen leaching and run-off: Trend in implied emission factor in the EU28 and range of values reported by countries

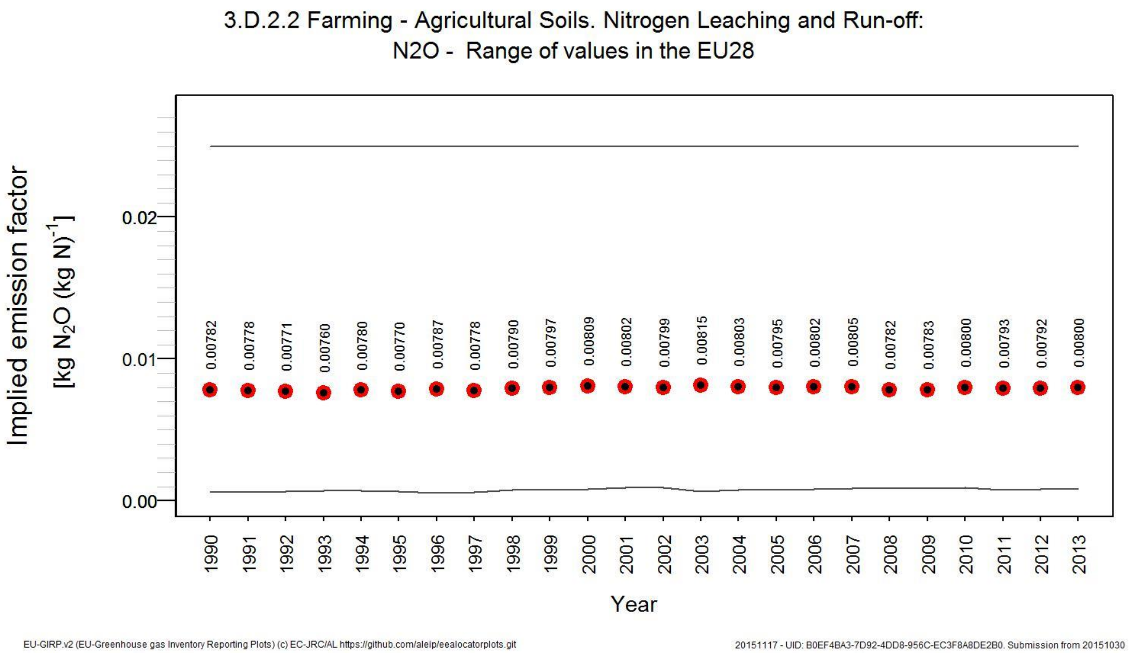


Table 5.47 3.D.2.2 - Indirect N_2O Emissions From Nitrogen leaching and run-off: Member States' and EU28 Implied emission factor (kg N_2O-N/kg N)

Member State	1990	2013	|	Member State	1990	2013
Austria	0.00750	0.0075	|	Italy	0.00750	0.0075
Belgium	0.00065	0.0008	|	Lithuania	0.00750	0.0075
Bulgaria	0.00750	0.0075	|	Luxembourg	0.00750	0.0075
Cyprus	0.00750	0.0075	|	Latvia	0.00750	0.0075
Czech Republic	0.00750	0.0075	|	Malta	0.00750	0.0075
Germany	0.00750	0.0075	|	Netherlands	0.00832	0.0086
Denmark	0.00439	0.0044	|	Poland	0.00750	0.0075
Estonia	0.00750	0.0075	|	Portugal	0.00750	0.0075
Spain	0.02500	0.0250	|	Romania	0.00750	0.0075
Finland	0.00750	0.0075	|	Sweden	0.00750	0.0075
France	0.00480	0.0048	|	Slovenia	0.00225	0.0022
Greece	0.00750	0.0075	|	Slovakia	0.02500	0.0250
Croatia	0.00750	0.0075	|	United Kingdom	0.00749	0.0075
Hungary	0.00750	0.0000	|	**EU28**	**0.00782**	**0.0080**
Ireland	0.00750	0.0075	|			

3.D.2.2 - Indirect emissions from nitrogen leaching and run-off - Fraction of N input to managed soils that is lost through leaching and run-off

The fraction of N input to managed soils that is lost through leaching and run-off, a parameter used for calculating N_2O emissions in source category 3.D.2.2 - Indirect emissions from nitrogen leaching and run-off, could not be evaluated at EU28 level. Table 5.48 shows the fraction of N input to managed soils that is lost through leaching and run-off in source category 3.D.2.2 - Indirect emissions from nitrogen leaching and run-off for the years 1990 and 2013 for all Member States and EU28.

Fraction of N input to managed soils that is lost through leaching and run-off decreased in three countries and increased in one country. It was in 2013 at the level of 1990 in 22 countries. No data were available for two countries. The largest decrease occurred in Hungary with an absolute decrease of 0.0099. There was an increase in Belgium with an absolute increase of 0.02.

Table 5.48 3.D.2.2 - Indirect emissions from nitrogen leaching and run-off: Member States' and EU28 Fraction of N input to managed soils that is lost through leaching and run-off (-)

Member State	1990	2013		Member State	1990	2013
Austria	0.1515	0.15	|	Hungary	0.0099	0.00
Belgium	0.0870	0.11	|	Ireland	0.1000	0.10
Bulgaria	0.3000	0.30	|	Italy	0.3000	0.30
Cyprus	0.3000	0.30	|	Lithuania	0.3000	0.30
Czech Republic	0.3000	0.30	|	Luxembourg	0.3000	0.30
Germany	0.3000	0.30	|	Latvia	0.3000	0.30
Denmark	0.3277	0.27	|	Poland	0.3000	0.30
Estonia	0.3000	0.30	|	Portugal	0.3000	0.30
Spain	0.3000	0.30	|	Romania	0.3000	0.30
Finland	0.3000	0.30	|	Sweden	0.1560	0.12
France	0.3000	0.30	|	Slovenia	0.3000	0.30
Greece	0.3000	0.30	|	Slovakia	0.3000	0.30
Croatia	0.3000	0.30	|	United Kingdom	0.3000	0.30

5.3 Uncertainties

For information on uncertainties please refer to chapter 1.6.

5.4 Sector-specific quality assurance and quality control and verification

5.4.1 Introduction

This section gives an overview of the QA/QC procedures applied specifically for the agriculture sector of the EU GHG inventory. It first gives an overview of the development of the agriculture QA/QC system with an outlook of further improvements to be discussed and/or implemented in coming years. A brief description of the QA/QC procedures used to process the data and interact with the Member States is given.

This is followed by brief summaries of selected activities that have been carried out in the past to improve and/or verify national and EU wide GHG emissions from agriculture in the frame of the EU GHG inventory system. The list is not comprehensive.

5.4.2 Improvements

Brief overview of the development of the QA/QC in the agriculture sector

A major revision of the present chapter on methodological issues and uncertainty in the sector agriculture was done for the submission in 2006 giving for the first time a complete overview of all relevant parameters required for the estimation of GHG emissions and the calculation of all background parameter in the CRF tables for agriculture.

The changes were partly due to a 'natural evolution' of the inventory generation over the years and partly motivated by recommendations made by the UNFCCC review team on the occasion of the in-country review in 2005. The main issues raised by the Expert Review Team in 2005 and the major changes included (i) more transparent overview tables on methodological issues; (ii) better presentation of trend development; (iii) streamlining information contained in CRF and NIR; (iv) continuous working with Member States in order to improve the inventory and allowing the quantification of all background data; (v) including a summary of workshops. For the submission in 2007, several errors identified in the background tables of the Member States could be eliminated, thus improving the calculation of EU-wide background information. Further details were added to the inventory report for the submission in 2008, based on recommendations by the Expert Review Team of the in-country review in 2007. For the submissions in 2009 through 2014, background information was further developed.

In 2008, a novel approach to calculate uncertainties at the EU level including the assessment of the quality of the emission estimates at MS and EU level has been implemented and described in the NIR. This method was presented during the in-country-review in 2007 and its implementation in the EC-IR was suggested by the ERT. This has been complemented by a series of tables giving background information for the estimates of the uncertainty levels for activity data and emission factors.

Over the time, several sections were added describing specific QA/QC and verification activities (see also sections below), such as:

- Summary of the workshop on 'Inventories and Projections of Greenhouse Gas Emissions from Agriculture' (2003)
- Summary of the findings of the GGELS project (Evaluation of the livestock sector's contribution to the EU greenhouse gas emissions (GGELS).
- A comparison between submissions and data from the FAO GHG database (2014)
- An analysis on the share of manure excretion by IPCC climate zones with EU wide independent data
- A description of the Survey on agricultural production methods (SAPM 2010)
- A summary of the LiveDate project on Nitrogen Excretion factors
- Workshop on improving national inventories for agriculture (2013)
- Comparison of Cultivated Organic Soil at the FAO GHG database and JRC calculations

Main improvements in 2015

For the current submission (2015) the QA/QC system for the EU GHG inventory was thoroughly revised. While this is true for the whole EU GHG inventory, this is particularly true for the agriculture sector. The following specific issues with GHG inventory in the agriculture sector were identified to require improvements:

- The chapter contained many information and details which could not be kept after the increase of the number of countries to be covered. Many methodological details included in the agriculture chapter EU-GHG inventory report 2014 did not have a significant relevance for EU total emissions and thus 'diluted' the relevant information provided. Even though the chapter was consistently structured, some details that were added (e.g. as response to reviews) lead to an overall imbalance of the information provided.

- The agricultural chapter applied a specific methodology to calculate "Tier levels" and aggregated uncertainties to more accurately account for correlation between the uncertainty estimates of the individual countries. The methodology was developed for the EU GHG inventory and published in peer-reviewed literature[34]. While this method was shown to provide additional insight for the uncertainty assessment of the EU GHG inventory, it was of no practical relevance for the overall GHG inventory, as a different method was used for other sectors. It was therefore decided to be not continued.
- One major drawback of previous GHG inventories was the difficulties to account for 'other' animal types or nitrogen inputs. With the new data processing framework[35], *all* data are now available so that a comprehensive analysis is possible
- Streamlining with other sector chapters was improved, not the least by using of harmonized plots to present trend-data at EU level while also showing data from those countries contributing most to EU values
- Due to the quantities of data to be processed some remaining inconsistencies in the agriculture chapter of the EU GHG inventory report persisted, despite the highly automated procedures[36] and considerably efforts made to detect remaining inconsistencies. The newly implemented data processing system should help avoiding further inconsistencies.

In the current submission, therefore, a new system has been developed and introduced as describe in the section QA/QC system in the agriculture sector

Further improvements

The current submission (2015) brought a complete revision of the approach taken for the EU GHG inventory report in general and for the agriculture chapter in particular, driven by the need to adapt to new CRF software, increased number of countries to describe, and a series of new communication softwares (e.g. EEA review tool, EU-GIRP).

The agriculture chapter reflects these changes as described in the next section. Improvements will regard:

- Addition of sector-specific checks that could not be performed for the current submission
- Further streamlining with other sectoral chapter, where possible and useful
- Improved analysis of the data, e.g. with regard to time series
- General streamlining of the data processing

[34] Leip, A., 2010. Quantitative quality assessment of the greenhouse gas inventory for agriculture in Europe. Clim. Change. 103, 245-261. *doi:http://dx.doi.org/10.1007/s10584-010-9915-5*.

[35] EU-GIRP: EU-Greenhouse gas Inventory Reporting and Plots, see *https://github.com/aleip/eealocatorplots.git*

[36] For an overview of the QA/QC system of the agriculture sector for the 2013 GHG inventory see presentation given for the ICR2013 at *https://prezi.com/f1d3elxzd4qn/20131002_icr_agri/*

5.4.3 QA/QC system in the agriculture sector

Quality checks

Several quality checks are performed in the EU-GIRP[37] software. They are documented in various modules of EU-GIRP and can be examined in the open source repository. The checks include:

- **Check on NEs**[38] and empty cells has been done by extracting all reported 'NE's from the data base. The results were compared with the data contained in the file NE_checks_20150903.xlsx provided which also contained a list of empty cells.
- **Outliers in activity data and emissions**: Data were checked on outliers in AD and emissions. For each source category the share of AD and emissions by the countries to total EU28 values were determined. A share above 95% was further assessed and in case this was not linnked to a source category which is dominated by single countries (such as emissions from buffalo, which are dominated by Italy) the country was notified
- **Check on erroneous units**: In several case, countries report background data using different units (e.g. fractions insteat of percent values or vice versa; values per day instead of per year of vice versa; absolute values instead of values per head etc.). While these inconsistencies do not influence the reported emission estimates, a harmonization (at EU28 level) is important to ensure correct comparison of countries' values adn a correct calculation of EU28 background data. An automated check[39] is carried out detecting *seven* cases which can easily be recognised. Other 'mistakes' in units used were detected following the outlier analysis (see below). The countries were notified via the review tool and in many cases corrections have already been implemented.
- **Within-country outliers**: within-country outliers in IEFs and other parameters are detected on the basis of the distribution of the values provided[40]. We used the method based on the mean values and the standard deviation. Specifically, those values were identified as outliers which were more distant from than 1.5 time the standard deviation in the data from the mean (both in positive and negative direction). As an additional criterium, the relation to the median was used. In case the value was within 10% of the median it was not considered as an outlier. This removed cases where a country uses a country-specific parameter while most countries use the default value.
- **Identification of potentially significant issues**: For each of the outliers identified it was determined whether or not this could be a potentially significant issue based on the criterium of a share of 0.5% of national total GHG emissions. The 'size' of the possible over- or under-estimation was quantified comparing the reported value with an estimate using the median IEF

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[37] EU-GIRP: EU-Greenhouse gas Inventory Reporting and Plots, see *https://github.com/aleip/eealocatorplots.git*

[38] *https://github.com/aleip/eealocatorplots/blob/master/eugirp_checknes.r*

[39] *https://github.com/aleip/eealocatorplots/blob/master/eugirp_checkunits.r*

[40] *https://github.com/aleip/eealocatorplots/blob/master/eugirp_checkoutliers.r*

or parameter as reported by all countries[41]. All outliers were 'manually' cross-checked and analysed. Countries were notified on the results of the analysis.

- **Time series outliers**: Time series outliers were detected on the basis of the same method as also used for the within-country-outlier check. Basis for the underlying distribution of data in this case, however, was not the values reported from all countries during the whole time series, but only the data reported by the country assessed. Only growth rates larger than ±3% could qualify as 'outliers'. However, this generated a large number of potential outliers which require further asseessment, which was not possible for the submission in 2015.

- **Sector-specific checks**: Several checks were performed tailored to the reporting in the sector agriculture [42][43]. First, the data are checked on consistency in reporting of activity data throughout the tables. Furhter, several other tests are performed:
  - Difference between the sum of nitrogen excreted and reported in the different manure management system (MMS) versus the total reported nitrogen excreted
  - Difference between the total nitrogen excreted and the product of animal population and nitrogen excretion rate
  - Difference of the sum of N handled in MMS over animal type vs. total N handled in each MMS
  - Check of the reported IEF per MMS with the total N excreted and the reported emissions
  - Calculation and evaluation of the IEF in category 3.B.2 by animal type and in relation to the total N excreted
  - Check that the sum of manure allocated to climate regions adds up to 100% over all MMS and climate regions

- **Recalculation**[44]: Countries were asked for justifications of recalculations of more than 0.5% of national total emissions (excluding LULUCF) and above or below the mean recalculations across all MS ±1.5 standard deviations.

Calculation of EU background data

EU-wide background data were calculated as weighted averages of the parameters provided by the countries, using activity data (animal numbers in category 3A and 3B and N input in category 3D) as weighting factors[45].

Care is being taken to not include in the calculation erroneous values:

- Data which had been identified as being reported with a different unit than the values reported by other countries (see above) were *converted* into the appropriate unit before calculating EU28 weighted averages

- Data which *obviously* wrong (very large outliers) but for which no clear correction could be identified were *eliminated* from the calcuation of the EU28 weighted averages to avoid biases in

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41 See function `ispotentialissue()` in the file https://github.com/aleip/eealocatorplots/blob/master/eugirp_functions.r

42 https://github.com/aleip/eealocatorplots/blob/master/agrichecks1ADs.r

43 https://github.com/aleip/eealocatorplots/blob/master/agrichecks2Nex.r

44 File: Recalculations_Sep15_Nov14_14Sep2014_2_agri.xlsx

45 https://github.com/aleip/eealocatorplots/blob/master/eugirp_euweightedaverages.r

the results. Therefore, the EU28 weighted averages - in some cases - could not represent 100% of EU28 activity data.

Compilation of the chapter agriculture for the EU-GHG inventory report

The agriculture chapter of the EU-GHG inventory report takes advantage of the data base generated by EU-GIRP. All numeric data presented in the chapter are calculated directly using the processed data as described above, thus eliminating the risk of transcription or copy errors. This does not eliminate the possibilty of mistakes completely. Therefore, all values are cross-checked.

5.1.2 Workshops and activities to improve the quality of the inventory in agriculture

Workshop on 'Inventories and Projections of Greenhouse Gas Emissions from Agriculture' (2003)

As a first activity to assure the quality of the inventory by Member States, a workshop on "Inventories and Projections of Greenhouse Gas Emissions from Agriculture" was held at the European Environment Agency in February 2003. The workshop focused on the emissions of methane (CH_4) and nitrous oxide (N_2O) induced by activities in the agricultural sector, not considering changes of carbon stocks in agricultural soils, but including emissions of ammonia (NH_3). The consideration of ammonia emissions allows the validation of the N_2O emission sources and it further strengthens the link between greenhouse gas and air pollutant emission inventories reported under the UNFCCC, the EC Climate Change Committee, the UNECE Long-Range Transboundary Air Pollution Convention, and the EU national emission ceiling directive. Objectives of the workshop were to compare the Member States? methodologies and to identify and explain the main differences. The longer term objective is to further improve the methods used for inventories and projections in the different Member States and to identify how national and common agricultural policies could be integrated in EU-wide emission scenarios.

The workshop report including the Recommendations formulated at the workshop are available *here*[46]

Survey on agricultural production methods (SAPM 2010)

The Survey on agricultural production methods, abbreviated as SAPM, is a once-only survey carried out in 2010 to collect data at farm level on agri-environmental measures. EU Member States could choose whether to carry out the SAPM as a sample survey or as a census survey. Data were collected on tillage methods, soil conservation, landscape features, animal grazing, animal housing, manure application, manure storage and treatment facilities and irrigation. With reference to irrigation, Member States were asked to provide estimation (possibly by means of models) of the volume of water used for irrigation on the agricultural holding.

The characteristics that were collected are given in the Regulation (EC) No 1166/2008 of the European Parliament and of the Council 19 November 2008 on farm structure surveys[47] and the survey on agricultural production methods and further defined in the Commission Regulation (EC) No 1200/2009 of 30 November 2009 implementing Regulation (EC) No 1166/2008 of the European

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[46] Leip, A., 2005. N_2O emissions from agriculture. Report on the expert meeting on 'improving the quality for greenhouse gas emission inventories for category 4D', Joint Research Centre, 21-22 October 2004, Ispra. Office for Official Publication of the European Communities, Luxembourg. *doi:http://dx.doi.org/10.13140/RG.2.1.4706.7607*.

[47] *http://eur-lex.europa.eu/legal-content/EN/ALL/?uri=CELEX:32008R1166*

Parliament and of the Council on farm structure surveys and the survey on agricultural production methods, as regards livestock unit coefficients and definitions of the characteristics[48].

A list of characteristics of potential relevance for the quantification of GHG emissions is given in Table 5.49.

Table 5.49 Selected characteristics included in the 'Survey on agricultural production methods' (SAPM)

Characteristic			**Units/categories**
Animal Grazing	Grazing on holding	Area grazed during the last year	ha
		Amount of time when aminals are outdoors on pasture	Month per year
	Common land grazing	Total number of animals grazing on common land	Head
		Amount of time when aminals are grazing on common land	Month per year
Animal housing	Cattle	Stanchion-tied table - with solid dung and liquid manure	Places
		Stanchion-tied table - with slurry	Places
		Loose housing - with solid dung and liquid manure	Places
		Loose housing - with slurry	Places
		Other	Places
	Pigs	On partially slatted floors	Places
		On completely slatted floors	Places
		On straw beds (deep litter housing)	Places
		Other	Places
	Laying hens	On straw beds (deep litter housing)	Places
		Battery cage (all types)	Places
		Battery cage with manure belt	Places
		Battery cage with deep pit	Places
		Battery cage with stilt house	Places
		Other	Places
Manure application	Used agricultural area on which solid/farmyard manure is applied	Total	UAA % band (2)
	Used agricultural area on which solid/farmyard manure is applied	With immediate incorporation	UAA % band (2)
	Used agricultural area on which slurry is applied	Total	UAA % band (2)
	Used agricultural area on which slurry is applied	With immediate incorporation	UAA % band (2)
	Percent of the total produced manure exported from the holding		Percentage band (3)

48 http://eur-lex.europa.eu/legal-content/EN/TXT/?qid=1448050507039&uri=CELEX:32009R1200

Manure storage and treatment facilities	Storage facilities for:	Solid dung	Yes/No
		Liqued manure	Yes/No
		Slurry: Slurry tank	Yes/No
		Slurry: Lagoon	Yes/No
	Are the storage facilities covered?	Solid dung	Yes/No
		Solid dung	Yes/No
		Slurry	Yes/No

Note 1: Utilised agricultural area (UAA) percentage band: (0), (> 0-< 25), (=25-< 50), (=50-< 75), (=75)

Note 2: Percentage band: (0), (> 0-< 25), (=25-< 50), (=50-< 75), (=75).

The LiveDate project on Nitrogen Excretion factors

The key indicator 'Gross Nutrient Balance' (GNB) is part of the set of agri-environmental indicators defined in the Commission Communication on the "Development of agri-environmental indicators for monitoring the integration of environmental concerns into the common agricultural policy"[49]. The Eurostat/OECD Methodology and Handbook on Nutrient Budgets has been updated and amended in 2013[50]. Nitrogen excretion coefficients have been identified of a major source of uncertainty for the estimation of the GNB, with high relevance for other reporting obligations, including the nitrate directive, reporting of ammonia emissions under the CLRTAP and the NEC directive, as well (and importantly) for the quantification of N_2O emissions from manure management and agricultural soils. An expert workshop was therefore organized on 28/03/2014 at Eurostat to discuss the possibility to improve the quality of N-excretion data by using a common improved methodology. A recommendation on such a common methodology served of the basis for discussion. The workshop was co-organized by JRC under the WG on Annual GHG inventories under the EU Climate Change Committee and was attended by agricultural experts of the EU GHG inventory system.

The following gives some information on the project that prepared the recommendations, as extracted from the report from Oenema et al. (2014)[51].

The general objective of the study "Nitrogen and phosphorus excretion coefficients for livestock; Methodological studies in the field of Agro-Environmental Indicators; Lot1" (2012/S 87-142068) is "to bring clarity into the issue of excretion coefficients so that a recommendation on a single, common methodology to calculate N and P excretion coefficients can be identified". The recommendation for a uniform and standard methodology for estimating N and P excretion coefficients must be based on a thorough analysis of the strength and weaknesses of the existing methodologies and on the data availability and quality in the Member States.

The specific objectives of the study were:

[49] http://epp.eurostat.ec.europa.eu/portal/page/portal/agri_environmental_indicators/introduction

[50] http://epp.eurostat.ec.europa.eu/portal/page/portal/agri_environmental_indicators/documents/Nutrient_Budgets_Handbook_%28CPSA_AE_109%29_corrected3.pdf

[51] Oenema, O., Sebek, L., Kros, H., Lesschen, J.P., van Krimpen, M., Bikker, P., van Vuuren, A., Velthof, G., 2014. Guidelines for a common methodology to estimate nitrogen and phosphorus excretion coefficients per animal category in eu-28. final report to eurostat, in: Eurostat (Ed.), Methodological studies in the field of Agro-Environmental Indictors. Eurostat, Luxembourg, pp. 1?108.

- To create an overview of the different methodologies used in Europe to calculate excretion factors for N and P, and analyse their strengths and weaknesses;
- To set up a database with the excretion factors presently used in different reporting systems and describe the main factors that cause distortion within a country and across the EU;
- To provide guidelines for a coherent methodology, consistent with IPCC and CLTRP guidelines, for calculating N and P excretion factors, and taking into consideration the animal balance and taking into account different methodologies identifies under the first bullet point;
- To create default P-excretion factors that can be used by the countries who do not have yet own factors calculated;

The recommendations of the LiveDate project from the authors of the report were:

- It is recommended to use the mass balance as a common and universally applicable method to estimate N and P excretion coefficients per animal category across EU-28:
  - $N_{excretion} = N_{intake} - N_{retention}$
  - $P_{excretion} = P_{intake} - P_{retention}$
- We recommend that the European Commission encourages Member States to invest in Tier 2 and 3 methods for key animal categories (and hence in country-specific, region-specific and/or year-specific excretion coefficients).
- We recommend that the European Commission encourages Member States to use a 3-Tier approach for the collection of data and information needed to estimate N and P excretion coefficients, so as to address differences between countries in livestock production and data collecting/processing infrastructure, and to economize on data collection/processing efforts. The three Tiers differ in the origin, scale and frequency of data and information collection.
- We recommend that the European Commission encourages Member States to use a Tier 3 approach for all key animal categories when livestock density in a country is > 2 livestock units per ha (>2 LSU per ha), equivalent to an excretion of about > 200 kg N or the inter-annual variation in N excretion by key animal categories is relatively large due to the effects of changing weather conditions and market prices.
- We recommend that the European Commission encourages Member States to use a Tier 2 approach for all main animal categories when livestock density in a country is between 0.5 and 2 LSU per ha (equivalent to an excretion of between about 50 and 200 kg N, under the condition that the inter-annual variation in N excretion by key animal categories is relatively small.
- We recommend that the European Commission reviews the current default N and P excretion coefficients of all animal categories and decides on a list of N and P excretion coefficients. Member States are recommended to use this list as a Tier 1 approach for all animal categories within a country when livestock density is <0.5 livestock units per ha (<0.5 LSU per ha, also at regional levels), which is equivalent to about 50 kg N and 10 kg P per ha agricultural land per year.
- We recommend that the European Commission encourages Member States to use region-specific N and P excretion coefficients when N and P excretion coefficients of the main animal categories differ significantly (>20%) between regions.
- We recommend that the European Commission makes computer programs available to Member States to encourage the calculation of the N and P excretion per animal category at regional and national levels in a uniform way. It is also recommended to provide training courses for the use of these programs and the calculation of the N and P excretion coefficients.

- We recommend that the European Commission encourages Member States to have well-documented and accessible methods for the estimation of N and P excretion coefficients per animal category. These reports should be updated once every 3-5 years and reviewed by external experts.
- We recommend that the European Commission encourages Member States to harmonise the various animal categories in formal policy reporting. We recommend that the FSS categorization is taken as the main list of animal categories for policy reporting, also because the inventory of the number of animals takes place regularly according to the FSS list of animal categories. We recommend also that a transparent scheme and computer program is developed for translating the inventory data of FSS into the animal categories of secondary databases (e.g., UNFCCC/IPCC-2006, EMEP/EEA, Nitrates Directive, FAO and OECD). The development of a uniform nomenclature for animal categories would be useful too, which should include definitions about key, main, minor, primary, secondary, functional categories
- We recommend that the European Commission encourages Member States to conduct a secondary animal categorization for key animal categories (e.g., cattle, pigs and poultry), when more than 20% of the animals are in ?another? system and when the N and/or P excretion coefficients differ by more than 20% from the overall mean N and P excretion coefficients. We recommend that the following aspects are considered for distinguishing different production systems:
  - Fast-growing and heavy breeds vs slow-growing breeds
  - Organic production systems vs common production systems
  - Housed ruminants vs grazing ruminants
  - Caged poultry vs free-range poultry
- Equally important is that the excretion coefficients can be translated in a transparent and well-documented manner from such secondary categories to the main categories of the FSS.
- We recommend that the European Commission conducts a review of the diversity of production systems and feeding practices within a country for the main animal categories cattle, pigs and poultry once in 5 yrs, so as to trace changes in production systems, including organic versus conventional systems, housed vs grazing ruminants, caged versus free range poultry, and fast growing breeds versus slow growing breeds.
- We recommend that the European Commission encourages Member States to review and update the N and P retention coefficients for all animal categories once in 5-10 yrs. All data should be stored in a database accessible by all Member States.
- We recommend that the European Commission conducts a review and adjusts/modifies/updates the classification system of livestock units (as presented also in Table 5 of this report), and livestock density, so as to better reflect the diversity of animals within an category and more in general the impact of livestock on the environment.

Regionalization of the Gross Nutrient Budget with the CAPRI model

The JRC was cooperating with EUROSTAT on a methodology to use the CAPRI model[52] for the regionalisation of the Gross Nutrient Budget (GNB) indicators (nitrogen and phosphorus) that needs to be reported regularly by countries to EUROSTAT and OECD. The GNBs are identified as one of the key agro-environmental indicators. Current reporting occurs at the national level. For policy making, a higher resolution, matching with legislative and environmental boundaries (NVZ, watershed) rather than administrative boundaries (country) is required. The CAPRI model is an economic model for agriculture, which has an environmental accounting model integrated. It has a spatial resolution of

52 http://www.capri-model.org/

NUTS2 and reports, a.o. Nitrogen Balances at this level. The CAPRI model has a down-scaling module integrated which estimates land use shares and environmental indicators at the pixel level (1 km by 1 km). The use of the CAPRI model is motivated in view of the lack of methodology for regionalisation of the GNB and the high costs associated with building up such systems in the countries at one hand, and the thrive to harmonise the conceptual approaches.

The Working Group (WG) on agri-environmental indicators (AEI, February 2012) and the subsequent Standing Committee for Agricultural Statistics (CPSA, May 2012) decided to start a pilot projects on regionalising Gross Nitrogen Balance (GNB) with the CAPRI model. The objective of the pilot project is to evaluate differences between national GNB and the GNB calculated with CAPRI at the country and the NUTS2 scale. Italy, France, Germany and Hungary volunteered for this pilot project. The RegNiBal project (Regionalisation of Nitrogen Balances with the CAPRI Model - Pilot Project) started in February 2013. The overall goal was to use the CAPRI model to provide (operationally) regional GNB data to complement the national Eurostat/OECD GNBs.

Four countries volunteered to share their national GNB estimates with the CAPRI team which were analyzed on differences with CAPRI estimates and recommendations were formulated to improve both national methods and the CAPRI model:

- France
- Germany
- Italy
- Hungary

The conclusions formaulated in the final RegNiBal report[53] included:

A total of 31 'issues' were identified that were related to major discrepancies between the methods and warranted further assessment. At the end of the project, 12 of the identified issues were solved, one was partially solved and 18 could not be solved, but some progress was achieved and concrete recommendations were made for almost all of them. The results and achievements of RegNiBal are summarised in Annex 12.

At the start of the RegNiBal project CAPRI data was generally judged to be more reliable than national data. The situation has changed with the improvements described above; at present, further analysis is needed to see whether CAPRI or national data is ?better? with regard to the remaining unresolved issues.

Overall, N excretion by swine and N removal by grass are considered the most important unresolved issues because of their considerable impact on N-input and N-output. The animal budget analysis for swine of DE and FR shows that CAPRI estimates higher feed intake than the national methodologies. Countries are not always sufficiently accurate in estimating and/or using the average number of animals and N-excretion coefficients in N manure excretion estimations. For the estimates of dry matter yields of grassland, the differentiation of permanent grassland according to the proposal of the GRASSDATE project (Velthof et al 2014)[54] would likely help (grassland out of production but maintained, unimproved grassland (including

[53] Özbek, F.S., Leip, A., Weiss, F., Grassart, L., Hofmeier, M., Kukucka, M., Pallotti, A., Patay, A., Thuen, T., 2015. Regionalisation of Nitrogen Balances with the CAPRI Model (RegNiBal) Pilot project in support of the Eurostat Working Group on Agri-Environmental Indicators. Publications Office of the European Union, Luxembourg. doi: *http://dx.doi.org/10.2788/078406*.

[54] Velthof, G.L., Lesschen, J.P., Schils, R.L.M., Smit, A., Elbersen, B.S., Hazeu, G.W., Mucher, C.A., Oenema, O., 2014. Grassland areas , production and use. Lot 2. Methodological studies in the field of Agro-Environmental Indicators. Alterra Wageningen UR, Wageningen, The Netherlands.

both sole use and common land) and improved grassland (by N-input levels <50, 50-100, >100 kg N/ha/yr, sole use and common land).

The CAPRI model is very strong in several parts of GNB calculations, and the RegNiBal project enabled us to identify several possible improvements in national data and methods. The use of the animal budget to estimate N excretion is a major asset in the CAPRI methodology, but runs the risk of outliers if the use of feed in the statistical sources is overestimated. There is large uncertainty in grass yield and other (non marketable) fodder yield and their N content. This affects the accuracy of national data as well. The other major areas of difficulties for the CAPRI model are the following: (i) Seed and planting materials should be explicit in the CAPRI GNB; (ii) N from organic fertilisers (other than manure) and manure withdrawal, stocks, and import estimations are not considered in the CAPRI model.

The CAPRI model can be used to calculate both land N budgets (GNB) and farm N budgets. The possibility of comparing the GNB with the farm N-budget helps to constrain the N-surplus results. For the farm N-budget, feed and fodder produced in the country (or region) and manure excreted and applied within the country (or region) are considered as ?internal flows? and thus do not need to be estimated to quantify the N-surplus; data on ?imported? feed and ?exported? animal products are needed instead (for details on the comparison of the two approaches, see Leip et al 2011[leip2011nbudgets]). In the CAPRI model, data on animal products and imported feeds are available from statistical sources and are thus more reliable than the data on the N intake of fodder and manure excretion, which would not be required. Generally, the RegNiBal project showed that the CAPRI model could be adequate to provide national (and later regional and spatially explicit) GNBs. However, for the four countries assessed, additional work needs to be carried out to understand residual disagreements in the data.

Workshop on improving national inventories for agriculture (2014)

Under the WG1 on Annual GHG inventories under the EU Climate Change Committee a workshop on improving GHG inventories in the sector agriculture was organized by the Joint Research Centre as part of the 7th Non-CO_2 Greenhouse Gas Conference (NCGG7), held November 5-7, 2014 Amsterdam, the Netherlands[55]. The workshop was co-organized by CEH in support of the UK greenhouse gas inventory programme.

The session raised a high interest, contained high quality presentations and allowed scientists, IPCC and FAO representatives and country delegates to discuss about greenhouse accounting methods, their difficulties and challenges to use IPCC guidelines, to select the appropriate tier methods and to design country-specific methodologies which allow reducing uncertainties. From a total attendance of about 200 conference participants and five parallel sessions, this session was temporary attended by almost 100 scientists.

The workshop focused on N_2O emissions from agricultural soils, as they are highly uncertain yet are often estimated with default methodology in lack of country-specific data of sufficient quality. N_2O emissions from agricultural soils are dominating the uncertainty of the total GHG emissions for many countries. The programme included presentations covering the whole range of aspects of N_2O emission estimates: the availability of flux data in Europe and network design strategies (Rene Dechow, Thuenen Institute, DE), use of process-based models in GHG inventories (Steve del Grosso, USDA) to inverse methods to estimated national total N_2O emissions (Rona Thompson, NILU, NO). Further presentation gave national examples on GHG improvements, such as UK (general), NZ (pasture emissions), Thailand (emissions from rice), Norway (emissions from dairy farms) and on the link to IPCC guidelines and the IPCC Emission Factor Database (Kiyoto Tanabe (see below) and

55 http://www.ncgg.info/

Baasansuren Jamsranjav, IPCC TFI TSU). A broader picture was given on the basis of the FAOSTAT GHG Database (FrancescoTubiello) and the CAPRI model (Carmona and Leip: The calculation of greenhouse gas emissions in the European agricultural sector; how much does the method matter?). Introduction and expectations were formulated by a presentation from Velina Pendolovska (DG Climate Action).

A final brainstorming exercise was done about how modelling and measurements could be improved in a way to reduce uncertainties, improve accuracy of measures and optimise resources. There was a debate around whether new models are needed or focusing on reducing the uncertainty in current models would be preferable, for example using the results of inverse modelling to contrast results. There is an agreement on the acceptability of simple models or inverse models for emission accounting at high scales, while more complex process-based models are needed when designing mitigation options. The problem of nitrogen surplus was pointed out as a proxy of N_2O emissions, which also informs about other additional pollution problems. About the estimation of uncertainties, the group agreed on the need, first of all, to improve their estimation. It seemed a general impression that uncertainties are usually overestimated, but it is difficult to quantify objectively. Another point that needs attention is the activity data: statistics do not always match at national level, and sometimes models demand a high quantity of data which is not available. Getting better activity data is important prior to focus on emission estimations.

As a conclusion, the combination of an expert meeting in support of the EU GHG inventory system and an international scientific conference was very successful, as it provided a high density of expertise that country delegates could use. The NCGG conference series is ideal for this purpose.

5.1.3 Verification

Comparison of national inventories with EU-wide calculations with the CAPRI model

An in-depth comparison between GHG emission estimates as calculated with the CAPRI model and national GHG emission inventories had been done in the frame of the GGELS project[56].

A brief summary of the report was included in previous submissions of the EU GHG emission inventories in the agriculture chapter. This summary is available from the JRC website[57].

Allocation to climate regions

In the year 2013, an analysis was performed to compare the allocation of livestock over the IPCC climate regions at the national scale between data available at high spatial resolution at the Joint Research Centre and data provided in the national GHG inventory reports.

For the submission in the year 2014, this section had been updated and is available at the JRC website[58]

56 ftp://mars.jrc.ec.europa.eu/Afoludata/Public/DOCU236/

57 ftp://mars.jrc.ec.europa.eu/Afoludata/Public/363_eughginventory2014/leip_weiss2014.ggels_summary.pdf

58 ftp://mars.jrc.ec.europa.eu/Afoludata/Public/363_eughginventory2014/koeble_leip2014.livestockallocation.pdf

Comparison of Cultivated Organic Soil at the FAO GHG database and JRC calculations

A comparison of the area of cultivated organic soils as reported by the FAO, in the national IRs with calculations done at the JRC has been performed by JRC in October 2013.

The FAO (FAO, 2103) provides area of cultivated organic soils on country level. The analysis is based on the Harmonized World Soil Database - HWSD - (FAO/IIASA/ISRIC/ISSCAS/JRC, 2009) and the Global Land Cover data set for the year 2000 (GLC2000).

At JRC the area of cultivated organic soils for the single countries in EU27 has been derived from overlaying the HWSD with the CORINE Land Use/Cover data set - CLC2006 (EEA, 2011) for the year 2006 (for some countries 2000). Both data sets have been resampled to a 1km by 1km raster cell size.

Definition of organic soils as given in IPCC (2006) based on FAO (1998): Soils are organic if they satisfy the requirements 1 and 2, or 1 and 3 below (FAO, 1998):

1. Thickness of 10 cm or more. A horizon less than 20 cm thick must have 12 percent or more organic carbon when mixed to a depth of 20 cm;
2. If the soil is never saturated with water for more than a few days, and contains more than 20 percent (by weight) organic carbon (about 35 percent organic matter);
3. If the soil is subject to water saturation episodes and has either: (i) at least 12 percent (by weight) organic carbon (about 20 percent organic matter) if it has no clay; or (ii) at least 18 percent (by weight) organic carbon (about 30 percent organic matter) if it has 60 percent or more clay; or (iii) an intermediate, proportional amount of organic carbon for intermediate amounts of clay (FAO, 1998).

FAO gave larger area of organic soils cultivated compared to JRC results for all countries except Germany Figure 5.69. This was mainly due to different source data sets for delineation of cropland area and the assumptions regarding the land use classification.

In the JRC approach Soil Typological Units (STU) of the HWSD are defined as 'organic soils'

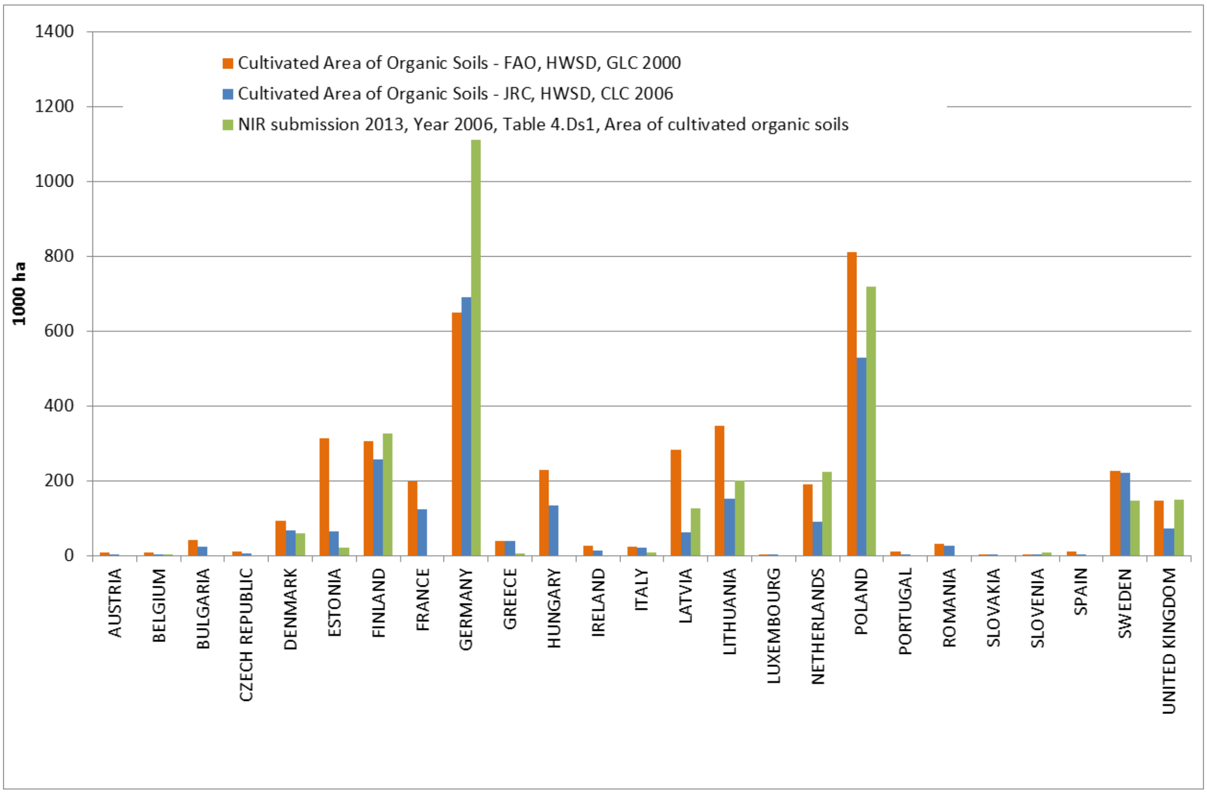
(1) if the topsoil organic carbon content is > 18% or

(2) if the topsoil organic carbon content is higher than the topsoil clay content * 0.1 + 12. All STUs in the EU27 of the HWSD which have been classified as 'organic soils' showed a organic carbon content of >30%, thus de facto only criterion (1) was applied.

To delineate 'cropland area' in the land use/cover map, FAO considers pure cropland classes as well as mixed cropland/other land use classes. For the latter, assumptions were made on the share of cropland within these mixed classes. However, the JRC approach takes assumes that in case of mixed land use classes the probability of the different land uses happening on organic soils are not the same, in contract to the approach of the FAO, which distribute land cover proportionally. As some crops do not grow well on organic soils it might occur that the land uses are not distributed equally on the mineral and organic soilbut that 100% of the forest is grown an organic soil and the crops are cultivated only on mineral soils.

In the JRC analysis mixed land use classes are not taken into account as the shares of cropland within these classes are given as ranges in the legend of CORINE. The cropland/other land use shares in the mixed land use classes might also vary between regions. Thus, by excluding mixed land use classes, the estimate of cropland area on organic soils can be considered as conservative compared to the FAO approach.

Figure 5.69: Area of cultivated organic soils based on two studies and the values given in the National Inventory Reports (2013) for the year 2006



Comparison of activity data in the FAO GHG database on the national inventory reports

A comparison between the activity data in the global FAO GHG data base[59] and the data reported in the national GHG inventories has been carried out for the submission in 2014.

This exercise could not be repeated for the current submission.

The corresponding chapter of the submission in 2014[60] has been extracted and is available here[61].

5.5 Sector-specific recalculations, including changes in response of to the review process and impact on emission trend

For information on recalculation please refer to chapter 10.

59 *http://faostat3.fao.org/browse/G1/*/E*

60 Chapter 6.7.3 in: EEA, 2014. Annual European Union greenhouse gas inventory 1990 - 2012 and inventory report 2014 Submission to the UNFCCC Secretariat. Technical report No 09/2014. European Environment Agency, Copenhagen, Denmark. Available at: *http://www.eea.europa.eu/publications/european-union-greenhouse-gas-inventory-2014*

61 *ftp://mars.jrc.ec.europa.eu/Afoludata/Public/363_eughginventory2014/carmona_leip2014.comparison_fao_nir.pdf*

6 LULUCF (CRF SECTOR 4)

Complying with relevant EU provisions (i.e. Regulation No 525/2013), Sector 4 LULUCF (Land Use, Land Use Change and Forestry) of the European Union (EU) GHG inventory is a compilation of the inventories submitted by individual EU´ Member States (MS). MS' submissions for 2015 are used as the primary source of data and information, unless otherwise specified and referenced through the text.

This chapter provides the general trends of GHG emissions and CO_2 removals from LULUCF at EU level, provides information on the methods used by different MS, and describes the efforts carried out to harmonize and improve the quality of EU GHG inventory. More detailed information can be found in individual national inventory reports (NIR) and common reporting format tables (CRF) of MS submissions.

In particular, this chapter includes: an overview of LULUCF sector including overall trends, the contribution of land use changes, the completeness of reporting, the key categories analysis of the EU GHG inventory, some general methodological information, the trends of net emissions and activity data for each land use category, some specific methodological information for the relevant categories; and an overview of cross-cutting issues including uncertainties, QA/QC, time series consistency and recalculations.

6.1 Overview of the sector

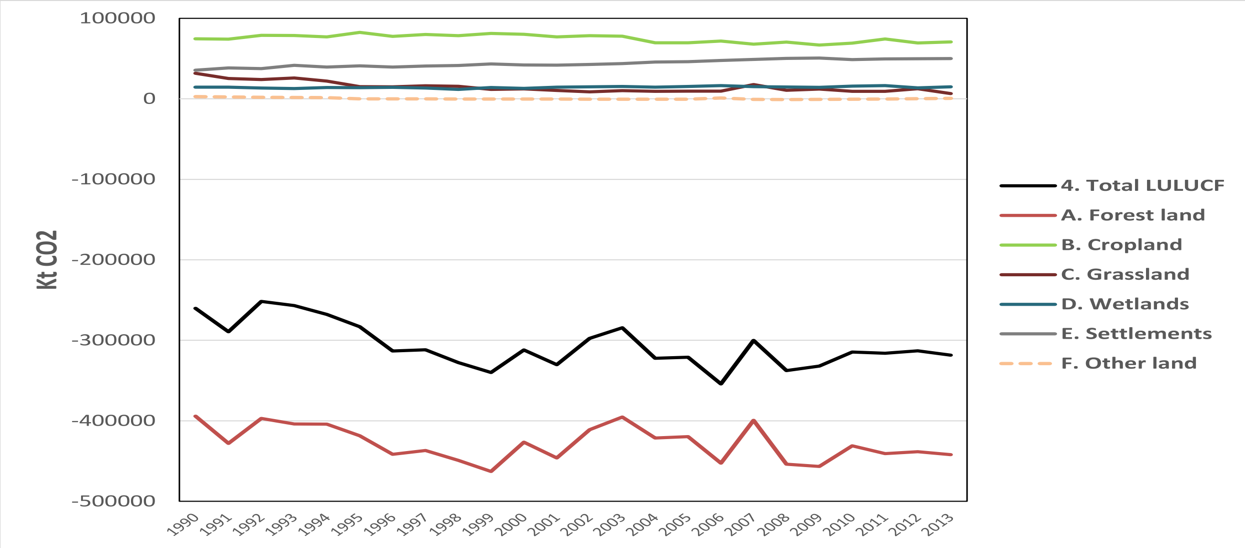
With almost all lands under more or less intensive management, Europe is a fine-grained mosaic of different land uses, resulting in a highly fragmented landscape. The EU agricultural and environmental policies have been the major driver of land use and land use change in Europe especially since 1990. In particular, the Common Agricultural Policy and rural development programs have stimulated less intense agricultural practices and a general decrease of area of the utilized arable land, compensated by the increase in forest and urban areas. Furthermore, the EU environmental policy (e.g. Natura 2000 network) has stimulated also the increase of forest and woodlands area under conservation regime with the purpose of preserving biodiversity and landscapes. Currently, at EU level, around 25% of total forest and woodland areas are excluded from harvesting. Felling accounts for only 60% of the net annual wood increment, which explains the significant build-up of biomass (i.e. carbon removal) in the forests.

6.1.1 Trends by land use categories

Sector 4 LULUCF of the EU GHG inventory is a net carbon sink, resulting from higher removals by sinks than emissions from sources. Overall, the only carbon sink is represented by Forest land category. Cropland is the larger source of emissions, and Grasslands represents a small source. In 2013, the LULUCF sector of the EU results in total net sink of -317.624 kt CO_2eq resulting in an increase of 22% as compared to net sink in 1990 (Figure 6.17). Emissions of CH_4 and N_2O offset about 4% of these annual removals. Harvested wood product carbon pool, as reported in CRF table 4, represents a net sink of 21.612 kt CO_2.

Finally, within the EU, few MS reported in the CFR table 4, under the category “Other”, additional emissions from sinks, or removals from sources, not reported in the sectorial background CRF tables for LULUCF. For instance, France reports CO_2 and CH_4 emissions form dam of Petit-Saut French Guiana, and biogenic NMVOC emissions from managed forest and methane removals from forest soil.

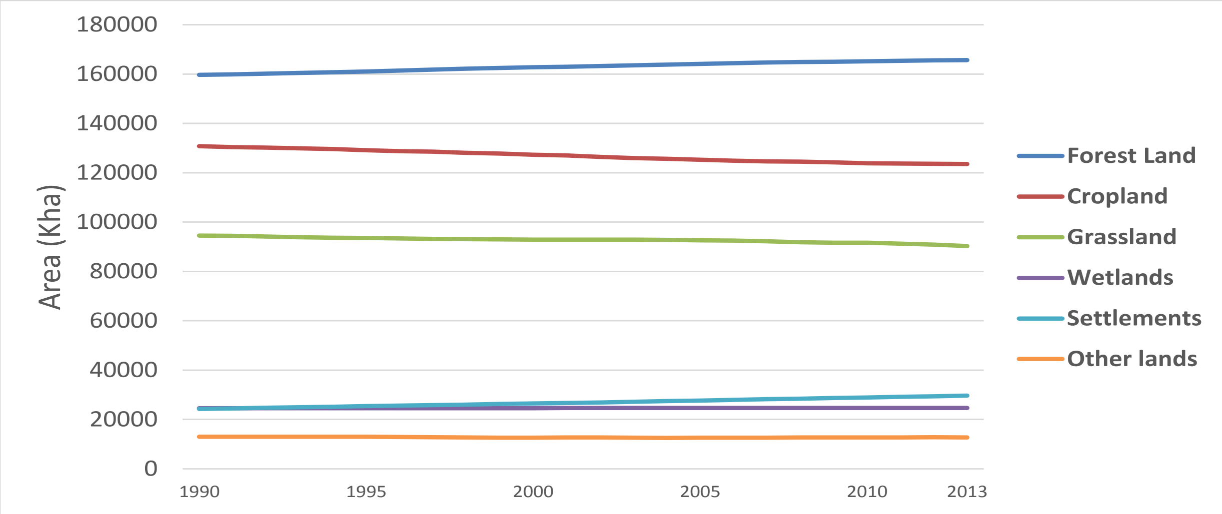
Figure 6.17 Sector 4 LULUCF: EU GHG net emissions (+) / removals (-) for 1990–2013, in CO_2 eq. (kt), for all land use categories.



Overall there is an increasing trend, since 1990, in the LULUCF sink. The most relevant trend in GHG net emissions and removals for the EU inventory is related to Forest land category. An increase of the forest sink occurred during the ‘90s, mainly due to forest area expansion. It has been followed by a decline largely attributable to a general increase in harvest rate. The significant decrease of the forest sink in 2002 is due to a drop in the sink from 4A.1 subcategory sink by Germany, all occurring in a single year due to the stock-difference method used. Inter-annual variations of the forest sink are mainly related to disturbances. Major wind storms in central-western Europe (e.g. 1999 and 2007) and wildfires (e.g. forest fires in 1990, 2003 and 2007) in Mediterranean countries.

The total reported land area of the different land use categories in 2013 is 446.585 kha. The trends in Figure 6.18 confirms the trends known from other EU statistics (e.g. Eurostat), although the absolute numbers may slightly differ due to different definitions linked to different reporting requirements under various processes. For the EU the main changes in area from 1990 to 2013 are from Settlements (+22%), Croplands (-6%), Forest land (+4%), Grassland (-4%), Other lands (-2%) and Wetlands (+1%).

Figure 6.18 EU total land area for each of the LULUCF categories (kha), as reported in the MS' GHGI 2013



Although EU reports a net sink in the LULUCF sector in 2013, which is increasing since 1990 (Table 6.1), it should be noted that the estimates reported by individual MS range from sources (e.g. Denmark, Netherlands, Ireland) to small sinks (e.g. Belgium, Estonia) or large sinks (e.g. France, Finland, Poland, Romania). Compared to 1990, some MS report large increase in their sink (e.g. Italy, Spain) whiles other reduced it substantially (i.e. Austria, Bulgaria, and Germany).

Table 6.1 Sector 4 LULUCF: MS' contributions to net CO_2 removals in 2013 (CRF table 4)

Member State	CO2 emissions in kt			Share in EU28 emissions in 2013	Change 2012-2013		Change 1990-2013	
	1990	2012	2013		kt CO2	%	kt CO2	%
Austria	-13 057	-6 035	-4 998	2%	1 037	-17%	8 059	-62%
Belgium	-2 350	-3 940	-3 855	1%	84	-2%	-1 505	64%
Bulgaria	-14 146	-9 155	-9 317	3%	-162	2%	4 829	-34%
Croatia	-5 543	-5 112	-5 139	2%	-27	1%	405	-7%
Cyprus	-614	-645	-652	0%	-7	1%	-39	6%
Czech Republic	-6 461	-7 123	-6 822	2%	302	-4%	-360	6%
Denmark	6 726	2 220	2 311	-1%	91	4%	-4 415	-66%
Estonia	-7 639	-1 471	-337	0%	1 133	-77%	7 302	-96%
Finland	-18 601	-30 048	-22 555	7%	7 493	-25%	-3 953	21%
France	-39 105	-50 276	-48 110	15%	2 166	-4%	-9 005	23%
Germany	-34 365	-17 516	-17 481	5%	36	0%	16 885	-49%
Greece	-2 439	-2 842	-3 333	1%	-491	17%	-893	37%
Hungary	-3 371	-4 420	-3 504	1%	916	-21%	-133	4%
Ireland	3 903	4 804	2 930	-1%	-1 874	-39%	-973	-25%
Italy	-7 419	-22 237	-34 318	10%	-12 081	54%	-26 899	363%
Latvia	-9 782	-1 441	-1 195	0%	246	-17%	8 587	-88%
Lithuania	-3 916	-8 954	-9 998	3%	-1 044	12%	-6 082	155%
Luxembourg	326	-447	-450	0%	-3	1%	-777	-238%
Malta	-3	-3	-3	0%	0	-1%	0	16%
Netherlands	5 665	6 087	6 142	-2%	55	1%	477	8%
Poland	-26 962	-34 546	-37 627	11%	-3 081	9%	-10 666	40%
Portugal	1 037	-10 698	-9 909	3%	789	-7%	-10 946	-1056%
Romania	-21 358	-25 264	-25 554	8%	-290	1%	-4 195	20%
Slovakia	-9 110	-7 345	-7 924	2%	-580	8%	1 186	-13%
Slovenia	-3 205	-4 775	-4 760	1%	15	0%	-1 555	49%
Spain	-23 775	-34 109	-34 291	10%	-182	1%	-10 516	44%
Sweden	-42 534	-44 876	-43 406	13%	1 469	-3%	-872	2%
United Kingdom	2 886	-5 770	-5 988	2%	-218	4%	-8 874	-307%
EU-28	**-275 212**	**-325 934**	**-330 143**	**100%**	**-4 209**	**1%**	**-54 931**	**20%**

Overall, at EU level, in the year 2013 the LULUCF sector offsets about 7% of the total emissions ("without LULUCF"), with big differences among MS (Table 6.2, column a). The most important LULUCF category, Forest Land, in 2013 was a net sink for all MS (Table 6.2, column b), offsetting about 10% of emissions from other sectors for the whole EU. The most significant contributors to total net sink are France, Germany and Sweden (Table 6.2 column c).

Table 6.2 Sector 4 LULUCF: Contribution of Sector 4 (column a) and Category 5A (column b) to total MS emissions (without LULUCF) and MS contribution to EU Category 5A (column c)

Member States	LULUCF over total inventory excluding LULUCF	Category 4A over total inventory excluding LULUCF	MS contribution to total category 4A
	(a) %	(b) %	(c) %
Austria	-6.3%	-5.5%	1.0%
Belgium	-2.5%	-2.7%	0.9%
Bulgaria	-16.7%	-19.8%	2.5%
Croatia	-20.9%	-22.4%	1.2%
Cyprus	-7.8%	-7.8%	0.1%
Czech Republic	-5.3%	-5.8%	1.7%
Denmark	4.4%	-4.2%	0.5%
Estonia	-1.5%	-7.5%	0.4%
Finland	-32.4%	-42.0%	6.0%
France	-9.5%	-13.4%	14.9%
Germany	-1.7%	-5.9%	12.8%
Greece	-3.2%	-1.8%	0.4%
Hungary	-6.0%	-5.6%	0.7%
Ireland	6.6%	-5.8%	0.8%
Italy	-7.8%	-8.5%	8.4%
Latvia	-1.4%	-29.5%	0.7%
Lithuania	-50.0%	-56.1%	2.5%
Luxembourg	-4.0%	-4.6%	0.1%
Malta	-0.1%	-0.1%	0.0%
Netherlands	3.2%	-1.4%	0.6%
Poland	-9.5%	-10.5%	9.4%
Portugal	-14.4%	-19.1%	2.8%
Romania	-22.2%	-24.2%	6.1%
Slovakia	-18.1%	-15.6%	1.5%
Slovenia	-26.1%	-39.4%	1.6%
Spain	-10.6%	-10.6%	7.7%
Sweden	-74.5%	-84.7%	10.7%
United Kingdom	-0.9%	-3.0%	3.9%
EU	-7.1%	-9.8%	100.0%

Source: MS' submissions 2015, CRF Table10s1and Table10s6.

6.1.2 Contribution of land use changes

Emissions from conversion of lands at EU level reached 5%, while in some categories their share is more that 50% of the total emissions in the corresponding category (Table 6.3). Entire land use change area represents 9% of the total reported land area in EU. The sink on conversions to Forest land and Grassland is balanced by emissions from conversions to Cropland and Settlements.

Table 6.3 Contribution of land use changes in 2013 for EU, in terms of area (columns a-b) and net CO_2 (columns c-d) (as aggregation of data from CRF Table 4.)

Land conversions	a) land area (Kha)	b) % of area of the corresponding category[1]	c) emissions (+) and removals (-) (Kt CO2)	d) % of net emissions of the corresponding category[1,2]
5A2. Land converted to Forest Land	8,406	5%	-56,151	12%
5B2. Land converted to Cropland	10,940	9%	45,240	67%
5C2. Land converted to Grassland	13,302	15%	-21,416	2194%
5D2. Land converted to Wetlands	1,430	6%	-674	5%
5E2. Land converted to Settlements	6,486	22%	46,890	94%
5F2. Land converted to Other Land	784	6%	563	100%
Total land use changes	**41,348**	**9%**	**14451**	**5%**

1 The corresponding category is 4A (Forest land) for 4A2, 4B (Cropland) for 4B2 and so on.

2 The contribution of emissions from land use changes to the total of each category was obtained by considering separately the absolute values of each subcategory, i.e. (abs 4A2)/(abs 4A1+ abs 4A2) x 100.

On average, in 2013, from total area under conversion, 32% is conversion to Grassland, 26% is conversions to Cropland, 20% is conversions to Forest land, 16 % is conversions to Settlements, and 3% and 2% conversions to Wetlands and Other lands respectively.

6.1.3 Completeness of the sector

Table 6.4 illustrates the current coverage of reporting for the various land use sub-categories in the year 2013. The three main land uses categories are in most of the MS fully covered.

Table 6.4 Sector 4 LULUCF: Coverage of CO_2 emissions and removals for each of the LULUCF land use sub-categories for the year 2013, as derived from 2015 GHGI submissions

MS	Reporting category											
	Forest land		Cropland		Grassland		Wetland		Settlements		Other land	
	5.A1. F-F	5.A2. L-F	5.B.1. C-C	5.B.2. L-C	5.C.1. G-G	5.C.2. L-G	5.D.1. W-W	5.D.2. L-W	5.E.1. S-S	5.E.2. L-S	5.F.1. O-O	5.F.2. L-O
Austria	R	R	R	E	E	E		E		E		E
Belgium	R	R	R	E	R	R		R		E		
Bulgaria	R	R	E	E		R		E		E		
Croatia	R	R	E	E	E	R		E		E		
Cyprus	R											
Czech Republic	R	R	R	E	R	R		E		E		
Denmark	R	E	E	R	E	E	E	E		E		
Estonia	R	R	E	E	E	R	E	E		E		E
Finland	R	R	E	E	E	E	E	E		E		
France	R	R	E	E	E	R		R		E		E
Germany	R	R	E	E	E	E	E	R	E	E		
Greece	R	R	R	E	E	R		E		E		E
Hungary	R	R	R	E	R	R	R	E		E		E
Ireland	E	R	R		E	E	E	E		E		E
Italy	R	R	E	E	R	R				E		
Latvia	R	R	E	E	E	R	E		R	E		
Lithuania	R	R	E	E	E	R	E			E		E
Luxembourg	R	R	E	E		R		E		E		E
Malta	R		R									
Netherlands	R	R	E	E	E	E		E	E	E		E
Poland	R	R	R	E	E	R	E		R	E		
Portugal	R	R	R	E	R	E		E		E		R
Romania	R	R	R	R	R	E		E		E		E
Slovakia	R	R	R	E		R				E		E
Slovenia	R	R	E	E		E		E		E		E
Spain	R	R	R	E	E	E		R		E		E
Sweden	R	R	E	E	R	E	E		R	E		
United Kingdom	R	R	E	E	R	R	E		E	E		E

R = the pool C stock change results in net Removals; E = the pool C stock change results in a net Emissions
Empty cells = the pool was not reported, included elsewhere or reported with no net C stock changes.

In general, the reporting of Wetlands, Settlements and Other lands categories involves lower tiers methods in comparison to the major land use categories. Carbon stocks changes in “land remaining in the same category” are often assumed in equilibrium for these categories while, there is a quite complete reporting on emissions and removals from land converted to them. Table 6.5 shows the completeness of reporting on carbon stock changes by carbon pools for the three most important land use categories in 2013. Compared to the previous submissions, several MS have increased the number of pools estimated and reported. As for Table 6.4, empty cells in Table 6.5 represent pools which are not reported with quantitative estimates (in some cases based on Tier 1 assumptions and in some cases providing also demonstration that they are not a net source of emissions). In most cases, efforts are ongoing by MS to prepare estimates for these pools in future submissions.

Table 6.5 Sector 4 LULUCF: Reporting of carbon pools for the most important land sub-categories for the year 2013 (from Tables 4A, 4B and 4C of MS's GHGI 2015 submissions)

MS	Reporting category																							
	Forest land								Cropland								Grassland							
	5.A.1. F-F				5.A.2. L-L				5.B.1. C-C				5.B.2. L-C				5.C.1. G-G				5.C.2. L-G			
	LB	DOM	SOCmin	SOCorg	LB	DOM	SOCmin	SOCorg	LB	DOM	SOCmin	SOCorg	LB	DOM	SOCmin	SOCorg	LB	DOM	SOCmin	SOCorg	LB	DOM	SOCmin	SOCorg
Austria	R	R	E		R	R	R		E		R		R	E	E				R	E	E	E	R	
Belgium	R	E	R		R		R		R		R	E	E	E	E				R	E	E	E	R	
Bulgaria	R				R	R	E		E		R		E		E						E		R	
Croatia	R				R		R		E		R	E	R		E					E	E		R	
Cyprus	R																							
Czech Rep	R				R		R		R		R		E	E	E				R		R	E	R	
Denmark	R	E		E	E	E	R	E	E		E	E	E	E	R	E	E			E	E	E	E	
Estonia	E	R	R	E	R	R	E	E	E		R	E	E	E	E	E	E	R		E	E	E	R	E
Finland	R		R	E	R		R	E	R		R	E	E	E	E	E	R			E	E	E	R	E
France	R	E			R	R	R	E					E	E	E	E					E	E	R	E
Germany	R	E	R	E	R	R	E	E				E	E	E	E	E	R		E	E	E	E	R	E
Greece	R				R				R			E	E	E	E		E						R	
Hungary	R			E	R		R		E		R		R	E	E				R		R	E	R	
Ireland	E	R		E	R	R		E	R		R								R	E	E	E		E
Italy	R	R			R	R	R		E			E			E		R	R			E		R	
Latvia	R	R		E	R	R		E	R	R		E			E	E	R	R		E			R	E
Lithuania	R	R			R	R			R		R	E	E		E	E				E			R	E
Luxembourg	R				R		R		E		R		R	E	E						E	E	R	
Malta	R								R															
Netherland	R	R			R		E	E				E	E	E	E	E				E	E	E	R	E
Poland	R		R	E	R		R	E	R		E	E			E				E	E	R		R	
Portugal	R	E	R		R	E	R		R		R		E	E	E				R		E	E	E	
Romania	R			E	R	R	R		R	E	R	E	R	E	R		R			R	E	E	R	
Slovakia	R				R	R	R		R		R		E	E	E						E	E	R	
Slovenia	R	E			R		R		R		E	E	E	E	E						E	E	E	
Spain	R				R	R	R		E		R		R	E	E						E	E	R	
Sweden	R	R	R	E	R	R	E	E	R	R	E	E	E	E	E	E	R	R	R	E	E	E	R	E
UK	R	R	R	R	R	R	R	R			E	E	E	E	E	E			R		E	E	R	E

Pools: DOM – dead organic matter, LB –living biomass, SOCmin –soil organic carbon in mineral soils, SOCorg –soil organic carbon in organic soils
R: net Removal;
E: net Emission
Empty cells = the pool was not reported or reported as zero, because it is: assumed "in balance" (following IPCC tier 1), stock changes are "not occurring", or the pool is not present.

6.1.4 Data and methods

This section provides an overview of the information on methods and data used for reporting emissions and removals from the three main land use categories. Detailed information regarding methodological issues is included as an annex of this report.

Given the heterogeneity of the MS in terms of ecological and socio-economic conditions, there are no unique definitions of land use categories. Methods used to estimate GHG emissions and CO_2 removals from the LULUCF sector also vary considerably among MS and land use categories. This heterogeneity is of course a richness in terms of biodiversity, but also, the implementation of country-specific data and methods (if in accordance with IPCC) that reflect national circumstances are likely to be more accurate than if they were prepared using and EU single approach.

Table 6.6 is a summary of relevant information on methodologies applied for each individual pool in the GHG inventory 2015 for the LULUCF sector. Usually, for reporting lands remaining in the same category a single data source is used which facilitate the categorization of the methods under one single tier, while multiple data sources are often used to estimate emissions from lands under conversions.

Because of different underlying methods applied by each MS, and their own national circumstances, the comparison of absolute levels or trends of emissions across MS should be done carefully to prevent erroneous interpretations. Indeed, in some cases, large differences may be attributable to the different estimating methodologies. For example, the gain-loss and stock-difference methods may lead to different trends in the short term. Some implied carbon stock change factors may be significantly affected by new areas entering in a given category or, time series for land conversions do not sum up for each reported year a 20-years transition period (e.g. dataset on land conversions started in 1990). Furthermore, the fact that not all MS use the 20-year default transition period for all pools or land conversions suggest that the corresponding carbon stock change factors are not fully comparable across MS.

Table 6.6 Summary of methods and carbon stock change factors used by MS to calculate CO_2 emissions and removals of different carbon pools in the LULUCF sector, as reported in the GHGI 2015 submissions

MS	Forest land								Cropland								Grassland							
	FL-FL				L-FL				CL-CL				L-CL				GL-GL				L-GL			
	LB	DOM (1)	SOC Min	SOC Org (2)	LB	DOM	SOC Min	SOC Org (2)	LB (3)	DOM	SOC Min (4)	SOC Org (2)	LB (5)	DOM	SOC Min	SOC Org (2)	LB	DOM	SOC Min (4)	SOC Org (2)	LB	DOM	SOC Min	SOC Org (2)
AT	CS	CS,D	D	NO	CS	CS	CS	NO	D,CS	D	CS,CS	NO	CS,CS	CS	CS	NO	NO	D	CS,CS	CS	CS	CS	CS	NO
BE	CS	CS,D	CS	NO	CS	D	CS	NO	NE	D	CS	NO	CS,NO	D	CS	NO	NO	D	CS	NO	CS,NO	D	CS	NO
BG	CS	D	D	NO	CS	D	CS	NO	CS,D	CS	CS	NO	CS,D	NO	CS	NO	NO	NO	NO	NO	CS,D	NO	CS	NO
CY	CS	D	D	NE	NE	D	NE	NO	NA	NA	NA	NA	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
CZ	CS	D	D	NO	CS	D	CS	NO	D	D	CS,D	NO	CS,D	CS	CS	NO	D	D	CS,D	NO	CS,D	CS	CS	NO
DE	CS	CS,D	D	CS	CS	CS	CS	CS	NO	NO	NO	CS	CS,CS	CS	CS	CS	CS	NO	CS	CS	CS	CS	CS	CS
DK	CS	CS,D	D	CS	CS	CS	CS	CS	CS	NA	CS	CS	CS,CS	NO	CS	CS	CS	NA	NA	D	D	CS	CS	CS
EE	CS	CS,D	D	CS,D	CS	CS	NE	CS,D	CS	NE	NE	CS,D	IE,NO	NO	NE	CS,D	CS,D	CS	NE	CS,D	CS	CS	NE	CS,D
ES	CS	D	D	NO	CS	NE	CS	NO	CS	NE	CS	NO	NO,NO	NO	NO	NO	NE	NE	NE	NO	NE	NE	CS	NO
FI	CS	CS	CS	CS	CS	CS	CS	CS	CS	NE	D	CS	D	CS	CS,D	CS	NE	NA	D	CS	D	NE	CS,D	CS
FR	CS	CS,D	D	NO	CS	CS	CS	NO	D	D	NO	NO	CS,NO	CS	CS	NO	D	D	NO	NO	CS	CS	CS	NO
GR	CS	D	D	NO	CS	D	D	NO	CS	D	D,D	D	NO,CS	NO	IE	NO	D	D	NO	NO	NO	NO	IE,NO	NO
HR	CS	D	NO	NO	CS	D	CS	NO	CS,D	NO	CS	D	CS	NO	CS	NO	NO	NO	NO	D	CS,D	NO	CS	NO
HU	CS	D	D	NO	CS	D	D	NO	D	NO	D,D	NO	CS,D	D	D	NO	D	D	D,D	NO	CS	CS	D	NO
IE	CS	CS,D	D	CS	CS	CS	NO	CS	NO	NO	CS,D	NO	CS	NO	CS	NO	NO	NO	CS	CS,D	NO	NO	CS	CS
IT	CS	D,CS	NO	NO	CS	CS	NO	NO	D,CS	CS	NE,NO	D	CS	NO	CS	NO	CS	CS	NE,NO	NO	NO	NO	CS	NO
LT	CS	CS	CS	CS	CS	D	NE	NE	D	NA	NA	CS	D	NA	D	NA	NA	NA	NA	CS	D	NA	D	CS
LU	CS	D	D	NO	CS	D	CS	NO	D	D	NO	NO	CS	D	CS	NO	NO	NO	NO	NO	CS	CS	CS	NO
LV	CS	D	D	CS	CS	D	NE	CS	NO	NO	NO	D	CS,NO	CS	CS	CS	NE	NO	NO	D	NO	NO	NE	IE
MT	CS	D	D	NE	NO	NO	NO	NO	D	NE	NE	NE	CS	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
NL	CS	CS	D	NE	CS	D	NE	NE	NE	NE	NE	IE	CS	CS	NE	NE	NE	NE	NE	CS	CS	CS	NE	NE
PL	CS	D	CS	CS	CS	CS	CS	CS	D	D	CS	CS	NA,NO	NO	CS	NO	NO	NO	CS	CS	NO	NO	CS	IE
PT	CS	CS	CS	NO	CS	CS	CS	NO	CS	NO	CS	NO	CS,CS	CS	CS	NO	NO	NO	CS	NO	CS	CS	CS	NO
RO	CS	D	D	NE	CS	D	NE	NE	D	CS	CS	D	NO	NO	CS	NO	NO	NO	NO	NE	NO	NO	CS	NO
SE	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS,CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS
SK	CS	D	D	NO	CS	D	CS	NO	D	D	NO	NO	CS,D	CS	CS	NO	D	D	NO	NO	CS	CS	CS	NO
SV	CS	CS	D	NO	CS	CS	CS	NO	CS	D	CS	CS	CS	CS	CS	NA,NO	D	D	NA	CS	CS	CS	CS	NA
UK	CS	CS	CS	CS	CS	CS	CS	CS	CS	D	CS	CS	CS,CS	CS	CS	IE	NO	NO	CS	NO	CS	CS	CS	CS

Source: CRFs 2015

(D: default; CS: country specific; NA: not applicable; NE: not estimated; NO: not occurring)

"CS" country specific data, associated either with IPCC method tier 2 or country-specific method tier 3, if data are highly disaggregated or derivate using models. Note that sometimes not all parameters involved in the estimation are truly "CS" (e.g. root/shoot ratio and BEF are often taken from IPCC GPG). However it is expected that if "CS" is reported in table 6.7, the most important parameters are truly "CS"

"D" means that the default IPCC emission factors are used in the estimation. D is typically associated with IPCC default method (tier 1).

"NE" means either country assumes insignificant emission/removal or not enough data is available for estimation

"NO" means emissions or removals "not occurring" in a country (it includes also "NA" - not applicable)

(1) for DOM under "FL r FL" the 2 notations separated by a comma mean: dead wood and litter respectively

(2) for SOCorg any notation key used under carbon stock changes estimation, if areas of organic soils are reported, should, in principle, be seen as NE. D refers to the use of IPCC default emissions factors

(3) for LB carbon stock change in CL-CL is assumed only for perennial woody crops. Biomass of annual crops is always assumed in balance

(4) for SOC MIN on CL and GL the 2 notation keys separated by comma mean that the country uses IPCC default method (which is tier 1 if associated with D data or tier 2 if associated with CS data); in this case, the first notation key refers to "reference C stock", and second to "C stock change factors" (see IPCC-GPG for details). A cell with a single "CS" indicate a country-specific method and data (i.e. tier 3 if data are highly disaggregated)

(5) for LB under L – CL, "conversion to cropland", the 2 notation keys used mean: first one refers to FL-CL and second to GL-CL

Grey heading means that for these pools IPCC TIER 1 allows to assume no change in C stock (note that if the category is a key category, in theory higher tiers should be used)

6.1.5 Key categories

The following LULUCF subcategories of the EU GHG inventory were found to be key categories (Table 6.7) for the trend (T) and the level assessment (L).

Table 6.7 Key category analysis for the EU (LULUCF sector excerpt)

Source category gas	kt CO2 equ.		Trend	Level	
	1990	2013		1990	2013
4 Biomass Burning Land Use: Land-Use Change and Forestry (CO2)	11,389	3,690	T	0	0
4.A.1 Land Use: Forest Land (CO2)	41,321	44,913	T	L	L
4.A.2 Land Use: Forest Land (CO2)	37,233	56,639	T	L	L
4.B.1 Land Use: Cropland (CO2)	24,985	22,279	T	L	L
4.B.2 Land Use: Cropland (CO2)	45,879	45,025	T	L	L
4.C.1 Land Use: Grassland (CO2)	31,679	21,035	T	L	L
4.C.2 Land Use: Grassland (CO2)	8,814	21,198	T	0	L
4.D.1 Land Use: Wetlands (CO2)	13,061	14,174	T	L	L
4.E.2 Land Use: Settlements (CO2)	32,077	46,644	T	L	L
4.G Wood product: Harvested Wood Products (CO2)	24,746	20,110	T	L	L
4.H Land Use: Other LULUCF (CH4)	3,214	1,003	T	0	0

6.2 Categories and methodological issues

6.2.1 Forest land (CRF 4A)

6.2.1.1 Overview of the Forest land category

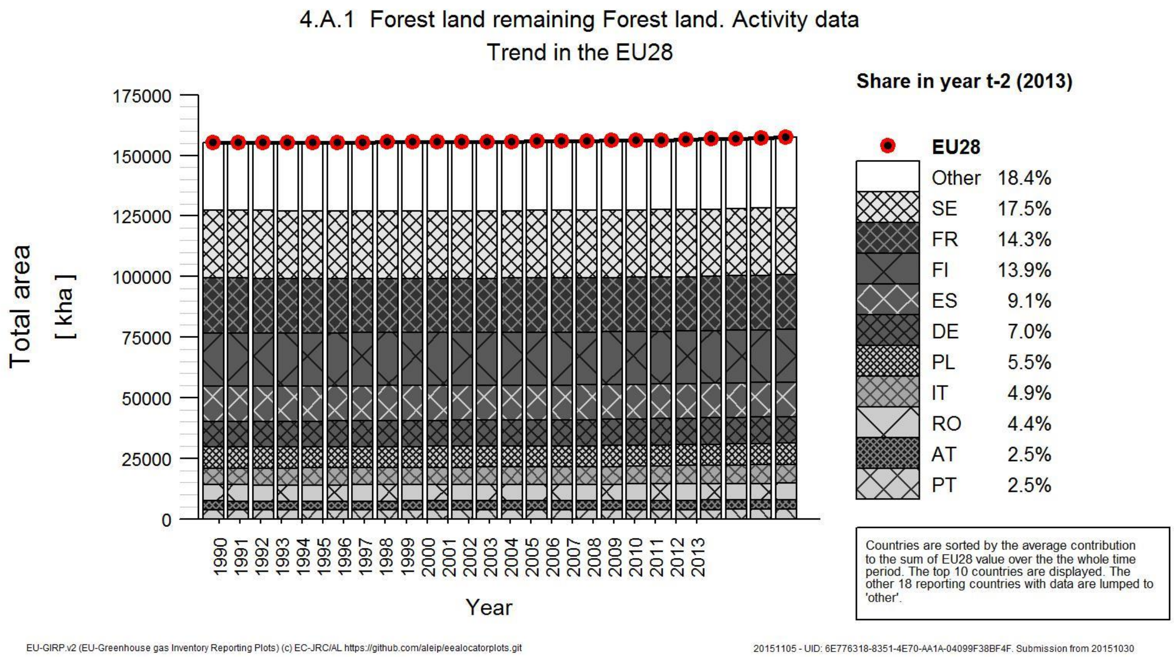
Forests land is the leading category in the LULUCF sector, and represents 37% of total EU area. According to the data provided by MS in their 2015 submissions, total forest area in EU increased from 159.644 kha in 1990 to 165.708 kha in 2013, which represent an increase of 4%. About 5% of this forest area is represented by land under conversion to forest land. This trend, reflected in official statistics of the EU, is due to the decreasing grazing pressure and decreasing agricultural activities on marginal lands, which promoted natural forest expansion, but also due to the promotion of national afforestation programs (including grant-aid). The largest forest area in 2013 is reported by Sweden, France and Finland. While, deforestation does not appear to be a major issue in Europe; it may be relevant for specific countries, nevertheless, the absolute area under conversion from forest is highly compensated by that of new planting and forest expansion.

6.2.1.2 Forest Land remaining Forest Land (CRF 4A1)

Overview of Forest Land remaining Forest Land category

The area of Forest Land remaining Forest Land slightly increased by 1% at EU level since 1990 with large differences among MS (e.g., UK +33%, Netherlands -11%) (Figure 6.19, Table 6.8).

Figure 6.19 Trend of activity data in the "Forest land remaining Forest Land" subcategory of EU MS (kha, 1990-2013)



For the year 2013, the total land area reported at EU level under the category 4.A1 reached 157.302 Kha of which 82% corresponds to the 10 MS with higher contribution.

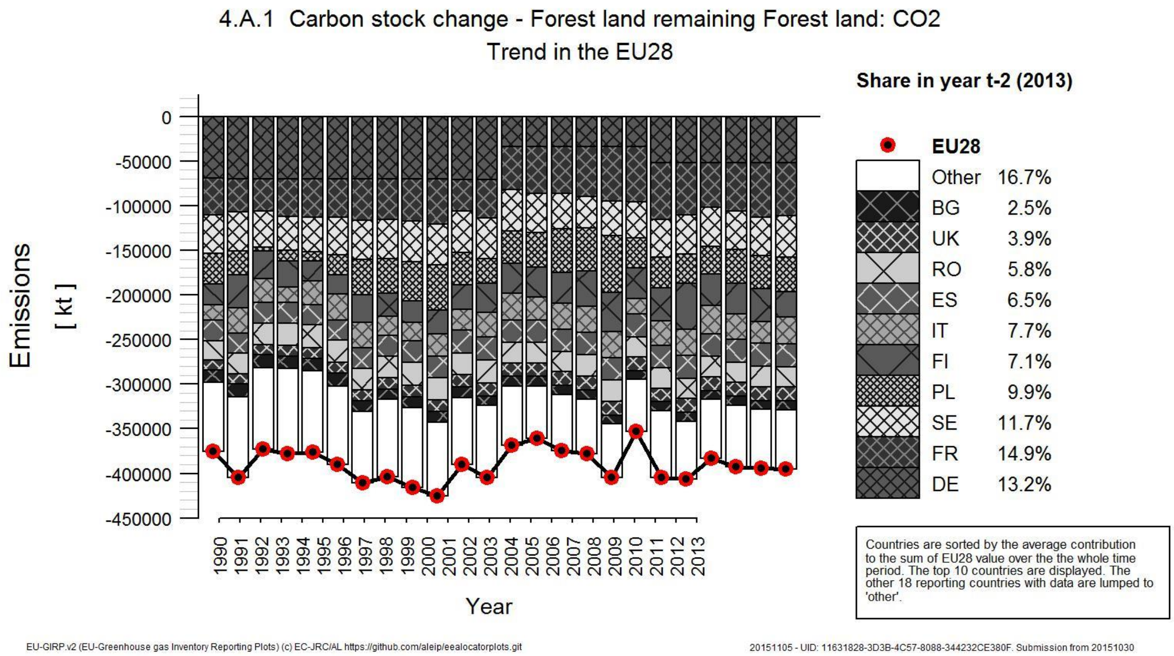
At EU level, Forest Land remaining Forest Land is a net sink of -392 649 kt CO_2 in 2013, increasing 6% as compared in 1990, and similar to the sink reported for the year 2012 (Table 6.8).

Table 6.8 4A1 Forest Land remaining Forest Land: MS' contributions to net CO_2 emissions (CRF table 4)

Member State	CO2 emissions in kt			Share in EU28 emissions in 2013	Change 2012-2013		Change 1990-2013	
	1990	2012	2013		kt CO2	%	kt CO2	%
Austria	-7 849	-2 542	-2 561	1%	-19	1%	5 288	-67%
Belgium	-2 930	-3 690	-3 689	1%	2	0%	-759	26%
Bulgaria	-14 279	-10 019	-10 004	3%	15	0%	4 274	-30%
Croatia	-5 589	-5 230	-5 291	1%	-61	1%	298	-5%
Cyprus	-614	-645	-652	0%	-7	1%	-39	6%
Czech Republic	-4 635	-7 182	-7 117	2%	65	-1%	-2 482	54%
Denmark	253	-2 899	-2 384	1%	515	-18%	-2 637	-1043%
Estonia	-8 763	-1 262	-115	0%	1 147	-91%	8 648	-99%
Finland	-22 882	-36 490	-27 963	7%	8 527	-23%	-5 081	22%
France	-38 987	-60 478	-58 885	15%	1 593	-3%	-19 897	51%
Germany	-69 436	-52 198	-52 270	13%	-71	0%	17 166	-25%
Greece	-1 176	-1 579	-1 776	0%	-198	13%	-601	51%
Hungary	-2 971	-2 719	-2 013	1%	706	-26%	959	-32%
Ireland	-2 720	267	74	0%	-193	-72%	2 794	-103%
Italy	-17 644	-24 515	-30 354	8%	-5 839	24%	-12 710	72%
Latvia	-15 040	-3 918	-3 603	1%	316	-8%	11 438	-76%
Lithuania	-7 150	-8 757	-10 491	3%	-1 734	20%	-3 342	47%
Luxembourg	239	-434	-444	0%	-10	2%	-684	-286%
Malta	-2	-2	-2	0%	0	0%	0	0%
Netherlands	-1 949	-2 063	-2 366	1%	-303	15%	-417	21%
Poland	-33 561	-36 838	-39 131	10%	-2 293	6%	-5 570	17%
Portugal	-2 214	-8 438	-8 880	2%	-442	5%	-6 666	301%
Romania	-21 590	-22 909	-22 966	6%	-57	0%	-1 376	6%
Slovakia	-6 088	-5 922	-6 481	2%	-559	9%	-394	6%
Slovenia	-4 248	-6 276	-6 321	2%	-45	1%	-2 073	49%
Spain	-23 089	-25 677	-25 714	7%	-37	0%	-2 625	11%
Sweden	-43 752	-43 267	-46 075	12%	-2 807	6%	-2 322	5%
United Kingdom	-11 005	-15 098	-15 174	4%	-76	1%	-4 169	38%
EU-28	**-369 670**	**-390 781**	**-392 649**	**100%**	**-1 868**	**0%**	**-22 979**	**6%**

For 2013, with the exception of Ireland, all the MS report a sink in Forest Land remaining Forest Land. The largest change in absolute terms reported by MS as compared with 1990 correspond to a significant increase of the sink reported by France. In a good match with the share in total areas, the 10 MS with the largest contribution to total sink account for about 83% of the EU sink reported for the year 2013.

Figure 6.20 Trend of emissions in the "Forest land remaining Forest Land" subcategory of EU MS (kha, 1990-2013)



In many cases, CO_2 emissions from biomass burning are implicitly included in CRF table 4.A, as a loss of carbon stock, while related non-CO_2 emissions are reported in CRF table 4(V). The main types of disturbances across EU are forest fires (mainly in Southern European countries) and wind storms (mainly in central Europe), while other type of disturbances generally have a localized effects and low magnitude. They are difficult to quantify in terms of biomass loss (e.g. insect outbreaks), thus they are practically not mentioned in the MS reports. Estimation of emissions from forest fires is made with Tier 1 method in case of small emissions or with higher tiers where such annual emissions are significant (e.g. Portugal, Spain).

Large inter-annual variability in GHG estimates that affect the EU trend is driven by natural disturbances:

- Forest fires (e.g. Portugal in 1990, 2003 and 2005; Italy in 1990, 1993 and 2007). For instance, Spain reports areas burnt ranging between 20 – 250 kha annually;
- Windstorms (e.g. France in 1999 and 2009, and Denmark in 2000, Sweden in 2005);

Or by the estimation method:

- For instance, Germany uses the stock-difference method between subsequent forest inventories. This method is accurate for estimating carbon stock changes over a time period but it may results in discontinuities in trends, i.e. "steps" in single years (e.g. 2002), because the significant decrease of the sink which occurred over a period since the previous forest inventory is counted in a single year when carbon stocks of the more recent inventory are integrated in the calculation.

Methodological issues for Forest Land remaining Forest Land category

Forest land definitions are reported by almost all EU MS in their submissions with the exception of Cyprus. (Table 6.9, Table 6.10). The consistency of these definitions with the land representation system is ensured within the MS in terms of time and space. The forest definitions among MS, slightly differ in terms of quantitative parameters (i.e., crown cover, tree height and minimum land area). In general, these forest definitions are consistent with definitions used under other international processes (i.e. Global Forest Resources Assessments 2005, 2010 FRA (FAO)). For forest administration purposes, lands without tree cover, may be included or not within forest land, thus, additional qualitative criteria complement the forest definition provided (i.e. treatment of forest roads, nurseries, willow crops, etc.). Few MS have changed their forest definition since 1990, but these changes do not affect consistency of the time series on activity data. Greece has a new forest definition applied from 2003. Denmark changed from a questionnaire based forestry information system to NFI but implemented methods for ensuring the consistency of the time series (i.e. reassessment of base year data based on earth observation information).

Table 6.9 Values for forest definitions thresholds as selected by MS

Member State	NIR 2015			
	Crown cover (%)	Height (m)	Area (ha)	Minimal width (m)
Austria	30	2	0.05	10
Belgium	20	5	0.5	-
Bulgaria	10	5	0.1	10
Croatia	10	2	0.1	-
Cyprus	-	-	-	-
Czech Republic	30	2	0.05	-
Denmark	10	5	0.5	20
Estonia	30	2	0.5	-
Finland	10	5	0.25 (0.5) for Southern (Northern) Finland	20
France	10	5	0.5	20
Germany	10	5	0.1	-
Greece	25	2	0.3	-
Hungary	30	5	0.5	-
Ireland	20	5	0.1	20
Italy	10	5	0.5	-
Latvia	20	5	0.1	20
Lithuania	30	5	0.1	-
Luxembourg	10	5	0.5	-
Netherlands	20	5	0.5	30
Malta	30	5	1	-
Poland	10	2	0.1	10
Portugal	10	5	0.5	20
Romania	10	5	0.25	20
Slovakia	20	5	0.3	20
Slovenia	10	5	0.25	-
Spain	20	3	1.0	25
Sweden	10	5	0.5	10
United Kingdom	20	2	0.1	20

The overall effect of different forest definitions on carbon stock changes at EU level is difficult to assess, as it depends on several factors (i.e. land fragmentation, land use change frequency, transition period, land registry systems, GHG estimation methodology, etc.), but it is likely to be very small (e.g. strict implementation of FRA 2005 criteria for forest and other woody lands against national thresholds would lead to 1-2% larger forests area as highlighted by Estonia's NIR).

Table 6.10 Additional qualitative criteria for defining "Forest land"

Member State	Forest land definition
Bulgaria	Areas of natural forest regeneration outside urban areas with a size of more than 0.1 ha also represent "forest". Forests are also: areas which are in a process of recovering and are still under the parameters, but it is expected to reach forest crown cover over 10% and tree height 5 meters; areas, which as the result of anthropogenic factors or natural reasons are temporarily deforested, but will be reforested; protective forest belts, as well as tree lines with an area over 0.1 ha and width over 10 meters; cork oak stands. City parks with trees, forest shelter belts, and single row trees do not fall under the category "forests.
Czech Republic	Forests excludes the areas of permanently unstocked cadastral forest land, such as forest roads, forest nurseries and land under power transmission lines.
Denmark	Temporarily non wooded areas, fire breaks, and other small open areas inside the Forest land, including Christmas tree crops.
Estonia	All temporarily unstocked forest areas and regeneration areas which have yet to reach a crown density of 30 per cent and a tree height of 2 meters are also included as forest, as are areas which are temporarily unstocked as a result of human intervention such as harvesting, or natural causes (fires, etc.) but which are expected to revert to forest.
Finland	Productive forest land, part of the poorly productive forest land and forest roads. Parks and yards are excluded regardless of whether they meet the forest definition.
France	Forest roads, forest openings less than 20 m wide (e.g. for fire control), windbreaks and forest belts, as well as the poplar plantations and short rotations woody crops, if the criteria for Forest land are met. 5% of France's European forests are unmanaged on lands such as strong slopes or used for loisir, esthétique, cultural or military. Also, 40% of France's dependencies Forest land is considered as unmanaged.
Germany	Any area of ground covered by forest vegetation, irrespective of the information in the relevant cadastral survey or similar records. "Forest" also refers to cutover or thinned areas, forest tracks, firebreaks, openings and clearings, forest glades, feeding grounds for game, landings, rides located in the forest, further areas linked to and serving the forest including areas with recreation facilities, overgrown heaths and moorland, overgrown former pastures, alpine pastures and rough pastures, as well as areas of dwarf pines and green alders. Heaths, moorland, pastures, alpine pastures and rough pastures are considered to be overgrown if the natural forest cover has reached an average age of five years and if at least 50% of the area is covered by forest. Forested areas of less than 1,000 m2 located in farmland or in developed regions, narrow thickets less than 10 m wide, watercourses up to 5 m wide do not break the continuity of a forest area.
Hungary	„Forest land" (includes FL-FL, L-FL sub-categories) includes areas covered by trees, as well as roads and other areas that are under forest management but that are not covered by trees.
Ireland	Minimum 50% of conventional stocking. Includes recently clear felled areas. Tree grown for fruits or flowers, and shrub species (furze, rhododendron) are excluded. Includes open areas within forest boundaries.
Italy	Forest roads, cleared tracts, firebreaks and other open areas within the forest as well as protected forest areas are included in forest. Plantations, mainly poplars, characterized by short rotation coppice system and used for energy crops, are not included as they do not fulfill national forest definition while other plantation typologies, as chestnut and cork oak, have been included in forest and therefore included.
Latvia	Young natural stands and all plantations established for the forestry purposes, which have to reach a crown density of 20 % or tree height of 5 m are considered under forest land; as well as the areas normally forming part of the forest area, which are temporarily unstocked as a result of human intervention or natural causes, but which are expected to revert to forest.
Lithuania	Tree lines up to 10 meters of width in fields, at roadsides, water bodies, in living areas and cemeteries or planted at the railways protection zones as well as single trees and bushes, parks planted and grown by man in urban and rural areas are not defined as forests.
Luxemburg	Permanently unstocked basal areas that are directly connected with forest in terms of space and forestry enterprise and contribute directly to its management (such as forestal hauling systems, wood storage places, forest glades, forest roads) also represent forests. Areas which are used in short rotation with a rotation period of up to thirty years as well as forest arboretums, forest seed orchards, Christmas tree plantations and plantations of woody plants for the purpose of obtaining fruits such as walnut or sweet chestnut do not account as forests but represent cropland. Rows of trees (except shelter belts for wind protection) and areas with woody plants in a park structure are not forest land.
Netherlands	Roads in the forest less than 6 m wide are included under 'Forest According to Definition' (FAD). Additional to FAD, 'Trees outside Forests' (TOF), that is - wooded areas that comply with the previous forest definition except for their surface area (=< 0.5 ha or less than 30 m width). These represent fragmented forest plots as well as groups of trees in parks and nature terrains and most woody vegetation lining roads and fields.
Poland	Young stands and all plantations that have yet to reach a crown density of 10 percent or a tree height of 2 m are included under forest. Areas normally forming part of the forest area that are temporarily un-stocked as a result of human intervention, such as harvesting or natural causes such as wind-throw, but which are expected to revert to forest are also included.
Portugal	Forests (areas occupied by forests and woodlands which can be used for the production of timber or other forest products) and agro-forestry areas (annual crops or grazing land under the wooded cover of forestry species). The forest trees are under normal climatic conditions higher than 5 m with at least 30% canopy closure.
Romania	It comprises deciduous forest, coniferous forest, mixt forests, clear-cut areas and nurseries, as defined by presence of deciduous trees, coniferous trees, deciduous and resinous trees, dead trees, clear-cuts and forest nursery.
Slovakia	This category includes the land covered by all tree species serving for the fulfilment of forest functions and the lands on which the forest stands were temporarily removed with aim of their regeneration or establishment of forest nurseries or forest seed plantation.
Slovenia	It includes abandoned agricultural land with natural expansion of forest. Abandoned agricultural land on area more than 0.5 ha, which have been abandoned for more than 20 years, with minimal tree height 5.00 m and have a tree crown cover between up to 75 % are defined as forests.
Spain	Any land having woody vegetation with no agricultural use/activities fulfilling the threshold of forest and any other land which is expected achieve these parameters (including for "dehesa" where tree cover meet the thresholds)
Sweden	Land which hosts a potential yield of stem-wood exceeding one cubic meter per hectare and year. Meanwhile, the Land which hosts a potential yield of stem-wood lower than one cubic metre per hectare and year are classfied as mire (under Wetlands). Permanent forest roads (width>5m) are not considered as forest land. All country forests are considered managed.
United Kingdom	Forestry statistics definition used for GHG inventory includes integral open space and felled areas that are awaiting restocking.

National Forest Inventories (NFIs) provide fundamental input data both for forest land and conversions to and from forest land areas, as well as, for the estimation of carbon stock changes in various pools. Nevertheless, this information is also taken from Forest management plan databases in some cases, especially, the information used for the base year (e.g. Slovakia). Data collection in NFIs is typically based on repeated measurements in permanent sampling plots, but the sampling design differs among MS in terms of spatial density and frequency of field surveys (e.g. Austria 3 years, Spain 10 years).

In recent years, the EU' MS have made considerable efforts to adjust their forest inventories to the specific requirements of UNFCCC/KP reporting, but also steps toward slight harmonization at European scale (e.g. COST E43 Action)[62]. Efforts have been made also to adjust the timing of inventory cycles to the timeline of first commitment period of the Kyoto Protocol. Time series of annual activity data are usually obtained by interpolation and extrapolation of available non-annual datasets. The main data source for forest area are the national forest inventories which often do not provide annual nationwide data. Other sources are national statistics or remote sensing products (satellite images, aerial photographs) including their derivatives products such as Corine Land Cover maps.

Furthermore, MS usually breakdown forest land area in various subdivisions according to available datasets. Breakdown criteria differ across MS, although they are consistent across time series: e.g. by groups of species or forest types (i.e. broadleaves/coniferous; evergreen/deciduous; species based

[62] http://www.metla.fi/eu/cost/e43

classification – beech, oak, pine, spruce, etc.); by climate (i.e. temperate, tropical); by soil and site type (e.g. lowland, organic or mineral soils), administrative or geographical boundaries, and management type (e.g. coppice, high stands).

For Forest land category, the carbon pools definitions are reported by most of the MS (Table 6.11). Among them, there are slight variations, however the impact on the estimates of such variability, even if difficult to assess in quantitative terms, is considered small. For instance, forest inventories define above-ground biomass carbon pool according to the threshold of minimal diameter (i.e. DBH–stem diameter at breast height of sampled trees) as ranging from 0 to 7,5 cm. Concerning the below-ground biomass, the information on what exactly is includes on this pool is sparse. Dead wood mostly differs in terms of decay time and thresholds of diameters and height/length of pieces included in the pool. Litter is either independently assessed or included with soils. In soils organic matter, carbon stock changes are computed according to various soil depths. Usually, carbon stock in understory biomass is only accounted in principle for estimating forest fires emissions (although such information is often not transparently reported in the NIR).

Table 6.11 Forest carbon pools definitions in the GHG inventories of the MS

Member State	Description
	Aboveground biomass
Austria	Stem wood over bark with a diameter at breast height over 5 cm.
Belgium	Tree and shrub species with circumference exceeding 20/22 cm at 1.50 m height (i.e. 7 cm in diameter), while in coppices the stems under 7 cm diameter are also included.
Denmark	Living trees with a height over 1.3 m, under different recording schemes (i.e. trees larger than 40 cm are measured only within a 15 m circle). Smaller trees, shrubs and other non woody are not counted. Aboveground biomass is defined as living biomass above stump height (1% of tree height).
Finland	Biomass of living trees with a height over 1.35 m, i.e. those trees that are measured in NFIs, including the stem wood, stem bark, living and dead branches, cones, needles/foliage. Understory is counted only to estimate the emission from forest fire.
France	Trees with DBH over 7.5 cm.
Germany	Trees with DBH over 7 cm.
Greece	Trees with DBH over 10 cm, but in cases of degraded forests (e.g. oak) and coppices (e.g. Castanea) the threshold is 4.6 cm. The trees in the sample area under the minimum diameter are not considered. Understory biomass is
Hungary	The total biomass above the stump, including all branches and bark, of trees taller than two meters.
Lithuania	Above ground biomass refers to all living biomass above the soil including stem, stump, bark, branches, seeds and foliage.
Ireland	Modeled individual cycle of living biomass (but not the understory and annual/perennial non woody vegetation).
Italy	Trees with DBH over 3 cm.
Lithuania	Above ground biomass refers to all living biomass above the soil including stem, stump, bark, branches, seeds and foliage.
Luxemburg	Diameter of 4 cm at 3.5 m of the total height (average value)
Portugal	Living biomass above the soil, including: stems, stumps, branches, bark and foliage, and forest understory (only for estimation of emissions from forest fires).
Slovakia	Merchantable volume, defined as tree stem and branch volume under bark with a minimum diameter threshold of 7 cm.
Slovenia	Volume over bark of all living trees more than 9.99 cm in diameter at breast height (1.3 m). Includes the stem from ground to a top diameter of 6.99 cm, and also branches to a minimum diameter of 6.99 cm.
Spain	Trees with DBH over 7.5 cm at the ground level are measured, while those under 7.5 cm are only counted.
Sweden	Biomass of living trees with a height over 1.3 m. Small trees, shrubs and other vegetation (i.e. herbs) are not counted. Aboveground biomass is defined as tree part above stump height (1% of tree height).
United Kingdom	Modeled living woody biomass (complete individual cycle of trees, it does not include understory and annual/perennial non woody vegetation).
	Belowground biomass
Austria, Ireland, United Kingdom	Fine roots pool is simulated within integrates models.
Belgium	Diameter of estimated roots > 5 mm.
Denmark	Stumps from harvested trees within a year from the measurement are measured.
France	Fine roots are included with the soil organic matter.
Finland	Stumps and roots down to a minimum diameter of 1cm.
Hungary	The total biomass of the above trees minus their above-ground biomass.
Czech Republic, Italy, Poland,	Applies a country specific “root- to-shoot” factor.
Lithuania	Below-ground biomass refers to all living biomass of live roots.
Portugal	Living biomass of belowground biomass (the lower limit of root diameter, if any, is not explicitly defined).
Sweden	Biomass of living trees below stump height (1% of tree height) down to a root diameter of 2 mm.
	Dead Organic Matter – Litter
Austria, Ireland, United Kingdom	Litter is simulated by models.
Denmark	Non-living biomass which is not included in other classes, under various status of decomposition on top of mineral or organic soil. It includes the litter, fumic and humic layers.
Finland	Non-living biomass with a diameter less than 10 cm in various status of decomposition (allocated by model in compartments: fine woody litter, coarse woody litter, extractives, celluloses and lignin-like compound). Biomass of ground vegetation (eg moss-, lichen-shrub- and twig vegetation) is not included in the living biomass, but it is included when the litter input to the soil is estimated.
France	Non-living dead wood lying on soil with maximum 7.5 cm diameter, dead leaves, humic and fumic layers, fine roots.
Germany	Dead organic cover with a fraction < 20 mm.
Italy	The amount of carbon in litter is estimated from the aboveground carbon amount with linear relations.
Portugal	Non-living biomass on top of mineral soil, in various stages of decomposition (include fumic, humic) (considered only in forest fires).
Slovakia	The litter pool definition used in the inventory includes all non-living biomass with a size less than the minimum diameter defined for dead wood (1 cm). The small-sized lying dead wood (diameter between 1 and 7 cm), in various states of decomposition above the mineral soil are not a part of litter, because they are included in dead wood. The litter includes the surface organic layer (L, F, H horizons) as usually defined in soil profile description and classification. Live fine roots above the mineral or organic soil (of less than the minimum diameter limit chosen for below-ground biomass) are included in litter.
Slovenia	The carbon stock in Ol, Of and Oh sub horizon. Volume of roots and coarse fragments (soil skeleton > 2 mm) is not included.
Sweden	Non-living biomass not classified in other classes, under various stages of decomposition, on top of mineral or organic soil: litter, fumic and humic layers. Litter includes, as well: a) live fine roots (<2 mm) from O horizon and b) coarse litter with “wood stem diameter” between 10-100 mm.
	Dead Organic Matter - Dead wood
Austria	Only standing dead wood.
Belgium	Dead wood as measured by NFI, namely standing dead trees and fallen logs and branches. A dead tree is considered as fallen when it tilts at a vertical angle equal or superior to 45°. Dead trees above 20 cm of circumference are measured, under 20 cm are estimated visually.
Denmark	Standing deadwood with a DBH larger than 4 cm. Lying dead wood with a diameter of more than 10 cm, whose length is recorded. The degree of decay is recorded on an ordinal scale.
Finland	Non-living biomass which is not contained in litter (described by model as coarse woody litter input, larger than 10 cm in diameter, from natural mortality of trees and harvesting residues).
France	Standing trees, dead for less than 5 years, plus 10% from the wood which is annually harvested.
Germany	Fallen dead wood with a thicker-end diameter of at least 20 cm; standing dead wood with a diameter of at least 20 cm at breast height and trunks with either a height of at least 50 cm or a cut surface diameter of at least 60 cm. NFI 2008 collected data on all dead-wood objects with a thicker-end diameter of at least 10 cm. Data collection was for both NFIs on 3 species groups and 4 decomposition class.
Ireland, United Kingdom	Pool is simulated by models.
Italy	The amount of carbon in dead wood is estimated from the aboveground carbon amount with an expansion factor.
Greece	Dead wood that remain on site after fire is assumed to fully decompose in 10 years.
Lithuania	Dead wood includes total standing and lying volume of dead tree stems.
Slovakia	The dead wood carbon pool contains dead trees from standing, stumps, coarse lying dead wood and small-sized lying dead wood not included in litter or soil carbon pools.
Slovenia	Dead wood content is all non-living woody biomass not contained in the litter, either standing, lying on the ground. According to definition from NFI 2007, dead wood in Slovenia includes: dead trees (DBH > 10 cm); stumps (D > 10 cm and H > 20 cm); snags (D > 10 cm and H > 50 cm); coarse woody debris (D > 10 cm and L > 50 cm).
Sweden	Dead wood is defined as fallen dead wood, snags or stumps including coarse and smaller roots down to a minimum “root diameter” of 2 mm. Dead wood of fallen dead wood or snags should have a minimum “stem diameter” of 100 mm and a length of at least 1.3 m.
	Soil Organic Carbon
Austria, Finland, United Kingdom Ireland	Pool is simulated by models (undefined depth or dimensions).
Belgium, France, Germany, Italy, Luxemburg, Portugal	Organic carbon in 0-30 cm top soil.
Bulgaria	Organic carbon in 0-40 cm top soil, includes also the C stock of the litter layer (humus layer).
Croatia	Organic carbon in 0-40 cm top soil.
Czech Republic	Soil organic carbon in 0-30 cm, including the upper organic horizon.
Denmark	Organic carbon in the mineral soils below the litter, fumic and humic layers and all organic carbon in soils classified as histosols. It is for 30 cm depth between top of the mineral soil or, alternatively, from the soil surface (if histosol).
Hungary	The soil carbon stocks were determined from humus content (Hu) values (Filep, 1999) that were measured for the uppermost 30 cm of the soil.
Slovakia	Organic carbon in the mineral soils 0-20 cm.
Slovenia	Carbon stock in mineral part of soil (SOM) in 0–40 cm soil depth.
Spain	Organic carbon in the mineral soils down to 100 cm.
Estonia, Sweden	Organic carbon in the mineral soils below the litter, fumic and humic layers and all organic carbon in soils classified as histosols, down to a depth of 50 cm.

For inventory completeness purpose, it should be considered that what is not reported under a pool is reported under another one (e.g., fine roots are reported either as litter or as soil organic matter), so that no bias in estimation are expected to occur.

Inventory estimates follow 2006 IPPC GL by estimating the changes in the forest carbon pools. For Living Biomass carbon pool the methods are based either on the “stock change” or “gain-loss” (Table 6.12)

Table 6.12 Estimation methods used by MS for C stock changes in Living Biomass carbon pool.

MS	Estimation method
Austria	Gain-loss
Belgium	Stock change/Gain-loss (Walloon/Flemish region)
Bulgaria	Stock change
Croatia	Gain-loss
Cyprus	Gain-loss
Czech Republic	Gain-loss
Denmark	Stock change
Estonia	Stock change
Finland	Gain-loss
France	Gain-loss
Germany	Stock change
Greece	Stock change
Hungary	Stock change
Ireland	Gain-loss
Italy	Gain-loss
Latvia	Gain-loss
Lithuania	Stock change
Luxemburg	Gain-loss
Malta	Gain-loss
Netherlands	Gain-loss
Poland	Gain-loss
Portugal	Gain-loss
Romania	Gain-loss
Slovakia	Gain-loss
Slovenia	Stock change
Spain	Stock change
Sweden	Stock change
UK	Gain-loss

Data sources for the estimation of carbon stock changes in living biomass also differ across MS, upon data availability. Actually, NFI represents the primary source of information for most of MS, while others rely on forestry statistics and yield tables. In addition, forest fire statistics complement both sources. Data collection and data analysis programs are ongoing in most of the MS to further improve the completeness and quality of the estimates, primarily of carbon stock changes.

In 2015 submissions, the implied carbon stock change factors for net carbon stock changes in biomass range from 2.33 to -0.23 T C ha^{-1} among MS (Table 6.13).Generally, low values of IEF are shown by MS with most intensive forest exploitation or with less favorable climatic conditions (i.e. lower growth and also more losses by natural disturbances); while higher values are for MS where planting is the main instrument to ensure forest regrowth.

Table 6.13 Implied net carbon stock change factor for living biomass pool in 4A1 (T C ha-1 year-1) reported in EU' MS GHGI 2015.

Member States	Net carbon stock change in living biomass per area
AUT	0.31
BEL	0.94
BGR	0.75
CYP	1.15
CZE	0.57
DEU	1.03
DNM	1.61
ESP	0.49
EST	-0.08
FIN	0.33
FRK	0.75
GBR	1.04
GRC	0.15
HRV	0.62
HUN	0.30
IRL	-0.23
ITA	1.04
LTU	1.37
LUX	1.34
LVA	0.36
MLT	2.33
NLD	1.89
POL	1.13
PRT	0.70
ROU	0.92
SVK	0.89
SVN	1.54
SWE	0.35

Changes of organic carbon stored in mineral soils and dead organic matter are mostly reported applying Tier 1 methods which assumes that these pools are in equilibrium and therefore no net carbon stock changes occur. In these cases, the notation key NO (or NE) is used in the corresponding CRF table (see also Table 6.5 on completeness). When they are estimated, MS mainly rely on data collected by NFI. The large use of the Tier 1 methods is due to the lack of appropriate data (and the high costs to set up a system that allows the proper collection of data) or the very high uncertainty of existing data. Nevertheless, in most cases, MS document the ongoing efforts to estimate emissions and removals from these pools. Existing data are either directly used for estimating carbon stock change by using stock difference or gain-loss methods, or integrated in models. According to available datasets, carbon stock changes in dead organic matter are often disaggregated between dead wood (DW) and litter (LT).

Carbon stock changes in dead organic matter are estimated by 18 MS. Some of them includes this pool within soil organic carbon (e.g. Finland). In overall, when reported, dead wood is mainly reported as a sink while Litter is either reported as a sink or source for most of MS (Table .614).

Table .614 Implied net carbon stock change factors in DOM pool in 4A1 (T C ha-1 yr-1) reported in EU' MS GHGI 2015.

Member States	Net carbon stock change in dead wood per area	Net carbon stock change in litter per area
AUT	0.06	NE,IE
BEL	-0.01	0.00
DNM	0.04	-0.31
FIN	IE	IE
FRK	-0.04	NO
DEU	-0.05	-0.01
GRC	NA,NO	NA,NO
IRL	IE	0.51
ITA	0.01	0.01
LUX	0.00	0.00
NLD	0.02	NE
PRT	IE	0.00
ESP	NE	NE
SWE	0.09	-0.07
GBE	IE	0.22
BGR	NO	NO
CYP	NO	NO
CZE	NO	NO
EST	0.02	NO
HRV	NO	NO
HUN	NO	NO
LVA	0.33	NO
LTU	0.01	NO
MLT	0.00	0.00
POL	NO	NO
ROU	NO	NO
SVK	NO	NO
SVN	0.00	NO

Carbon stock changes in mineral soils are quantitative estimated by 10 MS. Mineral soil is generally reported as a small net sink of carbon (i.e. with the exception of Austria) or assumed in balance under the Tier 1 assumption (Table 6.15). 11 MS reports CO_2 emissions from organic soils associated with managed forests (e.g. drainage of soils to establish plantations). Others MS report insignificant areas of organic soils under Forest land and, only UK reports a sink from organic soils in this category.

Table 6.15 Implied net carbon stock change factors in mineral and organic soils in 4A1 (T C ha-1 yr-1) reported in EU' MS GHGI 2015.

Member States	Net carbon stock change in mineral soils per area	Net carbon stock change in organic soils per area
AUT	-0.18	NO
BEL	0.53	NO
DNM	NA	-2.60
FIN	0.14	-0.30
FRK	NO	NO
DEU	0.41	-2.61
GRC	NA,NO	NA,NO
IRL	NO	-0.48
ITA	NA,NO	NO
LUX	NO	NO
NLD	NE	NE
PRT	0.01	NO
ESP	NE	NO
SWE	0.16	-0.38
GBE	0.33	1.84
BGR	NO	NO
CYP	NO	NO
CZE	NA	NA
EST	0.16	-0.28
HRV	NO	NO
HUN	NO	-2.60
LVA	NO	-2.60
LTU	NO	IE
MLT	0.00	NO
POL	0.12	-0.68
ROU	NO	-0.68
SVK	NO	NO
SVN	NO	NO

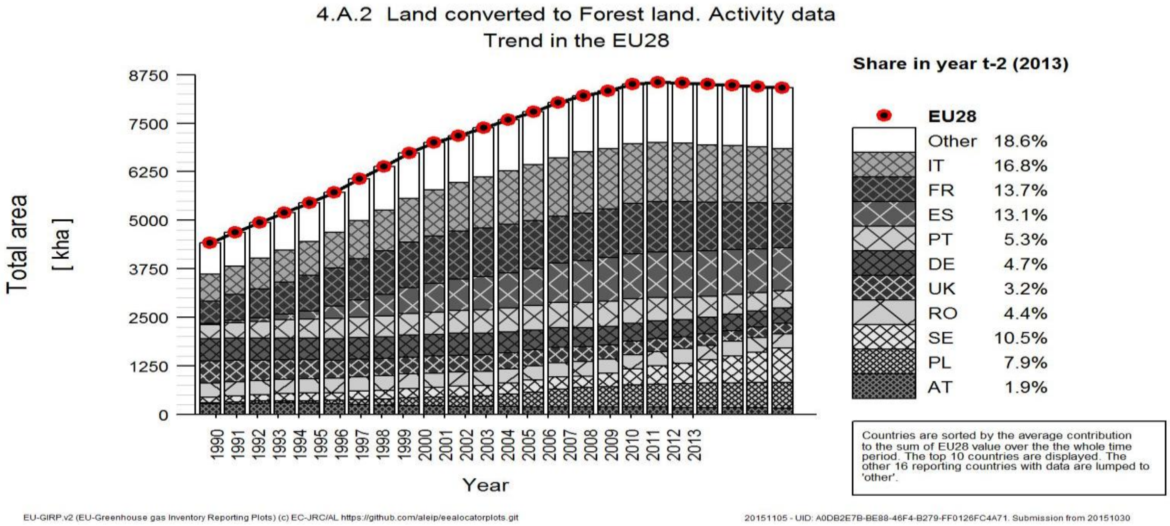
6.2.1.3 Land converted to Forest Land (CRF 4A2)

Overview of Land converted to Forest Land category

In 2013, the area reported under the subcategory 4A.2 represent 5.1% of the total Forest Land area, and increased by about 90% from 1990 (Figure 6.21). Largest conversions occur from Grasslands and Cropland. Estimated net removals for this subcategory represent 12% of total net removals of Forest land.

For 2013, Italy, France and Spain together contribute for 45% of areas reported under this subcategory while the 10 largest contributors account for around 82% of the total EU area under 4A.2.

Figure 6.21 Trend of activity data in subcategory 4A2 – Land converted to Forest Land – in EU MS (kha, 1990-2013)

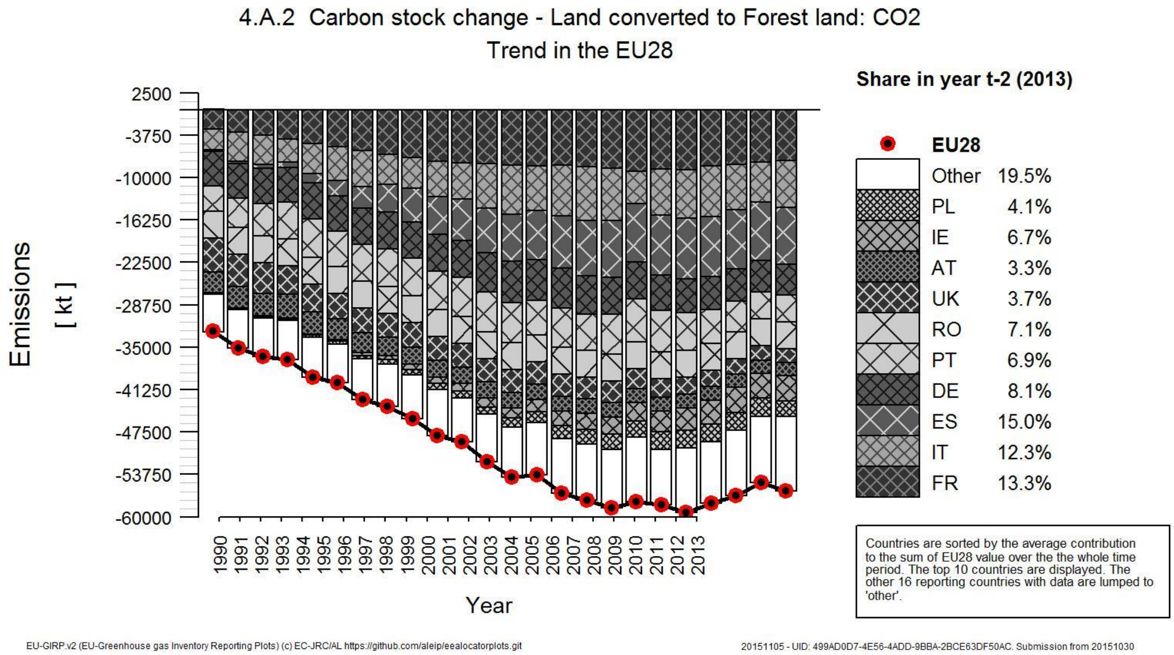


At EU level, in 2013, 4A.2 is a net sink for all the MS and it reached an EU total of -55 903 kt CO_2, which represent an increase of 72% compared with 1990 and 2% more than in 2012 (Table 6.16,Figure 6.22).

Table 6.16 4A2 Land converted to Forest Land: MS' contributions to EU28 net CO_2 emissions (CRF table 4)

Member State	CO2 emissions in kt			Share in EU28 emissions in 2013	Change 2012-2013		Change 1990-2013	
	1990	2012	2013		kt CO2	%	kt CO2	%
Austria	-3 081	-1 879	-1 825	3%	54	-3%	1 256	-41%
Belgium	-17	-287	-294	1%	-8	3%	-277	1592%
Bulgaria	-545	-755	-1 052	2%	-296	39%	-507	93%
Croatia	-39	-181	-201	0%	-19	11%	-161	411%
Cyprus	-	-	-	-	-	-	-	-
Czech Republic	-221	-340	-357	1%	-17	5%	-136	62%
Denmark	79	475	40	0%	-435	-92%	-39	-49%
Estonia	-1	-1 436	-1 523	3%	-87	6%	-1 522	296552%
Finland	-155	-485	-448	1%	37	-8%	-293	189%
France	-2 839	-7 765	-7 491	13%	274	-4%	-4 652	164%
Germany	-5 101	-4 603	-4 563	8%	40	-1%	539	-11%
Greece	NE,NO	-143	-164	0%	-21	15%	-164	100%
Hungary	-329	-1 238	-1 234	2%	5	0%	-905	275%
Ireland	27	-3 679	-3 747	7%	-68	2%	-3 774	-13847%
Italy	-3 105	-5 828	-6 885	12%	-1 057	18%	-3 780	122%
Latvia	0	-339	-368	1%	-29	9%	-368	504566%
Lithuania	-1 034	-1 144	-1 142	2%	1	0%	-108	10%
Luxembourg	-158	-81	-72	0%	9	-11%	86	-55%
Malta	NO	NO	NO	-	-	-	-	-
Netherlands	59	-306	-309	1%	-2	1%	-368	-620%
Poland	-141	-2 717	-2 291	4%	427	-16%	-2 150	1526%
Portugal	-3 571	-3 785	-3 730	7%	55	-1%	-159	4%
Romania	-3 978	-3 976	-3 975	7%	0	0%	2	0%
Slovakia	-2 210	-343	-353	1%	-9	3%	1 858	-84%
Slovenia	-838	-838	-838	1%	0	0%	0	0%
Spain	-162	-8 500	-8 379	15%	122	-1%	-8 216	5060%
Sweden	-132	-2 295	-2 617	5%	-322	14%	-2 485	1876%
United Kingdom	-4 974	-2 184	-2 085	4%	99	-5%	2 889	-58%
EU-28	**-32 465**	**-54 652**	**-55 903**	**100%**	**-1 251**	**2%**	**-23 438**	**72%**

Figure 6.22 Trend of emissions in the “Land converted to Forest Land” subcategory of EU MS (kha, 1990-2013)



In 2013, about 50% of total removals at EU level from subcategory 4A.2 were reported by France, Italy Spain and Germany, while the 10 MS with the larger contribution represent about the 80% of the total EU sink.

Methodological issues for Land converted to Forest Land category

Methods used to identify and represent the areas under conversion to forest, as well as to report GHG emissions and CO_2 removals, are generally the same used for category 4A.1. MS have developed land identification systems that are able to identify and track land use conversions to and from forest. Estimates of GHG emissions and CO_2 removals are usually reported at tier 2. Nevertheless, the heterogeneity in the approaches used by MS for subcategory 4A.2 suggests caution in interpreting differences in the implied carbon stock change factors. For instance, possible reasons of differences may include the length of the time series on activity data and their starting point, the use of time averaged on annual biomass growth, the estimated CO_2 emissions from previous land use, including lagged emissions. On top of that, due to the different methods applied, concerning changes in the carbon stock of soils, there is a high variability among MS on the carbon reference values considered in the estimations and the depth to which that values are associated. In general, this pool is estimated either at tier 2 or at tier 3 level by using soil carbon models (e.g. Denmark, UK).

6.2.2 Cropland (CRF 4B)

6.2.2.1 Overview of the Cropland category

Subject to intensive agriculture, Cropland category is an important contributor to European Union GHG budget. This category includes arable lands for annual crops and permanent crops, set aside lands or cultivated areas in ‘dehesa’ and rice-fields. Based on the MS submissions, Cropland area in EU covers

123.537 kha in 2013 (6% less than in 1990), and is equal to 28% of the total EU area. In 2013, 8.9% of the Cropland area is reported as land under conversion to Cropland.

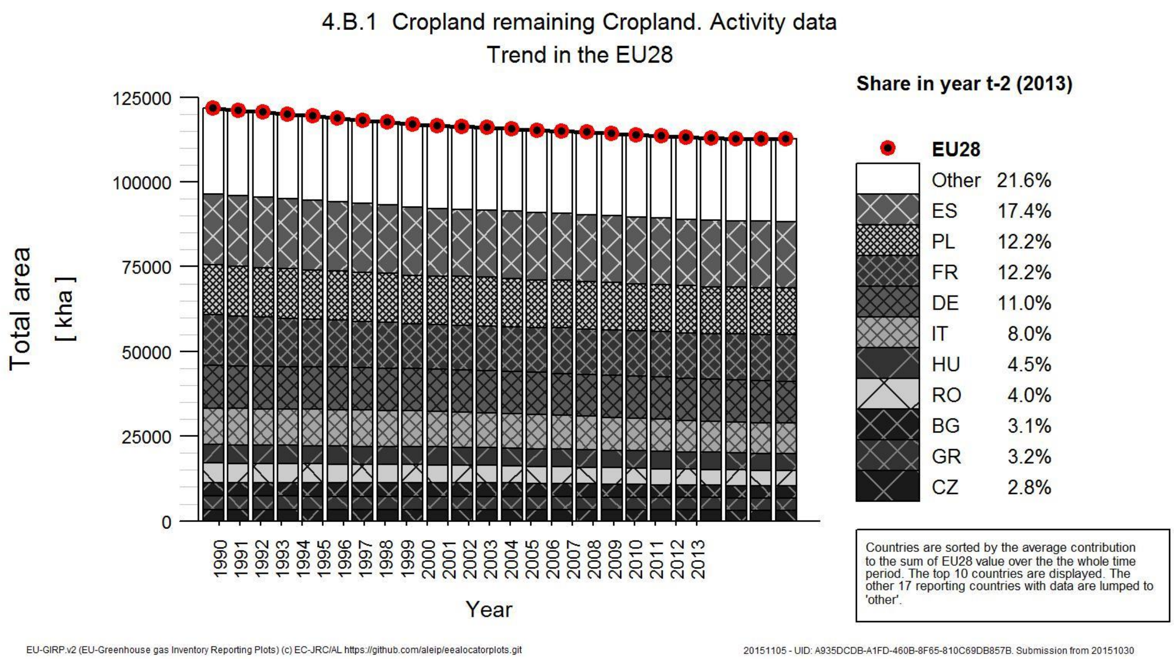
6.2.2.2 Cropland remaining Cropland (CRF 4B1)

Overview of Cropland remaining Cropland category

As reported by MS, the area of Cropland remaining Cropland constantly decreased (Figure 6.23). From 121.660 Kha in 1990 to 112.598 kha in 2013, which represent a decrease of 7%. With the exception of UK, Malta, Luxembourg and Slovakia all MS report a net decrease of Cropland area as compared with 1990.

At EU level, the 10 MS with the larger areas reported under this subcategory represent about 78% of its total EU area. Specifically, Spain, Poland and France report about 40% of the total EU area reported under 4B.1

Figure 6.23 Trend of activity data in the "Cropland remaining Cropland" subcategory of EU MS (kha, 1990-2013)



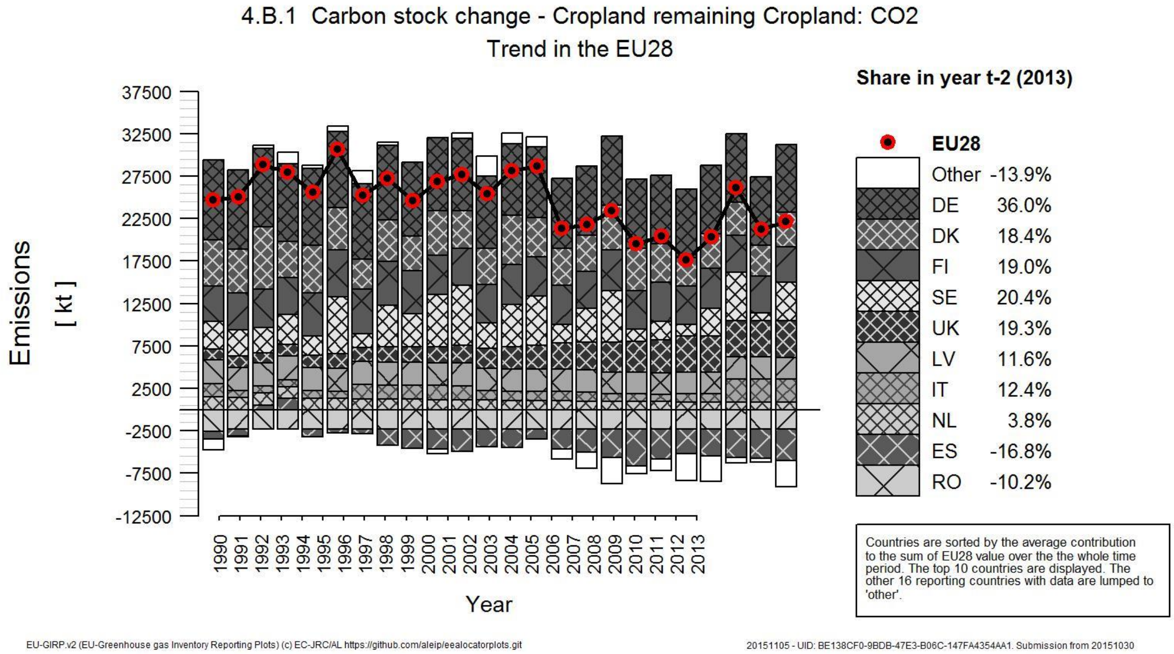
At EU level, in 2013 subcategory 4B.1 was a net source of 22 223 kt CO_2 that represent a decrease of 10% compared to 1990 (Table 6.17)

Table 6.17 4B1 Cropland remaining Cropland: MS contributions to net CO_2 emissions (CRF table 4)

Member State	CO2 emissions in kt			Share in EU28 emissions in 2013	Change 2012-2013		Change 1990-2013	
	1990	2012	2013		kt CO2	%	kt CO2	%
Austria	-261	-61	-55	0%	6	-10%	205	-79%
Belgium	239	-897	-880	-4%	17	-2%	-1 119	-469%
Bulgaria	524	695	695	3%	0	0%	171	33%
Croatia	195	149	113	1%	-36	-24%	-81	-42%
Cyprus	-	-	-	-	-	-	-	-
Czech Republic	-19	-17	-15	0%	1	-9%	3	-18%
Denmark	5 450	3 688	4 072	18%	384	10%	-1 378	-25%
Estonia	84	69	57	0%	-12	-18%	-27	-32%
Finland	4 160	4 343	4 222	19%	-120	-3%	62	1%
France	0	0	0	0%	0	#DIV/0!	0	#DIV/0!
Germany	9 419	8 055	7 990	36%	-65	-1%	-1 429	-15%
Greece	-982	-272	-231	-1%	41	-15%	750	-76%
Hungary	39	-900	-813	-4%	87	-10%	-851	-2211%
Ireland	-1 525	1 458	-364	-2%	-1 822	-125%	1 160	-76%
Italy	1 638	2 776	2 803	13%	27	1%	1 165	71%
Latvia	2 754	2 555	2 567	12%	12	0%	-187	-7%
Lithuania	537	92	84	0%	-8	-9%	-453	-84%
Luxembourg	-6	3	2	0%	-1	-42%	8	-131%
Malta	-1	-1	-1	0%	0	-3%	0	52%
Netherlands	1 467	880	853	4%	-28	-3%	-615	-42%
Poland	800	386	-665	-3%	-1 052	-272%	-1 466	-183%
Portugal	21	-203	-203	-1%	-1	0%	-225	-1064%
Romania	-2 569	-2 265	-2 263	-10%	2	0%	306	-12%
Slovakia	-955	-962	-874	-4%	89	-9%	82	-9%
Slovenia	41	63	63	0%	0	-1%	22	53%
Spain	-929	-3 516	-3 733	-17%	-217	6%	-2 803	302%
Sweden	3 303	900	4 528	20%	3 628	403%	1 226	37%
United Kingdom	1 299	4 268	4 273	19%	5	0%	2 974	229%
EU-28	**24 724**	**21 286**	**22 223**	**100%**	**937**	**4%**	**-2 501**	**-10%**

This subcategory is mainly reported as net source of emissions but some MS report 4B.1 as a net sink of CO_2 (e.g. Spain, Romania, Hungary, Belgium) due to large areas of woody crops (i.e. olive groves, vineyards). In spite of that, overall emissions are dominated by MS with cultivated areas on organic soils (e.g. Germany, Finland, and Denmark) (Figure 6.24).

Figure 6.24 Trend of emissions in the Cropland remaining Cropland" subcategory of EU MS (kha, 1990-2013)



6.1.1.1.1 Methodological issues for Cropland remaining Cropland category

Lands included under this subcategory generally have a well match with the IPCC definition (Table 6.18) although there may be small national particularities (e.g. treatment of some woody crops). Quite often, because of the management practices, croplands may not be clearly separated from grasslands, and their reporting approach may vary amongst MS.

Table 6.18 Information on Cropland definitions

Member State	Definition
Austria	Arable land, including annual and perennial crops (rotation period of up to thirty years), as well as forest arboretums, forest seed orchards, Christmas tree plantations and orchards (e.g. walnut or sweet chestnut) and rows of trees and areas with woody plants in parks and green areas, and house garden.
Belgium	Tillage land and agro-forestry systems with vegetation falling below the thresholds for forests.
Bulgaria	Cropland consists of annual crops (cornfields and kitchen gardens) and perennials (vineyards, fruit and berry plantation and nurseries). Arable land is the land worked regularly, generally under a system of crop rotation - area with annual crops, set - aside area as well as area with seeds and seedlings. Perennial crops include fruit and berry plantation, vineyards and other permanent crops, nurseries for wine, fruits, ornamental plants, forest trees etc. The orchard is a uniformly kept plantation (by annual pruning and regular treatment for protection from diseases and insects) of fruit trees (pip- trees, stone-trees and nut-trees).
Croatia	Cropland category includes non-irrigated arable land, permanently irrigated arable land, vineyards, fruit trees and berry plantations, olive groves, annual crops associated with permanent crops (Complex cultivation patterns.
Cyprus	No definition is provided in the NIR
Czech Republic	Cropland is predominantly represented by arable land (92.6%), while the remaining area includes hop-fields, vineyards, gardens and orchards.
Denmark	Annual crops, wooden perennial crops, hedgerows and “other agricultural area” (i.e. small undefined areas lying inside the cropland area). It includes farmlands, commercial plantations with perennial crops (fruit trees, orchards and willow), house gardens, hedgerows (perennial trees/bushes not meeting the forest definition) in the agricultural landscape, as well as willow plantations on agricultural land for bioenergy purposes.
Estonia	Cropland is arable land, area where annual or perennial crops are growing (incl. fallow, orchards, short-term and long-term cultural grasslands and temporary greenhouses). It does not include built garden land under 0.3 ha (that is included in Settlements). Abandoned cropland is classified as cropland until it has not lost arable land features – changes in soil and vegetation have not taken place and the land is still usable as cropland without the implementation of specific treatments.
Finland	Arable crops, grass covered (for less than 5 years), set-aside, permanent horticultural crops, greenhouses and kitchen gardens.
France	Annual crops, temporary pastures (which last for maximum 6 annual harvests) and permanent crops (orchards, vineyards, olives, etc).
Germany	Annual crops and cropland with perennial crops (long-lived crops: fruit crops, osiers, poplars, Christmas tree farms, nurseries) and lands for cultivation of vegetables, fruit and flowers
Greece	Annual and perennial crops, temporary fallow land and perennial woody crops, i.e. tree crops and vineyards.
Hungary	Cropland contains arable lands, vegetable gardens, orchards and the vineyard areas, as well as set-aside croplands. Arable lands are any land area under regular cultivation irrespective of the rate or method of soil cultivation and whether the area is under crop production or not due to any reason, such as temporary inland waters or fallow. Areas under tree nurseries (including ornamental and orchard tree nurseries, vineyard nurseries, forest tree nurseries excluding those for the own requirements of forestry companies grown in the forest), permanent crops (e.g. alfalfa and strawberries), herbs and aromatic crops are included. Vegetable gardens are areas around residential houses where, in addition to meeting the owners’ demand, may produce some surplus of low amount which is usually traded. Orchards are land under fruit trees and bushes that may include several fruit species (e.g.: apples, pears, cherries, etc.). Included are non-productive orchards and orchards of systematic layout in vegetable gardens if the area is 200 m² or above in case of berries and 400 m² or above in case of fruit trees. Vineyards are areas where grapes are planted in equal row width and planting space, and include non-productive areas and vineyards in vegetable gardens (e.g. trellises) if grapes are planted in equal row width and planting space, and the size of the area is at least 200 m². Set-aside cropland is land that is abandoned but not converted to any other land use.
Ireland	Permanent crops and tillage land, including set-aside, as recorded by annual statistics.
Italy	Annual crops and perennial woody crops (e.g. woody plantations, that don’t meet national forest definition, olive groves or vineyards). Plantations, mainly poplars, characterized by short rotation coppice system and used for energy crops are included (as they do not fulfill national forest definition).
Latvia	The cropland refers to the area of arable land, including orchards and extensively managed arable lands. Cropland also includes animal feeding glades, which according to national land use classification belong to forest land.
Lithuania	The area of cropland comprises of the area under arable crops as well as orchards and berry plantations. Arable land is continuously managed or temporary unmanaged land, used and suitable to use for cultivation of agricultural crops, also fallows, inspects, plastic cover greenhouses, strawberry and raspberry plantations, areas for production of flowers and decorative plants. Arable land set aside to rest for one or several years (<5 years) before being cultivated again as part of an annual crop-pasture rotation is still included under cropland. Orchards and berry plantations are areas planted with fruit trees and fruit bushes (apple-trees, pear-trees, plum-trees, cherry-trees, currants, gooseberry, quince and others).
Luxemburg	Agro-forestry systems where tree cover falls below the forest thresholds, respectively covered by permanent crops, annual crops, artificial meadows (not permanent) and lands temporarily set aside
Malta	In Malta cropland can be split into three types: arable area which is cultivated under a system of crop rotation; kitchen gardens that include small plots of cultivated land, in which most of the products are intended for consumption by the farmer; land under permanent crops where the crop occupies the same land for a period of time, normally 5 years or more. For inventory purposes, local cropland was split into two: annual crops and perennial woody crops. The main perennial crops considered for this inventory are vines, being the most cultivated crop.
Netherlands	Arable and tillage land, including rice-fields, and agro-forestry systems where the vegetation structure falls below the thresholds for forest and nurseries (including tree nurseries).
Poland	Agricultural land considered as cropland consists of: arable land includes land which is cultivated, i.e. sowed and fallow land. Arable land should be maintained in good agricultural condition. Cultivated arable land is understood as land sowed or planted with agricultural or horticultural products, willow and hops plantations, area of greenhouses, area under cover and area of less than 1000 m^2, planted with fruit trees and bushes, as well as green manure, fallow land includes arable land which are not used for production purposes but are maintained in good agricultural condition; orchards include land with the area of at least 1000 m^2, planted with fruit trees and bushes.
Portugal	Rain-fed annual crops (without irrigation and fallow-land integrated into crop-rotations), irrigated annual crops (under irrigation, greenhouses), rice cultivation lands, wineyards, olives and other species of woody crops
Romania	Cropland includes agricultural lands, i.e. lands covered or temporary uncovered by agricultural crops (major crops and horticultural plants cultures). It includes 3 groups (non-woody crops, woody crops and other wooded land and trees outside forests (which do not meet the forest definition parameters, e.g. forest belts which are narrower than 20m) with 9 categories: orchard, vineyard, shrubs, cultivated land agricultural, temporary fallow land, deciduous tree, coniferous tree, deciduous and resinous trees and dead trees.
Slovakia	Cropland includes lands for growing cereals, root-crops, industrial crops, vegetables and other kinds of agricultural crops; perennial woody crops; lands temporary overgrown with grass or used for growing of fodder lasting several years; hotbeds and greenhouses if they are built up on the arable land; fallow land which is arable land left for regeneration for one growing season during which were not sow specific crops or just crops for green manure, eventually it is covered by spontaneous vegetation, which would be ploughed in.
Slovenia	Annual: arable land breed more than 2 meters and grow the non-woody vegetation (cereals, potatoes, forage crops, vegetable crops, oilseed, ornamental plants, herbs, strawberries, hop fields...) and agricultural fallow ground. Also temporary meadows and greenhouses. Perennial: permanent crops on arable land such as vineyards, extensive and intensive orchards, olive groves, nursery (for grapevines, fruit and forest trees), forest plantations and forest trees on agricultural land.
Spain	Annual crops and fallow land, perennial crops (olive groves, wines and other woody crops) and mix of annual and permanent crops (except when they qualify as forest land, i.e. in “dehesa”).
Sweden	Regularly tilled agricultural land.
United Kingdom	Arable and horticultureal land.

Quantitative estimates are reported mainly for soils, and living biomass for perennial woody crops (i.e. orchards, vineyards, Christmas trees, fruits, bushes, and plantations). For soil organic matter, the definitions vary among MS, mainly in terms of the soil depth considered in the estimation of the carbon content (e.g. 30 cm in Finland and 100 cm in Spain) although in some cases the depth is not specified when MS used modeled approaches.

Carbon stock change factors for living biomass of permanent crops vary within a very narrow range, depending by the types of crops and management practices across Europe, from North (i.e. bush-type currant crops) to South (i.e. olives crops and agro-forestry systems) (Table 6.19).

Usually a net source of emissions in this category is associated with a decrease of area of woody crops. In few countries, the carbon stock in crops biomass is assumed at equilibrium and therefore reported by notation keys (e.g. Germany, UK), or is not estimated (by Netherlands).

Table 6.19 Implied net carbon stock change factor for carbon pools in 4B1 (T C ha-1 yr-1) reported in EU' MS GHGI 2015.

Member States	Net carbon stock change in living biomass per area	Net carbon stock change in dead organic matter per area	Net carbon stock change in mineral soils per area	Net carbon stock change in organic soils per area
AUT	-0.03	NO	0.04	NO
BEL	0.00	NO	0.30	-10.00
DNM	-0.01	NO	-0.14	-9.30
FIN	0.00	NE	0.04	-6.55
FRK	0.00	NO	NO	NO
DEU	NO	NO	NO	-8.10
GRC	0.04	NO	NE	-10.00
IRL	0.01	NO	0.13	NO
ITA	-0.06	NO	NO	-10.00
LUX	-0.01	NO	0.00	NO
NLD	NE	NE	NO	-3.99
PRT	0.02	NO	0.01	NO
ESP	0.00	NE	0.05	NO
SWE	0.03	0.00	-0.18	-6.22
GBE	NO	NO	-0.33	IE
BGR	-0.05	NO	0.00	NO
CYP				
CZE	0.00	NO	0.00	NA
EST	0.00	NO	0.09	-5.00
HRV	0.00	NO	0.00	-10.00
HUN	0.00	NO	0.04	NO
LVA	0.00	0.00	NO	-7.90
LTU	0.00	NO	0.02	-5.00
MLT	0.24	0.00	0.00	NO
POL	0.05	NO	0.00	-1.00
ROU	0.09	0.00	0.06	-2.50
SVK	0.15	NO	0.01	NO
SVN	0.04	NA,NO	0.00	-10.01

Carbon stock changes in dead organic matter are mainly reported using Tier 1 method so they are assumed in equilibrium and, in consequence, MS used the notation key NO (Table 6.19). In some case the notation key NE was also used when the Tier 1 assumption was applied. (e.g. Spain)

For the estimation of carbon stock changes in mineral soils, most MS apply IPCC default methodology along with default or country-specific data on emission factors (i.e. Tier 1 or 2). Few MS use Tier 3 methodologies based on models (e.g. C-tool by Denmark and ICBM by Sweden). In many cases, Tier 2 methods applied consist on country-specific soil organic carbon reference values along with IPCC default values for relative change factors (i.e. for Fmg, Flu, Fi). In some cases IPCC default factors have been slightly modified to adapt them; but changes rely more on expert judgment than on a statistical analysis of measurements. There is one exception, Austria derived own factors by close comparison with IPCC similar strata.

Overall, carbon stock changes in mineral soils are reported as a net sink of emissions, with implied carbon stock changes factors ranging from -0.33 to 0.30t C/ha (Table 6.19).

Carbon stock changes in organic soils on croplands are mostly reported applying Tier 1, or Tier 2 when country-specific emission factors are available (e.g. Finland, Sweden). Some countries developed a set of EF stratified by type of crops or soil status (e.g. Denmark on soil management type).

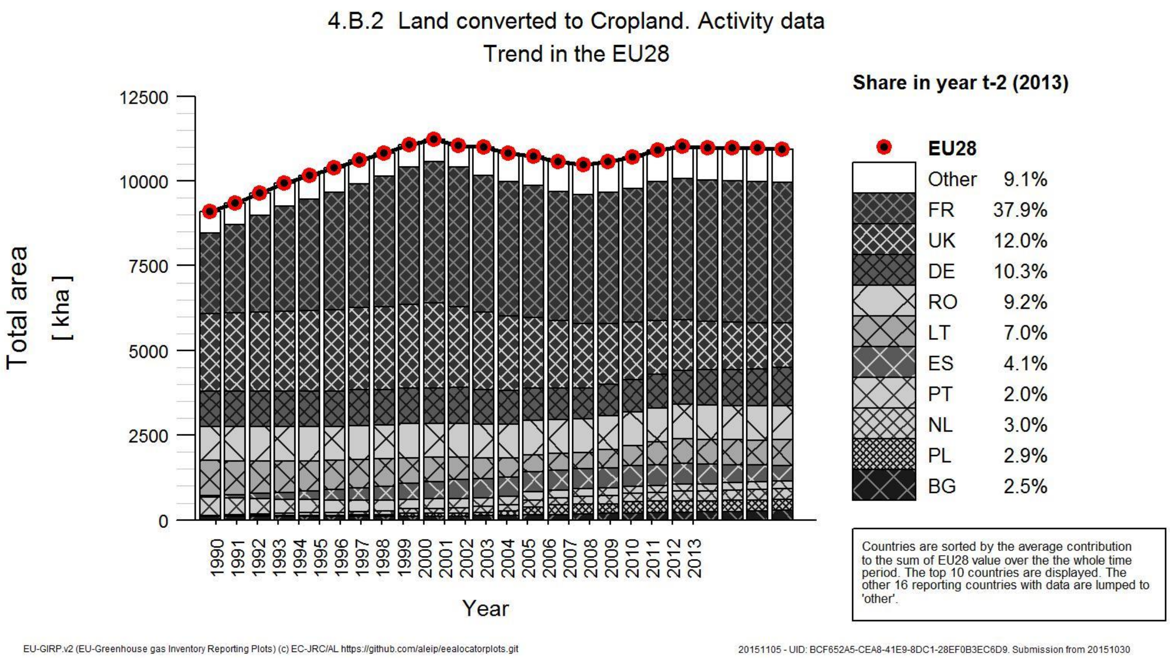
6.2.2.3 Land converted to Cropland (CRF 4B2)

Overview of Land converted to Cropland category

Area reported under subcategory 4B.2 increased by 20% since 1990. From 9.094 kha reported in 1990 to 10.940 Kha in 2013 (Figure 6.25). Overall, the area under conversions to croplands represents 9% of total Cropland area at EU level, and represents 67% of total annual emissions in Cropland category.

Largest conversions occur from Grassland and Forest land. Together, UK, France and Germany report 60% of total area of land converted to Cropland that is mostly associated with cultural rotation of crops and grasses on the same land.

Figure 6.25 Trend of activity data in the Land converted to Cropland subcategory of EU MS (kha, 1990-2013)



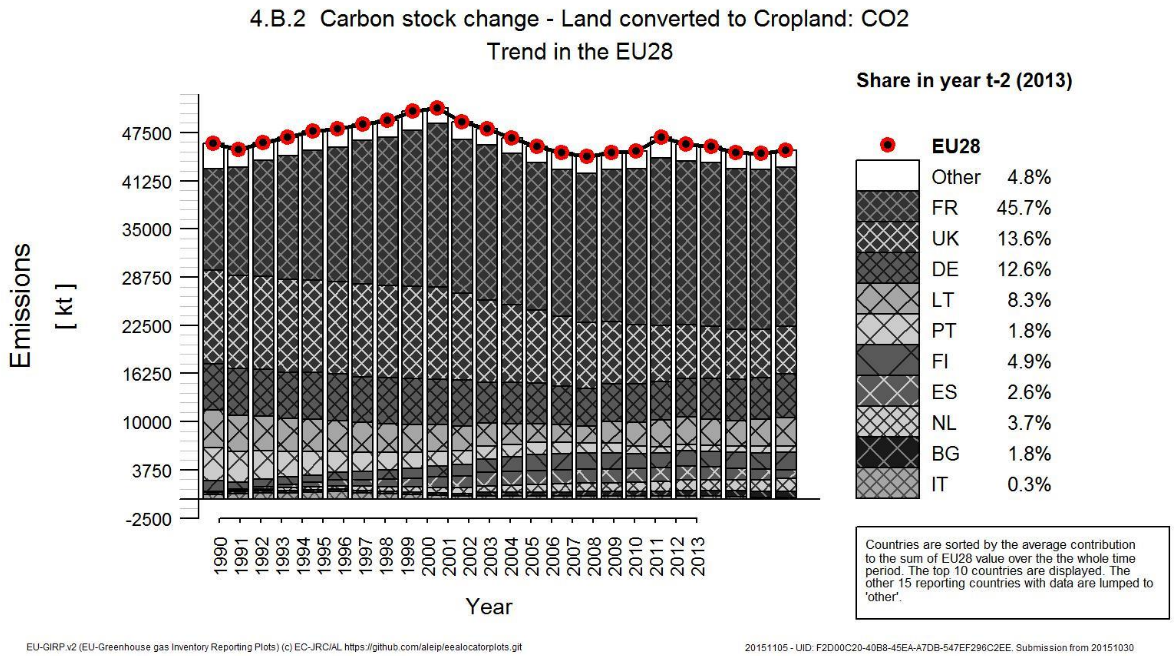
With the exception of Romania, all the MS reported emissions for the subcategory 4B.2. Total emissions in 4B.2 represent 45 210 kt CO_2. A decrease of 2% as compared with 1990 (Table 6.20).

Table 6.20 4B2 Land converted to cropland: MS' contributions to net CO_2 emissions (CRF table 4)

Member State	CO2 emissions in kt			Share in EU28 emissions in 2013	Change 2012-2013		Change 1990-2013	
	1990	2012	2013		kt CO2	%	kt CO2	%
Austria	192	180	185	0%	5	3%	-7	-3%
Belgium	63	555	557	1%	1	0%	493	781%
Bulgaria	290	770	795	2%	25	3%	505	174%
Croatia	23	42	47	0%	5	12%	24	102%
Cyprus	-	-	-	-	-	-	-	-
Czech Republic	109	82	85	0%	3	4%	-24	-22%
Denmark	10	-104	-2	0%	102	-99%	-12	-115%
Estonia	NO	96	89	0%	-7	-7%	89	100%
Finland	1 311	2 167	2 208	5%	41	2%	898	69%
France	13 209	20 748	20 680	46%	-68	0%	7 471	57%
Germany	6 056	5 378	5 681	13%	303	6%	-374	-6%
Greece	0	0	2	0%	2	461%	2	2529%
Hungary	132	312	293	1%	-19	-6%	162	122%
Ireland	NO	NO	NO	-	-	-	-	-
Italy	534	197	132	0%	-66	-33%	-402	-75%
Latvia	495	153	134	0%	-19	-13%	-361	-73%
Lithuania	4 847	3 504	3 734	8%	230	7%	-1 113	-23%
Luxembourg	52	25	25	0%	1	2%	-26	-51%
Malta	NO,IE	NO,IE	NO,IE	-	-	-	-	-
Netherlands	167	1 527	1 684	4%	156	10%	1 516	907%
Poland	345	229	229	1%	0	0%	-116	-34%
Portugal	4 314	804	802	2%	-2	0%	-3 512	-81%
Romania	1 091	-249	-249	-1%	0	0%	-1 340	-123%
Slovakia	466	72	74	0%	2	3%	-392	-84%
Slovenia	243	283	284	1%	2	1%	41	17%
Spain	-47	1 318	1 174	3%	-144	-11%	1 221	-2606%
Sweden	51	371	423	1%	52	14%	372	735%
United Kingdom	12 116	6 327	6 141	14%	-186	-3%	-5 975	-49%
EU-28	**46 070**	**44 789**	**45 210**	**100%**	**421**	**1%**	**-861**	**-2%**

In 2013, as well as, in 1990, the largest emissions from lands converted to Cropland are reported by France. In 2013, France reports almost half of total EU emissions under 4B.2 (Figure 6.26) that are associated with land conversions from Grassland to Croplands.

Figure 6.26 Trend of emissions in the land converted to Cropland subcategory of EU MS (kt CO_2, 1990-2013)



Methodological issues for Land converted to Cropland

IPCC default methodology is generally used, either along with country-specific data or by using IPCC default factors, for estimating and reporting carbon stocks changes in this subcategory. Data sources used by MS for estimating carbon stock changes are the same than those involved in the collection of data for estimating “land remaining in” and they depend on which land is converted to Cropland. Generally, it is assumed that the carbon stored in living biomass and dead organic matter is lost in the year of the conversion, while for soil organic carbon in mineral soils, following IPPC methodology, MS apply a 20 years transition period before the carbon stock of the soils converted to Cropland reach and equilibrium.

6.2.3 Grassland (CRF 4C)

6.2.3.1 Overview of Grassland category (CRF 4C)

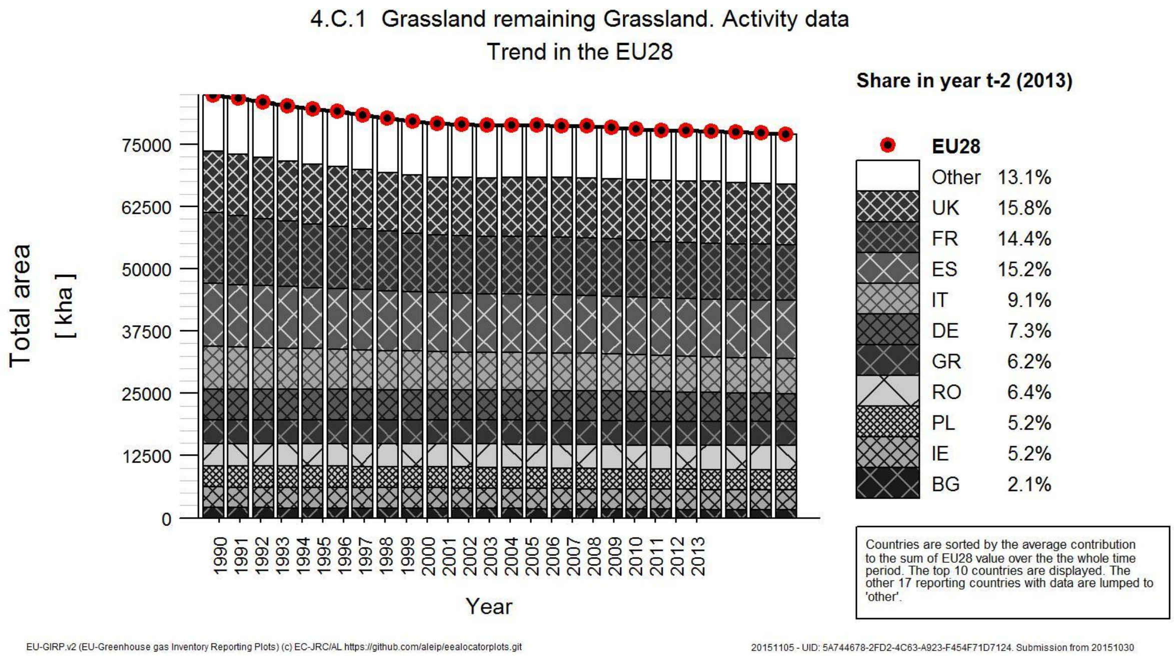
According to MS submissions, in 2013 the total Grassland area was 90.309 kha that represents 20% of total EU area, and a slightly decrease of 4% as compared with 1990. In terms of emissions, the category 4C, for the year 2013, represents a small net source of emissions of 976 kt CO_2 with a significant decrease of 94% compared with 1990.

6.2.3.2 Grassland remaining Grassland (CRF 4C1)

Overview of Grassland remaining Grassland category

In 2013, total area reported at EU level under the category 4C.1 reached 77.006 Kha, which represent 9% less compared to 1990 (Figure 6.27). Three MS (i.e. UK, France and Spain) reported about 45% of the total 4C.1 area, while the 10 MS with the larger contribution account for 87 % of the total EU area reported under this subcategory.

Figure 6.27 Trend of activity data in Grassland remaining Grassland subcategory in EU MS (kha, 1990-2013)



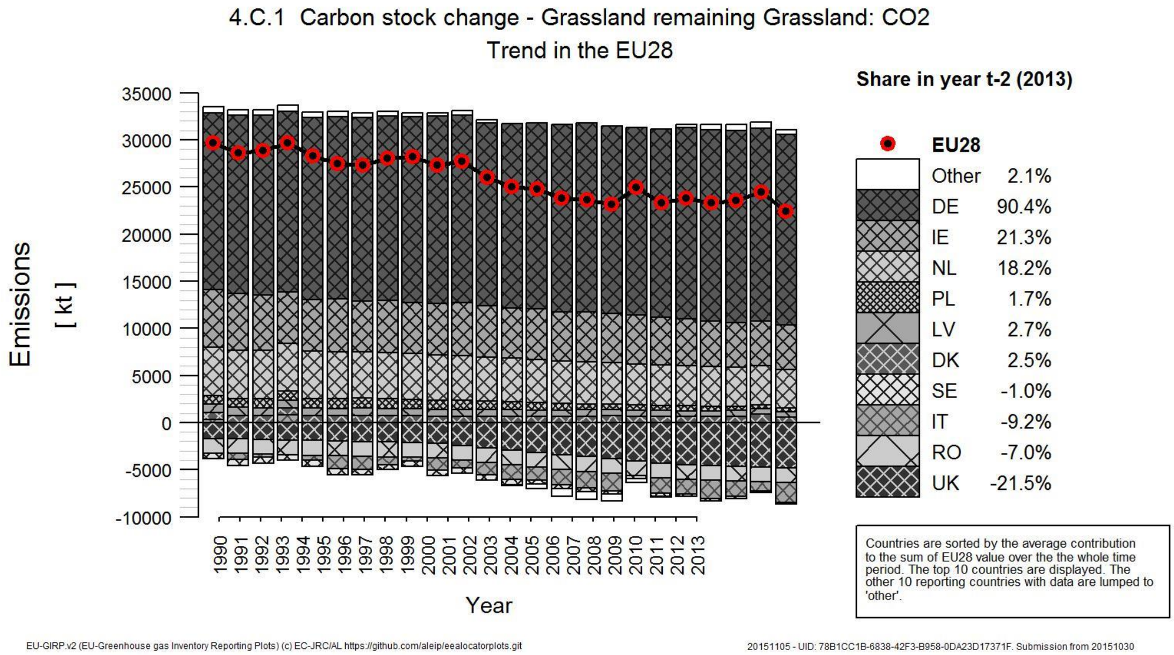
Category 4C.1 was a net source of 22 864 kt CO_2 emissions in 2013, which represents a decrease of 34% smaller than in 1990 (Table 6.21). In overall, significant emissions from this subcategory are related to MS with managed organic soils on Grassland areas (e.g. Netherlands, Germany, Ireland) while big sinks reported under this subcategory are related with woody biomass reported under Grassland category (e.g. Italy, Romania) or with mineral soils (e.g. UK)

Table 6.21 4C1 Grassland remaining Grassland: MS' contributions to net CO_2 emissions (CRF table 4)

Member State	CO2 emissions in kt			Share in EU28 emissions in 2013	Change 2012-2013		Change 1990-2013	
	1990	2012	2013		kt CO2	%	kt CO2	%
Austria	2	4	4	0%	0	3%	2	75%
Belgium	-43	-190	-189	-1%	1	-1%	-145	336%
Bulgaria	NO	NO	NO	-	-	-	-	-
Croatia	2	2	2	0%	0	0%	0	0%
Cyprus	-	-	-	-	-	-	-	-
Czech Republic	6	-1	-1	0%	0	2%	-7	-122%
Denmark	799	883	563	2%	-320	-36%	-236	-30%
Estonia	-42	673	456	2%	-216	-32%	498	-1191%
Finland	621	385	382	2%	-2	-1%	-239	-38%
France	0	0	0	0%	0	-	0	-
Germany	18 784	20 421	20 233	88%	-188	-1%	1 448	8%
Greece	0	0	0	0%	0	-99%	0	-99%
Hungary	51	1	-3	0%	-4	-456%	-54	-106%
Ireland	6 067	4 761	4 763	21%	2	0%	-1 304	-21%
Italy	5 272	3 271	-1 620	-7%	-4 891	-150%	-6 892	-131%
Latvia	851	597	601	3%	4	1%	-250	-29%
Lithuania	81	81	82	0%	1	1%	1	1%
Luxembourg	NO	NO	NO	-	-	-	-	-
Malta	NO	NO	NO	-	-	-	-	-
Netherlands	5 195	4 120	4 065	18%	-54	-1%	-1 129	-22%
Poland	979	440	409	2%	-31	-7%	-570	-58%
Portugal	NO	-270	-270	-1%	0	0%	-270	100%
Romania	-1 562	-1 562	-1 562	-7%	0	0%	0	0%
Slovakia	NO	NO	NO	-	-	-	-	-
Slovenia	NA,NO	NA,NO	NA,NO	-	-	-	-	-
Spain	NE,NO	NO,NE	NO,NE	-	-	-	-	-
Sweden	-620	-234	-230	-1%	5	-2%	391	-63%
United Kingdom	-1 680	-4 745	-4 821	-21%	-76	2%	-3 140	187%
EU-28	**34 762**	**28 634**	**22 864**	**100%**	**-5 770**	**-20%**	**-11 898**	**-34%**

The largest contributor to the overall source at EU level on Grassland remaining Grassland is Germany reporting large emissions from organic soils (Figure 6.28). UK reports a significant sink on mineral soils under this category. Some MS report notation keys under the assumption of no net carbon stock changes under tier 1 methods (e.g. living biomass) or justified by the assumption of no changes in managed practices of mineral soils. Additionally, some MS report areas of unmanaged grasslands (e.g. Ireland, UK).

Figure 6.28 Trend of emissions in the Grassland remaining Grassland subcategory of EU MS (1990-2013)



6.1.1.1.2 Methodological issues for Grassland remaining Grassland category

Definitions provided by MS of Grassland areas show good match with the IPCC land use definition, despite different eco-regions and management approaches across the EU (Table 6.22)

Table 6.22 Definition of Grassland category

Member State	Definition
Austria	Meadows cut once/twice/several times, cultivated pastures, litter meadows, rough pastures, alpine meadows and pastures and abandoned grassland.
Belgium	Rangelands and pasture land that is not considered under cropland. It also includes systems with vegetation that fall below the threshold of forest land category and are not expected to exceed it, without human intervention.
Bulgaria	Grassland includes the permanent grasslands – natural meadows, low productive grasslands, permanent lawns and grassland which are not used for production purposes.
Croatia	Grassland includes pastures, land principally occupied by agriculture, with significant areas of natural vegetation, natural grasslands, moors and heathland, sclerophyllous vegetation.
Cyprus	No definition is provided in the NIR
Czech Republic	Grassland as defined in this inventory is mostly used as pastures for cattle and meadows for growing feed. Additionally, the fraction of permanently unstocked cadastral FL is also included under Grassland. This is because it predominantly has the attributes of Grassland (such as land under power transmission lines).
Denmark	Land defined as grazing land under LPIS, heath land which may or may not be used for sheep grazing, as well as all other areas not meeting the definitions of forest land. The area of grassland is divided in “grazing land” and “other grassland”.
Estonia	Grassland includes rangelands and pasture, land that is not considered cropland nor forest land: land with perennial grasses that is proper for mow and pasture, smaller fallows and former cultural grasslands that have lost arable land features and grassland from wild lands (natural grassland). Overgrown wooded pasture with canopy cover between 30 and 50% is classified as grassland or forest, depending on the main land-use purpose. The national land cover class ‘bushes’ (area covered with natural or wildered cultivated bush and shrub species where canopy cover is over 50%) is included into GL.
Finland	Grassland includes area of grass cover (for more than 5 years), ditches associated with agricultural land and abandoned arable land. Abandoned arable land in this context means fields which are not used any more for agricultural production and where natural reforestation is possible or is already going on.
France	Land covered by natural and seeded herbaceous for more than 5 years. Includes areas covered trees and bushes being under the forest definition or not included under land category.
Germany	Meadow and pasture areas that cannot be considered cropland. Includes land covered with trees and shrubs that does not fall within the definition of "forest", as well as natural grassland and recreational areas.
Greece	Rangeland and pasture with vegetation that falls below the threshold of national forest definition and are not expected to exceed that without human intervention. Pastures that have been fertilized or sown are considered as cropland.
Hungary	Grassland includes meadows, i.e., land under grass (artificial planting included) where the production is utilized by cutting, irrespective of whether it is used for grazing sometimes, and pasture, i.e., land under grass (artificial planting included) that is utilized for grazing irrespective of whether it is used for cutting sometimes. Grassland includes areas with trees which are utilized for grazing and unmanaged grasslands which are not in use for agricultural purposes.
Ireland	Improved grassland (pasture and areas used for the harvesting of hay and silage) and unimproved grassland (rough grazing) in use as recorded by annual statistics.
Italy	Grazing lands, forage crops, permanent pastures, and set-aside lands since 1970, all shrub lands (data derived from NFI) and other woodlands that don’t fulfill forest definition.
Latvia	The grassland category consists of lands used as pastures, as well as glades and bush-land which do not fit to forest definition, vegetated areas on non-forest lands complying to forest definition where land use type can be easily switched back to grassland without legal requirement of transformation of the land use, but except grassland used in forage production and extensively managed cropland.
Lithuania	Grassland includes meadows and natural pastures planted with perennial grasses or naturally developed, on a regular basis used for moving and grazing. Grasslands cultivated for less than 5 years, in order to increase ground vegetation, still remain grasslands.
Luxemburg	All grasslands that are not considered as cropland including systems with vegetation or tree cover below forest threshold, natural grassland, recreational areas as well as agricultural systems. It includes one cut meadows; two and more cut meadows, cultivated pastures, litter meadows, rough pastures and pastures and abandoned grassland.
Malta	This category is split into other grassland and maquis. On the basis of expert judgement it was decided that maquis will be included in this category. The data of this category was derived from the Corine Land Cover 1996, 2000, 2006 under the sclerophyllous vegetation and Grassland.
Netherlands	Any type of terrain which is predominantly covered by grass. Rangeland and pasture land is the land that is not considered croplands. It also includes all orchards (with standard fruit trees, dwarf varieties or shrubs) and the vegetation that falls below the threshold used in the forest land category and are not expected to exceed, without human intervention, the threshold used in the forest land category. The category includes: “Grasslands” - areas predominantly covered by grass vegetation (whether natural, recreational or cultivated) and “Nature” - natural areas (excluding grassland) consisting in heath land, peat moors and other nature areas, with many of them having occasional tree as part of the typical vegetation structure.
Poland	Grassland consists of: permanent meadow and pastures include land permanently covered with grass, but does not include arable land sown with grass as part of crop rotation; permanent meadow are understood as the land permanently covered with grass and mown in principle in mountain area; also the area permanent pastures are understood as the land permanently covered with grass not mown but grazed in principle in mountain area; also the area of grazed pastures and meadows.
Portugal	Lands covered by permanent herbaceous cover.
Romania	Grassland includes land whose destination is grazing or mowing hay for livestock production, as well as other wooded land and trees outside forests (which do not meet forest definition parameters, e.g. forest belts which are narrower than 20m). It includes pastures, hayfields in hilly and mountainous areas and meadows in lowlands.
Slovakia	This category includes permanent grasslands and meadows used for the pasture or hay production, which is not considered as cropland.
Slovenia	Agricultural areas grown by grass and other herbs that are regularly cut or grazed. These areas are not in tillage or fallow ground. Included are areas covered with some of forest trees (less than 50 trees/ha) and the alpine pastures too. In this class there are swamp pastures and meadows on organic or mineral-organic soils, where the groundwater rises few times in the year. It includes also uncultivated agriculture land.
Spain	Pasture land, including grazing land not included in cropland. It includes also pastures and meadows in the dehesa (forested pasture) that do not comply with the definition of forest.
Sweden	Agricultural land that is not regularly tilled. All grasslands are assumed managed.
United Kingdom	Area classified as following broad habitats: improved grassland, natural grassland, calcareous grassland, acid grassland, bracken, dwarf shrub heath, fen/marsh/swamp, bogs and mountains.

Distinguishing among Grassland and Cropland is challenging because of cultural systems with rotation of crops and grasses (indeed conversions of Cropland to Grassland and Grassland to Cropland cover around 50 % of the total EU area under land use conversion), for this reason several data sources are usually involved in the identification of these lands.

In terms of methods, there is widespread use of Tier 1 methods as compared with methods used for reporting of Forest land and Cropland.

Table 6.23 Implied net carbon stock change factors for carbon pools in 4C1 (T C ha-1 yr-1) reported in EU' MS GHGI 2015.

Member States	Net carbon stock change in living biomass per area	Net carbon stock change in dead organic matter per area	Net carbon stock change in mineral soils per area	Net carbon stock change in organic soils per area
AUT	NO	NO	0.00	-0.25
BEL	NO	NO	0.10	-2.50
DNM	-0.05	NO	NO	-8.40
FIN	0.39	NE	NO	-3.50
FRK	0.00	NO	NO	NO
DEU	0.03	NO	0.00	-6.79
GRC	0.00	NO	NO	NO
IRL	NO	NO	0.01	-3.64
ITA	0.08	0.00	NA,NO	NO
LUX	NO	NO	NO	NO
NLD	NE	NE	NE,NO	-4.55
PRT	NO	NO	0.18	NO
ESP	NE	NE	NE	NO
SWE	0.09	0.20	0.01	-1.56
GBE	NO	NO	0.11	NO,IE
BGR	NO	NO	NO	NO
CYP				
CZE	NO	NO	0.00	NO
EST	-0.35	0.01	NO	-0.86
HRV	NO	NO	NO	-2.50
HUN	NO	NO	0.00	NO
LVA	0.02	0.00	NO	-6.10
LTU	NO	NO	NO	-0.25
MLT	NO	NO	NO	NO
POL	NO	NO	-0.02	-0.25
ROU	0.09	NO	NO	0.25
SVK	NO	NO	NO	NO
SVN	NA	NA	NA	NA

Carbon stock changes in living biomass of Grassland category is reported by 10 MS and, most of them reported a net source of CO_2 due to the existence of woody biomass under these areas. While many other, as occurring also for dead organic matter carbon pool, report the notation key NO (NE) under the Tier 1 assumption of no carbon changes in these pools (Table 6.23).

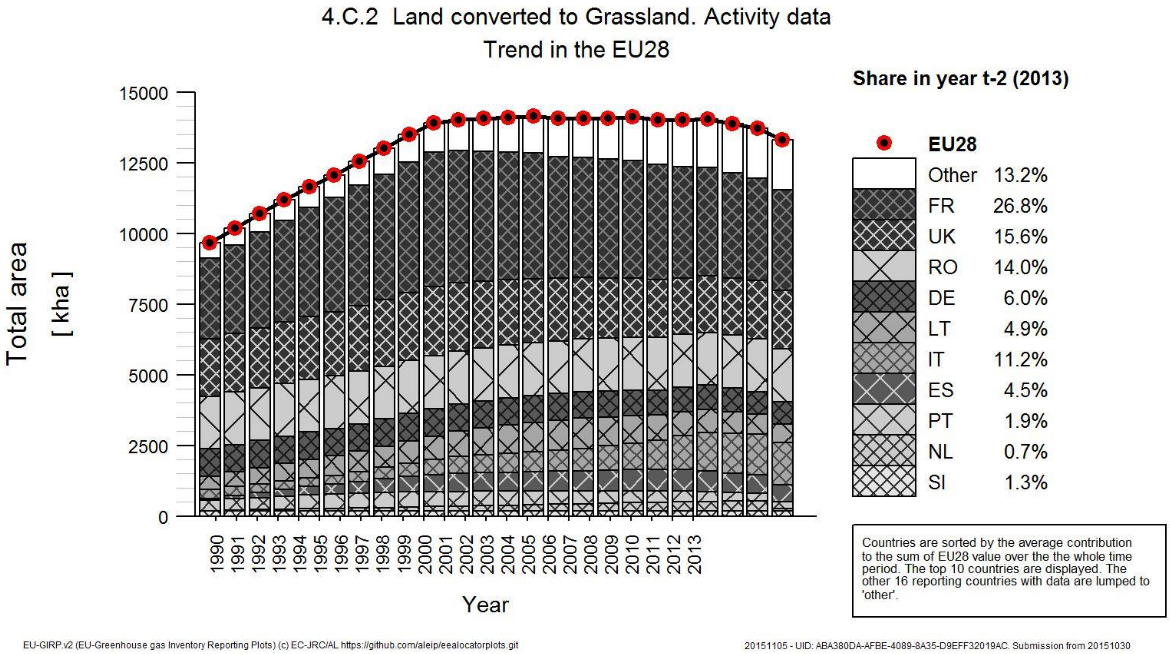
For reporting mineral soils, most of the MS use Tier 1, or Tier 2 methods. Often, MS use specific values of organic soil carbon from field data collection schemes and, then implement, in a second step, default values for relative stock changes factor values. For MS with managed organic soils under this category, the final net estimate result in most of the cases in a net source of emissions.

6.2.3.3 Land converted to Grassland (CRF 4C2)

Overview of Land converted to Grassland category

The total area of Land converted to Grassland represents 13.302 kha which is 15% of the total Grassland area at EU level. Lands converted to Grassland increased by 38 % in 2013 as compared with 1990. Most of the areas converted to Grasslands derived from Cropland and Forest land. France, UK and Romania reported more that 50% of the total are converted to Grassland (Figure 6.29).

Figure 6.29 Trend of activity data in the "Land converted to Grassland" subcategory4C2 in EU MS (kha, 1990-2013)



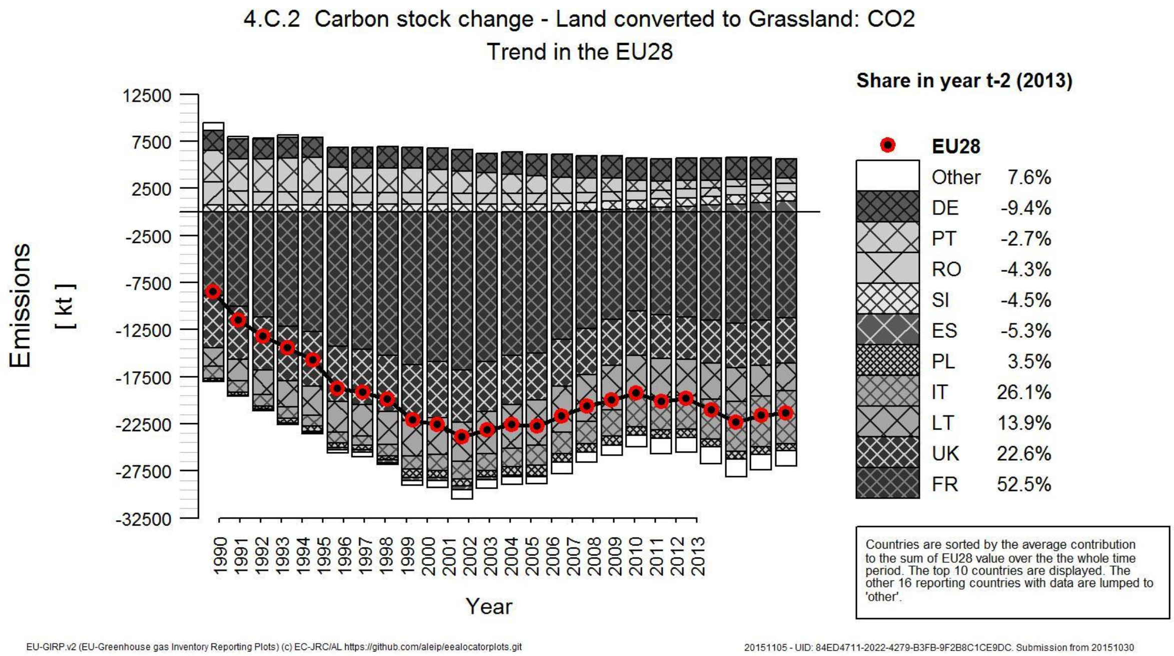
In term of emissions, the conversions to Grassland in the EU represent a total net sink of 21 151 kt CO_2 that results in an increase of about 149% compared to the net sink reported for the year 1990 (Table 6.24, Figure 6.30). In overall, the net sink reported under this subcategory is comparable to the net source of emissions reported under the subcategory 4C.1

Table 6.24 4C2 Land converted to Grassland: MS' contributions to the net CO_2 emissions (CRF table 4)

Member State	CO2 emissions in kt			Share in EU28 emissions in 2013	Change 2012-2013		Change 1990-2013	
	1990	2012	2013		kt CO2	%	kt CO2	%
Austria	322	41	47	0%	6	14%	-276	-86%
Belgium	85	-285	-283	1%	2	-1%	-368	-435%
Bulgaria	-158	-432	-466	2%	-34	8%	-308	195%
Croatia	-106	-137	-106	0%	31	-23%	0	0%
Cyprus	-	-	-	-	-	-	-	-
Czech Republic	-141	-306	-321	2%	-15	5%	-180	128%
Denmark	21	108	16	0%	-92	-85%	-6	-26%
Estonia	14	-99	-53	0%	47	-47%	-67	-465%
Finland	242	232	225	-1%	-7	-3%	-17	-7%
France	-8 857	-11 481	-11 221	53%	260	-2%	-2 364	27%
Germany	2 098	2 279	2 005	-9%	-274	-12%	-93	-4%
Greece	0	-917	-1 055	5%	-138	15%	-1 055	-3640469%
Hungary	-34	-169	-242	1%	-73	43%	-207	603%
Ireland	3	38	59	0%	21	57%	57	2086%
Italy	-1 275	-5 440	-5 583	26%	-143	3%	-4 309	338%
Latvia	0	-426	-413	2%	14	-3%	-413	18756533%
Lithuania	-2 025	-3 198	-2 983	14%	215	-7%	-958	47%
Luxembourg	35	-46	-43	0%	3	-6%	-78	-225%
Malta	NO	NO	NO	-	-	-	-	-
Netherlands	257	147	342	-2%	196	133%	85	33%
Poland	-266	-781	-757	4%	24	-3%	-492	185%
Portugal	3 336	651	573	-3%	-79	-12%	-2 763	-83%
Romania	2 474	921	921	-4%	0	0%	-1 553	-63%
Slovakia	-202	-217	-204	1%	13	-6%	-2	1%
Slovenia	735	958	970	-5%	12	1%	234	32%
Spain	-19	997	1 141	-5%	144	14%	1 160	-6239%
Sweden	491	790	864	-4%	74	9%	373	76%
United Kingdom	-5 522	-4 631	-4 585	22%	46	-1%	936	-17%
EU-28	**-8 492**	**-21 404**	**-21 151**	**100%**	**253**	**-1%**	**-12 659**	**149%**

The highest sink from conversion to Grassland in 2013 was reported by France, Italy and UK that estimates a significant amount of removals in mineral soils from the conversion of Cropland to Grassland.

Figure 6.30 Trend of emissions in the Land converted to Grassland subcategory of EU MS (kt CO_2, 1990-2013)



Methodological issues for Land converted to Grassland category

The methods and data sources for estimating CO_2 emissions and removals from this land subcategory are fully consistent with those used for 4C.1, both for activity data and carbon stock changes estimation. In overall, MS apply IPCC approach for estimating carbon stock changes in this subcategory along with, country-specific or default factors, depending on the pool that is being estimated and on the land use category involved in the conversion.

6.2.4 Wetlands, Settlements and Other land (CRF Tables 4D, 4E, 4F)

6.2.4.1 Wetlands (CRF 4D)

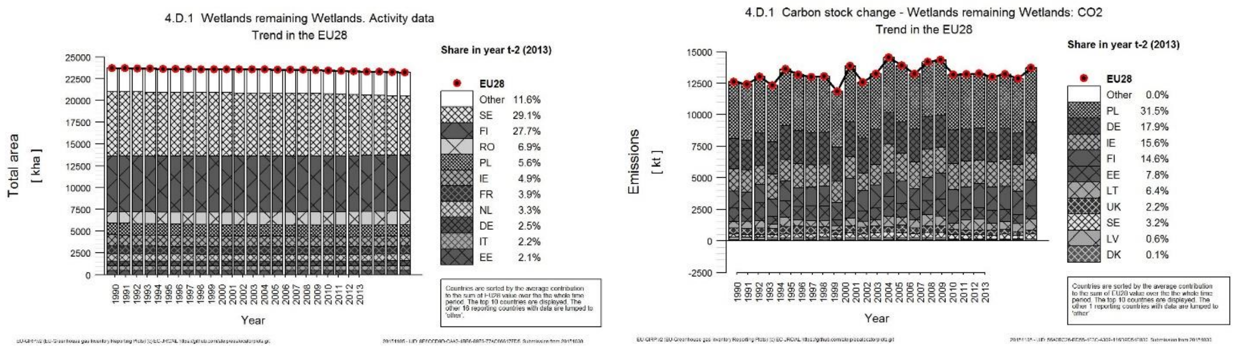
At EU level, Wetlands areas represent 24.648 kha that is 6% of total EU area reported in 2013. As compared with 1990, these areas have slightly increased by 1% (Figure 6.31). The largest areas have been reported in Finland and Sweden which together report more than 50% of total Wetlands areas in EU. Within this category, areas of lands converted to Wetlands represent only 6% of the total category.

Under 4D.1, total emissions reported at EU level represent 13.711 kt CO_2. Under Wetlands, MS include different lands that not always are subject to management activities (Table 6.25). This explain why MS with the largest share on areas at EU level not always report the largest emissions. In general this happens when large areas within wetlands include flooded lands or other wetlands that are not subject to management activities (e.g. Romania). The main driver of emissions in this subcategory is represented by peat extraction which, even if affecting small areas, has a big impact on final emissions. (e.g. Estonia, Lithuania).

Table 6.25 Definitions of land included by MS under the category 4D Wetlands

Austria	Rivers, lakes, mires and peat areas (protected areas, in general) as classified by national statistical system.
Belgium	Land covered or saturated by water for all or part of the year (e.g. peatland) and that does not fall into the other land category. It includes reservoirs as a managed subdivision and natural rivers and lakes as unmanaged subdivisions.
Bulgaria	Wetlands category - wetlands surface water areas are included (wetlands) – covered with water or water saturated lands (throughout the year or partially in the year) which does not fall in the other categories. These are natural or artificial water-courses serving as water drainage channels, natural or artificial stretches of water, coastal lagoons, wetlands areas and peatbogs.
Croatia	Inland marshes, salt marshes, salines, intertidal flats, water courses, water bodies, coastal lagoons
Cyprus	No definition is provided
Czech Republic	Category Wetlands includes riverbeds, and water reservoirs such as lakes and ponds, wetlands and swamps.
Denmark	Permanent wetlands, wetlands for peat extraction and re-established anthropogenic wetlands. Several subdivisions may be distinguished: unmanaged fully water covered wetlands (lakes and rivers); unmanaged partly water covered wetlands (fens and bogs); managed drained land for peat extraction; managed partly water covered wetlands (re-established wetlands on primarily former cropland and grassland).
Estonia	Land permanently saturated by water and/or areas where the peat layer is at least 30 cm and the minimum potential tree height does not conform to the forest land definition. It does include smaller bog holes.
Finland	Inland waters (reservoirs, natural lakes and rivers), peat extraction areas and peatlands which do not fulfill the definition of other land uses.
Germany	Reporting in the wetlands category primarily covers emissions from organic soils that are released during peat extraction, covering: CO2 losses from extraction areas, and during extraction and spreading of peat. Also, it includes (but they are not estimated) the few non-drained semi-natural bogs that have been largely free of anthropogenic impacts, flooded lands, water-storage facilities (dams, reservoirs, etc.) and settling basins that are used for energy production, irrigation, shipping and recreation, and that are flooded or drained, or that otherwise have large water-level fluctuations.
Greece	Land that is covered or saturated by water for all or the greatest part of the year (e.g. lakes, reservoirs, marshes), river bed (including torrent beds) and that does not fall into the forest land, cropland, grassland or settlements categories.
France	Lands covered or saturated by water all year long or part of it.
Hungary	Wetland includes the wetlands and water bodies as defined by the CORINE land-cover databases and contain inland marshes (low-lying land usually flooded in winter, and more or less saturated by water all year round), peat bogs (peat land consisting mainly decomposed moss and vegetable matter), water courses (natural or artificial water-courses including those serving as water drainage) and water bodies (natural or artificial lakes, ponds etc.).
Ireland	Natural unexploited wetlands and areas commercially exploited for public and private extraction of peat and areas used for domestic harvesting of peat.
Italy	Lands covered or saturated by water, for all or part of the year, harmonized with the definitions of the Ramsar Convention on Wetlands.
Latvia	Wetlands category includes all inland water bodies (rivers, ponds, lakes), swamps (constantly wet areas where height of trees cannot reach more than 5 m in height and ground vegetation consists mostly of sphagnum and different sword grasses), flood-lands (small areas) and alluvial lands (larger flood-lands).
Lithuania	Wetlands include peat extraction areas and peat lands which do not fulfil the definition of other categories. Water bodies and swamps (bogs) are also included under this category. Peat extraction areas are considered as managed land.
Luxemburg	Land that is covered or saturated by water for all or part of the year (e.g. peat land, reservoirs) and that does not fall into other categories.
Malta	In the Maltese islands wetlands are mostly saline.
Netherland	Land covered or saturated with water for all or part of the year and does not fall into the other land category. It includes reservoirs as a managed sub-division and natural lakes and rivers as unmanaged, including natural open water in rivers, but also man-made open water in channels, ditches and artificial lakes.
Poland	Wetland consists of: marine internal; surface flowing waters, which covers land under waters flowing in rivers, mountain streams, channels, and other water courses, permanently or seasonally and their sources as well as land under lakes and artificial water reservoirs. from or to which the water course flow; land under surface lentic water which covers land under water in lakes and reservoirs other than those described above, land under ponds including water reservoirs (excluding lakes and dam reservoirs for water level adjustment) including ditches and areas adjacent and related to ponds; land under ditches including open ditches acting as land improvement facilities for land used.
Portugal	Inland wetlands, coastal wetlands, salt marshes, saline and intertidal flats.
Romania	Wetlands includes all lands covered by water (rivers, ponds, dams, swimming pools, etc.) and land affected by humidity (caused by water stagnation, marshy areas, etc.), with the exception of agricultural land. It contains two sections (waters and wetlands) and 11 categories (permanent streams, temporary streams, lakes, dams, floating vegetation, hydrophilic vegetation (stubble etc.), harbors, temporarily flooded areas, bogs, channels and piers.
Slovakia	The wetlands include artificial reservoirs and dam lakes, natural lakes, rivers and swamps.
Slovenia	Wetlands are fens and raised bogs. Vegetation is higher than swamp pastures and meadows and there is no cutting of the grass or grazing. There are the areas with reeds and low placed areas frequently floated. All that areas are not in agricultural use. In this class there are the inland water bodies (major rivers, lakes and water reservoirs) too.
Spain	Includes the lands covered or saturated by water all year long or part of it.
Sweden	Wetlands is assumed unmanaged (mires and areas saturated by fresh water) and managed (cca 10 000 ha used for peat extraction).
United Kingdom	Includes sites currently registered for commercial extraction where extraction activity is visible on recent aerial/ satellite photographs or by field visits.

Figure 6.31 Trend of activity data and emissions in "Wetlands remaining Wetlands" subcategory of EU MS (kha, 1990-2013)

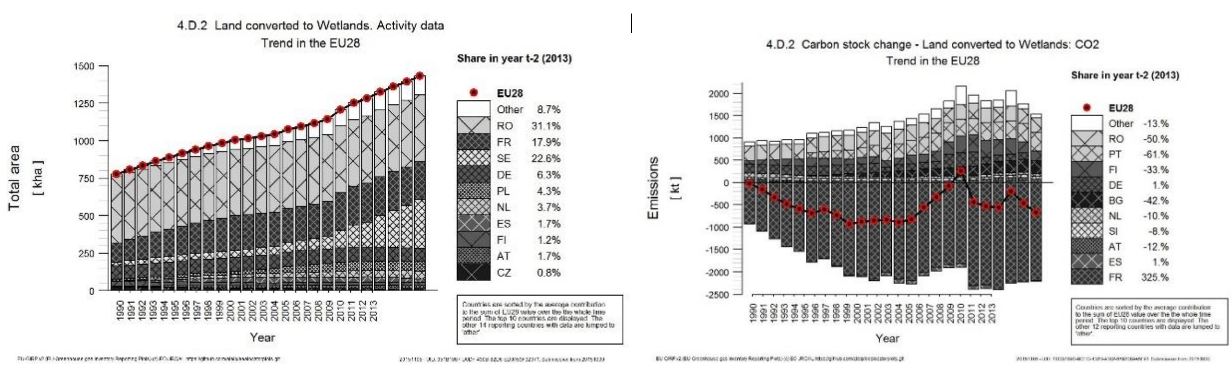


In 2013, 1.430 Kha are reported under Land converted to Wetlands that represent an increase of 84% as compared with 1990 (Figure 6.32). Conversion to Wetlands are mainly reported by Romania, France and Sweden. In term of emissions, this subcategory is reported at EU level as a small sink of 674 kt CO_2.

Lands reported under wetlands have different definitions among MS. Differences mostly relay on if wetland areas are subject to economic activities (Northern countries).

Category 4D.2 is often subject to conversions to natural water regime and wetlands in general established in areas of organic soils on Grasslands. Under 4D.2 MS report either a source or sink depending on the previous land use category that is converted to Wetlands. Generally, emissions and removals from this category are related to soils carbon pools (e.g. France reports significant removals on organic soils from the conversion of Grassland to other wetlands) of with living biomass if the conversion is related to deforestation (e.g. Romania)

Figure 6.32 Trend of activity data and emissions in "lands converted to Wetlands" subcategory of EU MS (kha, 1990-2013)



6.2.4.2 Settlements (CRF 4E)

At EU level, the total reported Settlements area in 2013 is 29.653 Kha. Settlements represent 7% of the total EU area, and increased by 22% as compared with 1990. All the MS report increasing areas under this land category. In overall, Land converted to Settlements represent 22% of the total area reported under 4E and it is mainly due to conversions from Cropland, Grassland or Forest lands.

Definitions of lands included under this category vary across MS (Table 6.26).

Table 6.26 Definitions of land reported by MS under land category 4E Settlements

Member State	Definition
Austria	Includes buildings land: sealed, partly sealed and unsealed areas; parks and gardens; roads and railway tracks; excavation areas, and other not further differentiated settlement area.
Belgium	All developed land, including transportation infrastructure and human settlements of any size (i.e. including road sides) unless they are already included under other categories.
Bulgaria	The Settlements refer to all classes of urban formation. These are areas that are functionally or administratively associated with public or private land in cities, villages or other settlement types.
Croatia	Continuous and discontinuous urban fabric area, industrial or commercial units, road and rail networks and associated land, port areas, airports, mineral extraction sites, dump sites, construction sites, green urban areas, sport and leisure facilities.
Cyprus	No definition is provided
Czech Republic	Settlements includes two categories built-up areas and courtyards and other lands. Other lands includes all types of land-use were included with the exception of "unproductive land", which corresponds to category 4.F Other Land. Hence, the Settlements category also includes all land used for infrastructure, as well as that of industrial zones and city parks.
Denmark	Urban cores, industrial areas, roads, high and low buildup areas. Low build-up areas are characterized as single-family houses surrounded by gardens, graveyards, sports facilities, etc. (estimates are reported only for low build-up areas).
Estonia	Built-up areas, with roads, streets and squares, traffic and power lines, urban parks, industrial and manufacturing land, sports facilities, airports, legal waste down points, construction sites and buildings with up to 0.3 ha of garden yard (including permanent greenhouses), and open cast areas (except peat extraction areas) are included into this land-use category
Finland	Combined area of NFI built-up land, traffic lines and power lines. Includes parks, yards, farm roads and barns.
France	Artificialized land (settlements, parks, roads and infrastructure, etc.).
Germany	Open settlement and transport areas.
Greece	Developed land, including transportation infrastructure and human settlements of any size, unless they are already included under other land-use categories.
Hungary	Settlements comprises the urban areas, industrial, commercial and transport units, as well as mines, dump and construction sites and artificial non-agricultural vegetated areas.
Ireland	Urban areas, roads, airports and the footprint of industrial commercial/institutional and residential buildings.
Italy	Artificial surfaces, transportation infrastructures (urban and rural), power lines and human settlements of any size, comprising also parks.
Latvia	According to national definitions settlements include: land under buildings including yards and gardens as well as land necessary to maintain and to access those buildings; land under roads including buffer zones; forest infrastructure excluding ditches and other wetlands, but including seed orchards, forest nurseries and fire-breaks; other infrastructure – buffer zones of industrial networks, quarries etc.
Lithuania	All urban territories, power lines, traffic lines and roads are included under this category as well as orchards and berry plantations planted in small size household areas and only used for householders' meanings.
Luxemburg	Developed land, including transportation and any size of human settlement unless already included under other category.
Malta	The land-use category Settlements includes all classes of urban tree formations, namely trees grown along roads and streets, in public and private gardens, and in cemeteries, airports, construction sites, dumpsites, industrial or commercial units, port areas and sport and leisure facilities.
Netherlands	Developed land, including transportation infrastructure and human settlements of any size, unless they are already included under other categories.
Poland	Settlements consists of: residential areas include land not used for agricultural and forest production, put under dwelling buildings, devices functionally related to dwelling buildings (yards, drives, passages, playgrounds adjacent to houses), as well as gardens adjacent to houses; industrial areas include land put under buildings and devices serving the purpose of industrial production; other built-up areas include land put under buildings and devices related to administration; undeveloped urbanised areas include land that is not built over, allocated in spatial management plans to building development and excluded from agricultural and forest production; recreational and resting areas comprise the following types of land not put under buildings; areas of recreational centres,. children playgrounds, beaches, arranged parks, squares, lawns (outside street lanes); areas of historical significance: ruins of castles, strongholds, etc.; sport grounds: stadiums, football fields, ski-jumping take-offs, toboggan-run, sports rifleranges, public baths etc.; area for entertainment purposes: amusement, grounds, funfairs etc.; zoological and botanical gardens; areas of non-arranged greenery, not listed under woodlands or land planted with trees or shrubbery; transport areas including land put under: roads; stopping yards next to railway stations, bus stations and airports, maritime and river ports and other ports, as well as universal accesses to unloading platforms and storage yards; railway grounds; other transport grounds.
Portugal	Artificial areas such as urban, industrial, commerce and transport units, mines, dump and construction sites and artificial non-agricultural vegetated areas.
Romania	Settlements has 3 groups (urban/rural, buildings and infrastructure) and includes: fenced and constructed areas, sealed lands (e.g. car parks, roundabouts, platforms), urban/rural lawns, playgrounds in green areas, beach lawn and other areas with lawn, dwellings, industrial and administration buildings (e.g. banks, churches, railway stations, restaurants), warehouses, huts, ruins, greenhouses, graveyards, dirt roads, trails, rail roads and roads (street, sidewalk, square), bridges and dams.
Slovakia	The settlements include all developed land, including transportation infrastructure and human settlements of any size.
Slovenia	Settlements are all piece of land where the buildings, roads, parking places, mines, stone pits and all other infrastructure are in human use.
Spain	All developed land, transport infrastructure and establishments of any size, unless they are included in other categories.
Sweden	Infrastructure such as roads and railways, power lines, municipality areas, gardens and gravel pits.
United Kingdom	Covers urban and rural settlements, farm buildings, caravan parks and other man-made built structures such as industrial estates, retail parks, waste and derelict ground, urban parkland and urban transport infrastructure. It also includes domestic gardens and allotments, linearly arranged landscape features such as hedgerows, walls, stone and earth banks, grass strips and dry ditches.

In terms of emissions, most of the MS report carbon stock change in the subcategory 4E.1 using notation keys under the Tier 1 assumption of equilibrium for carbon pools on these areas.

In overall, at EU level, Settlements remaining Settlements is reported as a source of 2.838 kt CO_2, mainly due to emissions reported in mineral soils by UK, or emissions from disturbed organic soils reported by Germany or Netherlands (Figure 6.33,Figure 6.34). Few MS report removals from Living biomass on Settlements remaining Settlements. (e.g. Latvia, Poland)

Figure 6.33 Trend of activity data and emissions in “Settlements remaining Settlements” subcategory of EU MS (kha, 1990-2013)

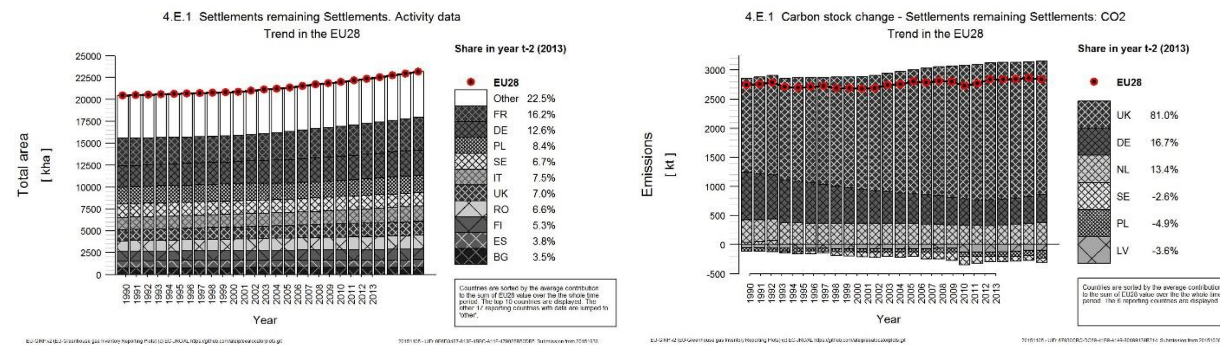
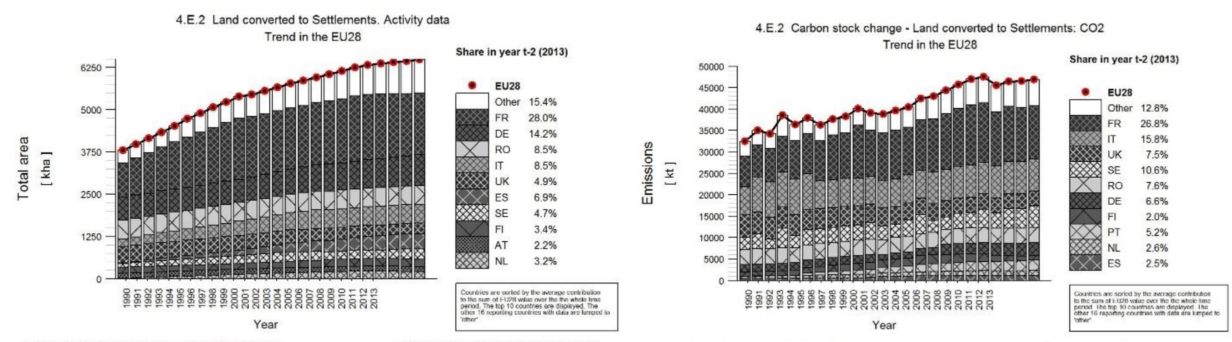


Figure 6.34 Trend of activity data and emissions in “Land converted to Settlements” subcategory of EU MS (kha, 1990-2013)



Annual emissions from conversions to Settlements have increased by 44% since 1990 (Table 6.27). In 2013 this subcategory was reported as a net source of emissions of 46.859 kt CO_2

From conversions of major land categories the reporting on carbon pools is almost complete, the most significant emissions are due to disturbed mineral soils (UK, Italy, and France). Conversion from Forest land to Settlements is an important component of the total deforestation, being around 30% of total area reported as deforested and 16% of the conversion to Settlements. While conversions to Wetlands and Other land may be caused by natural effects, conversions to Settlement is always, by definition, the result of human actions. Generally, carbon pools are not uniformly disturbed over the whole area converted; usually only part of converted area is sealed, trees or upper soils layer is removed and, carbon stored in dead organic matter and soil organic matter diminish significantly. Generally, carbon stock changes associated with deforestation are reported by using country-specific data.

Table 6.27 4E2 Land converted to Settlements: MS' contributions to the net CO_2 emissions (CRF table 4)

Member State	CO2 emissions in kt			Share in EU28 emissions in 2013	Change 2012-2013		Change 1990-2013	
	1990	2012	2013		kt CO2	%	kt CO2	%
Austria	385	135	215	0%	80	59%	-169	-44%
Belgium	236	595	593	1%	-2	0%	357	151%
Bulgaria	678	948	978	2%	30	3%	300	44%
Croatia	240	535	546	1%	11	2%	305	127%
Cyprus	-	-	-	-	-	-	-	-
Czech Republic	84	99	83	0%	-16	-16%	-1	-1%
Denmark	13	91	74	0%	-17	-19%	61	472%
Estonia	0	342	353	1%	11	3%	352	118245%
Finland	976	1 091	947	2%	-143	-13%	-28	-3%
France	7 110	12 747	12 550	27%	-197	-2%	5 439	76%
Germany	1 728	2 942	3 104	7%	161	5%	1 375	80%
Greece	6	25	11	0%	-14	-56%	4	70%
Hungary	115	219	232	0%	13	6%	118	103%
Ireland	74	259	55	0%	-204	-79%	-19	-26%
Italy	6 641	7 419	7 425	16%	6	0%	784	12%
Latvia	163	1 071	1 107	2%	36	3%	944	578%
Lithuania	NO	277	318	1%	40	15%	318	100%
Luxembourg	150	79	75	0%	-3	-4%	-74	-50%
Malta	NO	NO	NO	-	-	-	-	-
Netherlands	509	1 133	1 205	3%	72	6%	696	137%
Poland	461	515	400	1%	-115	-22%	-60	-13%
Portugal	30	2 348	2 428	5%	80	3%	2 397	7863%
Romania	3 550	3 550	3 550	8%	0	0%	0	0%
Slovakia	96	81	96	0%	15	18%	0	0%
Slovenia	730	871	877	2%	6	1%	148	20%
Spain	411	1 139	1 152	2%	13	1%	741	180%
Sweden	2 854	4 487	4 955	11%	468	10%	2 100	74%
United Kingdom	5 219	3 541	3 530	8%	-11	0%	-1 690	-32%
EU-28	**32 462**	**46 539**	**46 859**	**100%**	**320**	**1%**	**14 397**	**44%**

For reporting dead organic matter it is generally assumed that the entire carbon stock in this pool is instantaneously oxidized in the moment of conversion from Forest land to Settlements. It is also assumed that there is no dead wood and litter on Settlements. Emissions are estimated based on per area average carbon stock of these carbon pools determined either at national or regional scale or specific to each deforestation site.

For reporting soils organic matter different assumptions have been implemented by MS, generally based on expert judgment or, occasionally, from some scientific studies. For instance, in Sweden carbon stock in Settlements is estimated as the weighted average of carbon stocks in two strata: unsealed and sealed. Unsealed area is usually considered to cover 40-60% of national Settlements or conversion to

Settlements area (e.g. Austria, Luxembourg), going down to 2-3% in cities (i.e. Bulgaria). Associated carbon stocks are derived from one of the following options (depending on MS):

- data from measurements in green area of the city (from scientific studies);
- same carbon stock as under 'GL remaining GL' (assuming that under national circumstances GL is the source of land for Settlement's expansion);
- lowest carbon stock value among the major land categories Forest land, Cropland and Grassland (assuming limited change of carbon stock in the soil under construction);
- applying a factor against carbon stock in previous land use (e.g. constant loss of 50% by FR).

6.2.4.3 Other land (CRF 4F)

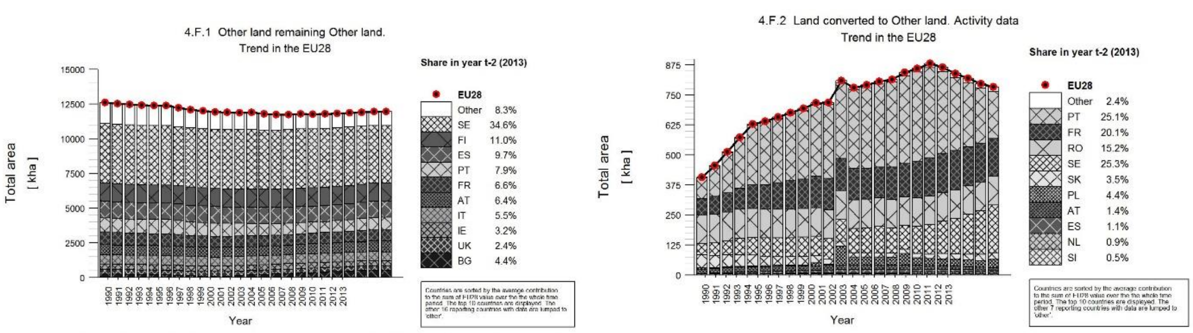
The area of the category Other land covers at EU level 12.730 kha in 2013, which is 2% less than in 1990 and 3% of the total reported EU area. Area under conversion in this category shares the 6% of the total area. Definitions implemented to report such lands are close amongst MS and match IPCC general description (Table 6.28). In some cases, this category is used to ensure that total reported area is consistent along the time series and match official country area by the inclusion of all the areas that do not fall into any other land use category.

Table 6.28 Definition for the categorization of lands under 4F - Other land

Member State	Description and supplementary elements for land classification
Austria	Area with i) rocks and screes, ii) glaciers and iii) unmanaged alpine dwarf shrub heaths. It is calculated as the difference of total country area and all other land uses, showing max 2% difference by relevant cadastral data.
Belgium	Bare soil, rock, ice, and all unmanaged land areas that do not fall into any of the other five categories.
Bulgaria	Other land category includes bare soil, rock and all area that do not fall into any of other five land-use categories.
Croatia	Definition is not available in NIR 2015.
Cyprus	Definition is not available in NIR 2015.
Czech Republic	Other Land represents unmanaged (unmanageable) land areas, matching the IPCC (2006) default definition.
Denmark	Unmanaged area like moors, fens, beaches, sand dunes, lakes and other areas without human interference.
Estonia	Land areas that do not fall into any of the other five land-use categories.
Finland	Mineral soils on poorly productive forest land, which do not fulfill the threshold values for forest, unproductive lands on mineral soils on rocky lands and treeless mountain areas.
France	All lands that do not correspond to any other land use categories (e.g. rock areas).
Germany	Waste and swaths/aisles, glacier areas, scree slopes and sand bars and other land which cannot be allocated under other land categories. "Other land" consists of areas that are neither influenced nor cultivated by people.
Greece	All land areas that do not fall into any of other land-use categories (e.g. rocky areas, bare soil, mine and quarry land).
Hungary	Other Land includes comprises any area not included in another categories.
Ireland	Natural grasslands not in use for agricultural purposes. Water bodies, bare rocks.
Italy	Definition is not available in NIR 2015.
Latvia	According to the national land use statistics other lands include unmanaged lands, wetlands and settlements (1 459.3 mill. ha in 2008). Instead of the official statistics since 2009 the NFI is used to estimate area of other lands. It is assumed that other lands are dunes not covered by woody vegetation.
Lithuania	All other land which is not assigned to any other category such as quarries, sand - dunes and rocky areas is defined as Other land.
Luxemburg	This category includes bare soil, rock, ice, and all unmanaged land areas that do not fall into any of the other five categories. It allows the total of identified land areas to match the national area.
Malta	This category includes bare soil, rock, and all unmanaged land areas that do not fall into any of the other five categories. Mineral extraction sites in Malta are included under this land-use category.
Netherlands	Surfaces of bare soil which are not included in any other category like: bare sands and the earliest stages of succession from sand in the coastal areas (beaches, dunes and sandy roads) or uncultivated land alongside rivers. It does not include bare areas that emerge from shrinking and expanding water surfaces (which are included in wetlands).
Poland	Definition is not available in NIR 2015.
Portugal	Beaches, dunes, sand plains and bare rocks and shrub land.
Romania	Other land includes following categories: rocky areas, excavations, stone quarries (active, closed), stony debris, gravel/sand/earth pits, drilling perimeters and locally degraded lands.
Slovakia	Other land represents bare soil, rock and all unmanaged land areas that do not fall into any of the other categories.
Slovenia	Other land includes non-forest land covered with vegetation lover than 2 m or covered less than 75%, which is not used in agriculture. There are inbuilt areas with little or no vegetation as rocks, sands, sand banks (bigger than 5000 m2), waste and other opened areas. This is all land that is not classified in other land use definitions.
Spain	Bare soil, rock areas, ice and other areas of land that do not fall into any of the other land category.
Sweden	Waste land and most of the mountain area in northwest Sweden. It is assumed unmanaged.
United Kingdom	Inland rock, standing water and canals and rivers and streams.

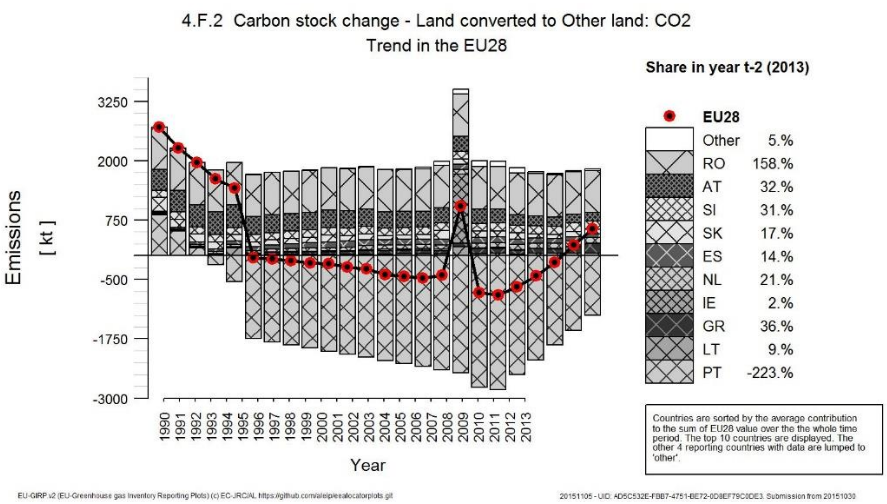
In overall, the largest area reported in this category is reported by Sweden that report about one third of the total EU area (Figure 6.35). Conversions to other lands are mainly reported by Portugal, France, Sweden and Romania, without a defined pattern about the land of origin.

Figure 6.35 Trend of activity data and emissions in "Other land category" subcategory of EU MS (kha, 1990-2013)



In terms of emissions, in 2013, the subcategory 4E.2 represent a net source of 563 kt CO_2 (Figure 6.36). Mainly due to a decrease of the removals reported by Portugal in mineral soils due to abandonment of agricultural lands. Other MS report emissions from these conversions as a result of the conversion from forests (e.g. Romania, Austria). Emissions reported by Ireland for the year 2006 are the result of forest conversion to other lands although apparently they seems to be due to a typo in the IEF used.

Figure 6.36 Trend of emissions and emissions in "Land converted to Other lands" subcategory of EU MS (kha, 1990-2013)



6.2.5 Other source of emissions: Tables 4(I)-4(V)

6.2.5.1 Direct nitrous oxide (N_2O) emissions from nitrogen (N) inputs to managed soils (CRF Table 4(I))

This source category covers direct N_2O emissions from organic and inorganic fertilizers applied to soils managed. The majority of MS report that there is no fertilization of Forest land, while if any, emissions from fertilization of other land categories is often reported under agriculture sector using corresponding notation keys in the CRF table 4(I) (Table 6.29). Only Finland, Sweden and the UK report N_2O emissions under this source category due to forest fertilization. Sweden actually reports the highest amount of N_2O emissions from N fertilization occasionally applied to increase the wood production in older forest stands on mineral soils.

Table 6.29 Direct nitrous oxide (N_2O) emissions from nitrogen (N) inputs to managed soils (kt)

Member State	N2O emissions in kt CO2 equiv.			Share in EU28 emissions in 2013	Change 2012-2013		Change 1990-2013	
	1990	2012	2013		kt CO2 equiv.	%	kt CO2 equiv.	%
Austria	NO	NO	NO	-	-	-	-	-
Belgium	NO	NO	NO	-	-	-	-	-
Bulgaria	NO	NO	NO	-	-	-	-	-
Croatia	NO	NO	NO	-	-	-	-	-
Cyprus	NO	NO	NO	-	-	-	-	-
Czech Republic	IE,NO	IE,NO	IE,NO	-	-	-	-	-
Denmark	IE,NO	IE,NO	IE,NO	-	-	-	-	-
Estonia	NA,NO	NA,NO	NA,NO	-	-	-	-	-
Finland	21	12	13	42%	2	13%	-8	-37%
France	NO	NO	NO	-	-	-	-	-
Germany	NO	NO	NO	-	-	-	-	-
Greece	NA,NO	NA,NO	NA,NO	-	-	-	-	-
Hungary	IE,NA,NO	IE,NA,NO	IE,NA,NO	-	-	-	-	-
Ireland	NO,NE,IE	NO,NE,IE	NO,NE,IE	-	-	-	-	-
Italy	NO	NO	NO	-	-	-	-	-
Latvia	NO	NO	NO	-	-	-	-	-
Lithuania	NO	NO	NO	-	-	-	-	-
Luxembourg	NO	NO	NO	-	-	-	-	-
Malta	NA,NO	NA,NO	NA,NO	-	-	-	-	-
Netherlands	NE,NO	NE,NO	NE,NO	-	-	-	-	-
Poland	NA,NO	NA,NO	NA,NO	-	-	-	-	-
Portugal	IE,NO	IE,NO	IE,NO	-	-	-	-	-
Romania	IE	IE	IE	-	-	-	-	-
Slovakia	NO	NO	NO	-	-	-	-	-
Slovenia	NO	NO	NO	-	-	-	-	-
Spain	NO	NO	NO	-	-	-	-	-
Sweden	49	32	17	54%	-15	-48%	-32	-66%
United Kingdom	5	1	1	4%	0	-19%	-3	-76%
EU-28	**74**	**45**	**31**	**100%**	**-14**	**-31%**	**-43**	**-58%**

For reporting this category, activity data result from national or sectorial statistics, either in terms of total amount and type of synthetic fertilizer annually applied (i.e. Finland, Sweden) or as a fixed application rate and total annually fertilized area (i.e. UK). IPCC default emission factor are applied. The IEF of the N_2O-N emissions per unit of fertilizer applied is around 0.01 kg N_2O-N/kg N yr^{-1}.

N_2O emissions from this source category are 58% and 31% less in 2013 as compared to 1990 and 2012 respectively. Total EU emissions from fertilization of managed soils in 2013 from this category is 31 kt CO_2eq.

6.2.5.2 Emissions and removals from drainage and rewetting and other management of organic and mineral soils (CRF Table 4(II))

This source category covers CO_2, CH_4 and N_2O emissions from drainage, rewetting and other management practices of soils. Emissions in kt CO_2 eq. for 2013 were reported respectively as 6 777, 3 673, 3 040 kt CO_2 eq.

Just in few cases CO_2 emissions from this source are reported in CRF table 4(II) since, when occurring, they use to be already covered in CRF tables 4A-4F. UK reports 77 % of the CO_2 emissions included in the CRF table 4 (II) from organic soil in Cropland and Grassland categories. Most countries do not report them also because those emissions are considered negligible (NO or NE), although few transparently report drained area. Overall, annual CO_2 emissions reported for 2013 practically did not change over time (Table 6.30).

Table 6.30 CO_2 Emissions and removals from drainage and rewetting and other management of organic and mineral soils (kt)

Member State	CO2 emissions in kt			Share in EU28 emissions in 2013	Change 2012-2013		Change 1990-2013	
	1990	2012	2013		kt CO2	%	kt CO2	%
Austria	NO	NO	NO	-	-	-	-	-
Belgium	NO	NO	NO	-	-	-	-	-
Bulgaria	NO	NO	NO	-	-	-	-	-
Croatia	NA,NO	NA,NO	NA,NO	-	-	-	-	-
Cyprus	NO	NO	NO	-	-	-	-	-
Czech Republic	NO	NO	NO	-	-	-	-	-
Denmark	IE	IE	IE	-	-	-	-	-
Estonia	IE,NA,NO	IE,NA,NO	IE,NA,NO	-	-	-	-	-
Finland	IE,NA,NO	IE,NA,NO	IE,NA,NO	-	-	-	-	-
France	NO	NO	NO	-	-	-	-	-
Germany	IE,NO	IE,NO	IE,NO	-	-	-	-	-
Greece	NO	NO	NO	-	-	-	-	-
Hungary	2	7	7	0%	0	0%	5	316%
Ireland	197	165	165	2%	0	0%	-31	-16%
Italy	NO	NO	NO	-	-	-	-	-
Latvia	1 017	883	936	14%	53	6%	-81	-8%
Lithuania	406	430	431	6%	1	0%	25	6%
Luxembourg	NO	NO	NO	-	-	-	-	-
Malta	NE,NO	NE,NO	NE,NO	-	-	-	-	-
Netherlands	E,NA,NE,NO	E,NA,NE,NO	E,NA,NE,NO	-	-	-	-	-
Poland	NA,NO	NA,NO	NA,NO	-	-	-	-	-
Portugal	NO	NO	NO	-	-	-	-	-
Romania	NO	NO	NO	-	-	-	-	-
Slovakia	NO	NO	NO	-	-	-	-	-
Slovenia	NO	NO	NO	-	-	-	-	-
Spain	NO	NO	NO	-	-	-	-	-
Sweden	IE,NA,NO	IE,NA,NO	IE,NA,NO	-	-	-	-	-
United Kingdom	5 238	5 238	5 238	77%	0	0%	0	0%
EU-28	**6 859**	**6 724**	**6 777**	**100%**	**53**	**1%**	**-82**	**-1%**

Table 6.31 N_2O Emissions and removals from drainage and rewetting and other management of organic and mineral soils (kt)

Member State	N2O emissions in kt CO2 equiv.			Share in EU28 emissions in 2013	Change 2012-2013		Change 1990-2013	
	1990	2012	2013		kt CO2 equiv.	%	kt CO2 equiv.	%
Austria	NO	NO	NO	-	-	-	-	-
Belgium	NO	NO	NO	-	-	-	-	-
Bulgaria	NO	NO	NO	-	-	-	-	-
Croatia	NA,NO	NA,NO	NA,NO	-	-	-	-	-
Cyprus	NO	NO	NO	-	-	-	-	-
Czech Republic	NO	NO	NO	-	-	-	-	-
Denmark	35	35	35	1%	0	0%	0	-1%
Estonia	1	2	2	0%	0	0%	0	17%
Finland	1 216	1 208	1 208	33%	0	0%	-8	-1%
France	NO	NO	NO	-	-	-	-	-
Germany	370	362	366	10%	4	1%	-4	-1%
Greece	NO	NO	NO	-	-	-	-	-
Hungary	0	1	1	0%	0	0%	1	825%
Ireland	105	182	182	5%	0	0%	77	73%
Italy	NO	NO	NO	-	-	-	-	-
Latvia	572	589	594	16%	4	1%	22	4%
Lithuania	27	27	27	1%	0	0%	0	0%
Luxembourg	NO	NO	NO	-	-	-	-	-
Malta	NE,NO	NE,NO	NE,NO	-	-	-	-	-
Netherlands	IE,NA,NE,NO	IE,NA,NE,NO	IE,NA,NE,NO	-	-	-	-	-
Poland	NA,NO	NA,NO	NA,NO	-	-	-	-	-
Portugal	NO	NO	NO	-	-	-	-	-
Romania	27	27	27	1%	0	0%	0	0%
Slovakia	NO	NO	NO	-	-	-	-	-
Slovenia	NO	NO	NO	-	-	-	-	-
Spain	NO	NO	NO	-	-	-	-	-
Sweden	1 056	1 170	1 185	32%	15	1%	129	12%
United Kingdom	45	46	46	1%	0	0%	1	3%
EU-28	**3 454**	**3 649**	**3 673**	**100%**	**24**	**1%**	**219**	**6%**

Concerning N_2O and CH_4 emissions, Finland and Sweden report the largest emissions from this source (Table 6.31,Table 6.32). In Finland a Tier 2 methodology is used, with directly measured emissions factors for CO_2, N_2O and CH_4, while the activity data (annual area of peatlands with active extraction, set aside peat lands, industrial stocks) are compiled from statistics.

Table 6.32 CH_4 Emissions and removals from drainage and rewetting and other management of organic and mineral soils (kt)

Member State	CH4 emissions in kt CO2 equiv.			Share in EU28 emissions in 2013	Change 2012-2013		Change 1990-2013	
	1990	2012	2013		kt CO2 equiv.	%	kt CO2 equiv.	%
Austria	NO	NO	NO	-	-	-	-	-
Belgium	NO	NO	NO	-	-	-	-	-
Bulgaria	NO	NO	NO	-	-	-	-	-
Croatia	NA,NO	NA,NO	NA,NO	-	-	-	-	-
Cyprus	NO	NO	NO	-	-	-	-	-
Czech Republic	NO	NO	NO	-	-	-	-	-
Denmark	10	7	7	0%	0	-4%	-3	-27%
Estonia	0	0	0	0%	0	0%	0	17%
Finland	1 535	922	921	30%	0	0%	-614	-40%
France	NO	NO	NO	-	-	-	-	-
Germany	848	846	845	28%	-1	0%	-3	0%
Greece	NO	NO	NO	-	-	-	-	-
Hungary	NA,NO	NA,NO	NA,NO	-	-	-	-	-
Ireland	344	463	467	15%	5	1%	124	36%
Italy	NO	NO	NO	-	-	-	-	-
Latvia	276	322	337	11%	15	5%	61	22%
Lithuania	NO,NE	NO,NE	NO,NE	-	-	-	-	-
Luxembourg	NO	NO	NO	-	-	-	-	-
Malta	NE,NO	NE,NO	NE,NO	-	-	-	-	-
Netherlands	IE,NA,NE, NO	IE,NA,NE, NO	IE,NA,NE, NO	-	-	-	-	-
Poland	NA,NO	NA,NO	NA,NO	-	-	-	-	-
Portugal	NO	NO	NO	-	-	-	-	-
Romania	NO	NO	NO	-	-	-	-	-
Slovakia	NO	NO	NO	-	-	-	-	-
Slovenia	NO	NO	NO	-	-	-	-	-
Spain	NO	NO	NO	-	-	-	-	-
Sweden	449	460	462	15%	1	0%	13	3%
United Kingdom	NA,NE,NO	NA,NE,NO	NA,NE,NO	-	-	-	-	-
EU-28	**3 461**	**3 020**	**3 040**	**100%**	**20**	**1%**	**-422**	**-12%**

6.2.5.3 Direct nitrous oxide (N_2O) emissions from nitrogen (N) mineralization/immobilization associated with loss/gain of soil organic resulting from change of land use or management of mineral soils (CRF Table 4(III))

Changes of land use (usually from Forest land, Cropland, Grassland and Wetlands) or management practices, causes the loss of carbon stored in mineral soils due to the mineralization of organic matter (so emissions of both CO_2 and N_2O) followed by the stabilization of the carbon content in soil at a lower level.

At the EU level, N_2O emissions reported in table CRF Table 4(III) represent 2 999 kt CO_2eq. in 2013, with the highest contribution on total emissions reported by UK, Romania and Germany (Table 6.33). These emissions are reported mainly under land converted to Settlement, Grassland, and land converted to Croplands. (N_2O emissions in Cropland remaining Cropland are already covered under Agriculture sector). Overall, N_2O emissions from this source decreased by 27% in 2013 as compared with 1990.

Table 6.33 Direct nitrous oxide (N_2O) emissions from nitrogen (N) mineralization/immobilization associated with loss/gain of soil organic matte resulting from change of land use or management of mineral soils.

Member State	N2O emissions in kt CO2 equiv.			Share in EU28 emissions in 2013	Change 2012-2013		Change 1990-2013	
	1990	2012	2013		kt CO2 equiv.	%	kt CO2 equiv.	%
Austria	15	19	20	1%	1	4%	5	34%
Belgium	9	98	98	3%	0	0%	89	939%
Bulgaria	NO	NO	NO	-	-	-	-	-
Croatia	5	10	10	0%	1	7%	6	121%
Cyprus	NO	NO	NO	-	-	-	-	-
Czech Republic	8	5	5	0%	0	-2%	-4	-42%
Denmark	0	9	38	1%	29	313%	38	10938%
Estonia	NA,NO	5	5	0%	0	0%	5	100%
Finland	23	30	29	1%	-1	-3%	6	24%
France	NO	NO	NO	-	-	-	-	-
Germany	494	457	468	16%	11	2%	-25	-5%
Greece	0	0	0	0%	0	-72%	0	853%
Hungary	24	46	45	1%	-1	-3%	20	84%
Ireland	20	140	139	5%	-1	-1%	120	613%
Italy	45	17	11	0%	-6	-33%	-34	-75%
Latvia	4	99	101	3%	2	2%	96	2375%
Lithuania	7	5	5	0%	0	0%	-1	-21%
Luxembourg	4	4	4	0%	0	-1%	-1	-13%
Malta	NE,NO	NE,NO	NE,NO	-	-	-	-	-
Netherlands	6	88	94	3%	6	7%	88	1570%
Poland	883	1	1	0%	0	0%	-882	-100%
Portugal	507	340	341	11%	1	0%	-167	-33%
Romania	850	617	586	20%	-31	-5%	-264	-31%
Slovakia	60	8	8	0%	0	0%	-52	-86%
Slovenia	13	13	13	0%	0	0%	0	-1%
Spain	17	159	144	5%	-15	-9%	127	753%
Sweden	66	177	186	6%	8	5%	120	181%
United Kingdom	1 019	660	648	22%	-12	-2%	-371	-36%
EU-28	**4 080**	**3 008**	**2 999**	**100%**	**-9**	**0%**	**-1 082**	**-27%**

6.2.5.4 Indirect nitrous oxide (N_2O) emissions from managed soils (CRF Table 4(IV))

This source category cover indirect N_2O emissions from managed soils. Indirect emissions from nitrogen inputs on Cropland and Grassland area reported in agriculture sector, as well as, indirect emissions related to N mineralization in Cropland remaining Cropland. Therefore, since it is under these land categories where more direct N_2O emissions are reported in CRF table 4 (I) and 4 (III); MS often used the notation key IE to report related indirect emissions in CRF table (IV). Emissions from this source category reported under LULUCF represent 119 kt CO_2eq and they are mainly reported by Germany (Table 6.34).

Table 6.34 Indirect nitrous oxide (N_2O) emissions from managed soils

Member State	N20 emissions in kt CO2 equiv.			Share in EU28 emissions in 2013	Change 2012-2013		Change 1990-2013	
	1990	2012	2013		kt CO2 equiv.	%	kt CO2 equiv.	%
Austria	NO	NO	NO	-	-	-	-	-
Belgium	IE	IE	IE	-	-	-	-	-
Bulgaria	NO	NO	NO	-	-	-	-	-
Croatia	IE	IE	IE	-	-	-	-	-
Cyprus	-	-	-	-	-	-	-	-
Czech Republic	8	5	5	4%	0	-2%	-4	-42%
Denmark	IE	IE	IE	-	-	-	-	-
Estonia	NE	NE	NE	-	-	-	-	-
Finland	2	3	3	2%	0	-4%	1	27%
France	NO	NO	NO	-	-	-	-	-
Germany	111	103	105	89%	2	2%	-6	-5%
Greece	NO	NO	NO	-	-	-	-	-
Hungary	IE	IE	IE	-	-	-	-	-
Ireland	IE	IE	IE	-	-	-	-	-
Italy	NO, NE	NO, NE	NO, NE	-	-	-	-	-
Latvia	0.2	3	3	3%	0	5%	3	1753%
Lithuania	IE	IE	IE	-	-	-	-	-
Luxembourg	NO	NO	NO	-	-	-	-	-
Malta	IE	IE	IE	-	-	-	-	-
Netherlands	IE	IE	IE	-	-	-	-	-
Poland	NO	NO	NO	-	-	-	-	-
Portugal	IE	IE	IE	-	-	-	-	-
Romania	NO	NO	NO	-	-	-	-	-
Slovakia	IE	IE	IE	-	-	-	-	-
Slovenia	NO	NO	NO	-	-	-	-	-
Spain	NO, NE	NO, NE	NO, NE	-	-	-	-	-
Sweden	8	5	3	2%	-2	-48%	-5	-66%
United Kingdom	IE	IE	IE	-	-	-	-	-
EU-28	**129**	**119**	**119**	**-**	**0**	**0%**	**-11**	**-8%**

6.2.5.5 CO_2, CH_4 & N_2O emissions from Biomass Burning (CRF Table 4(V))

This source category covers CO_2, CH_4 and direct N_2O emissions from biomass burning, as well as emissions of other GHG (NO_X and CO). It includes emissions both from wildfires and controlled burning, on any type of land use. In general, CO_2 emissions from forest fires are reported under 4A Forest land, while CO_2 and non-CO_2 emissions from fires affecting other categories are reported in table 4(V).

Controlled burning on managed land is not common practice in the EU, with few exceptions (.e.g. Finland, Sweden, UK for forest land and UK, Spain for Grassland) for confined areas. For most of the MS, emissions from fires are indeed negligible. Methodology used to report emissions for fires is always Tier 2 for CO_2 with activity data provided by national statistics and country-specific emission factors, whereas Tier 1 data is mainly used for estimation of CH_4 and N_2O emissions.

Overall, emissions from biomass burning decreased compared to 1990. CO_2 emissions from burning biomass are reported as NO or IE when they are already covered under 4A. Overall, CO_2 emissions have decreased by 68% since 1990 (Table 6.35). The CH_4 emissions decreased by 51% (Table 6.36) and those of N_2O by 59% (Table 6.37), nevertheless, their real trends are related to wildfire incidence, which is characterized by a large inter-annual variability.

Table 6.35 CO_2 emissions from Biomass Burning (in kt CO_2)

Member State	CO2 emissions in kt			Share in EU28 emissions in 2013	Change 2012-2013		Change 1990-2013	
	1990	2012	2013		kt CO2	%	kt CO2	%
Austria	NO,IE	NO,IE	NO,IE	-	-	-	-	-
Belgium	5	NO	NO	-	-	-	-5	-100%
Bulgaria	IE,NO	IE,NO	IE,NO	-	-	-	-	-
Croatia	IE,NO	IE,NO	IE,NO	-	-	-	-	-
Cyprus	1	9	3	0%	-6	-66%	2	434%
Czech Republic	1 056	641	594	16%	-47	-7%	-462	-44%
Denmark	IE,NO	IE,NO	IE,NO	-	-	-	-	-
Estonia	IE,NE,NO	IE,NE,NO	IE,NE,NO	-	-	-	-	-
Finland	4	1	5	0%	4	363%	1	31%
France	1 596	269	104	3%	-165	-61%	-1 491	-93%
Germany	IE,NO	IE,NO	IE,NO	-	-	-	-	-
Greece	154	217	17	0%	-200	-92%	-136	-89%
Hungary	IE,NA,NO	IE,NA,NO	IE,NA,NO	-	-	-	-	-
Ireland	554	74	551	15%	478	649%	-3	-1%
Italy	5 020	4 216	504	14%	-3 712	-88%	-4 516	-90%
Latvia	256	84	83	2%	0	0%	-173	-67%
Lithuania	4	1	1	0%	0	-16%	-4	-87%
Luxembourg	NO	NO	NO	-	-	-	-	-
Malta	NO,NE	NO,NE	NO,NE	-	-	-	-	-
Netherlands	3	4	4	0%	0	1%	1	37%
Poland	546	403	103	3%	-301	-75%	-443	-81%
Portugal	2 037	1 662	1 325	36%	-337	-20%	-712	-35%
Romania	4	11	12	0%	1	5%	8	207%
Slovakia	7	52	8	0%	-44	-84%	1	16%
Slovenia	21	39	3	0%	-35	-92%	-18	-85%
Spain	4	115	57	2%	-58	-51%	53	1460%
Sweden	IE,NA,NO	IE,NA,NO	IE,NA,NO	-	-	-	-	-
United Kingdom	118	485	316	9%	-168	-35%	198	168%
EU-28	**11 389**	**8 282**	**3 690**	**100%**	**-4 592**	**-55%**	**-7 699**	**-68%**

Table 6.36 CH_4 emissions from Biomass Burning (in kt CH_4)

Member State	CH4 emissions in kt CO2 equiv.			Share in EU28 emissions in 2013	Change 2012-2013		Change 1990-2013	
	1990	2012	2013		kt CO2 equiv.	%	kt CO2 equiv.	%
Austria	0.5	0.1	0.2	0%	0	64%	0	-55%
Belgium	1	NO	NO	-	-	-	-1	-100%
Bulgaria	4	46	12	1%	-34	-75%	8	219%
Croatia	1	39	2	0%	-37	-95%	1	57%
Cyprus	0.04	0.7	0.2	0%	0	-66%	0	434%
Czech Republic	115	70	65	3%	-5	-7%	-50	-44%
Denmark	1	0.03	0.04	0%	0	43%	-1	-94%
Estonia	0.3	0.01	0.002	0%	0	-67%	0	-99%
Finland	5	1	1	0%	1	112%	-4	-77%
France	1 319	1 062	1 097	58%	35	3%	-222	-17%
Germany	7	1	1	0%	0	-25%	-6	-84%
Greece	49	62	13	1%	-49	-79%	-36	-73%
Hungary	23	36	12	1%	-24	-67%	-11	-48%
Ireland	131	16	132	7%	116	714%	1	1%
Italy	1 673	1 204	199	11%	-1 005	-84%	-1 475	-88%
Latvia	28	10	11	1%	2	18%	-16	-59%
Lithuania	3	1	1	0%	0	-21%	-2	-73%
Luxembourg	NO	NO	NO	-	-	-	-	-
Malta	NE,NO	NE,NO	NE,NO	-	-	-	-	-
Netherlands	0.2	0.3	0.3	0%	0	1%	0	39%
Poland	44	32	37	2%	5	16%	-7	-16%
Portugal	205	174	154	8%	-21	-12%	-52	-25%
Romania	0	1	1	0%	0	5%	1	207%
Slovakia	7	12	9	0%	-3	-26%	2	21%
Slovenia	3	5	0.5	0%	-5	-92%	-3	-85%
Spain	206	175	91	5%	-84	-48%	-115	-56%
Sweden	2	1	3	0%	2	160%	1	43%
United Kingdom	21	68	36	2%	-32	-48%	15	70%
EU-28	**3 849**	**3 017**	**1 877**	**100%**	**-1 140**	**-38%**	**-1 972**	**-51%**

Table 6.37 N$_2$O emissions from Biomass Burning (in kt N$_2$O)

Member State	N2O emissions in kt CO2 equiv.			Share in EU28 emissions in 2013	Change 2012-2013		Change 1990-2013	
	1990	2012	2013		kt CO2 equiv.	%	kt CO2 equiv.	%
Austria	0.3	0.1	0.1	0%	0	64%	0	-55%
Belgium	5	NO	NO	-	-	-	-5	-100%
Bulgaria	1	8	2	1%	-6	-75%	1	219%
Croatia	1	27	1	1%	-25	-95%	1	72%
Cyprus	0.03	0.4	0.1	0%	0	-66%	0	434%
Czech Republic	9	6	5	2%	0	-7%	-4	-44%
Denmark	0.4	0.03	0.04	0%	0	32%	0	-90%
Estonia	0.04	0.002	0.0004	0%	0	-83%	0	-99%
Finland	0	0	0	0%	0	113%	0	-77%
France	175	120	116	49%	-4	-3%	-59	-33%
Germany	4	1	1	0%	0	-25%	-4	-84%
Greece	4	5	1	0%	-4	-79%	-3	-73%
Hungary	15	32	8	3%	-24	-75%	-7	-46%
Ireland	22	3	23	10%	20	751%	0	2%
Italy	260	218	26	11%	-192	-88%	-234	-90%
Latvia	3	1	1	1%	0	16%	-2	-55%
Lithuania	3	1	1	0%	0	-18%	-2	-71%
Luxembourg	NO	NO	NO	-	-	-	-	-
Malta	NE,NO	NE,NO	NE,NO	-	-	-	-	-
Netherlands	0.1	0.2	0.2	0%	0	1%	0	38%
Poland	10	8	2	1%	-6	-75%	-8	-80%
Portugal	34	29	25	11%	-3	-12%	-8	-25%
Romania	0.1	0.4	0.4	0%	0	5%	0	207%
Slovakia	5	8	6	3%	-2	-26%	1	21%
Slovenia	0.4	1	0.1	0%	-1	-92%	0	-85%
Spain	17	14	7	3%	-7	-48%	-9	-56%
Sweden	0.2	0.1	0.2	0%	0	162%	0	46%
United Kingdom	13	39	8	4%	-30	-79%	-5	-36%
EU-28	**583**	**521**	**236**	**100%**	**-285**	**-55%**	**-346**	**-59%**

6.2.6 Emissions from Harvested Wood Products in the EU GHG inventory

This carbon pool covers emissions and removals resulting from carbon stock changes in harvested wood products (HWP). According to the 2006 IPCC Guidelines, HWP includes all wood material (including bark) that leaves harvest sites. Slash and other material left at harvest sites should be regarded as dead organic matter in the associated land use category and not as HWP.

Harvested wood products represent at EU level a net sink of about -21.612 kt CO_2 in 2013 (). Most of the MS reported this pool as a net sink but for 5 MS this carbon pool resulted in a net source of emissions in 2013. The largest contributor of CO_2 removals was Sweden, Finland, Germany and Latvia, while Czech

Republic, Belgium, Portugal and Netherlands reported a net source of emissions from HWP. Five MS did not report quantitative estimates for this pool in CRF table 4.

The methods and data sources for estimating this carbon pool are consistent with methodologies provided by 2006 IPCC GL. MS providing estimates in CRF table 4 used mainly IPCC Approach B (production approach) that allows to consistently estimate and report the HWP contribution, both under the Convention as well as under KP reporting; few of them used Approach A (stock change approach) and none of them used Approach C (Atmospheric flow).

Generally, MS reported carbon stock changes in this pool considering individual estimates for the semi-finished wood products categories of: Solid wood (disaggregated in Sawnwood and wood panels) and Paper and paperboard.

Activity data has been often collected from FAOSTAT database, from the TIMBER database of the United Nations Economic Commission for Europe (UNECE, 2011), national statistics or in specific cases from surveying the wood industries.

Table 6.38 Net carbon stock change and approach implemented by MS for Harvested Wood Products

MS	Net CO2 emissions/removals (kt)	GHG source and sink categories		Approach A	Approach B	Approach C
Austria	-1265.50	1. Solid wood	x		x	
		2. Paper and paperboard	x			
		3. Other	NO			
Belgium	336.31	1. Solid wood	x	x		
		2. Paper and paperboard	NA			
		3. Other	NO			
Bulgaria	-545.01	1. Solid wood	x		x	
		2. Paper and paperboard	NA			
		3. Other				
Croatia	-264.12	1. Solid wood	x		x	
		2. Paper and paperboard	x			
		3. Other	NA			
Cyprus	NO	1. Solid wood				
		2. Paper and paperboard				
		3. Other				
Czech Republic	791.82	1. Solid wood	x	x		
		2. Paper and paperboard	x			
		3. Other	NO			
Denmark	-88.86	1. Solid wood	x		x	
		2. Paper and paperboard	x			
		3. Other	NO			
Estonia	-726.47	1. Solid wood	x		x	
		2. Paper and paperboard	x			
		3. Other	x			
Finland	-4356.63	1. Solid wood	x		x	
		2. Paper and paperboard	x			
		3. Other	NA			
France	-1652.60	1. Solid wood	NO		x	
		2. Paper and paperboard	NO			
		3. Other	x			
Germany	-2588.00	1. Solid wood	IE		x	
		2. Paper and paperboard	x			
		3. Other	x			
Greece	-324.19	1. Solid wood	x		x	
		2. Paper and paperboard	NO			
		3. Other	NO			
Hungary	47.90	1. Solid wood	x		x	
		2. Paper and paperboard	x			
		3. Other	NA			
Ireland	-691.95	1. Solid wood	x		x	
		2. Paper and paperboard	x			
		3. Other				
Italia	-234.89	1. Solid wood	x	x		
		2. Paper and paperboard	x			
		3. Other	NO			
Latvia	-2141.52	1. Solid wood	x	x		
		2. Paper and paperboard	x			
		3. Other	NO			
Lithuania	-955.24	1. Solid wood	x	x		
		2. Paper and paperboard	x			
		3. Other	NA			
Luxembourg	NO	1. Solid wood	NO			
		2. Paper and paperboard	NO			
		3. Other	NO			
Malta	NO	1. Solid wood	NO			
		2. Paper and paperboard	NO			
		3. Other	NO			
Netherlands	105.72	1. Solid wood	x		x	
		2. Paper and paperboard	x			
		3. Other				
Poland	NA	1. Solid wood	x			
		2. Paper and paperboard	x			
		3. Other				
Portugal	220.00	1. Solid wood	x		x	
		2. Paper and paperboard	x			
		3. Other	NO			
Romania	-234.48	1. Solid wood	NO,NA,NE,IE	x		
		2. Paper and paperboard	x			
		3. Other	NA,NO			
Slovakia	-278.08	1. Solid wood	x		x	
		2. Paper and paperboard	x			
		3. Other				
Slovenia	-25.37	1. Solid wood	x		x	
		2. Paper and paperboard	x			
		3. Other				
Spain	NE	1. Solid wood	NE			
		2. Paper and paperboard	NE			
		3. Other	NE			
Sweden	-5620.22	1. Solid wood	x		x	
		2. Paper and paperboard	x			
		3. Other	NA			
United Kingdom	-1120.63	1. Solid wood	x		x	
		2. Paper and paperboard	x			
		3. Other				

6.2.7 Emissions from organic soils in the EU GHG inventory

At EU level, organic soils on 4A, 4B and 4C cover some 16.928 kha, mostly located in Northern MS. Total emissions from organic soils from these categories was, in 2013, 88.185 kt CO_2 which represents 27% of total EU net removals from LULUCF 2013 (Table 6.40). Emissions from organic soils in these land categories decreased by 7% as compared with 1990. Finland and Sweden report respectively 37% and 27% of the total area of organic soil in these categories.

Definitions of organic soils reported by MS are presented in Table 6.198 presumably other MS apply the FAO definition as suggested in the 2006 IPCC GL.

Table 6.198 Elements to define C pool in organic soils

MS	Definition
Austria	>17% of organic matter in top 30cm of soil
Belgium	Definition of organic soils is not available in the NIR 2015
Croatia	Definition of organic soils is not available in the NIR 2015
Czech Republic	The organic soils occur only in the areas of the Spruce sub-category on FL remaining FL. They represent protected peat areas in mountainous regions dominated by spruce stands, with no or specific management practices.
Denmark Ireland	>20% of organic matter in top 30cm of soil
Estonia	Definition of organic soils is not available in the NIR 2015
Finland	Soil is considered to be organic if the soil type is peat. In forest land a site is classified as peatland if the organic layer is peat or if more than 75% of the ground vegetation consists of peatland vegetation. In cropland and grassland >20% of organic matter in top 20 cm of soil
France	Definition of organic soils is not available in the NIR 2015
Germany	Soils with a minimum organic carbon content of 9% (15% soil organic matter) in the mixed sample the top 20 cm
Hungary	Definition of organic soils is not available in the NIR 2015
Latvia	Soils are considered organic as defined in the NFI: a soil is classified as organic if the organic layer (H horizon) is at least 20 cm deep.
Lithuania	Organic soils are identified with peat and peaty soil layer equal to or being more than 30 cm of the total thickness. Drained organic soils are defined as organic soils identified with peat and peaty soil layer equal to or being more than 20 cm of the total thickness.
Netherlands	Previously, only peat soils, which have a peat layer of at least 40 cm within the first 120 cm, were included, but with the new definition from the 2006 IPCC guidelines also the peaty soils, in Dutch called 'moerige gronden', which have a peat layer of 5-40 cm within the first 80 cm, are included.
Poland	Definition of organic soils is not available in the NIR 2015
Romania	Organic soils on FL are represented by drained hydromorphic mineral soils (under excess of groundwater for at least part of the year), showing high clay and organic matter content. Organic soil on CL includes histic soil types, like „gleiosoils" and „distric and eutric histosols". Definition used is consistent with FAO/IPCC definition.
Slovenia	Definition of organic soils is not available in the NIR 2015
Sweden	Organic soils are classified as histosols. Definition used is consistent with FAO/IPCC definition.
United kingdom	Modeled based on habitat explicit soil C content database assuming 1 m depth (without implementing any threshold between mineral and organic soils)

Area of forest organic soils is mainly estimated using country-specific values, while countries having a small share of organic soils report carbon stock changes for this pool by using IPCC default factors. Overall, in the EU, most of organic soils area is under Forest land use, but most of the emissions are due to managed organic soil in Grassland and Croplands (Table 6.40).

In Finland, organic soils activity data were derived from NFI database and geo-referenced soil database across all land uses. In Sweden, data is also provided by NFI combined with Swedish Forest Soil Inventory. Emission factors are derived based on a continuous monitoring system.

Organic soils in Forest land show the lowest IEF values due to the fact that not the entire area of organic soils under forest land is drained, at the same time under Forest land UK report removals in organic soils.

Table 6.40 Area, CO_2 emissions and average implied C stock change factors in the EU reported for 2013

Land use subcategory	Area (Kha)	ICECF (tC/ha)	CO2 emissions (Kt CO2)
4A1	12169	[-2.61-1.84]	-19421
4A2	878		-1798
4B1	1439	[-10.01-0.0]	-25848
4B2	209		-5166
4C1	1863	[-8.4-0.0]	-32081
4C2	370		-5884

6.3 Uncertainties

For information on uncertainties please refer to chapter 1.6.

6.4 Sector-specific quality assurance and quality control and verification

6.4.1 Time series consistency

EU GHG inventory is compiled by aggregation of national GHG inventories, thus its consistency strictly depends on MS inventory consistency. Time series consistency is annually checked for all MS submissions as part of quality control procedures implemented under the EU GHG Monitoring Mechanism Regulation. Consistency is checked, in terms of land categories definitions and land representation across time and over space (e.g. the sum of all land use areas should be constant over time and match the official MS area), as well as trends and outliers in datasets. MS provide early submissions to the European Commissions that is in charge to implement a set of quality checks and to provide suggestions on how to solve any detected problem.

One of the key features of the methodologies implemented by MS national systems is to ensure full consistency in definitions, parameters and datasets used for preparing the LULUCF sector. The main challenge is to ensure consistency when historical data are used and they are not fully adequate to the reporting requirements; mainly for the reporting of initial years of the time series.

Land use category and subcategory definitions are not fully consistent across the EU' MS (in the sense of identical quantitative thresholds), but they are consistent with IPCC definitions for each individual MS (2006 IPCC GL). Differences are given by slightly different treatment of particular lands (e.g. different thresholds for forest definitions; hedges or bush areas categorized either under the Cropland, Grassland or Forest land; woody plantations either under Cropland or Forest land), which is mainly related to historical definitions and available databases.

Following the improvements made within the national systems over recent years, in 2015 submissions there were very small inconsistencies in the time series of activity data and land allocation on land sub-categories (e.g. against country's official geographical area). Such small differences are justified as due to data updating and to the mapping systems (e.g. measurement errors, increase of land area or coastal erosion). In general, the land reported under UNFCCC varies by 1-2% than official geographical area, so there are small risks that some emissions have not been counted.

6.4.2 Quality Assurance and Quality control

GHG inventories of the EU' MS are under double QA/QC checks: one at the country level, and another one performed at EU level by the Joint Research Centre of the European Commission in collaboration with MS in the context of the EU GHG Monitoring Mechanism Regulation.

At the EU level, the main activity is the annual checking of early versions of national GHG inventories. The checks focus on completeness, calculation errors and time series inconsistencies. QA/QC procedures are implemented by interacting with national experts to get clarifications and to plan possible improvements. During the analysis of the 2015 submissions, around 160 findings (i.e. possible problems) were communicated to the MS on: use and justifications of notations keys, inconsistency in land representation, inconsistent reporting of activity data amongst CRF tables and between CRF tables and NIR, and outliers in IEFs values for all categories.

Specific, completeness and consistency checks are applied to time series of estimates reported under Convention and under KP, as follows (non-exhaustive list):

1. Completeness check: the use of the notation key "NE", but also possible inappropriate use of "NA" or "NO", whenever IPCC methods are available, is carefully monitored and followed up where necessary with the relevant MS;
2. Checks of time series of activity data for both KP and GHG inventory
    a. Total reported land area against official data from national authorities and international databases (i.e. country's official websites, FRA 2010 (FAO));
    b. Discontinuities in time series for any land subcategory and subdivisions.
    c. The share of the land category "Other land" on the total area reported;
3. Checks of the time series of emissions factors (for each land subcategory and subdivision, and each pool)
    a. Comparison of IEF with IPCC default factors;
    b. Discontinuities in IEFs along the time series;
    c. Comparison among IEF of other MS, with taking into consideration of eco-regions, soil type and method used for each estimate, and any information provided in the latest NIR, including the definition of the pool;
    d. Comparison with other data sources (country's official submission under other international processes, e.g. FAO);
    e. Comparison of CO_2 and N_2O emissions to check consistency of C/N ratio
4. Check the consistency within annual submissions
    a. Between GHG inventory tables; e.g. activity data for the estimation of N_2O emissions from mineral soils in land under conversion from Forest land and Grassland to Cropland)
5. Check the consistency between KP and GHG inventory tables (land area between UNFCCC and KP: 4A2 with AR; sum of area of 4B2.1; 4C2.1; 4D2.1; 4E2.1; 4D2.1 with D; 4A1 with FM). It is expected that AR area equals conversion to forest in 2009 (only if a 20 years transition is implemented and all conversion to forest are directly human induced) or that FM area is smaller or equal to 4A1 area any time, with explanation to be provided in NIR.
6. Consistency within KP tables
    a. Area reported under activity tables matches NIR2;

    b. NIR2 is consistent across years (i.e. is ARD area increasing or constant over the commitment period? Is CM, GM area change explained by transfers to other elected 3.4 activities? Is the final area reported for an activity in the year X equal to the initial area reported for the same activity in the year X+1?);
    c. For each activity, data reported in NIR table-2 are identical to data reported in the activity-tables;
    d. For KP CRF 1990 data relevant for net-net accounting of elected activities are provided.
7. Consistency with the 2006 IPCC GL, ERT recommendations and reporting requirements set under decision 2/CMP7.
    a. Is a key category? If so, is a higher tier implemented?
    b. Pools omitted from accounting under the KP: is documentation provided demonstrating that the pool is “not a source”?
    c. Transparency and documentation: description of data sources, methods, assumptions, inferences used.
    d. Are reported values supported by adequate information on uncertainties?
    e. Are rationales, methodological changes and quantitative effects of recalculations explained in the NIR?
8. Accounting tables: check of the CRF reporting tool settings (e.g. is 3.3 offset option activated for countries that elected FM?)

Additional activities at EU level are meant to improve reporting and the quality of both national GHG inventories of the MS and EU, as follows:

- Starting 2010, the EU has implemented an internal review, as an annual exercise, which focuses on key LULUCF issues identified mainly in conjunction with reporting under Kyoto Protocol. The exercise is led by the JRC and involves LULUCF reviewers also involved in the UNFCCC review process. For example, in 2012 the exercise focused on reporting DW, LT and SOC. In 2013 the following issues were analyzed: “providing transparent demonstration and justification that a pool is not a source” and “methods used by MS to estimate emissions from DOM and SOM in Forest land converted to Settlements”.
- Efforts for improving and harmonizing MS inventories, in close cooperation with the research community. Examples include:
    - Two support-projects for improved reporting by some MS are implemented by the European Commission;
    - Starting in 2010, the implementation of the “JRC decision trees on notation keys”: a) Use of notations keys for C POOLS - Tables 5(KP-I) of mandatory or elected activities and b) Use of notations keys for GHG SOURCES- Tables 5(KP-II) of mandatory or elected activities. The purpose was to ensure more harmonized use of notation keys as to identify the incompleteness issues in due time and allow further automatic checks by EU, both for reporting under the Convention and Kyoto Protocol.

For the purpose of enhancing reporting, sharing experiences amongst MS, and also for the harmonization of methods for estimation of the sector, a series of technical workshops dedicated to UNFCCC reporting (including Kyoto Protocol), under the auspices of European Commission/Joint Research Center (DG ENV, DG JRC) were organized:

- JRC technical workshop on LULUCF reporting under the Kyoto Protocol, 26-27 may 2015 Arona (NO), Italy.
- JRC technical workshop on LULUCF reporting under the Kyoto Protocol, 05-07 May 2014, Arona (NO), Italy.
- II JRC technical workshop on LULUCF reporting under the Kyoto Protocol, 04-06 November 2013, Arona (NO), Italy.
- JRC technical workshop on LULUCF reporting under the Kyoto Protocol, 27 February-1 March 2013, Ispra (VA), Italy.
- "JRC technical workshop on LULUCF issues under the Kyoto Protocol", held in Brussels, November 21, 2011.
- "JRC technical workshop on LULUCF issues under the Kyoto Protocol", held in Brussels, November 9-10, 2010.
- Technical workshop on projections of GHG emissions and removals in the LULUCF sector, Ispra (VA), Italy. 27-28 January 2010.
- Technical workshop on LULUCF reporting issues under the Kyoto Protocol, Ispra (VA), Italy. November 13-14, 2008.
- "Technical meeting on specific forestry issues related to reporting and accounting under the Kyoto Protocol" Ispra (VA), Italy. 27-29 November 2006).
- "Improving the Quality of Community GHG Inventories and Projections for the LULUCF Sector". Ispra (VA), Italy. September 22-23, 2005.

For further information on these workshops, see:
http://forest.jrc.ec.europa.eu/activities/lulucf/workshops/.

The JRC's AFOLU DATA web site offers interrogative databases (e.g. BEFs, conversion factors, European forest inventories and yield tables, models and other tools) to promote transparent, complete, consistent and comparable estimates of greenhouse gas fluxes in the AFOLU sector in Europe, and for the use of researchers, inventory experts and GHG inventory reviewers. Unfortunately at this moment due to technical

6.4.3 Verification

It is not in the EU GHG inventory scope to provide independent verification of LULUCF estimates; however, the EU ran a project funded by the European Commission and implemented by its Joint Research Center, "Analysis of proposals for enhancing Monitoring, Reporting and Verification of greenhouse gases from Land Use, Land Use Change and Forestry in the EU (LULUCF MRV)" which had a component aimed at modeling the forest net C stock changes for all MS, based on NFI data. The output of this modeling are offered for comparison by MS with their own estimates as a verification exercise. Another exercise on comparison has been implemented by the EU JRC for biomass burning data, carrying out a comparison of the data reported by some MS with the data provided by the European Forest Fire Information system

Finally, the JRC recommended to national LULUCF experts to verify, where available data allow, the gain-loss methodology applied for estimating their forest land with an alternative estimate prepared by applying the stock-difference method and vice versa

6.5 Sector-specific recalculations, including changes in response of to the review process and impact on emission trend

6.5.1 Recalculations

For information on recalculations please refer to chapter 10.

7 WASTE (CRF SECTOR 5)

This chapter starts with an overview on emission trends in CRF Sector 5 Waste for EU-28 Member States. For each EU-28 key category, overview tables are presented including the Member states contributions to the key category in terms of level and trend.

7.1 Overview of sector

CRF Sector 5 Waste is the fourth largest sector in the EU-28, after energy, agriculture and industrial processes, contributing 3 % to total GHG emissions. Total emissions from waste have been decreasing by 38 % from 244 Mt in 1990 to 152 Mt in 2013 (Figure 7.1). In 2013, emissions decreased by 4.8 % compared to 2012. The key sources in this sector are:

- 5 A 1 Managed Waste disposal on Land (CH_4)
- 5 A 2 Unmanaged Waste Disposal Sites (CH_4)
- 5 B 1 Composting (CH_4)
- 5 B 1 Composting (N_2O)
- 5 D 1 Domestic Wastewater Treatment and Discharge (CH_4)

Figure 7.1 Sector 5 Waste: EU-28 GHG emissions, 1990-2013

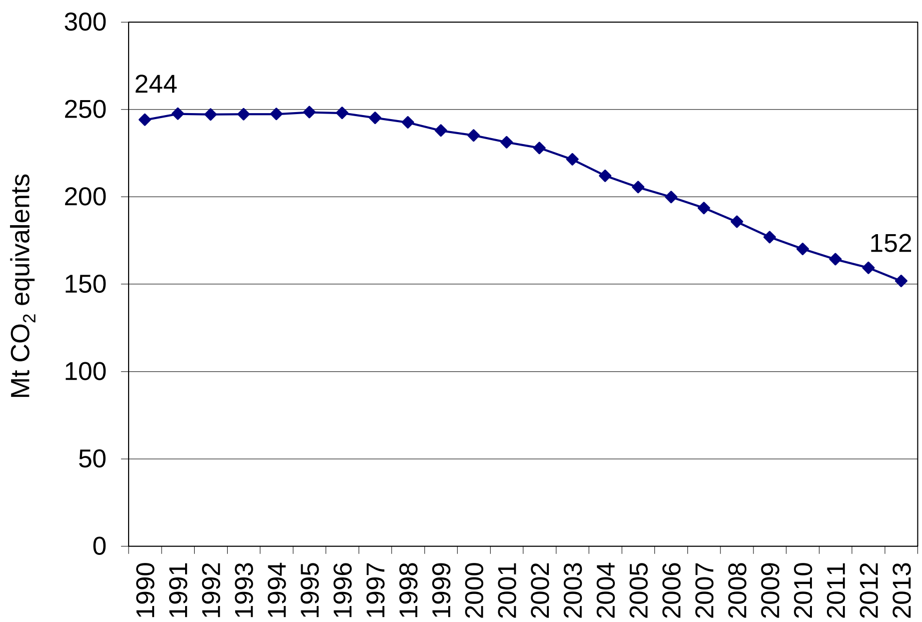
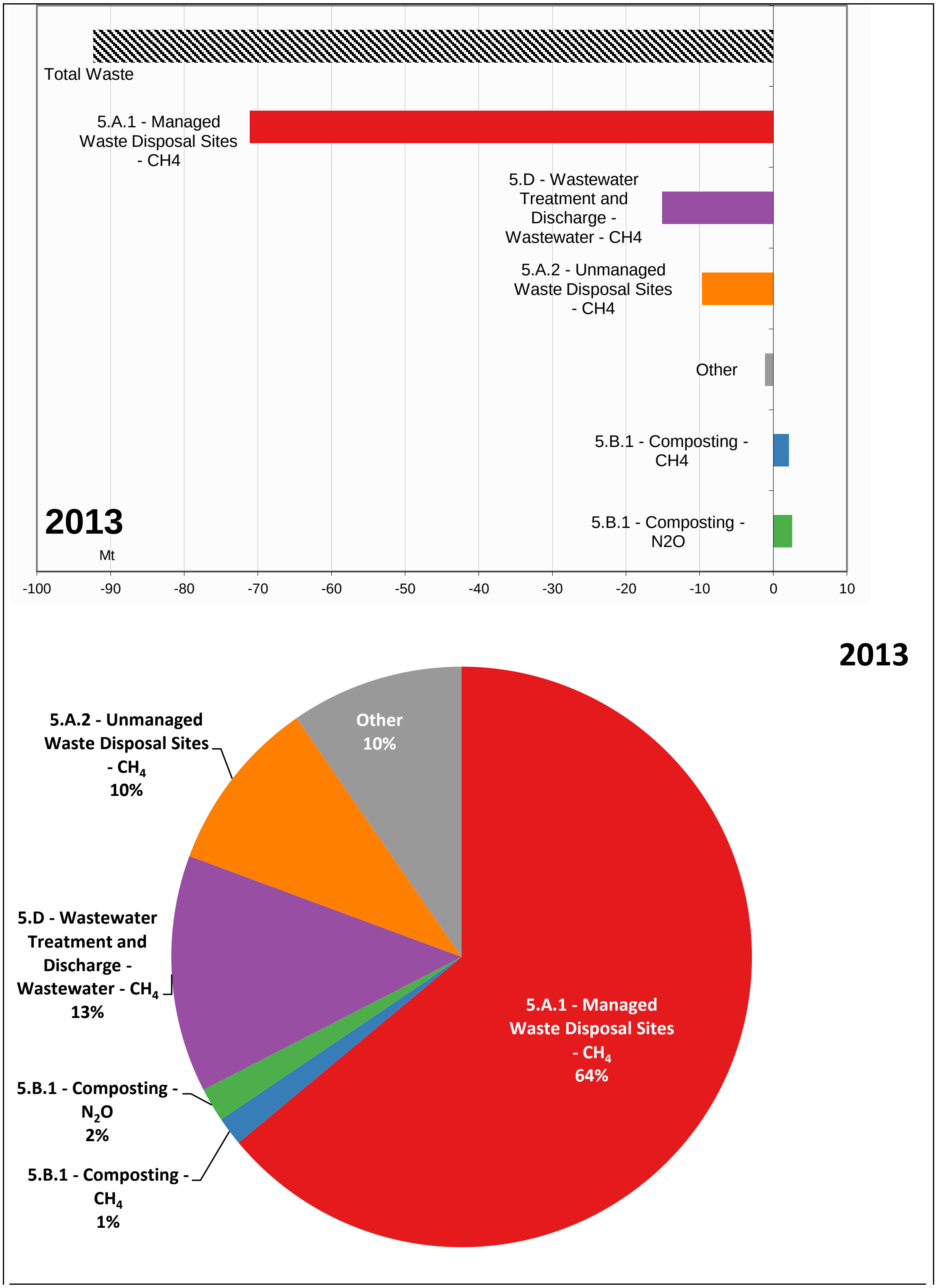


Figure 7.2 shows that CH_4 emissions from 5A1 Managed Waste Disposal on Land had the greatest decrease of all waste-related emissions, but still accounts for 64 % of waste-related GHG emissions in the EU-28 in 2013.

Figure 7.2 Sector 5 Waste: Absolute change of GHG emissions (in CO_2 equivalents) by large key source categories, 1990–2013, and share of largest key source categories in 2013

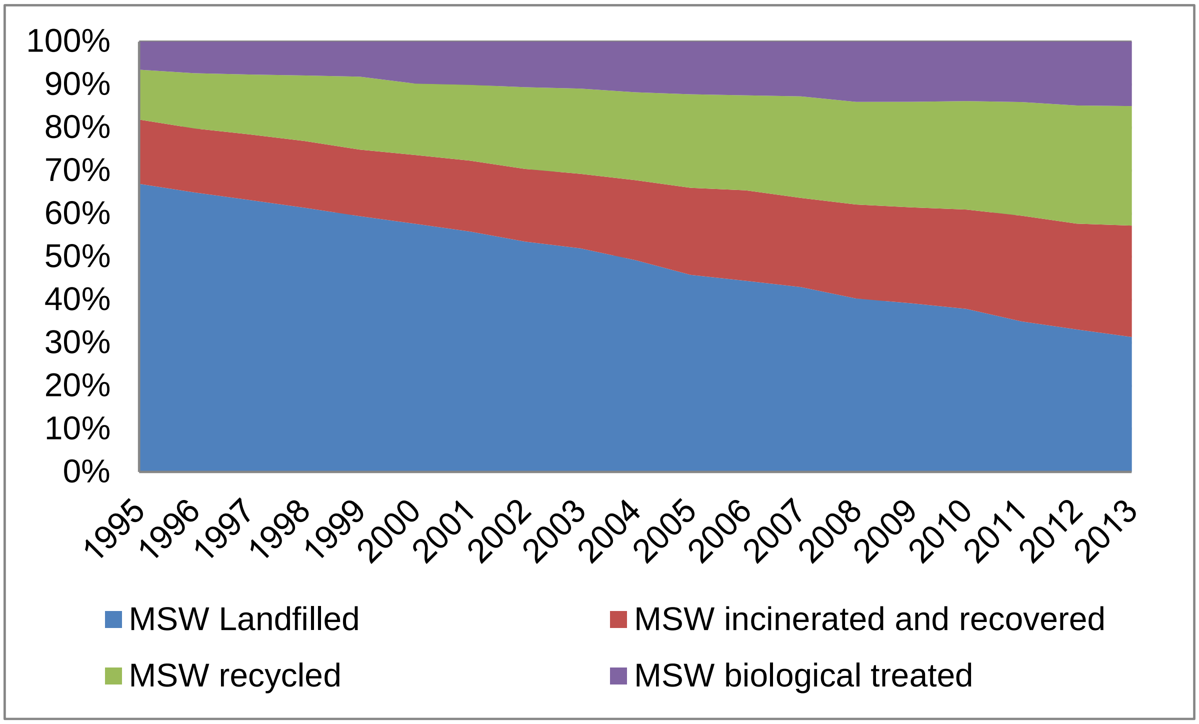


GHG emissions in the waste sector are generated from the treatment and disposal of liquid and solid waste. According to the IPCC 2006 Guidelines emission estimates in the waste sector need to be carried out for four subcategories:

- 5.A Solid waste disposal
- 5.B Biological treatment of solid waste
- 5.C Incineration and open burning
- 5.E Wastewater treatment and discharge.

Of the above, the first three categories mainly refer to possible routes for treatment and disposal of solid waste. Solid waste can be recycled, landfilled, incinerated and biological treated. The decrease of total GHG emissions in the waste sector is mainly driven by the development of the different waste treatment routes. Figure 7.3 shows the share of the waste treatments over the time series 1990 to 2013 based on activity data. The figure is based on Eurostat data as information on waste recycling is also included and there is a common definition for the reporting of waste. On the basis of the Regulation on waste statistics (EC) No. 2150/2002, amended by Commission Regulation (EU) No. 849/2010, data on the generation and treatment of waste is collected from the Member States. The information on waste generation has a breakdown in sources (several business activities according to the NACE classification and household activities) and in waste categories (according to the European Waste Classification for statistical purposes). The information on waste treatment is broken down to five treatment types (recovery, incineration with energy recovery, other incineration, disposal on land and land treatment) and in waste categories. While the amount of waste landfilled is continuously decreasing in the EU Member States the share of waste treated with waste treatment methods like recycling or biological treatment of waste increases. In 1990 67 % of waste has been landfilled, 15 % was incinerated, 12 % recycled and only 7 % of the waste has been biologically treated. In 2013 the share of waste landfilled decreased to 31 % of total waste treated while incineration including energy recovery increased to 26 %, recycling increased to 28 % and biological treatment of waste makes up 15 % of total solid waste treated in 2013.

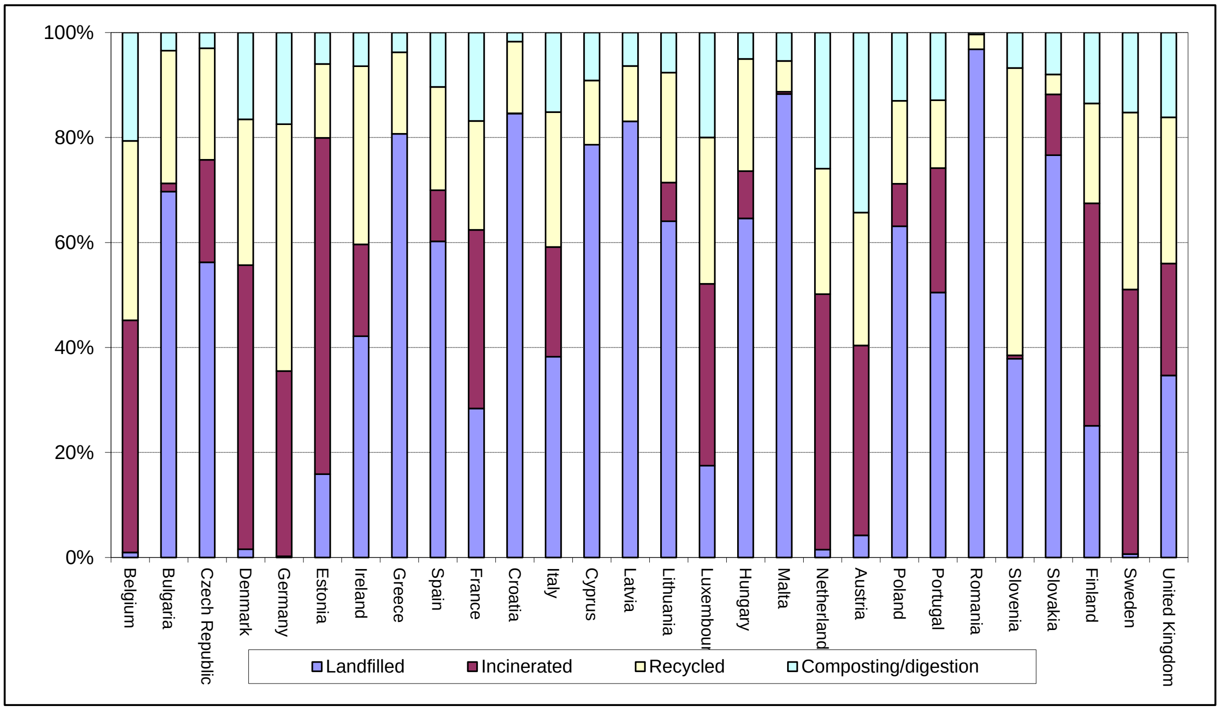
Figure 7.3 Sector 5 Waste: Development of waste treatment in the EU-28



Source: EUROSTAT 2015, own calculation

The share of the single waste treatment routes differs significantly among Member States in 2013, compare Figure 7.4.

Figure 7.4 : Waste management practices in the EU-28 (shares) in 2013



Source: EUROSTAT 2015, own calculations

Many member states experienced a reduction of waste landfilled and an increase of recycling, composting and landfill gas recovery. These trends have already taken place before the Landfill Directive and the Directive on packaging waste, but are further supported by these directives.

The waste management practices and policies which determine the fraction of municipal solid waste (MSW) disposed to SWDS, the fraction of waste incinerated and the fraction of waste recycled or with biological treatment differ significantly between the Member States. For example, disposing waste on SWDS is the predominant waste disposal route in Greece, Croatia, Latvia, Malta and Romania with correspondingly fewer quantities of waste incinerated, recycled or with biological treatment. In Belgium, Denmark, Germany, Estonia, Luxemburg, the Netherlands, Austria, Finland and Sweden, (see Figure 7.4) it is vice versa. Since 2005, landfills in Germany remaining in operation may only store waste that conforms to strict categorization criteria. Landfills also must reduce landfill gas formation from such waste by more than 90 % compared to gas production from untreated waste. In the Netherlands (also in Belgium), waste policy also has the aim of reducing landfilling by introducing bans for the landfilling of certain categories of waste, e.g. the organic fraction of household waste (in the early 1990s) and by raising the landfill tariff to comply with the incineration of waste.

7.2 Source categories and methodological issues

This chapter includes information on emission levels and emission trends for all 28 Member States. Additionally information on national methods and circumstances which are available in the member states' national inventory reports will be provided in the next submission. The focus is laid on the reporting categories 5A1 CH_4 emissions from managed solid waste disposal sites and 5A2 CH_4 emissions from unmanaged solid waste disposal sites since they are EU-28 key categories and contribute 2 % and 0.3 % of total GHG emissions, respectively. CH_4 emissions from the reporting category 5D1 Domestic Wastewater Treatment and Discharge are a key source in the EU-28 as well and is also comprehensively analysed. CH_4 and N_2O emissions from composting are a key category in trend changes and therefore also included in the analysis. Emissions from source categories 5B, 5C and 5E are also included.

7.2.1 Solid waste disposal on land (CRF Source Category 5A)

Source category 5A Solid waste disposal on land includes two key sources: CH_4 from 5A1 Managed waste disposal on land and CH_4 from 5A2 Unmanaged waste disposal on land. Methane is produced from anaerobic microbial decomposition of organic matter in solid waste disposal sites. Source category 5A1 Managed waste disposal on land includes CH_4 emission arising from managed solid waste landfills. Source category 5A2 comprises corresponding CH_4 emissions from unmanaged landfills. Under 5A3 CH_4 emissions from uncategorized landfills are reported, but only Estonia and Poland report emissions from this category. As this is no EU key category no further information on 5A3 is included in the following chapters.

The EU-28 reports CH_4 emissions from managed solid waste landfills in source category 5A1. The methane recovery that takes place in those managed solid waste landfills is also reported in CRF-table 5A but those amounts are not included in the reported CH_4-emissions, as prescribed by the IPCC guidelines. In the unmanaged solid waste landfills, no CH_4-recovery is taken place. Only Ireland and Latvia report CH_4 recovery from unmanaged landfills for a few years in the time series, as there were no managed landfills in Ireland at this time.

Table 7.1 provides total greenhouse gas and CH_4 emissions by Member state from 5A Solid Waste Disposal on Land. CH_4 emissions from this category decreased by 42 % between 1990 and 2013 in the EU-28. Fifteen EU-28 Member states reduced their emissions from this source, while Croatia, Cyprus, the Czech Republic, Estonia, France, Greece, Hungary, Latvia, Malta, Portugal, Romania, Slovakia and Spain did not.

Table 7.1 5A Solid Waste Disposal on Land: Member states' contributions to total GHG emissions and CH_4 emissions

Member State	GHG emissions in 1990 (kt CO2 equivalents)	GHG emissions in 2013 (kt CO2 equivalents)	CH4 emissions in 1990 (kt CO2 equivalents)	CH4 emissions in 2013 (kt CO2 equivalents)
Austria	3 946	1 333	3 946	1 333
Belgium	3 053	1 141	3 053	1 141
Bulgaria	3 960	3 516	3 960	3 516
Croatia	289	947	289	947
Cyprus	0	475	IE,NO	475
Czech Republic	1 979	3 324	1 979	3 324
Denmark	1 774	844	1 774	844
Estonia	214	243	214	243
Finland	4 328	1 952	4 328	1 952
France	12 679	14 705	12 679	14 705
Germany	33 525	9 850	33 525	9 850
Greece	2 244	3 104	2 244	3 104
Hungary	2 840	3 347	2 840	3 347
Ireland	1 396	1 106	1 396	1 106
Italy	18 158	13 872	18 158	13 872
Latvia	393	533	393	533
Lithuania	1 029	900	1 029	900
Luxembourg	80	31	80	31
Malta	17	42	17	42
Netherlands	14 299	3 383	14 299	3 383
Poland	10 366	8 547	10 366	8 547
Portugal	2 728	4 004	2 728	4 004
Romania	1 372	3 307	1 372	3 307
Slovakia	670	1 033	670	1 033
Slovenia	433	366	433	366
Spain	6 057	13 336	6 057	13 336
Sweden	3 422	1 193	3 422	1 193
United Kingdom	62 479	16 499	62 479	16 499
EU-28	**193 728**	**112 932**	**193 728**	**112 932**

Abbreviations explained in the Chapter 'Units and abbreviations'.

7.2.1.1 Managed waste disposal sites (CRF Source Category 5A1)

Emissions and trends

Table 7.2 provides information on emission trends of the key source CH_4 from 5A1 Managed Waste Disposal on Land by Member state. CH_4 emissions from this source account for 2 % of total EU-28 GHG emissions. Between 1990 and 2013, CH_4 emissions from managed landfills declined by 42 % in the EU-

28. Twelve EU-28 Member states reduced their emissions from this source during that period, Bulgaria, Croatia, Cyprus, the Czech Republic, Estonia, France, Greece, Hungary, Ireland, Italy, Latvia, Malta, Portugal, Romania, Slovakia and Spain did not or reported no emissions from managed landfills in 1990. In 2013, CH_4 emissions from managed landfills decreased by 7 % compared to 2012. A main driving force of CH_4 emissions from managed waste disposal on land is the amount of biodegradable waste going to landfills. According to the CRF Tables submitted in 2015 total municipal waste disposal on managed landfills declined by 55 % between 1990 and 2013. In addition, CH_4 emissions from landfills are influenced by the amount of CH_4 recovered and utilized or flared. The share of CH_4 recovery has increased significantly in EU-28 since 1990 (see Figure 7.7).

The Member States with most emissions from this source in 2013 were the United Kingdom, Germany, Spain, Italy and France. These MS account for 68 % of EU-28 emissions in 2013. The largest reductions in absolute terms between 1990 and 2013 were reported by Germany and the United Kingdom. The emission reductions are partly due to the (early) implementation of the landfill waste directive or similar legislation in the Member States. The landfill waste directive was adopted in 1999 and requires the member states to reduce the amount of biodegradable waste disposed untreated to landfills and to install landfill gas recovery at all new sites.

Table 7.2 5A1 Managed Waste Disposal on Land: Member states' contributions to CH_4 emissions and information on method applied and emission factor

Member State	CH4 emissions in kt CO2 equiv.			Share in EU28 emissions in 2013	Change 2012-2013		Change 1990-2013		Method applied	Emission factor
	1990	2012	2013		kt CO2 equiv.	%	kt CO2 equiv.	%		
Austria	3 946	1 430	1 333	1%	-97	-7%	-2 613	-66%	NA	NA
Belgium	3 053	1 259	1 141	1%	-119	-9%	-1 913	-63%	T2	D
Bulgaria	NO	676	702	1%	26	4%	702	100%	NA	NA
Croatia	14	656	701	1%	45	7%	687	4802%	T2	CS
Cyprus	NO	475	475	0%	0	0%	475	100%	NA	NA
Czech Republic	1 979	3 298	3 324	3%	27	1%	1 345	68%	T1	CS,D
Denmark	1 774	879	844	1%	-35	-4%	-930	-52%	T2	CS,D
Estonia	NO	281	243	0%	-38	-14%	243	100%	NA	NA
Finland	4 328	2 068	1 952	2%	-116	-6%	-2 376	-55%	T2	CS,D
France	12 679	15 286	14 705	15%	-581	-4%	2 026	16%	-	-
Germany	33 525	10 575	9 850	10%	-725	-7%	-23 675	-71%	T2	CS
Greece	81	1 248	1 357	1%	108	9%	1 276	1578%	T2	CS,D
Hungary	2 840	3 545	3 347	3%	-198	-6%	507	18%	T2	D
Ireland	NO	788	959	1%	171	22%	959	100%	NA	NA
Italy	11 974	14 194	12 268	13%	-1 925	-14%	294	2%	T2	CS
Latvia	NO	171	187	0%	15	9%	187	100%	NA	NA
Lithuania	879	854	806	1%	-48	-6%	-73	-8%	T2	D
Luxembourg	80	31	31	0%	0	-1%	-49	-62%	T2	D
Malta	NO	23	5	0%	-18	-77%	5	100%	NA	NA
Netherlands	14 299	3 570	3 383	3%	-187	-5%	-10 915	-76%	T2	CS
Poland	4 614	4 358	4 466	5%	108	2%	-148	-3%	T2	D
Portugal	722	3 171	3 003	3%	-168	-5%	2 281	316%	T2	CS,D
Romania	NO,NE	774	965	1%	191	25%	965	100%	NA	NA
Slovakia	NO	584	622	1%	38	6%	622	100%	NA	NA
Slovenia	433	393	366	0%	-26	-7%	-67	-15%	T1	CS,D
Spain	5 003	12 307	12 307	13%	0	0%	7 304	146%	T2	CS,D,OTH
Sweden	3 422	1 303	1 193	1%	-110	-8%	-2 229	-65%	NA	NA
United Kingdom	62 479	20 274	16 499	17%	-3 776	-19%	-45 980	-74%	T2	CS
EU-28	**168 123**	**104 469**	**97 032**	**100%**	**-7 438**	**-7%**	**-71 092**	**-42%**		

Abbreviations explained in the Chapter 'Units and abbreviations'.

The ERT recommended to provide reasons for the increase of methane emissions from managed waste disposal on land for those Member states showing the largest increase during the time series (France, Spain, Portugal) (FCCC/ARR/2009/EC, para 83). Therefore and in response to another recommendation by the ERT (FCCC/ARR/2009/EC, para 81), an analysis of the trends of emissions of these Member states and of those Member States influencing most the European Union's trends is given.

Figure 7.5 provides an overview of the relevant trends of the most important Member States.

CH_4 emissions in Spain increased almost continuously from 1990 and 2009 due to a growth of the annual municipal solid waste going to solid waste disposal sites. Key drivers are a growing population and the shift of waste disposal from unmanaged to managed landfills. CH_4 recovery and flaring of CH_4 has already been practiced in earlier years of the time series 1990-2013. Very high amounts of CH_4 recovery could be found from 2006-2008, while in the most recent years CH_4 recovery was declining again.

Portugal, contributing with 3 % to EU-28 emissions in 2013, showed an increasing trend of CH_4 emissions from solid waste disposal on managed landfills until 2011. Key drivers for this trend have been increased waste generation due to population growth and urbanization. Since 2004 the share of CH_4 recovery and flaring constantly increased and from 2012 onwards Portugal managed to slow down the increasing trend of CH_4 emissions from managed landfills.

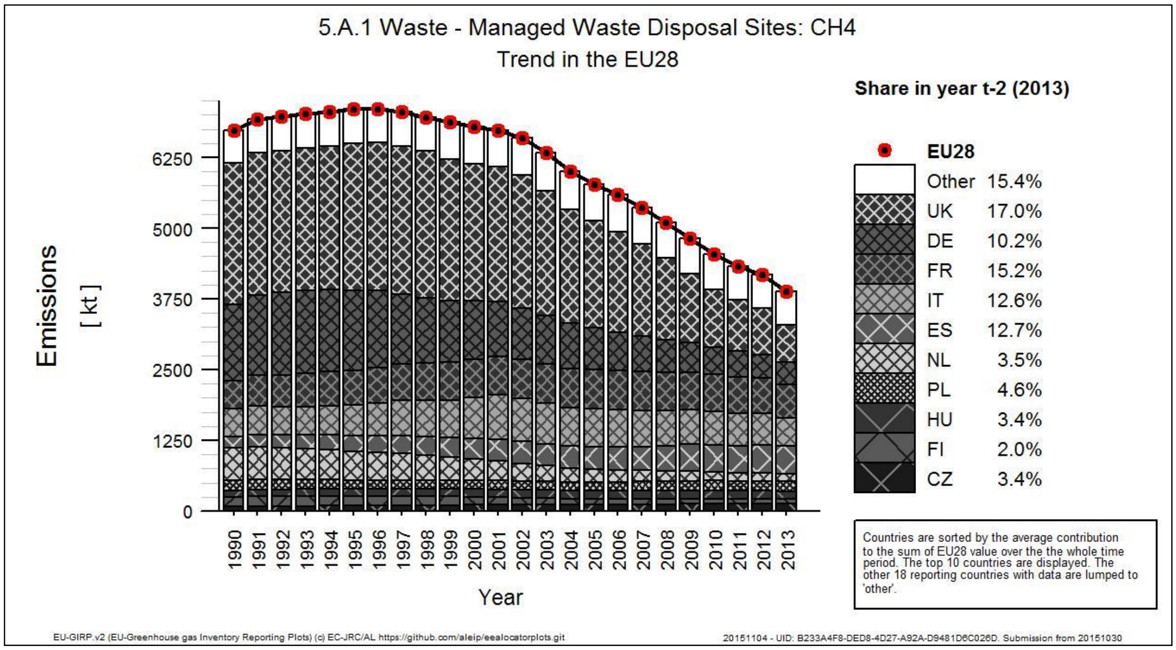
France, contributing with 15 % to EU-28 emissions in 2013 increased its emissions from managed solid waste disposal sites steadily until 2003; followed by rather stable emissions until 2008 and a slight decrease thereafter. Emissions followed the increased amount of municipal waste going to landfills until 2000, which decreased afterwards. Small amounts of CH_4 have been flared and recovered already in 1990, while very high amounts of CH_4 recovery could be found from 2009 onwards.

The UK has the highest share of CH_4 emissions from managed landfills among Member States with 17 % in 2013. From 1996 onwards CH_4 emission decreased continuously due to a reduction of the amount of waste landfilled and also due to very high amounts of CH_4 recovery from 2003 onwards.

Italy, contributing with 13 % to EU-15 emissions in 2013, featured an increasing trend of CH_4 emissions from landfills until 2001 and a decreasing trend thereafter. This is driven, inter alia, by the increasing amount of waste landfilled until 2000 and a decrease thereafter. Also, CH_4 recovery has increased throughout the time series. The key drivers for the fall in emissions are the national policy diverting solid waste from landfill to waste incineration plants and waste diversion measures. Composting and mechanical and biological treatment have shown a remarkable rise due to the enforcement of legislation.

Germany, contributing with 10 % to EU-28 emissions in 2013, managed to reduce CH_4 emissions steadily until now from 1995 onwards. The amount of waste disposed on landfills shows a strong decrease from 1990 onwards, while in parallel CH_4 recovery increased. The highest share of CH_4 recovery could be found in 2002 and declined thereafter due to a decreasing amount of waste landfilled.

Figure 7.5 5A1 Managed waste disposal on land: CH_4 emissions (Trend in relevant MS)

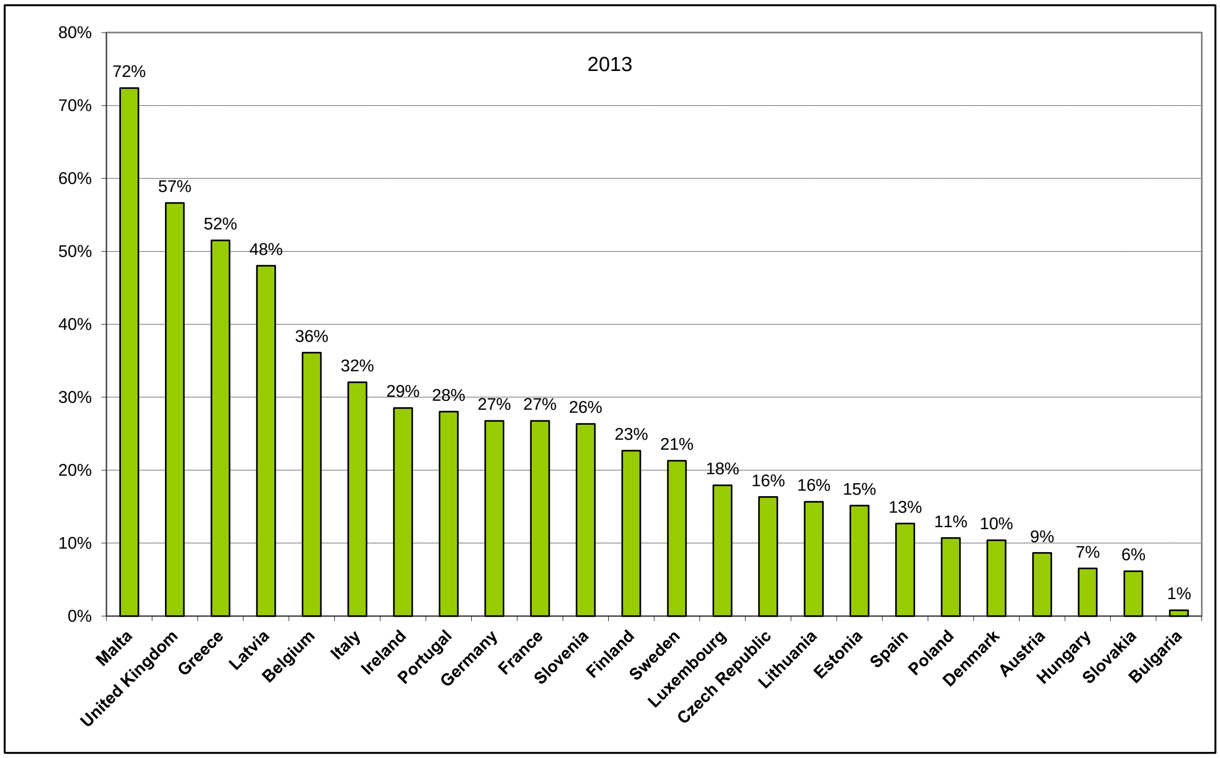


Methane recovery

Besides lower quantities of organic carbon deposited on landfills, the major determining factor for the decrease in net CH_4 emissions are increasing methane recovery rates from landfills.

The recovered CH_4 is the amount of CH_4 that is captured for flaring or energy use and is a country-specific value which has significant influence on the emission level. The percentage of CH_4 recovered, in Figure 7.6, varies among the member states between 1 % in Bulgaria and 72 % in Malta and depends - amongst other - on the share of solid waste disposal sites where flaring or recovery installations exist. In Malta methane recovery from managed sites increased drastically through the implementation of gas recovery at ghallies. Since Ghallies is the major active managed landfill in operation locally, gas recovery from this one landfill has a very high effect on the % methane recovered. Croatia, Cyprus, the Netherlands and Romania do not report any CH_4 recovery, but Croatia and Romania report flaring of CH_4 in their CRF tables.

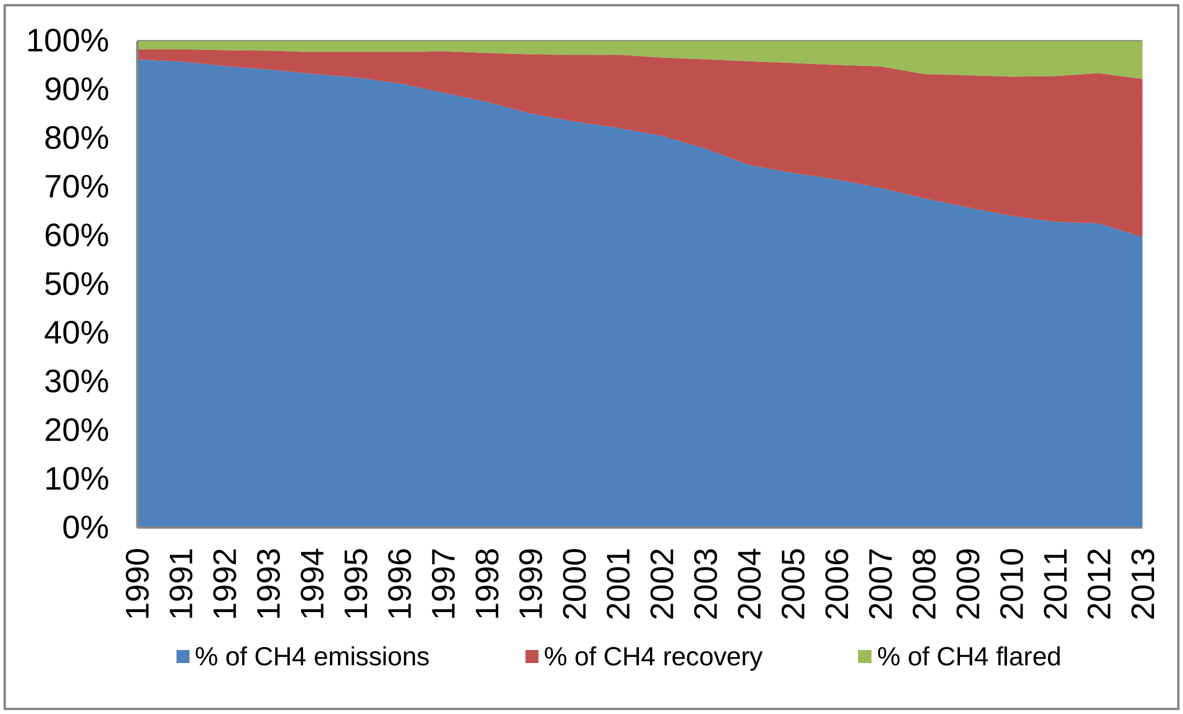
Figure 7.6 5A1 Managed Solid Waste Disposal: Methane recovery rates for 2013



CH_4 recovery in % = CH_4 recovery in Gg/ (CH_4 recovery in Gg + CH_4 flared + CH_4 emissions 5A1 in Gg)
CH_4 emissions from 5A2 unmanaged landfills are not included in this calculation
Source: CRF 2015 Table 5A

Compared to 2012 the methane recovery in 2013 increased for eleven member states, out of which for two with a significant absolute increase (Italy and France). In 12 Member States the amount of CH_4 recovery decreased in comparison to 2012.

Figure 7.7 5A1 Managed Solid Waste Disposal: Development of the share of methane recovery, methane flared and CH_4 emissionson total CH_4 produced in managed landfills in the EU 28



CH_4 recovery in EU-28 increased from 2 % of total CH_4 emissions from managed landfills in 1990 to 32% of generated CH_4 from managed SWDS (only 5A1) in 2013. Methane recovery is further promoted by the Landfill Directive, and monitoring programs will need to be established. The recovery potential depends on the waste management strategies, e.g. diverting organic fractions to composting leaves more inert materials on landfills and reduces the potentials to recover and use CH_4. Compared to 2012, CH_4 recovery of generated CH_4 for the EU-28 increased by 2.2% in 2013.

Moreover, Member States use different methods to determine CH_4 recovery. Several member states combine different methods and sources to estimate the amounts of CH_4 recovered for flaring of energy purposes, some member states are using only one method. Data on landfill gas recovery can be based on measured plant specific data, questionnaires and survey or can be taken from the energy statistics.

Methodological issues

For key sources in the source category 5A it is good practice to use the First Order Decay (FOD) method to calculate the emissions and to display emissions trends over time. According to Table 7.2 the Czech Republic and Slovenia apply a Tier 1 method to estimate CH_4 emissions from solid waste disposal on managed landfills. Giving the IPCC 2006 Guidelines for National Greenhouse Gas Inventories a First Order Decay (FOD) method that accounts for the fact that the degradable organic components decay slowly over decades has to be applied for all Tier levels. The Tier 1 method applies mainly default parameters and default activity data. The Tier 2 FOD method requires data on current as well as historic waste quantities, composition and disposal practices for several decades. Historical waste disposal data for 10 years or more should be based on country-specific statistics, surveys or other similar sources. In the following, a short overview of the most important parameters and methodological aspects of the FOD method is presented. The main factors influencing the quantity of CH_4 produced are the amount of waste disposed of on land and the concentration of biodegradable carbon in that waste.

Municipal Waste landfilled

The amount of waste disposed on SWDS depends on the total amount of waste generated and on the per capita waste generation rate, respectively. The total amount of waste disposed can be calculated by using total population numbers, waste generation rate per capita and the share of waste disposed. However, in many EU Member States solid waste disposal is not estimated based on the per capita waste generation rate and a share of waste landfilled, but on direct measurements. The restructured CRF tables contain only data on the total amount of annual waste disposed at the solid waste disposal sites in kt.

The FOD method requires historic data on waste generation and the share of waste landfilled over decades but it is difficult to achieve consistent time series for the activity data over such long periods. The data sources used for generating time series of activity data by the Member States will be summarized in the Annex in the next submission.

Industrial waste

Data on industrial waste may be difficult to obtain in many countries, as there are only very few default values available. Only industrial waste that contains organic or fossil carbon fractions needs to be included in the inventory. Further information on the reporting of industrial waste by the Member States will be summarized in the Annex in the next submission.

Waste composition

The amount of methane generated on SWDS depends strongly on the waste composition. Disposing waste with no or hardly degradable carbon (e.g. metal or plastics) does not contribute to CH_4 emissions, but the disposal of paper or food waste with large degradable organic carbon fractions leads to high CH_4 emissions. The composition of the waste landfilled is strongly influenced by waste management practices, such as recycling or composting. Country specific information on waste composition will be provided in the Annex in the next submission.

Emission factors and parameters

Besides information on the amount of waste landfilled and the waste composition further parameters are relevant for the calculation of CH_4 emissions from waste disposal. The fraction of dissolved organic carbon (DOC) dissimilated in the individual waste fractions and the methane generation rate constant that reflects the years which the degradable organic carbon needs to decompose are the most relevant parameters for calculating CH_4 emissions. Further parameters included in the calculation are the methane correction factor (MCF), the fraction of DOC that decomposes the fraction of CH_4 in generated landfill gas, methane recovery rate and the oxidation factor.

Fraction of Dissolved Organic Carbon (DOC) in MSW: There are default IPCC values for DOC of the different waste fractions available (paper, food waste etc.). Some countries have conducted own chemical analysis on the DOC value of different waste fractions. The DOC content of total landfill waste is based on the composition of waste and can be calculated from a weighted average of the carbon content of various components of the waste. Member States have MSW with widely differing waste compositions. If large amounts of organic waste is composted and waste is pretreated before disposed on landfills the average DOC is very low, even if still a high amount of waste is disposed. As waste composition varies over time and single DOC values are used for individual waste fractions the DOC-values also vary over time. In the case of the United Kingdom, a detailed review of waste composition with regard to materials, moisture content and dissimilable degradable organic carbon was carried out. For Austria composting of biodegradable waste is reported separately. Consequently, considerable amounts of waste with high DOC are excluded from category 5A which results in a lower DOC for the remaining MSW. In Italy, DOC values are based on different national studies. In addition the DOC reflects the considerable reductions achieved in diverting biodegradable waste to other waste management methods such as composting or mechanical-biological treatment.

The restructured CRF tables do not include information on the average DOC anymore. Within the next submission a table in the Annex will be provided that contains corresponding detailed information on the DOC values extracted from the NIR.

Methane generation rate constant: CH_4 is emitted on SWDS over a long period of time rather than instantaneously. The FOD model can be used to model landfill gas generation rate curves for individual landfills over time. One important parameter is the methane generation rate constant. It is determined by a large number of factors associated with the composition of waste and the conditions at the site. The restructured CRF tables do not include information on the methane generation rate constant anymore. Within the next submission a table in the Annex will be provided that contains corresponding detailed information on the methane generation rate constant extracted from the NIR.

7.2.1.2 Unmanaged waste disposal sites (CRF Source Category 5A2)

Emissions and Trends

CH_4 emissions from 5A2 Unmanaged Waste Disposal on Land account for 0.3 % of total EU-28 GHG emissions in 2013. Between 1990 and 2013, CH_4 emissions from this source decreased by 40 % (Table 7.3). All member states with unmanaged waste disposal feature a decreasing emission trend, due to a decreasing amount of municipal waste going to unmanaged waste disposal sites. Only Romania showed an increase of CH_4 emissions from unmanaged landfills until 2012, while from 2012 between 2012 and 2013 CH_4 emissions decreased by 3 %.

Not all member states reported emissions from this source since all waste disposal sites in the countries are managed (Austria, Belgium, the Czech Republic, Denmark, Estonia, Finland, France, Germany, Luxembourg, the Netherlands, Slovenia, Sweden and the United Kingdom) or they are included elsewhere (Cyprus, Hungary). Bulgaria, Greece, Italy, Poland and Romania are responsible for about 78 % of the total EU-28 emissions from unmanaged waste disposal sites. Italy and Poland show large absolute reductions between 1990 and 2013. In these two countries, waste is not disposed on unmanaged landfill sites any more (in Italy since 2000, in Poland since 2012). In Romania solid waste disposal on unmanaged landfills is still practiced, but the amount of waste disposed is considerably decreasing since 2000. While in the year 2000 more than 6,000 kt have been disposed on unmanaged landfills only 769 kt were disposed in 2013 (see *Figure **7.8***). However, emissions are still produced from the waste disposed in the past.

The reduction of emissions from unmanaged waste disposal on land in Italy is caused by legal acts. The first legal provision concerning waste management was issued in 1982. In this decree, uncontrolled waste dumping as well as unmanaged landfills is forbidden, but the enforcement of these measures was concluded only in 2000. Thus the share of waste disposed on uncontrolled landfills gradually decreased, and in the year 2000 it is assumed as equal to zero; nevertheless emissions still occur due to the waste disposed in the past years.

Poland's CH_4 emissions from the disposal of solid waste on unmanaged landfills are decreasing from 2001 onwards. Key drivers for this decrease are the implementation of the landfill directive 1999/31/EC and the introduction of new waste treatment technologies that reduce the amount of waste disposed on unmanaged landfills.

Table 7.3 shows that 100 % of the EU-28 emissions are estimated using higher tier methodologies.

Table 7.3 5A2 Unmanaged Waste Disposal on Land: Member states' contributions to CH_4 emissions and information on method applied and emission factor

Member State	CH4 emissions in kt CO2 equiv.			Share in EU28 emissions in 2013	Change 2012-2013		Change 1990-2013		Method applied	Emission factor
	1990	2012	2013		kt CO2 equiv.	%	kt CO2 equiv.	%		
Austria	NO	NO	NO	-	-	-	-	-	NA	NA
Belgium	NO	NO	NO	-	-	-	-	-	NA	NA
Bulgaria	3 960	2 925	2 813	19%	-112	-4%	-1 146	-29%	T2	CS,D
Croatia	275	282	246	2%	-35	-13%	-28	-10%	T2	CS
Cyprus	IE	IE	IE	-	-	-	-	-	NA	NA
Czech Republic	NO	NO	NO	-	-	-	-	-	NA	NA
Denmark	NO	NO	NO	-	-	-	-	-	NA	NA
Estonia	NO	NO	NO	-	-	-	-	-	NA	NA
Finland	IE	NO	NO	-	-	-	-	-	NA	NA
France	NO	NO	NO	-	-	-	-	-	NA	NA
Germany	NO	NO	NO	-	-	-	-	-	NA	NA
Greece	2 163	1 813	1 748	12%	-65	-4%	-415	-19%	T2	CS,D
Hungary	IE	IE	IE	-	-	-	-	-	NA	NA
Ireland	1 396	158	147	1%	-10	-7%	-1 249	-89%	T2	CS,D
Italy	6 184	1 683	1 604	11%	-79	-5%	-4 580	-74%	T2	CS
Latvia	393	363	346	2%	-16	-5%	-47	-12%	T2	CS,D
Lithuania	150	103	95	1%	-8	-8%	-55	-37%	T2	D
Luxembourg	NO	NO	NO	-	-	-	-	-	NA	NA
Malta	17	37	36	0%	0	-1%	20	118%	M	M
Netherlands	NO	NO	NO	-	-	-	-	-	NA	NA
Poland	4 806	3 187	2 943	20%	-244	-8%	-1 863	-39%	T2	D
Portugal	2 007	1 074	1 002	7%	-73	-7%	-1 005	-50%	-	-
Romania	1 372	2 405	2 343	16%	-63	-3%	971	71%	T2	CS,D
Slovakia	670	436	411	3%	-25	-6%	-259	-39%	T2	CS,D
Slovenia	NO	NO	NO	-	-	-	-	-	NA	NA
Spain	1 054	1 081	1 029	7%	-52	-5%	-25	-2%	T2	D
Sweden	NO	NO	NO	-	-	-	-	-	NA	NA
United Kingdom	NO	NO	NO	-	-	-	-	-	NA	NA
EU-28	**24 444**	**15 545**	**14 763**	**100%**	**-782**	**-5%**	**-9 682**	**-40%**		

Abbreviations explained in the Chapter 'Units and abbreviations'.

*Figure **7.8*** shows the relevant trends for the amount of waste disposed on unmanaged landfills, where the highest reductions in waste disposal between 1990 and 2013 are find for Italy and Poland. *Figure **7.9*** shows that even if the amount of waste disposal (*Figure **7.8***) is rather drastic CH_4 emissions from unmanaged landfills show only a moderate decrease during the time series.

Figure 7.8 5A2 Waste disposal on unmanaged landfills: Total waste disposed on unmanaged landfills (Trend in relevant MS)

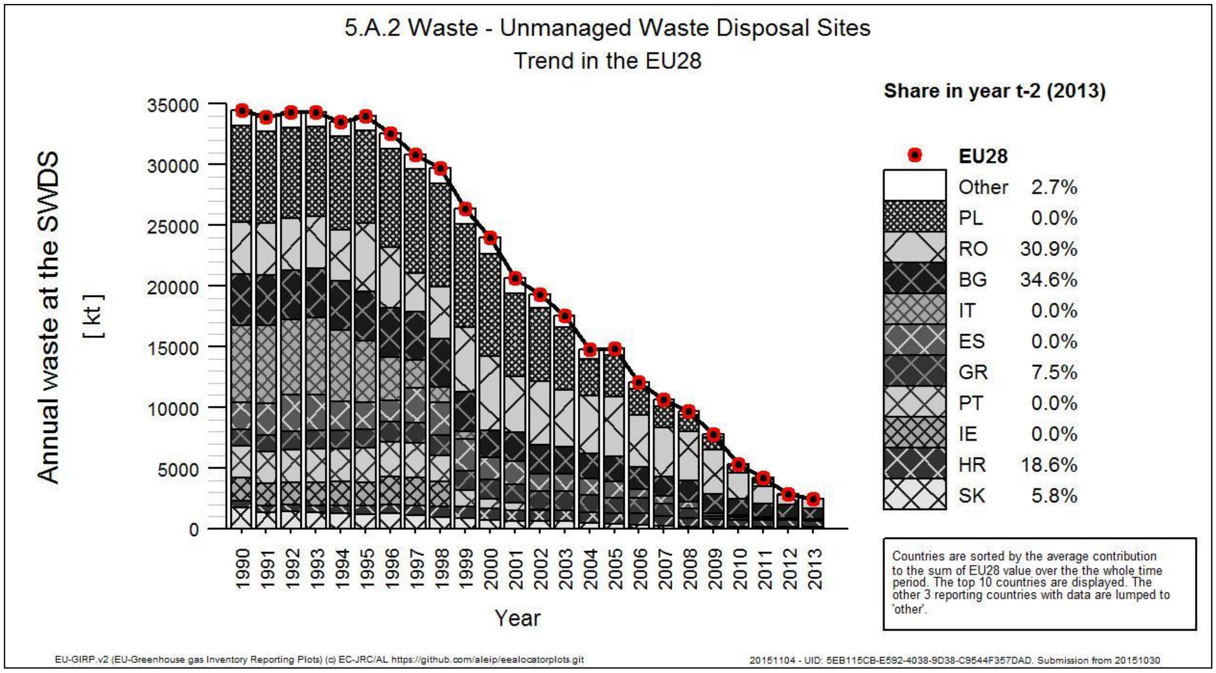
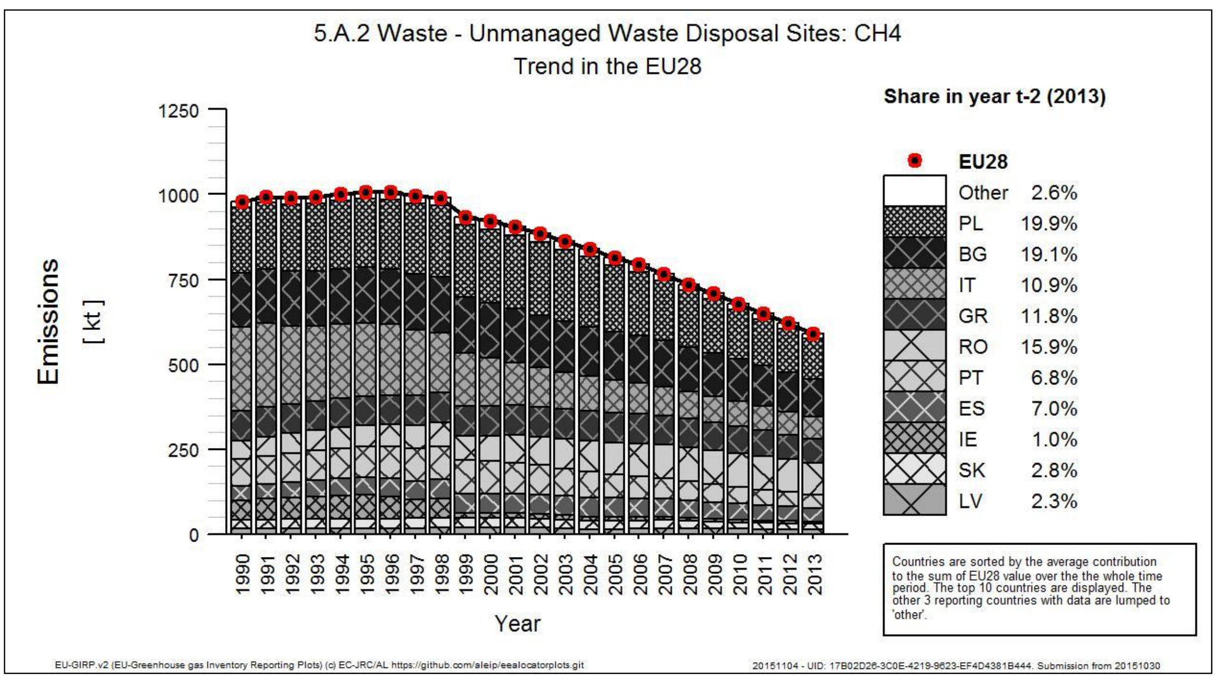


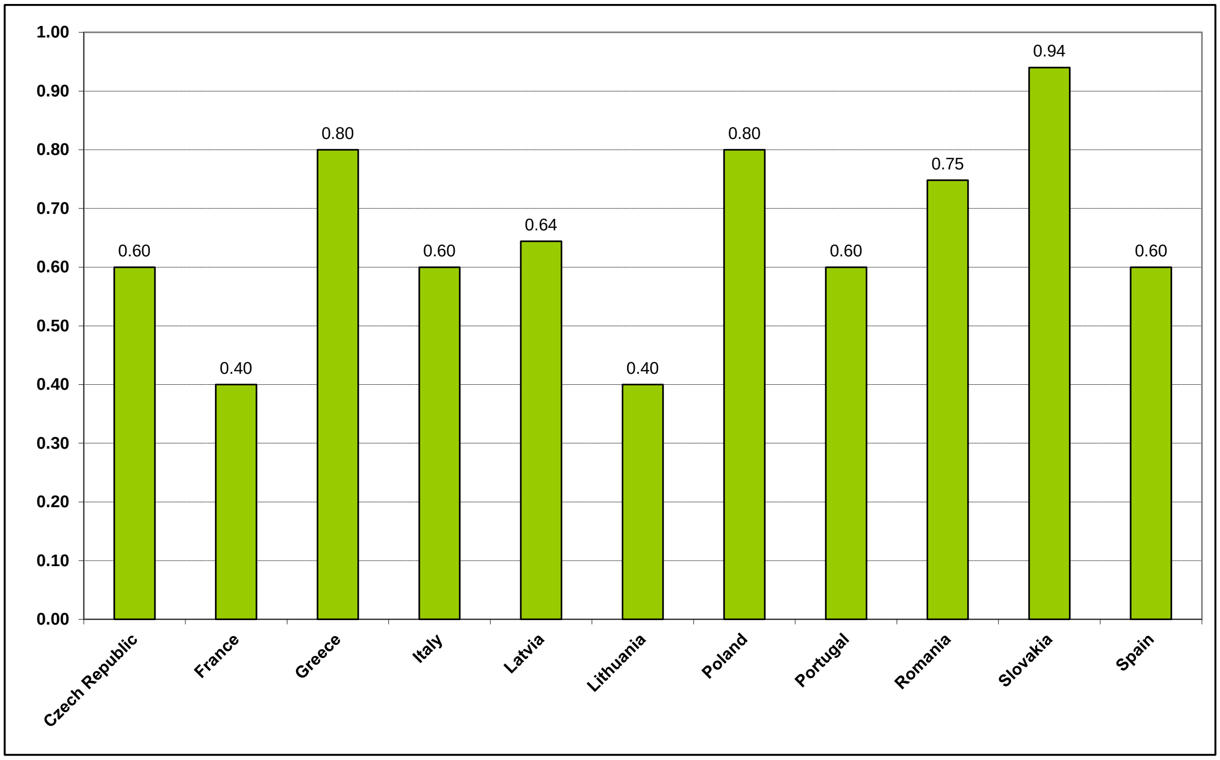
Figure 7.9 5A2 Waste disposal on unmanaged landfills: CH_4 emissions (Trend in relevant MS)



Methodological issues

CH_4 emissions from unmanaged solid waste disposal were reported in thirteen member states in 2013 (Bulgaria, Croatia, Greece, Ireland, Italy, Latvia, Lithuania, Malta, Poland, Portugal, Romania, Slovakia and Spain). Only six of these Member States (Bulgaria, Croatia, Greece, Lithuania, Romania and Slovakia) still dispose MSW to unmanaged SWDS, although in small quantities, while in all other countries waste disposals from the past still emits (see Table 7.3). 100% of all EU-28 emissions from this category are calculated using higher tier methods. The Methane Correction Factor (MCF) reflects the way in which MSW is managed and the effect of management practices on CH_4 generation. According to the 2006 IPCC Guidelines, the MCF for unmanaged disposal of solid waste depends of the type of site – shallow or deep. The IPCC default MCF for deep landfills is 0.8, while shallow landfills have an MCF of only 0.4 as in shallow landfills more waste decomposes aerobically. *Figure **7.10*** shows the different MCFs used by countries to estimate CH_4 emissions from waste disposal on unmanaged landfills in 2013.

Figure 7.10 5A2 Waste disposal on unmanaged landfills: MCFs applied by countries in 2013



Source: CRF Table 5.A 2015

7.2.1.3 Recalculations (CRF Source Category 5A)

For information on recalculations please refer to chapter 10.

7.2.2 Biological treatment of solid waste (CRF Source Category 5B)

Source category 5B Biological treatment of solid waste includes the key sources: CH_4 and N_2O from 5B1 Composting. Besides composting the source category 5B includes the subcategory 5B2 anaerobic digestion and also emissions from mechanical-biological treatment according to the IPCC 2006 Guidelines. Decomposition of biomass during biological treatment is much faster than on landfills and the CH_4 and N_2O emissions are estimated on an annual basis without the need for long time series as in the case of landfills. Whereas for composting the decomposition of the organic waste fraction takes place under aerobic conditions, under anaerobic digestion the decomposition takes place without oxygen. Further information on emission trends and methodologies is only provided for source category composting 5B1, as anaerobic digestion 5B2 is no EU key source.

Table 7.4 provides total GHG and CH_4 and N_2O emissions by Member State from 5B Biological treatment of solid waste. Total emissions from this category increased considerably between 1990. Eleven countries (Bulgaria, Croatia, Cyprus, Czech Republic, Greece, Ireland, Latvia, Luxembourg, Malta, Romania and Slovenia) did not practice this kind of waste treatment in 1990. Due to landfill regulations etc. this type of waste treatment increases considerably during the last years and only Malta and Romania do not report emissions from this category.

Table 7.4 5B Biological treatment of solid waste: Member States' contributions to total GHG emissions and CH_4 and N_2O emissions

Member State	GHG emissions in 1990 (kt CO2 equivalents)	GHG emissions in 2013 (kt CO2 equivalents)	N2O emissions in 1990 (kt CO2 equivalents)	N2O emissions in 2013 (kt CO2 equivalents)	CH4 emissions in 1990 (kt CO2 equivalents)	CH4 emissions in 2013 (kt CO2 equivalents)
Austria	36	164	23	102	13	63
Belgium	7	64	4	39	3	26
Bulgaria	0	20	NO	10	NO	11
Croatia	0	8	IE,NE,NA	4	IE,NE	5
Cyprus	0	0	NO	0	NO	0
Czech Republic	0	585	IE,NO	40	IE,NO	545
Denmark	47	249	12	123	35	126
Estonia	1	34	1	16	1	18
Finland	45	129	20	55	26	74
France	87	718	57	470	30	248
Germany	41	1 055	16	318	25	738
Greece	0	38	NO	18	NO	20
Hungary	9	156	4	30	5	126
Ireland	0	25	NO	12	NO	13
Italy	19	507	17	442	2	66
Latvia	0	3	NO,NE	1	NO,NE	1
Lithuania	8	23	4	11	4	12
Luxembourg	0	14	NE,NO	6	NE,NO	8
Malta	0	0	NO	NO,NA	NO	NO
Netherlands	20	159	7	83	14	76
Poland	9	260	4	123	5	137
Portugal	21	38	10	16	11	22
Romania	0	0	NO	NO	NO	NO
Slovakia	123	142	58	67	65	75
Slovenia	0	9	NO	4	NO	5
Spain	146	865	69	399	77	466
Sweden	13	126	6	47	7	79
United Kingdom	10	1 319	5	606	5	713
EU-28	**643**	**6 712**	**316**	**3 041**	**327**	**3 671**

Abbreviations explained in the Chapter 'Units and abbreviations'.

7.2.2.1 Composting (CRF Source Category 5B1)

Emission and Trends

CH_4 emissions from 5B1 Composting account for 0.05 % of total EU-28 GHG emissions in 2013. Between 1990 and 2013, CH_4 emissions from this source increased considerably from 323 kt CO_2 equivalents to 2327 kt CO_2 equivalents in 2013 (Table 7.5). All Member States that practice composting feature an increasing emission trend from 1990 onwards. Nevertheless between 2012 and 2013 eleven Member States experienced a decrease in CH_4 emissions from composting due to a decreasing amount of waste composted.

Table 7.5 5B1 Composting: Member States' contributions to CH_4 emissions

Member State	CH4 emissions in kt CO2 equiv.			Share in EU28 emissions in 2013	Change 2012-2013		Change 1990-2013	
	1990	2012	2013		kt CO2 equiv.	%	kt CO2 equiv.	%
Austria	13	64	63	3%	-2	-2%	50	381%
Belgium	3	29	26	1%	-3	-11%	23	886%
Bulgaria	NO	8	11	0%	3	31%	11	100%
Croatia	IE,NE	IE,NE	4	0%	4	100%	4	100%
Cyprus	NO	0	0	0%	0	-14%	0	100%
Czech Republic	NO	54	45	2%	-9	-16%	45	100%
Denmark	35	89	126	5%	37	41%	91	263%
Estonia	1	15	18	1%	3	21%	17	2555%
Finland	26	69	68	3%	-1	-1%	42	165%
France	28	194	205	8%	11	6%	177	639%
Germany	25	311	311	13%	0	0%	286	1127%
Greece	NO	20	20	1%	0	0%	20	100%
Hungary	5	41	42	2%	1	3%	37	741%
Ireland	NO	13	13	1%	0	1%	13	100%
Italy	0	5	5	0%	0	4%	5	2510%
Latvia	NE,NO	2	1	0%	0	-18%	1	100%
Lithuania	4	10	12	1%	3	27%	8	202%
Luxembourg	NO	8	8	0%	-1	-6%	8	100%
Malta	NO	NO	NO	-	-	-	-	-
Netherlands	14	79	76	3%	-2	-3%	63	458%
Poland	5	106	137	6%	31	29%	132	2707%
Portugal	11	16	18	1%	2	11%	7	58%
Romania	NO	NO	NO	-	-	-	-	-
Slovakia	65	85	75	3%	-10	-12%	10	16%
Slovenia	NO	5	5	0%	0	-3%	5	100%
Spain	77	447	447	18%	0	0%	370	481%
Sweden	7	56	53	2%	-3	-5%	46	645%
United Kingdom	5	603	635	26%	32	5%	630	11492%
EU-28	**323**	**2 327**	**2 423**	**100%**	**97**	**4%**	**2 100**	**650%**

Abbreviations explained in the Chapter 'Units and abbreviations'.

N_2O emissions from 5B1 Composting account for 0.06 % of total EU-28 GHG emissions in 2013. Between 1990 and 2013, CH_4 emissions from this source increased considerably from 316 kt CO_2 equivalents to 2772 kt CO_2 equivalents in 2013 (Table 7.6).

Table 7.6 5B1 Composting: Member states' contributions to N_2O emissions

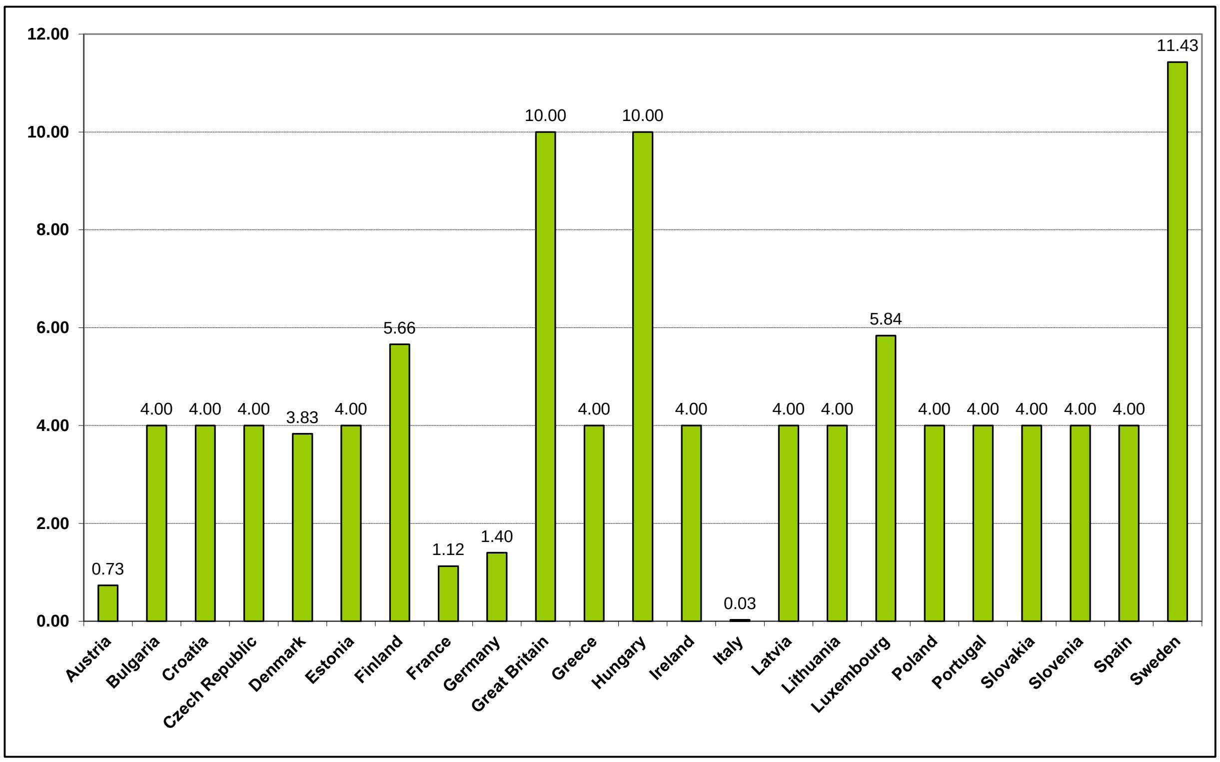
Member State	N2O emissions in kt CO2 equiv.			Share in EU28 emissions in 2013	Change 2012-2013		Change 1990-2013	
	1990	2012	2013		kt CO2 equiv.	%	kt CO2 equiv.	%
Austria	23	105	102	4%	-3	-3%	79	347%
Belgium	4	44	39	1%	-5	-11%	35	886%
Bulgaria	NO	7	10	0%	2	31%	10	100%
Croatia	IE,NE	IE,NE	4	0%	4	100%	4	100%
Cyprus	NO	0	0	0%	0	-14%	0	100%
Czech Republic	NO	48	40	1%	-8	-16%	40	100%
Denmark	12	87	123	4%	36	41%	111	898%
Estonia	1	13	16	1%	3	21%	15	2555%
Finland	20	55	55	2%	-1	-1%	35	179%
France	57	450	470	16%	20	4%	412	719%
Germany	16	196	196	7%	0	0%	180	1127%
Greece	NO	18	18	1%	0	0%	18	100%
Hungary	4	29	30	1%	1	3%	26	741%
Ireland	NO	12	12	0%	0	1%	12	100%
Italy	17	426	442	15%	15	4%	425	2510%
Latvia	NE,NO	2	1	0%	0	-18%	1	100%
Lithuania	4	9	11	0%	2	27%	7	202%
Luxembourg	NO	7	6	0%	0	-6%	6	100%
Malta	NO	NO	NO	-	-	-	-	-
Netherlands	7	87	83	3%	-3	-4%	77	1175%
Poland	4	95	123	4%	28	29%	118	2707%
Portugal	10	14	16	1%	2	11%	6	58%
Romania	NO	NO	NO	-	-	-	-	-
Slovakia	58	76	67	2%	-9	-12%	9	16%
Slovenia	NO	4	4	0%	0	-3%	4	100%
Spain	69	399	399	14%	0	0%	331	481%
Sweden	6	50	47	2%	-3	-5%	41	645%
United Kingdom	5	539	568	20%	29	5%	563	11492%
EU-28	**316**	**2 772**	**2 882**	**100%**	**110**	**4%**	**2 566**	**813%**

Abbreviations explained in the Chapter 'Units and abbreviations'.

Methodological information

According to the IPCC 2006 Guidelines CH_4 and N_2O emissions from composting are estimated by using the quantity of organic waste processed by composting and the respective emission factor. The application of a Tier 2 method requires the use of a country specific emission factor based on representative measurements. The IPCC default emission factor for CH_4 emissions from composting is 10 g CH_4/kg waste treated on a dry weight basis and 4 g CH_4/kg based on a wet weight basis. The range of this emission factor is very high and varies between 0.08 and 20 g CH_4/kg waste treated. Reported EFs by Member States show also large variation ranging from 0.03 for Italy to 11.4 in Sweden. Most countries applied the default EF for CH_4 emissions based on a wet weight basis. Italy uses a country specific EF for CH_4 emissions from composting that is based on literature data and refers to national experimental measurements and assumes that CH_4 emissions are almost zero if the facility is well operating.

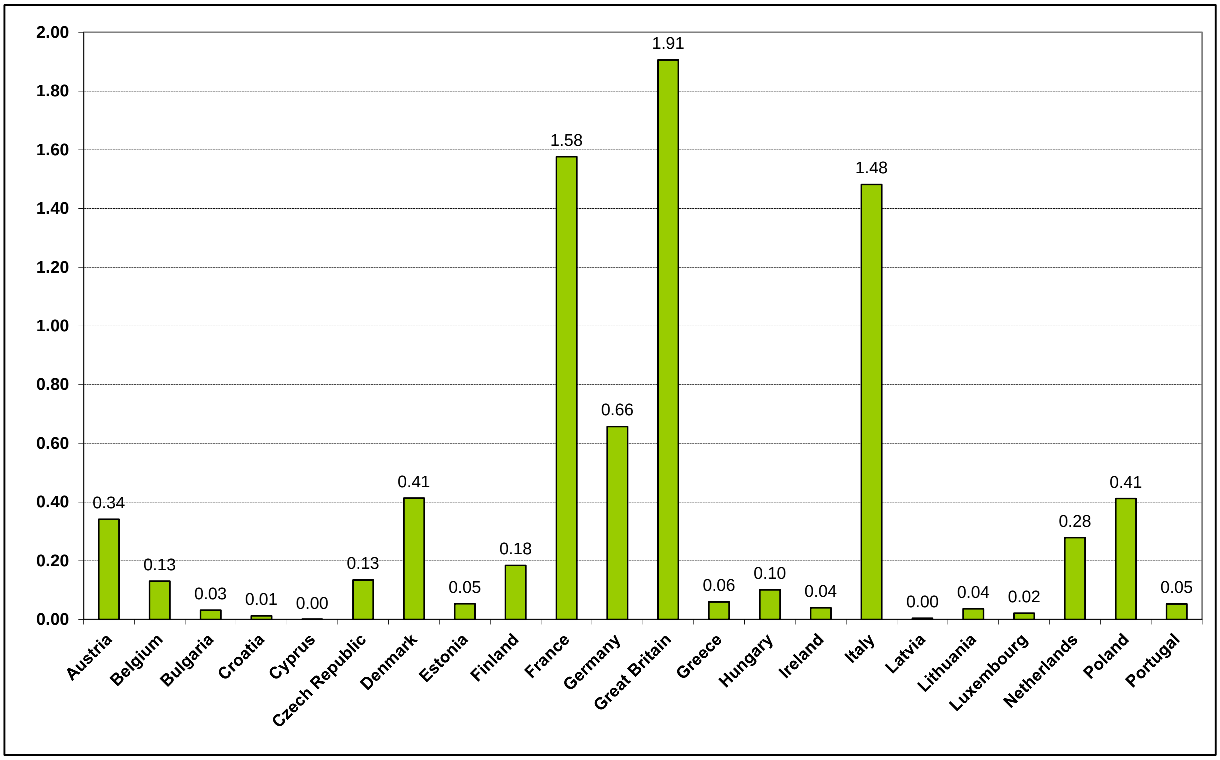
Figure 7.11 5B1 Composting: EFs applied by Member States in 2013 in g CH_4/kg waste treated



Source: CRF Table 5.B 2015

The IPCC default emission factor for N_2O emissions from composting is 0.6 g N_2O/kg waste treated on a dry weight basis and 0.3 g N_2O/kg based on a wet weight basis. The range of this emission factor is very high and is between 0.2 and 1.6 g N_2O/kg for dry waste treated and 0.06 and 0.6 g N_2O/kg for wet waste. Reported EFs by Member States show also large variation ranging from 0.000015 for Cyprus to 1.91 in UK.

Figure 7.12 5B1 Composting: EFs applied by Member States in 2013 in g N_2O/kg waste treated



Source: CRF Table 5.B 2015

7.2.2.2 Recalculations (CRF Source Category 5B)

For information on recalculations please refer to chapter 10.

7.2.3 Incineration and open burning of waste (CRF Source Category 5.C)

This category includes incineration of waste and open burning. Emissions from waste incinerated for energy use are reported under 1A Fuel combustion activities. Emissions from burning of agricultural wastes should be reported under 3 Agriculture.

Table 7.7 gives an overview of greenhouse gas emissions from waste incineration and open burning by member state. Total emissions from (non-biogenic) waste incineration and open burning, including CO_2, N_2O and CH_4 emissions account for 0.08 % of total EU-28 GHG emissions. Total emissions decreased by 36 % between 1990 and 2013. Most member states decreased their emissions from waste incineration and open burning between 1990 and 2013, except for Belgium, Bulgaria, Czech Republic, Greece, Hungary, Malta, Poland, Portugal, Romania, Slovenia and Sweden. The United Kingdom, France, Italy and Spain feature the largest decreases in absolute terms; these Member States account for 59 % of emissions from this source in 2013.

Table 7.7 5C Incineration and open burning of waste: Member States' contributions to total GHG emissions and CO_2, CH_4 and N_2O emissions

Member State	GHG emissions in 1990 (kt CO2 equivalents)	GHG emissions in 2013 (kt CO2 equivalents)	CO2 emissions in 1990 (kt)	CO2 emissions in 2013 (kt)	N2O emissions in 1990 (kt CO2 equivalents)	N2O emissions in 2013 (kt CO2 equivalents)	CH4 emissions in 1990 (kt CO2 equivalents)	CH4 emissions in 2013 (kt CO2 equivalents)
Austria	27	2	27	2	0	0	0	0
Belgium	290	311	287	310	3	1	NO,NA	NO,NA
Bulgaria	21	42	20	39	2	3	0	0
Croatia	1	0	1	0	0	NA,NO	NA,NO	NA,NO
Cyprus	0	0	NO	NO	NO	NO	NO	NO
Czech Republic	24	179	23	176	0	3	0	0
Denmark	0	0	NO	NO	0	0	0	0
Estonia	3	1	1	0	0	0	1	0
Finland	0	0	NO,NE,IE	NO,NE,IE	NO,NE,IE	NO,NE,IE	NO,NE,IE	NO,NE,IE
France	2 243	1 599	2 129	1 521	91	49	22	29
Germany	0	0	NO	NO	NA,NO	NA,NO	NA,NO	NA,NO
Greece	0	4	0	3	0	1	0	0
Hungary	122	200	121	197	1	2	0	0
Ireland	92	44	91	43	1	0	1	0
Italy	594	272	507	194	37	23	50	55
Latvia	6	5	1	0	5	4	NO,NA,NE	NO,NA,NE
Lithuania	3	1	3	1	0	0	0	0
Luxembourg	0	0	IE,NO	IE,NO	IE,NO	IE,NO	IE,NO	IE,NO
Malta	0	1	0	0	0	0	0	0
Netherlands	0	0	IE,NA,NO	IE,NA,NO	IE,NA,NO	IE,NA,NO	IE,NA,NO	IE,NA,NO
Poland	358	598	350	553	7	44	NO,NA	0
Portugal	8	20	7	14	1	5	0	1
Romania	0	9	NO	9	NO,NE	1	NE,NO	NE,NO
Slovakia	66	9	60	7	6	2	0	0
Slovenia	1	12	1	12	NO	0	NO	NO
Spain	346	4	305	3	25	0	16	0
Sweden	45	63	44	58	1	5	0	0
United Kingdom	1 459	306	1 292	252	30	44	137	10
EU-28	**5 708**	**3 680**	**5 270**	**3 394**	**210**	**190**	**228**	**96**

Abbreviations explained in the Chapter 'Units and abbreviations'.

7.2.3.1 Recalculations (CRF Source Category 5C)

For information on recalculations please refer to chapter 10.

7.2.4 Wastewater treatment and discharge (CRF Source Category 5D)

Source category 5D includes the CH_4 and N_2O emissions from domestic and industrial and other wastewater treatment and discharge. Methane and nitrous oxide are produced from microbial processes (anaerobic decomposition of organic matter, nitrification) in sewage facilities. N_2O is also indirectly released from disposal of wastewater effluents into aquatic environments63. According to the key category analysis only CH_4 emissions from 5D1 Domestic wastewater are an EU key source and analysed in more detail in the following chapter. Domestic wastewater includes the handling of liquid wastes and sludge from housing and commercial sources through wastewater collection and treatment, open pits/latrines, ponds, or discharge into surface waters.

Table 7.8 shows total GHG, CH_4 and N_2O emissions by member state from 5D Wastewater Handling. Between 1990 and 2013, total emissions from wastewater handling decreased by 36% in EU-28. All Member States except for France, Ireland and Portugal decreased their emissions from wastewater

[63] In most countries, indirect N_2O emissions from disposal of wastewater effluents are the major source of N_2O emissions from wastewater handling, whereas direct N_2O emissions from wastewater treatment plants are small or not relevant.

treatment and discharge between 1990 and 2013. Due to the implementation of new wastewater treatment technologies CH_4 emission decreased considerably by 43 % between 1990 and 2013, while N_2O emissions decreased moderatly by 6 %.

Table 7.8 5D Wastewater handling: Member states' contributions to total GHG, CH_4 and N_2O emissions from 5D

Member State	GHG emissions in 1990 (kt CO2 equivalents)	GHG emissions in 2013 (kt CO2 equivalents)	N2O emissions in 1990 (kt CO2 equivalents)	N2O emissions in 2013 (kt CO2 equivalents)	CH4 emissions in 1990 (kt CO2 equivalents)	CH4 emissions in 2013 (kt CO2 equivalents)
Austria	217	185	96	160	121	25
Belgium	1 082	484	247	269	835	215
Bulgaria	4 176	908	0	0	4 176	908
Croatia	305	284	67	84	238	200
Cyprus	26	26	14	20	12	6
Czech Republic	1 217	793	234	204	983	589
Denmark	200	187	101	74	99	113
Estonia	151	93	39	30	113	63
Finland	300	251	79	77	221	174
France	2 254	2 609	729	449	1 525	2 160
Germany	2 843	581	1 068	516	1 775	65
Greece	4 255	1 861	279	323	3 976	1 538
Hungary	1 332	618	260	228	1 072	389
Ireland	157	170	96	119	61	51
Italy	4 488	3 846	1 266	1 330	3 222	2 516
Latvia	366	209	6	7	360	202
Lithuania	609	266	67	46	542	220
Luxembourg	16	11	9	7	7	4
Malta	25	12	8	12	17	NA,IE
Netherlands	454	273	149	69	306	205
Poland	3 658	1 625	723	739	2 936	886
Portugal	3 460	3 541	500	610	2 960	2 931
Romania	3 652	2 532	505	553	3 146	1 979
Slovakia	604	366	138	50	466	317
Slovenia	210	138	50	49	159	89
Spain	2 399	1 800	733	961	1 666	839
Sweden	261	235	226	208	35	27
United Kingdom	5 239	4 371	1 092	1 039	4 148	3 331
EU-28	**43 960**	**28 273**	**8 782**	**8 230**	**35 178**	**20 043**

Abbreviations explained in the Chapter 'Units and abbreviations'.

7.2.4.1 Domestic wastewater (CRF Source Category 5D1)

Emission and Trends

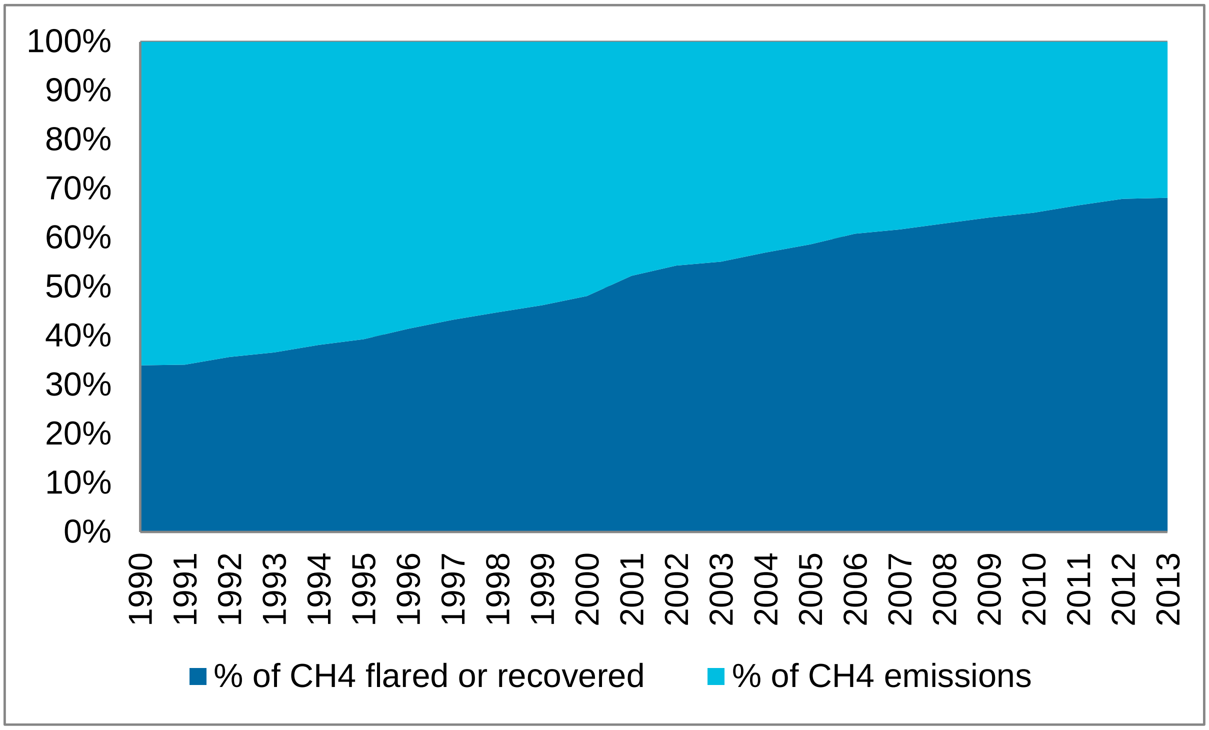
CH_4 emissions from 5D1 Domestic Wastewater account for 0.2 % of total EU-28 GHG emissions. Between 1990 and 2013, CH_4 emissions decreased by 51 %. Key drivers for the large emission reduction are the introduction of wastewater treatment technologies and an increase of CH_4 recovery and flaring (see *Figure **7.13***). Large decreases in absolute terms are reported by Germany, Greece and Poland, contributing together to only 11 % of EU-28 emissions from source 5D1 in 2013, whereas France shows significant emission increases (Table 7.9). France is responsible for 19 %, Italy for 10 % and Romania for 16 % of EU-28 emissions from this source in 2013. Although one of these Member States (France) increased its emissions between 1990 and 2013, the trend of EU-28 emissions is dominated by the large emission reductions in Germany, Greece and Poland.

Table 7.9 5D1 Domestic and commercial wastewater: Member states' contributions to CH_4 emissions

Member State	CH4 emissions in kt CO2 equiv.			Share in EU28 emissions in 2013	Change 2012-2013		Change 1990-2013		Method applied	Emission factor
	1990	2012	2013		kt CO2 equiv.	%	kt CO2 equiv.	%		
Austria	121	25	25	0%	0	1%	-96	-79%	-	-
Belgium	835	255	215	2%	-40	-16%	-620	-74%	CR,T1	CR,D
Bulgaria	890	570	681	6%	111	19%	-209	-23%	T2	CS
Croatia	141	113	112	1%	-1	-1%	-29	-21%	T1	D
Cyprus	11	4	3	0%	-1	-27%	-8	-74%	T1	D
Czech Republic	371	308	308	3%	0	0%	-63	-17%	T1,T2	CS,D
Denmark	99	112	113	1%	1	1%	13	13%	CS	CS
Estonia	113	52	49	0%	-2	-5%	-63	-56%	T1	D
Finland	194	152	150	1%	-2	-1%	-45	-23%	CS,T2	CS,D
France	1 435	2 053	2 060	19%	8	0%	625	44%	-	-
Germany	1 766	27	24	0%	-3	-11%	-1 742	-99%	CS	CS,D
Greece	2 959	521	522	5%	1	0%	-2 437	-82%	D	D
Hungary	919	360	356	3%	-5	-1%	-563	-61%	T1	D
Ireland	61	51	51	0%	0	0%	-10	-17%	T1,T2	CS,D
Italy	1 702	1 148	1 113	10%	-35	-3%	-589	-35%	D	D
Latvia	223	58	65	1%	7	13%	-158	-71%	D	CS
Lithuania	542	238	220	2%	-18	-8%	-322	-59%	T1	D
Luxembourg	7	4	4	0%	0	-3%	-3	-46%	T1	CS
Malta	17	NA	NA	-	-	-	-17	-100%	D	CS
Netherlands	298	192	195	2%	3	2%	-103	-35%	T2	CS
Poland	2 309	568	631	6%	63	11%	-1 678	-73%	T1	D
Portugal	1 258	885	879	8%	-5	-1%	-378	-30%	T2	CS,D
Romania	2 768	1 790	1 789	16%	-2	0%	-979	-35%	D	D
Slovakia	437	315	311	3%	-5	-2%	-126	-29%	CS,T2	D
Slovenia	152	82	87	1%	6	7%	-64	-42%	T1	CS,D
Spain	1 167	261	261	2%	0	0%	-906	-78%	T1,T2	D
Sweden	31	23	23	0%	0	1%	-9	-27%	-	-
United Kingdom	1 427	750	726	7%	-24	-3%	-701	-49%	CS	CS
EU-28	**22 255**	**10 916**	**10 973**	**100%**	**57**	**1%**	**-11 282**	**-51%**		

Abbreviations explained in the Chapter 'Units and abbreviations'.

Figure 7.13 5D1 Domestic wastewater: Share of CH_4 recovered or flared and CH_4 emissions on total CH_4 produced from domestic wastewater handling



An important driver for CH_4 emissions from 5D Wastewater Handling are CH_4 emissions from 5D1 Domestic Wastewater in Germany, Greece, Poland and Romania in 1990. Therefore and in response to the recommendation by the ERT (FCCC/ARR/2009/EC, para 84), more information about the development of CH_4 emissions from wastewater handling in these countries is presented. *Figure **7.14*** show the relevant trends of the most important Member States for the time series 1990-2013.

French CH_4 emissions from domestic wastewater (5D1) show an increasing trend from 1990 to 2001 and remain at a rather constant level thereafter (with a slight increase since 2004). One driver influencing the trend is the share of population connected to different wastewater treatment systems. The share of the population connected to septic tanks increased from 1990 to 2000 (from 13 % in 1990 to 18 % in 2000), and remained almost constant thereafter (17 %). In the same period, the share of the population with direct discharge of wastewater decreased from 8 % in 1990 to 2 % in 2013. Wastewater treatment in collective systems increased slightly from 79 % in 1990 to 81 % in 2013.

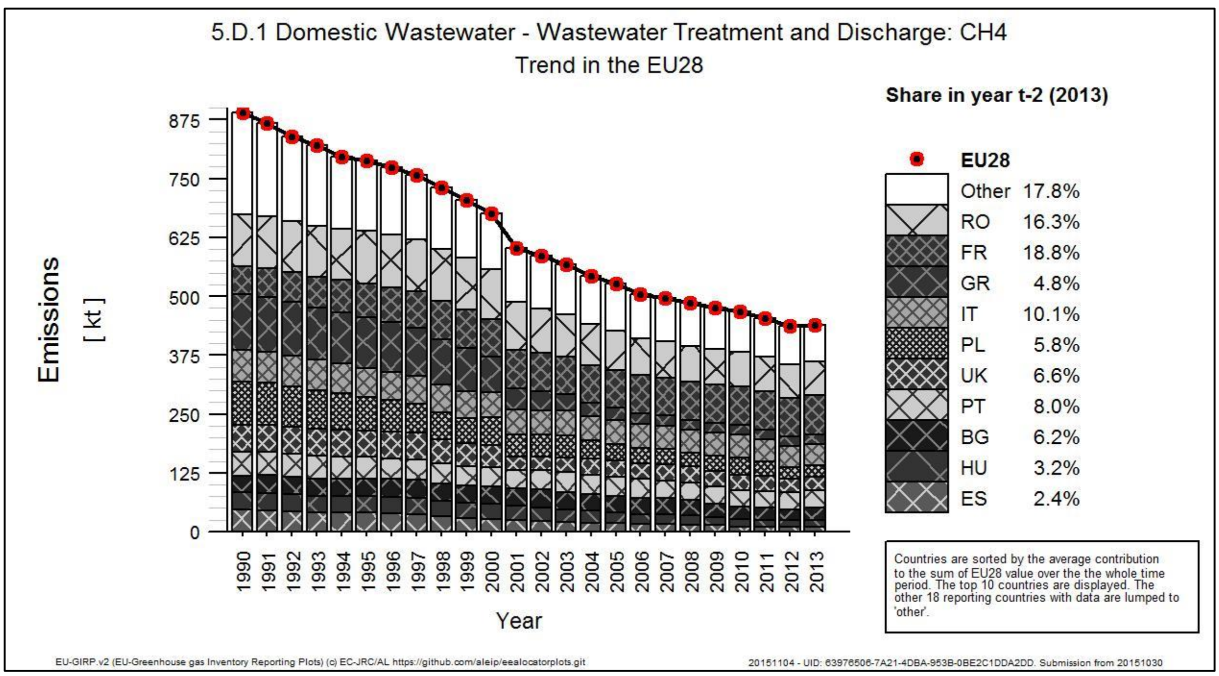
CH_4 emissions from domestic wastewater are continuously decreasing from 1999 onwards in Romania. The amount of wastewater that underlies sufficient treatment increases over the years. About 60 % of the total wastewater has been treated appropriate in 2013. Between 2000 and 2013 public sewage systems have been expanded and modernized.

Germany's reduction in CH_4 emissions from domestic and commercial wastewater (5D1) occurred mainly between 1990 and 1998. The decrease of 95 % in that period was due to the legal requirement to connect households to decentralised wastewater treatment plants. The basis for legal requirements for the collection and treatment of domestic and commercial wastewater is the Council directive 91/271/EWG concerning urban wastewater treatment from 1991. Many wastewater plants had to be built in the former GDR after the German reunification, as most households were not connected to a sewage system, but used septic tanks.

The Greek CH_4 emissions from 5D1 decreased mainly between 1999 and 2007 (-82 %) due to the increased number of wastewater handling facilities with aerobic conditions. Domestic wastewater handling in aerobic treatment facilities shows a substantial increase since 1999, while in the industrial sector only a few units exist where wastewater is handled under anaerobic conditions.

Italian CH_4 emissions from domestic wastewater handling have decreased slightly throughout the time series. In 1990 57 % of population was served by sewer systems and only 52 % of the population was served by wastewater treatment plants. In 2013 about 80 % of population is served by wastewater treatment plants.

Figure 7.14 5D1 Domestic wastewater: CH_4 emissions (Trend in relevant MS)



Methodological information

All wastewater generated by households as well as any wastewater not disposed of on site in industrial installations is reported as domestic wastewater. CH_4 emissions from wastewater occur under anaerobic conditions, they can originate during all stages from wastewater generation to final disposal. CH_4 emissions from domestic wastewater handling (5D1) are a significant emission source in category 5D and key source in the EU. The IPCC 2006 Guidelines introduce three different Tier methods to calculate

CH_4 emissions from waste water handling. Input data needed to estimate CH_4 emissions from domestic wastewater handling is the total degradable organic carbon (TOW) produced in a country. The TOW needs to be calculated based on the total population and the quantity of carbon discharged per person and day expressed in Biochemical Oxygen Demand (BOD). Many Member States apply the default value for BOD (0.6 kg CH_4/kg BOD) to estimate the total degradable organic carbon. Furthermore the country specific share of the different treatment pathways and systems of wastewater need to be identified. This is mainly done by analysing wastewater statistics and determining the share of population that is connected to the central sewage system and remaining wastewater that is treated in septic tanks or other wastewater treatment plants. The IPCC 2006 Guidelines provide default MCFs (methane correction factor) for each pathway, but also country specific MCFs can be applied. In the next submission a table on Member States specific methodology will be provided in the Annex.

If methane is recovered and burned (see *Figure **7**.**13***), the emissions from wastewater need to be adjusted accordingly. If sludge is removed from the wastewater, a corresponding quantity needs to be deducted from the Total Organically Degradable Content (TOW). Emissions from sludge decomposition are reported under solid waste disposal, biological treatment, burning or in the AFOLU sector depending on the disposal method.

7.2.4.2 Recalculations CH_4 emissions (CRF Source Category 5D)

For information on recalculations please refer to chapter 10.

7.2.5 Waste – Other (CRF Category 5E)

With the inclusion of the new IPCC category 5B on biological treatment of solid waste, the reporting of emissions from composting formerly reported under the category Other shifted. Only Denmark, Germany and Spain still report emissions under this category.

Germany reports N_2O and CH_4 emissions from the mechanical-biological treatment under the category 5E. Mechanical-biological treatment started in 1995 and continuously increases until 2013 in Germany. Denmark reports CO_2 and CH_4 emissions from accidental fires under 5E Other. Spain reports under the category 5E CH_4 emissions from the collected extended sludge from sewage treatment plants for drying, which can considered as an integral process of wastewater treatment.

Table 7.10 5E Other: Member states‘contributions to CO_2, CH_4 and N_2O emissions

Member State	GHG emissions in 1990 (kt CO2 equivalents)	GHG emissions in 2013 (kt CO2 equivalents)	CO2 emissions in 1990 (kt)	CO2 emissions in 2013 (kt)	N2O emissions in 1990 (kt CO2 equivalents)	N2O emissions in 2013 (kt CO2 equivalents)	CH4 emissions in 1990 (kt CO2 equivalents)	CH4 emissions in 2013 (kt CO2 equivalents)
Austria	0	0	NO	NO	NO	NO	NO	NO
Belgium	0	0	NO	NO	NO	NO	NO	NO
Bulgaria	0	0	NO	NO	NO	NO	NO	NO
Croatia	0	0	NO	NO	NO	NO	NO	NO
Cyprus	0	0	NO	NO	NO	NO	NO	NO
Czech Republic	0	0	NO	NO	NO	NO	NO	NO
Denmark	19	18	18	16	NA	NA	2	2
Estonia	0	0	NO	NO	NO	NO	NO	NO
Finland	0	0	NO	NO	NO	NO	NO	NO
France	0	0	NO	NO	NO	NO	NO	NO
Germany	0	133	NA	NA	NO	127	NO	6
Greece	0	0	NO	NO	NO	NO	NO	NO
Hungary	0	0	NO	NO	NO	NO	NO	NO
Ireland	0	0	NO	NO	NO	NO	NO	NO
Italy	0	0	NO	NO	NO	NO	NO	NO
Latvia	0	0	NO	NO	NO	NO	NO	NO
Lithuania	0	0	NO	NO	NO	NO	NO	NO
Luxembourg	0	0	NO	NO	NO	NO	NO	NO
Malta	0	0	NO	NO	NO	NO	NO	NO
Netherlands	0	0	NA	NA	NO	NO	NO	NO
Poland	0	0	NO	NO	NO	NO	NO	NO
Portugal	0	0	NA	NA	NO	NO	NO	NO
Romania	0	0	-	-	-	-	-	-
Slovakia	0	0	NO	NO	NO	NO	NO	NO
Slovenia	0	0	NO	NO	NO	NO	NO	NO
Spain	44	1	NA	NA	NA	NA	44	1
Sweden	0	0	-	-	-	-	-	-
United Kingdom	0	0	NO	NO	NO	NO	NO	NO
EU-28	**63**	**152**	**18**	**16**	**0**	**127**	**46**	**8**

7.3 EU-28 uncertainty estimates

For information on uncertainties please refer to chapter 1.6.

7.4 Sector-specific quality assurance and quality control

Under the Climate Change Committee a workshop was conducted in spring 2005 on inventories and projections of greenhouse gas emissions from waste. The main objectives of the workshop were: (1) to provide an opportunity to learn about the methods used for inventories and projections in the different member states, to share information, experience and best practice; (2) to compare the parameters chosen in the estimation methodologies across EU-28 member states; (3) to compare emissions and methods used for GHG inventories with data and methods for EPER; and (4) to strengthen links between assessment of air pollution under the IPPC and emissions under the UNFCCC. In addition, the workshop provided an opportunity to discuss potential methodological changes or improvements of the draft 2006 IPCC inventory guidelines. The recommendations and presentations of this workshop can be downloaded from the Internet under the following link: http://air-climate.eionet.eu.int/docs/meetings/050502_GHGEm_Waste_WS/meeting050502.html. Clarifications from discussions of individual parameters used in the estimation of emissions from waste were incorporated in this report.

A second expert meeting under the Climate Change Committee on the estimation of CH_4 emissions from solid waste disposed to landfills was conducted in March 2006. This meeting was targeting in particular those EU member states that do not yet use the IPCC FOD methods for their inventories (mostly new EU member states). The objective of the expert meeting was to use the new default model provided by draft 2006 IPCC Guidelines for national GHG inventories in order to calculate CH_4 emissions for the participants' countries. 11 member states, 2 EEA Member countries, and one accession country participated. 9 of the 14 countries had previously not estimated CH_4 emissions with a FOD method. The meeting enabled those member states that still used Tier 1 method to use the FOD model with national/default data as available. Other member states used the IPCC FOD model as quality check and for comparison with the results of the country-specific model with usually minor differences compared to the national model. The meeting also contributed to the exchange of experiences of specific circumstances regarding waste generation, composition and solid waste disposal in new member states and on the estimation of CH_4 recovery in the absence of monitored data. In addition, the meeting provided recommendations to IPCC for further improvement and corrections of the draft default model.

In 2012 a comprehensive review was carried out for all sectors and all EU Member States in order to fix the base year 2020 under the EU Effort Sharing Decision. (ESD review 2012). This review also covered the waste sector of the MS GHG inventories (peer review).

Every year before and during the compilation of the EU GHG inventory several checks are made of the Member States data in particular for time series consistency of emissions and implied emission factors, comparisons of implied emission factors across Member States and checks of internal consistency.

In 2015, additional quality checks of the EU NIR chapter waste were carried out in order to improve the consistency between the CRF tables and the EU NIR and consistency of tables and figures with text in the EU NIR.

7.5 Sector-specific recalculations

For information on recalculations please refer to chapter 10.

8 OTHER

This sector does not include any emissions in 2015.

9 INDIRECT CO_2 AND NITROUS OXIDE EMISSIONS

9.1 Description of sources of indirect emissions in the GHG inventory

Figure 9.1 summarizes indirect CO_2 and nitrous oxide emissions reported in the CRF. For the 2013 reporting round nine countries provided values for indirect CO_2 emissions[64]. The highest shares of the EU-28 total of indirect CO_2 emissions are held by the Czech Republic (49%), France (22%) and Denmark (10%). Eight countries reported indirect N_2O emissions, whereof the United Kingdom holds a share of 99% of the total EU-28 indirect N_2O emissions in 2013.

Figure 9.1 Indirect CO_2 and nitrous oxide emission for EU-28

Member States	indirect CO_2 kt CO_2 equiv.	Share in EU-28 %	indirect N_2O kt CO_2 equiv.	Share in EU-28 %
Austria	NO,NA	-	NO,NA	-
Belgium	NE,NO	-	NE,NO	-
Bulgaria	NO	-	2	0.06%
Croatia	NA,NO	-	NA,NO	-
Cyprus	NO	-	NO	-
Czech Republic	2249	49%	8	0.2%
Denmark	465	10%	0.8	0.02%
Estonia	14	0.3%	NO	-
Finland	80	2%	0.6	0.015%
France	1001	22%	NO	-
Germany	NE,NA,NO	-	IE,NE,NA,NO	-
Greece	NE,NO	-	NE,NO	-
Hungary	NE,NO	-	NE,NO	-
Ireland	66	1.5%	NO,NE	-
Italy	NO	-	4	0.1%
Latvia	112	2.5%	IE,NA,NO	-
Lithuania	NE,NO	-	NE,NO	-
Luxembourg	NE,NO	-	NE,NO	-
Malta	NO,NE	-	NO,NE	-
Netherlands	329	7%	NE,NO	-
Poland	NA	-	NA	-
Portugal	236	5%	NE,NO	-
Romania	NE,NO	-	5	0.1%
Slovakia	NE,NO	-	NE,NO	-
Slovenia	NE,NO	-	NE,NO	-
Spain	NE	-	NE	-
Sweden	NE,NO	-	0.009	0.0002%
United Kingdom	NE,NO	-	4221	99%
EU-28	**4 553**	**100%**	**4 243**	**100%**

[64] According to the UNFCCC reporting guidelines, Annex I Parties may report indirect CO_2 from the atmospheric oxidation of CH_4, CO and NMVOCs. For Parties that decide to report indirect CO_2 the national totals shall be presented with and without indirect CO_2. For technical reasons in the 2015 inventory submission, the EU-28 totals shown in this report are based on national totals excluding LULUCF and excluding indirect CO_2. This does not pre-empt the inclusion of these emissions in future inventory submissions.

10 RECALCULATIONS AND IMPROVEMENTS

10.1 Explanations and justifications for recalculations, including responses to the review process

This chapter includes an overview of the recalculations made since the the submission 2014. As new global warming potentials have been used in 2015 for CH_4, N_2O and fluorinated gases the recalculations are not only the result of methodological changes and revised activity data but also reflect the new global warming potentials.

10.2 Implications for emission levels

Table 10.1 provides the differences in total EU-28 GHG emissions between the latest submission and the previous submission in absolute and relative terms. The table shows that due to recalculations, total EU-28 1990 GHG emissions excluding LULUCF have increased in the latest submission compared to the previous submission by 1.0 %. EU-28 GHG emissions for 2012 increased by 0.4 % due to recalculations.

Table 10.1 Overview of recalculations of EU-28 total GHG emissions (difference between latest submission and previous submission in Gg CO_2 equivalents)

	1990	1995	2000	2005	2010	2011	2012
Total CO_2 equivalent emissions including LULUCF (absolute)	52 629	77 573	46 820	29 218	32 563	22 762	9 703
Total CO_2 equivalent emissions including LULUCF (percent)	1.0%	1.6%	1.0%	0.6%	0.7%	0.5%	0.2%
Total CO_2 equivalent emissions excluding LULUCF (absolute)	53 890	69 093	55 602	45 614	34 900	26 900	18 480

Table 10.2 and Table 10.3 give an overview of absolute and percentage changes of Member States' emissions due to recalculations for 1990 and 2012. Large recalculations in relative terms (more than 2 %) for 2012 were made in Belgium, Croatia, Finland, Hungary, Netherlands, Portugal, Slovakia, and Spain.

Table 10.2 Contribution of Member States to EU-28 recalculations of total GHG emissions without LULUCF for 1990–2012 (difference between latest submission and previous submission Gg of CO_2 equivalents)

	1990	1995	2000	2005	2010	2011	2012
Austria	597	-287	-153	-85	-20	-178	-266
Belgium	4,166	3,943	3,492	2,954	2,727	2,803	2,700
Bulgaria	240	-222	300	454	296	196	91
Croatia	3,178	1,089	413	42	-567	-823	-914
Cyprus	-528	-400	-435	-290	-65	16	-124
Czech Republic	-2,790	1,634	-246	-1,545	-1,374	-654	-868
Denmark	607	1,067	1,231	1,394	1,038	880	962
Estonia	-585	-104	-78	-29	-2	-19	220
Finland	737	856	802	706	1,310	1,184	1,400
France	-7,988	-5,325	-6,086	-3,916	0	-912	-623
Germany	-181	2,573	3,990	-1,767	-3,731	-5,981	-10,991
Greece	82	1,460	1,358	1,027	1,238	1,339	1,594
Hungary	-3,380	-2,740	-2,855	-2,427	-2,145	-2,128	-1,994
Ireland	1,426	741	799	1,693	975	1,012	1,005
Italy	2,003	2,339	2,505	3,996	7,131	7,691	8,830
Latvia	-29	115	154	-17	-90	-9	-12
Lithuania	-909	279	-61	-151	-212	-262	-381
Luxembourg	-13	-9	-44	87	18	-22	-95
Malta	8	-4	22	-22	31	51	31
Netherlands	7,627	7,429	5,943	3,781	4,505	4,985	4,599
Poland	7,537	4,237	-3,305	-559	635	-590	-456
Portugal	-341	-277	-499	212	-295	-372	-1,796
Romania	5,654	8,433	7,068	6,060	1,907	1,052	2,213
Slovakia	2,306	1,801	1,296	1,337	1,566	1,472	996
Slovenia	118	146	121	142	83	37	-13
Spain	6,991	8,446	9,824	9,434	9,639	9,344	7,913
Sweden	-877	-243	124	-89	-90	40	-279
United Kingdom	28,233	32,115	29,921	23,192	10,394	6,749	4,736
EU-28	**53,890**	**69,093**	**55,602**	**45,614**	**34,900**	**26,900**	**18,480**

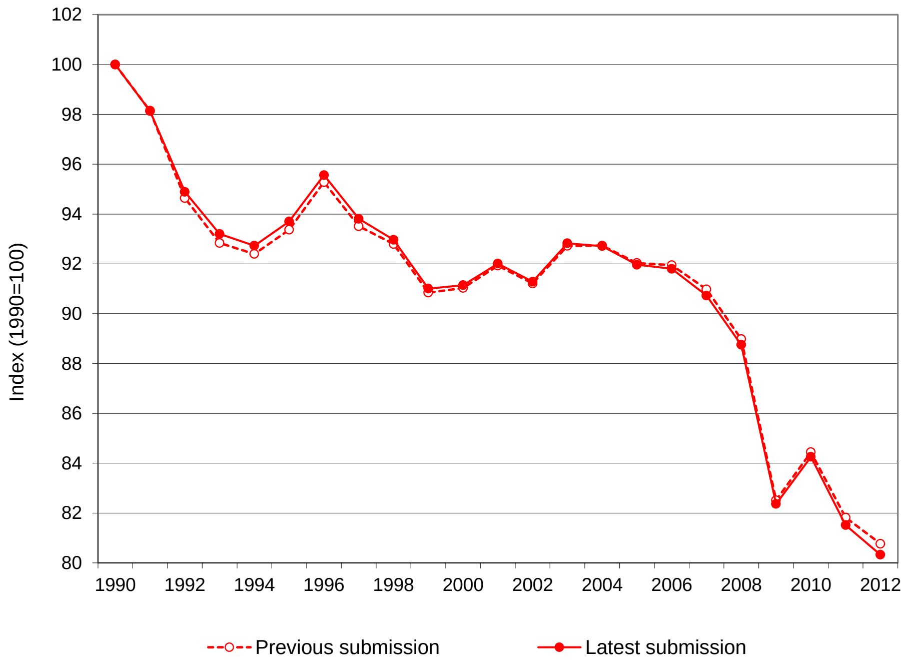
Table 10.3 Contribution of Member States to EU-28 recalculations of total GHG emissions without LULUCF for 1990–2012 (difference between latest submission and previous submission in percentage)

	1990	1995	2000	2005	2010	2011	2012
Austria	0.8%	-0.4%	-0.2%	-0.1%	0.0%	-0.2%	-0.3%
Belgium	2.9%	2.6%	2.4%	2.1%	2.1%	2.3%	2.3%
Bulgaria	0.2%	-0.3%	0.5%	0.7%	0.5%	0.3%	0.1%
Croatia	10.0%	4.6%	16%	0.1%	-2.0%	-2.9%	-3.5%
Cyprus	-8.7%	-5.3%	-4.9%	-2.9%	-0.6%	0.2%	-13%
Czech Republic	-14%	1.1%	-0.2%	-1.1%	-10%	-0.5%	-0.7%
Denmark	0.9%	14%	18%	2.2%	17%	16%	19%
Estonia	-14%	-0.5%	-0.5%	-0.2%	0.0%	-0.1%	1.1%
Finland	10%	12%	12%	10%	18%	18%	2.3%
France	-14%	-10%	-1.1%	-0.7%	0.0%	-0.2%	-0.1%
Germany	0.0%	0.2%	0.4%	-0.2%	-0.4%	-0.6%	-12%
Greece	0.1%	13%	1.1%	0.8%	1.1%	12%	14%
Hungary	-3.5%	-3.5%	-3.7%	-3.1%	-3.2%	-3.2%	-3.2%
Ireland	2.6%	13%	12%	2.4%	16%	18%	17%
Italy	0.4%	0.4%	0.5%	0.7%	14%	16%	19%
Latvia	-0.1%	0.9%	15%	-0.1%	-0.8%	-0.1%	-0.1%
Lithuania	-19%	13%	-0.3%	-0.6%	-10%	-12%	-18%
Luxembourg	-0.1%	-0.1%	-0.4%	0.7%	0.1%	-0.2%	-0.8%
Malta	0.4%	-0.2%	0.9%	-0.8%	10%	17%	10%
Netherlands	3.6%	3.3%	2.8%	18%	2.2%	2.6%	2.4%
Poland	16%	10%	-0.8%	-0.1%	0.2%	-0.1%	-0.1%
Portugal	-0.6%	-0.4%	-0.6%	0.2%	-0.4%	-0.5%	-2.6%
Romania	2.3%	4.8%	5.3%	4.3%	16%	0.9%	19%
Slovakia	3.1%	3.4%	2.6%	2.7%	3.5%	3.3%	2.3%
Slovenia	0.6%	0.8%	0.6%	0.7%	0.4%	0.2%	-0.1%
Spain	2.5%	2.6%	2.6%	2.2%	2.8%	2.7%	2.3%
Sweden	-12%	-0.3%	0.2%	-0.1%	-0.1%	0.1%	-0.5%
United Kingdom	3.6%	4.4%	4.3%	3.4%	17%	12%	0.8%
EU-28	**1.0%**	**1.3%**	**1.1%**	**0.9%**	**0.7%**	**0.6%**	**0.4%**

10.3 Implications for emission trends, including time series consistency

Figure 10.1 shows that due to the fact that recalculations in 1990 were higher than in 2012 the emission trend in the EU-28 change. In the previous submission the trend of GHG excluding LULUCF between 1990 and 2012 was – 19.2 %. In the latest submission the trend is -19.7 %.

Figure 10.1: Comparison of EU-28 GHG emission trends 1990–2012 (excl. LULUCF) of the latest and the previous submission



10.4 Planned improvements in response to the review process

10.4.1 EU response to UNFCCC review

In Table 10.4 a list of recommendations and improvements is presented in. The table focuses on UNFCCC recommendations from the review reports 2013 and 2014

Table 10.4 Improvements in the in 2015 in response to UNFCCC review findings

NIR chapter / Sectors	Source category / Issues	Reccomendation/ improvements planned	References	Status
Energy	Feedstocks and non-energy use of fuels	Previous review reports recommended that the European Union use weighted averages of carbon stored for all fuels in a consistent manner.11 The ERT commends the Party for implementing this recommendation. However, the ERT noted that some of the weighted averages of carbon stored reported in CRF table 1.A(d) were significantly higher than IPCC default values in the Revised IPCC Guidelines. For example, for lubricants, the weighted average is 0.77 compared with the IPCC default value of 0.5. In response to questions raised by the ERT during the review, the European Union indicated that some Parties used 1.0 as the fraction of carbon stored in order to remove fuel emissions that are reported under other sectors (industrial processes) and avoid double counting. The ERT recommends that the European Union clearly explain this in its annual submission and make efforts to enhance the consistency and accuracy of reporting among member States. (para 46)	Draft ARR 2014	Planned for 2015
Chapter 3 / Energy	1A3 / Transport	The ERT noted that the European Union has provided many tables in the NIR giving details on tiers and sources of EFs used in the member States' estimates for each subcategory (e.g. table 3.6). The ERT believes such tables are very useful. However, the information is often reported in an inconsistent way. For example table 3.51 (road transport, gasoline) does not describe all methods as tier 1, 2 or 3 (e.g. Belgium reports "other (OTH)", Austria reports "country specific, model"). Further, these labels are not always consistent with the accompanying text in the NIR. The ERT also noted that not all abbreviations are explained (e.g. OTH, CR) and the version of the core inventory of air emissions (CORINAIR) used is not specified. The ERT recommends that the European Union check these tables and ensure that: all member States' methods are correctly and consistently classified where tiers are provided in the Revised 1996 IPCC Guidelines or the IPCC good practice guidance; all codes used in the table are explained in the section Units and abbreviations; and references to sources such as CORINAIR are included.	ARR 2013	Ongoing This issue has been corrected in almost all cases in the EU NIR 2014, with the collaboration of MSs. But we will continue to improve the quality of these tables since they are useful.
Chapter 3 / Energy	1A3 / Transport	The ERT noted that the 2013 NIR states that "[a]t the moment two versions of the COPERT model are being used in EU–15 countries to estimate emissions, namely COPERT III and COPERT 4" (page 220), while table 3.56 indicates that only COPERT 4 is used." In response to an earlier draft of this report, the European Union revealed that, in fact, COPERT III was used by only one region of Belgium. The ERT reiterates the recommendation made in the previous review report that the European Union strengthen the QA/QC procedures to ensure that the member States' information is updated and correctly represented in the NIR.	ARR 2013	Ongoing This issue has been corrected in the EU NIR 2014, since Belgium in now using COPERT 4. But we will continue the effort to ensure that the MSs information is updated and correctly represented in future inventory submissions.

NIR chapter / Sectors	Source category / Issues	Reccomendation/ improvements planned	References	Status
Chapter 3 / Energy	1A3b / Transport - Road Transport diesel N_2O IEF	The ERT noted that the peak for the IEF for road transportation (diesel oil - N_2O) for 1998 is not explained in the NIR. The ERT recomments that the Party improve the transparency of its reporting by ensuring that explanatory information regarding the emission and IEF trends is included in the NIR in a comprehensive manner	Draft ARR 2014	Some explanatory information has been incluede in the NIR 2015
Chapter 3 / Energy	1A3b / Transport - Recalculations	The ERT noted that some improvements that resulted in recalculations were not reported as such in the NIR: for example, during the review the European Union informed the ERT that Belgium had recalculated the emissions from transport for the entire time series using COPERT 4v10 but this is not reflected in the European Union NIR under recalculations. Therefore, the ERT recommends that the Party ensure transparency, completeness and consistency in its reporting of the recalculations, by working with its member States to achieve the enhancement of the European Union QA/QC system	Draft ARR 2014	ongoing
Chapter 3 / Energy	International bunker fuels	The ERT recommends to use most recent results of the collaboration with Eurocontrol to improve the accuracy of emission estimates for the European Union and for the member States, ensuring the consistency in the time series in accordance with the IPCC good practice guidance	Draft ARR 2014	The results of the collaboration with Eurocontrol are provided in the EU NIR 2015
Chapter 3 / Energy	1A3a / Transport - Civil Aviation	The ERT recommends to promote the use of the results of the collaboration between the European Union and Eurocontrol to improve the accuracy of the inventory in the annual submission	Draft ARR 2014	In the 2015 NIR we reporedt the results of the collaboration with Eurocontrol, in order to improve the accuracy of the emissions estimates
IPPU	Sector overview	Para 44, ERT recommends that the European Union explore ways to replace the use of notation keys with actual values in background data . . . in order to improve the transparency of the reporting of the background data.	ARR 2013	implemented
IPPU	Sector overview	Para 56, The ERT . . .recommends that the Party provide justifications in the NIR as to why the use of international data sources to report AD at European Union's level would lead to strongly inaccurate reporting	ARR 2014	ongoing
IPPU	Sector overview	Para 57, … the ERT noted significant disparities among the description of methods for individual member States in the summary tables presented in the Party's NIR, whereby there are no sufficient subcategory descriptions of methods for some member States, for example there is a lack of methodology descriptions in NIR table 4.4 and 4.22 …The ERT recommends that the European Union improves the summary descriptions of methodologies in the NIR for all member States.	ARR 2014	ongoing

NIR chapter / Sectors	Source category / Issues	Reccomendation/ improvements planned	References	Status
IPPU	Cement production – CO_2	Para 59. The ERT was provided with further information on Germany using the same clinker EF for the whole time series and recommends that the European Union include this information in the NIR.	ARR 2014	implemented
IPPU	Cement production – CO_2	Para 60. The ERT found insufficient methodological information for the methodology used by the United Kingdom	ARR 2014	implemented
IPPU	Cement production – CO_2	61. On the basis of table 4.5 of the NIR (on the implementation of previous recommendations), the ERT reiterates the recommendation made in previous review reports that the EU continue to work with Spain to implement a qualitative assessment of the range of IEFs based on of the composition of raw material used.	ARR 2014	ongoing
IPPU	Cement production – CO_2	62. The ERT noted in the NIR that Latvia reports the use of a tier 1 approach and recommends that the EU work with Latvia to ensure that it uses a tier 2 rather than a tier 1 approach when estimating cement production emissions, given that it is possible to obtain clinker data from the plants.	ARR 2014	ongoing
IPPU	Cement production – CO_2	63. The ERT considers that referring to the NIRs of member States does not ensure sufficient transparency within the NIR of the EU.	ARR 2014	implemented
IPPU	Lime production – CO_2	64. ERT reiterates previous recommendations that the EU provide more information for Italy about the methods used to estimate emissions from lime production for the entire time series	ARR 2014	implemented
IPPU	Limestone and dolomite use – CO_2	65. Croatia reports on approaches for the collection of AD (mainly surveys), for an overall period of 1990–1996, without explaining what data collection methods have been used from 1997 to 2012. In response to a question raised by the ERT during the review, the European Union stated that Croatia explained that more detailed AD have been collected from individual plants for the period 2008–2012, and that all data regarding this category are currently being further investigated in order to ensure accurate CO_2 emission calculations for the whole time series in a consistent manner. The ERT recommends that the European Union include this information for Croatia in the NIR in order to enhance the transparency of the description of methods and also recommends that the European Union work with Croatia to ensure the consistency of the full time series.	ARR 2014	ongoing
IPPU	Ammonia production – CO_2	52. In the United Kingdom, CO_2 emissions from ammonia production are assumed to be stored in chemical feedstocks in one plant. The ERT ecommended that the EU provide more detailed explanations.	ARR 2013	implemented

NIR chapter / Sectors	Source category / Issues	Reccomendation/ improvements planned	References	Status
IPPU	Ammonia production – CO_2	66. The ERT noted in the NIR that the European Union did not provide adequate methodology overviews for emissions from ammonia production for France and Germany. The methodology summary for France essentially mentions four ammonia production plants in France, without giving details on AD, EFs and other methodological information. The methodology summary for Germany essentially mentions a tier 3 approach being used without giving any further details. The ERT recommends that the European Union provide in its NIR adequate and transparent methodology overviews for France and Germany to enable the ERT to make a thorough review of the AD and EFs used in the ammonia production emission estimations of these countries.	ARR 2014	implemented
IPPU	Ammonia production – CO_2	67. On the basis of the status report provided by the European Union in table 4.23 of the NIR (on the implementation of previous recommendations), the ERT reiterates the recommendation made in previous review reports that the European Union make efforts to ensure that Greece complete the on-going work to obtain more accurate data on the amount of liquid fuel used as feedstock and the updated AD in the emission estimates.	ARR 2014	implemented
IPPU	Nitric acid production – N_2O	68. The ERT noted that the European Union did not provide adequate methodology overviews in its NIR for emissions from nitric acid production for France, Germany and Greece. The methodology summary for Germany essentially mentions a tier 3 approach being used without giving any further details. The methodology summary for Greece essentially mentions the source of data and use of average IPCC default factors for the single production unit in the country, without giving details on AD, rationale for the EFs used and other methodological information. The ERT recommends that the European Union provide in its NIR adequate methodology overviews for France, Germany and Greece to enable the ERT make a thorough review of the AD and EFs used in the nitric acid production emission estimations of those member States.	ARR 2014	implemented
IPPU	Nitric acid production – N_2O	69. On the basis of the status report provided by the European Union in table 4.27 of the NIR (on the implementation of previous recommendations), the ERT reiterates the recommendation made in the previous review report that the European Union improve the transparency of information provided in the NIR for Spain by finding alternative ways of reporting the necessary information without violating the existing rules on confidentiality.	ARR 2014	implemented
IPPU	Other (chemical industry) – CO_2	70. On the basis of the status report provided by the European Union in table 4.37 of the NIR (on the implementation of previous recommendations), the ERT reiterates the recommendation made in previous review reports that the European Union work with Finland in order to develop a way of reporting indirect CO_2 emissions which will allow CO_2 emissions from biomass to be distinguished from the fossil fuel component and use this in the CRF tables of its annual inventory submission, and provide an appropriate methodology description in the NIR.	ARR 2014	implemented

NIR chapter / Sectors	Source category / Issues	Reccomendation/ improvements planned	References	Status
IPPU	Other (chemical industry) – CO_2	71. From table 4.37 of the NIR, the ERT reiterates recommendations to include the methodological description of France for this subcategory.	ARR 2014	implemented
IPPU	Other (chemical industry) – CO_2, refinery catalyst coke burn off emissions	para 72, … The ERT welcomes the clarification provided by the European Union regarding Germany's effort to better understand the nature of emissions and recommends that the European Union work with Germany to report follow-up information on the appropriate allocation of catalyst coke burn off emissions.	ARR 2014	ongoing
IPPU - Product uses as substitutes to ODS (2F)	Methodologies for emission estimates from 2.F onlyfor EU-15 in EU NIR	74. Noting that the Party's reference to the NIRs from member States, which are included as annexes and, in total, cover thousands of pages, does not ensure the transparency of reporting, the ERT recommends that the European Union endeavour to provide in the NIR summary overviews of methodology descriptions for key categories based on the relevant methodological descriptions reported in the NIRs of its member States.	AAR 2014	Done
IPPU - Product uses as substitutes to ODS (2F)	Notation keys partly lacking or recommendations unresolved	75. The unresolved issues on notation keys include the following: "NE" reported by Denmark for amount of gas remaining in products at decommissioning; "NO" (not occurring) reported by Finland for SF_6 emissions from aluminium and magnesium foundries; "IE" and "NA" (not applicable) by Ireland regarding AD and emission estimates for HFC emissions from refrigeration and air-conditioning equipment (except mobile air conditioning); "NO" by Luxembourg for reporting potential emissions of PFCs from refrigeration and air-conditioning equipment; "NA" and "NA and NO" by the Netherlands for AD and IEFs of emissions from stocks in industrial refrigeration and mobile equipment, whereas the emissions are actually estimated; and empty cells in the CRF tables for Spain as a replacement of "NA" and "NE" notation keys in reporting emissions from semiconductor manufacturing.	AAR 2014	Partly resolved, partly software issues
IPPU - Product uses as substitutes to ODS (2F)	Transparency of emission reporting done by the Netherlands	77. The ERT noted in the NIR of the European Union that the Netherlands explains that many processes related to the use of HFCs and SF_6 take place in only one or two companies, and that because of the sensitivities of the data from these companies only certain emissions are reported. In response to a question raised by the ERT during the review, the European Union stated that the Netherlands explained that there was a misunderstanding in the way the information was portrayed in the NIR of the European Union, and that the information was clearer in the NIR of the Netherlands. The Netherlands had further informed the Party that the correct version was: "The consumption data of aerosols, fire extinguishers, foams and solvents originate from only one or two companies and because of the sensitivity of data from these companies, the HFC emissions from categories 2F2-2F5 are reported together in 2F9. In addition, processes related to the use of PFCs and SF_6 in semiconductor manufacture and electrical equipment take place in only one or two companies. Because of the sensitivity of data from these companies, only the sum of the PFC and SF_6 emissions of 2F7	AAR 2014	Resolved.

NIR chapter / Sectors	Source category / Issues	Reccomendation/ improvements planned	References	Status
		and 2F8 is reported (included in 2F9)". The ERT accepted this clarification and recommends that the European Union include this explanation in the annual submission when reporting emissions for the Netherlands and enhance the QC procedures to ensure that the information in the Party's NIR accurately reflects the information in the NIR of member States.		
IPPU - Product uses as substitutes to ODS (2F)	Activity data for emission reporting from fire protection equipment (2F3)	78. The ERT observed that the NIR of the European Union reports that Greece uses AD from neighbouring countries (Italy, Spain and Portugal) to estimate emissions from consumption of halocarbons and SF_6. In response to a question raised by the ERT during the review, the European Union informed the ERT that Greece stated that it had explained in its NIR 2014 for Greece (p. 207) that this approach has been used for estimating HFC-227ea emissions from "fire protection equipment" only, which accounted for about 0.9 per cent of total F-gas emissions from the use of ozone-depleting substances (ODS) substitutes in 2012. Greece explained that this was due to a lack of information to implement the methodology suggested in the IPCC good practice guidance, but a country-specific estimation of the emissions has been used, based on the assumption that the use of HFCs in fire equipment in Greece is similar to the use in other Mediterranean countries (Italy, Portugal, Spain) and taking into consideration each country's population. Greece also stated that, in the framework of the 2011 improvement plan, the Greek Fire Service-Fire Safety Division has been contacted in order to determine the availability of information for the use of HFCs and/or PFCs in fire equipment. The ERT recommends that the European Union work with Greece in order to implement appropriate country-specific methodologies to estimate these emissions in accordance with the IPCC good practice guidance.	AAR 2014	Ongoing.

Table 10.5 Improvements in the sector Agriculture in 2015 in response to UNFCCC review findings

NIR chapter / Sectors	Source category / Issues	Reccomendation/ improvements planned	References	Status
Agriculture		ERT encouragement: use the NIR structure as it is included in the Annotated outline of the National Inventory Report including reporting elements under the Kyoto Protocol.	ICR 2013	New structure has been implementd

NIR chapter / Sectors	Source category / Issues	Reccomendation/ improvements planned	References	Status
Agriculture		para 67. The ERT commends the Party for the increased use of higher-tier approaches in comparison to the 2012 annual submission (e.g. for manure management, the percentage of emissions estimated based on a country-specific methodology increased from approximately 63 per cent in the 2012 annual submission to 86 per cent in 2013). The ERT recommends that the European Union further support and encourage member States to develop country-specific AD and EFs in order to allow for increased use of higher-tier approaches.	ARR 2013	no further action required
Agriculture	Consist.	• Several inconsistencies within the NIR, for example:	ICR 2013	
		o in Tables 6.14 and 6.86 a Tier 1 method is specified as used by Greece for Non -Dairy Cattle, while in Table 6.15 a Tier 2 method is presented;		
		o in Table 6.23 only the value of uncertainty associated with the Cattle livestock number in Austria in presented, in Table 6.24 only the value for Cattle related EF is included, while in Table 6.25 containing background information from the MSs NIRs, values are included for all livestock.		Sector-specific method for the quantification of the Tier level and the aggregation of the uncertainty has been dropped in 2015. No further action required
		• ERT recommendations:		
		o improve the implementation of QC activities;		A completely new QA/QC system has been implemented in 2015.
		o update the algorithm of inclusion of MSs data and information into the EU inventory .		
Agriculture	Transp.	In addition, the ERT identified some transparency issues linked to the reporting of the tier method used to estimate CH_4 emissions from enteric fermentation in tables 6.2, 6.14 and 6.15 of the NIR for sheep and cattle for some member States. During the review, the Party explained that the aforementioned three tables have different sources: table 6.2 was obtained from the officially submitted CRF tables of the European Union member States; table 6.15 comprises quotations from the member States' NIRs, with the level of detail and nature of the information depending on each NIR; and table 6.14 provides a quantification of the tier level according to the approach from Leip (2010).9 The ERT recommends that, in the next annual submission, the Party improve the transparency of the reported information. The ERT welcomes the information provided by the Party on the thorough update of the tables on the basis of the data in the NIRs for the next annual submission. (para 74)	ARR 2012	Sector-specific method for the quantification of the Tier level and the aggregation of the uncertainty has been dropped in 2015. No further action required
Agriculture	Consist.	The ERT noted some inconsistencies within the NIR, within the CRF tables and between the CRF tables and the NIR concerning the reporting of some data and methods. For example: a tier 1 method for estimating emissions from enteric fermentation is reported for France in table 6.15 for sheep, whereas a tier 2 method is reported in table 6.14 and a tier 3 method in table 6.3;	ARR 2012	see above

NIR chapter / Sectors	Source category / Issues	Reccomendation/ improvements planned	References	Status
Agriculture	Consist.	the summation of the allocation per animal waste management system for swine is lower than 100 per cent in table 6.29 (74 per cent) and table 6.30 (80 per cent) of the NIR; and reference is made to a non-existent CRF table 7s2 in section 6.3 of the NIR. The ERT also noted that data on the weight reported for different livestock differ from CRF table 4.A to CRF table 4.B(a); and that the numbers of dairy cattle and non-dairy cattle are reported as 17,525,000 and 58,515,000, respectively, in table 6.13 of the NIR and CRF table 4.A, and these values are different from those reported in table 6.16 of the NIR for dairy cattle (19,045,000) and non-dairy cattle (61,169,000). In response to questions raised by the ERT during the review, the Party attributed the inconsistencies related to the population size of dairy cattle and non-dairy cattle within the NIR and between the NIR and the CRF tables to unintentional double counting of the number of cattle that were reported using option B. The ERT recommends that, in the next annual submission, the European Union improve its QC activities to ensure the consistency of the reporting within the NIR, within the CRF tables and between the CRF tables and the NIR. (para 75)	ARR 2012	no further action required
Agriculture	Transp.	68. Recalculations were performed for the entire time series (see table 9 below) and are documented in the NIR at the sectoral level. However, only the reasons for recalculations by categories for some member States are included, and it is not clear whether all the reasons for recalculations are reported. In addition, no numerical information by member State on the impact of recalculations per category is included (CRF table 8(b) only refers to member States which performed recalculations). Furthermore, there are inconsistencies in how recalculations are presented in the NIR. For example, a section on the recalculations of CH_4 emissions from field burning of agricultural residues is not included in the NIR, but a section on the recalculations of CH_4 emissions from agricultural soils is (although it includes primarily a discussion on rice cultivation). The ERT reiterates the recommendation made in the previous review report that the Party include in the NIR information on recalculations for all member States that conducted recalculations, including numerical information per member State, and include the rationale and impact of the recalculations on the category. The ERT encourages the European Union to include a specific section in the NIR on the recalculations performed for CH_4 emissions from field burning of agricultural residues and recommends that the Party resolve the error described above in the section on agricultural soils.	ARR2013	No further action required. The approach of reporting re-calculation in the 2015 submission is different due to the specifities of this year.
Agriculture	Transp.	However, the ERT noted some issues relating to a lack of transparency, as background information related to data and methods is not provided for all member States (e.g. tables of background information on AD and EFs related to CH_4 from manure management covered 11 and 14 member States, respectively; background information on methods and EFs related to N_2O from manure management was provided for nine and six members States, respectively; and the background information on agricultural soils, including methods, data and parameters, such as $Frac_{GRAZ}$, $Frac_{GASF}$, $Frac_{GASM}$ and FracLEACH, also did not cover all member States). The ERT reiterates the recommendation made in the previous review report that the European Union provide complete background tables with information for all member States in its next annual submission. (para 73)	ARR 2012	Methodological tables are now provided as Annex

NIR chapter / Sectors	Source category / Issues	Reccomendation/ improvements planned	References	Status
Agriculture	4A	para 69. The ERT noted that sheep and swine population numbers reported in the CRF tables are below the values included by the Food and Agriculture Organization of the United Nations (FAO) (0.6 per cent and 3.5 per cent difference, respectively). In response to a question raised by the ERT during the review, the European Union identified which member States are mainly responsible for the differences (for sheep, Ireland and Portugal are responsible for approximately 80 per cent of the difference and in the case of swine, Germany and Portugal are responsible for over 90 per cent) and provided the rationale for them. The ERT encourages the European Union, in the context of implementing its verification activities, to include in the NIR the results of the comparison of livestock population data used in the inventory with similar data reported to FAO and Eurostat, together with the description of the potential reasons for differences.	ARR2013	NO further action required. The exercise of comparing FAO data and CAPRI data with national inventories might be repeated in a following year
Agriculture	4A - Trans	para 70. The ERT noted that in table 6.20 of the NIR some additional background information on milk production (kg milk/head/day) associated with the CH_4 emissions for dairy cattle are reported as “NA” for the Netherlands, while data which allow their derivation (milk production expressed as kg milk/head/year) are available in the respective member States’ NIRs. The ERT recommends that the Party continues its efforts to achieve the completeness and comparability of reported data.	ARR2013	Several issues of missing background information (or wrong units used) have been raised during the QA/QC checks
Agriculture	4B	para 72. The ERT commends the Party for the inclusion in the NIR of a distinct section on the distribution of livestock by IPCC climate regions, including the comparison of data reported by member States with an independent estimate elaborated by JRC. During the review, the Party presented the need to further assess, perhaps in a workshop setting, the conclusions of the previously presented analysis considering also the uncertainty associated with the model used. The ERT welcomes the Party’s initiative to consider further these conclusions, including through workshop(s) and through Working Group 1 under the Climate Change Committee. The ERT recommends that the Party continue the analysis through the collaboration between the JRC, member States, DG CLIMA and EEA, focusing on the differences revealed. In addition, the ERT recommends that the Party, as appropriate, update the member States’ livestock allocation to climate regions and associated parameters and report in the NIR on the status and results of any further analysis.	ARR2013	No further action required
Agriculture	4B - Cons.	71. During the review, the Party described a pilot project implemented by Eurostat and member States (in cooperation with JRC) related to animal waste management systems (AWMS). The ERT commends the Party for the extensive discussions held at the European Union level with the goal of developing country-specific parameters for AWMS and housing, as well as the implementation of the pilot project and use by member States of the results. The ERT welcomes the European Union efforts and recommends that the Party continue efforts to develop and implement country-specific data. The ERT encourages the European Union to consider further opportunities to coordinate EU-wide data collection and inventory improvements, including through Working Group 1 under the Climate Change Committee. In addition, the ERT recommends that the European Union report in the NIR on the status and results of further progress in collecting farm-level data.	ARR2013	Sectio had been added in 2014. No further action required

NIR chapter / Sectors	Source category / Issues	Reccomendation/ improvements planned	References	Status
	4C - trans	para 66. The ERT found several areas where there was lack of transparency in the NIR. For example, table 6.61 on relative uncertainty estimates for AD and EFs for rice cultivation includes data only for Greece, Italy and Portugal, although the activity occurs also in France and Spain. In addition, the NIR does not include a section on category-specific planned improvements. The ERT encourages the European Union to use the NIR structure as it is included in the annotated outline of the NIR. The ERT recommends that the Party include in the NIR uncertainty data for all member States and for the European Union at the category level, as well as category-specific planned improvements.	ARR2013	Rice is no EU key source category and is not discussed in detail in the EU GHG inventory report.
	4D	para 73. According to table 6.75 in the NIR, N_2O emissions from the cultivation of histosols for Portugal and Ireland were regarded as negligible although in CRF table 4.D the AD and emissions were reported as “NO”. In response to a question raised by the ERT during the review, the Party responded that in relation to Portugal the NIR already describes that histosols are at most negligible, which is supported by data available at European Soil Data Centre. Regarding Ireland, the Party responded that based on discussions with experts on agricultural practices and geographic information system analysis, cultivated organic soils are designated as not occurring, that non-permanent grassland is accounted for under cropland, consistent with the definition of arable land temporarily used for forage crops or grazing (page 3.69 of the IPCC Good Practice Guidance for Land Use, Land-Use Change and Forestry (hereinafter referred to as the IPCC good practice guidance for LULUCF)). The Party also indicated that, in its understanding, the term “cultivated” refers to soil disturbance by ploughing, and that discussions on the term were included within the KP-LULUCF workshop organized by JRC in November 2013. Additionally, the Party responded that data from FAO on the existence of cultivated organic soils for agricultural purposes might reflect that sometimes countries report data on the drained areas. The ERT recommends that the Party resolve the inconsistencies between the NIR and CRF tables, clarifying whether emissions arise from cultivation of histosols. The ERT commends the Party for the inclusion of a discussion on the meaning of “cultivated” in the JRC KP-LULUCF workshop in November 2013, believing that the term includes more than ploughing, and recommends that the European Union include in the NIR the clarifications provided to the ERT during the review, together with the results of the workshop discussion.	ARR2013	No further action required.
	4A, 4B, and 4D - Cons.	Several inconsistencies between the NIR and CRF tables, for example: o in page 499 of the NIR reindeer, deer, fur farming, rabbits and other poultry livestock are presented as characterized by several MSs while in the CRF tables 4.A, 4.B(a)s1 and 4.B(b) NE has been assigned to the population data. ERT recommendations: strengthen the QC activities; update the algorithm of extracting MSs CRF data and filling of the EU CRF. (partly re-iteration of para 82 from ARR 2012)	ICR2013	No further action required. Better data on 'other animal' types are now available.
Agriculture	4D	para 74. The ERT noted a large inter-annual change in the fraction of livestock nitrogen excreted and deposited onto soil during grazing (FracPRP) between 2010 (0.3512) and 2011 (0.3315), the 2011 value being 5.6 per cent lower than 2010. In response to a question raised by the ERT during the review, the European Union indicated that this is due to a mistake resulting from the use of a zero in the FracPRP to reflect the non-reporting by the United Kingdom. The Party added that the correct value for 2011 is 0.3475, resulting in a 1 per cent decrease. The ERT notes that this error does not lead to an underestimate of emissions, but recommends that the Party include the correct value and improve the implementation of QC procedures in order to prevent such errors.	ARR2013	No further action required

NIR chapter / Sectors	Source category / Issues	Reccomendation/ improvements planned	References	Status
Agriculture	4E	para 64. Prescribed burning of savannas is reported as “NA, NO” in CRF table 4.E but no information is included in the NIR. The ERT recommends that the European Union provide information in the NIR on the occurrence of this category within the Party	ARR2013	Savannah burnig is no EU key source category and is not discussed in detail in the EU GHG inventory report.
Agriculture	4F	• The Agriculture Sector is complete, but several elements were not included in the NIR, for example:	ICR2013	Field burnig of agricultural residues is no EU key source category and is not discussed in detail in the EU GHG inventory report.
		o in Table 6.84 on CH_4 and N_2O emissions from IPCC 4F category, the activity has not been characterized for Belgium, Germany, Ireland, Luxemburg, Netherlands, Sweden and United Kingdom of Great Britain and North Ireland;		
		o in Table 6.85 on methodologies used to estimate CH_4 and N_2O emissions associated to the IPCC 4F category, no methodological element but a general description was included while for Greece, except the fraction of residues burned on field, no AD, EFs		
		and estimation method were presented.		
		• ERT recommendations:		
		o strengthen the QC activities;		
		o update the algorithm of filling the EU NIR from the data and information provided by MSs;		
		o strengthen the collaboration between EU and MSs in order that complete data and information be included in the MSs NIRs, for example, in the context of the Working Group 1 under the Climate Change Committee and/or dedicated workshop(s)		

10.4.2 Improvements planned at EU level

The following activities are planned at EU level with a view to improving the EU GHG inventory:

- Further implement the recommendations from the past reviews;
- Continue sector-specific QA/QC activities within the EU internal review;
- Further develop the EU QA/QC activities on the basis of the experience in 2014/2015

At the beginning of each year the EU inventrory team drafts the EU improvement plan. This improvement plan takes into account the recommendations and encouragements of the most recent UNFCCC review reports as well as planned improvements that have not yet been fully implemented and are therefore still ongoing. After the submission the coordinator evaluates the implementation status of the improvements.

PART 2: SUPPLEMENTARY INFORMATION REQUIRED UNDER ARTICLE 7, PARAGRAPH 1

11 KP-LULUCF

As explained in the Chapter 1, the present report is not an official submission under Kyoto Protocol. For this reason the information to be provided in accordance with Decision 15/CMP.1 Annex I, Paragraph D is not included in the present report. In particular, information in relation to KP LULUCF tables cannot be provided due to the issues with the CRF Reporter.

12 INFORMATION ON ACCOUNTING OF KYOTO UNITS

As stated in chapter 1 the present report is not the first inventory submission for the first year of the second commitment period of KP, and consequently it does not include information as per Decision 15/CMP.1 Annex I section E Decision 15/CMP.1.

13 CHANGES TO THE NATIONAL SYSTEM

As explained in the chapter 1, the present report is not an official submission under Kyoto Protocol. For this reason the information to be provided in accordance with Decision 15/CMP.1 Annex I, section F is not included in the present report. Information on any changes to the national system under the Convention are reported in paragraph 1.2.4 of the Introduction.

14 INFORMATION ON CHANGES IN NATIONAL REGISTRY

The report is not an official submission under Kyoto Protocol as, explained in chapter 1. and, consequently does not present information as per Decision 15/CMP.1 Annex I, section G.

15 INFORMATION ON MINIMIZING ADVERSE IMPACTS IN ACCORDANCE WITH ARTICLE 3, PARAGRAPH 14

As stated in chapter 1 the present report is not an official submission under the Kyoto Protocol. For this reason the information to be provided in accordance with Decision 15/CMP.1 Annex I, section H is not updated in the present report. This chapter will be updated in the first inventory submission for the first year of the second commitment period of KP.

15.1 Information on how the EU is striving, under Article 3, paragraph 14, of the Kyoto Protocol, to implement the commitments mentioned in Article 3, paragraph 1, of the Kyoto Protocol in such a way as to minimize adverse social, environmental and economic impacts on developing country Parties, particularly those identified in Article 4, paragraphs 8 and 9, of the Convention

Editorial comment: The EU is only required to report changes related to the information on minimizing adverse impacts in accordance with Article 3, paragraph 14. However for an improved understanding, text from the last year's inventory report was included and additional and new information is marked in bold.

In this section the EU provides information on how it is implementing its commitment under Article 3, paragraph 14 of the Kyoto Protocol, i.e. how it is striving to implement its commitment under Article 3, paragraph 1 of the Kyoto Protocol in such a way as to minimize potential adverse social, environmental and economic impacts on developing countries. In order to strive for such a minimization, an assessment of potential positive and negative impacts – both of direct and indirect nature - is necessary with a double objective to maximize positive impacts and to minimize adverse impacts. The EU is well aware of the need to assess impacts, and has built up thorough procedures in line with our obligations. This includes bilateral dialogues and different platforms in which we interact with third countries, explain new policy initiatives and receive comments from third countries.

Impacts on third countries are mostly indirect and can frequently neither be directly attributed to a specific EU policy, nor directly measured by the EU in developing countries. Therefore, the reported information covers potential adverse social, environmental and economic impacts that result from complex assessments of indirect influences and that are based on accessible data sources in developing countries.

Impact assessment of EU policies

In the EU a wide-ranging impact assessment system accompanying all new policy initiatives has been established. This regulatory impact assessment is a key element in the development of the

Commission's legislative proposals. The Commission is required to take the impact assessment reports into account when taking its decisions, while the impact assessments are also presented and discussed during the scrutiny of legislative proposals from the Council and the Parliament. This approach ensures that potential adverse social, environmental and economic impacts on various stakeholders (in the case on developing country Parties) are identified and minimized within the legislative process. In general, impact assessments are required for all legislative proposals, but also other important Commission initiatives which are likely to have far-reaching impacts. Below the impact assessment process implemented in the EU policy making is explained in more detail in order to better demonstrate how the EU is striving for all strategies and policies to minimize their adverse impacts. Specific guidelines for the impact assessment have been adopted (European Commission 2009).

The Impact Assessment Guidelines specifically address impacts on third countries and also issues related to international relations. In this area the following questions have to be assessed:

- Trade relations with third countries: some policies may affect trade or investment flows between the EU and third countries; the impact assessment should analyse how different groups (foreign and domestic businesses and consumers) are affected, and help to identify options which do not create unnecessary trade barriers.
- Impact on WTO obligations: it should be analysed which impact each proposed policy option has on the international obligations of the EU under the WTO Agreement; the impact assessment should examine whether the policy options concern an area in which international standards exist.
- Impacts on developing countries: initiatives that may affect developing countries should be analysed for their coherence with the objectives of the EU development policy. This includes an analysis of consequences (or spill-overs) in the longer run in areas such as economic, environmental, social or security policies.

Key economic questions to be assessed in relation to third countries are:

- How does the policy initiative affect trade or investment flows between the EU and third countries? How does it affect EU trade policy and its international obligations, including in the WTO?
- Does the option affect specific groups (foreign and domestic businesses and consumers) and if so in what way?
- Does the policy initiative concern an area in which international standards, common regulatory approaches or international regulatory dialogues exist?
- Does it affect EU foreign policy and EU development policy?
- What are the impacts on third countries with which the EU has preferential trade arrangements?
- Does it affect developing countries at different stages of development (least developed and other low-income and middle income countries) in a different manner?
- Does the option impose adjustment costs on developing countries?
- Does the option affect goods or services that are produced or consumed by developing countries?

Key questions on social impacts in third countries are:

- Does the option have a social impact on third countries that would be relevant for overarching EU policies, such as development policy?
- Does it affect international obligations and commitments of the EU arising from e.g. the ACP-EU Partnership Agreement or the Millennium Development Goals?

- Does it increase poverty in developing countries or have an impact on income of the poorest populations?

Key questions on environmental impacts in relation to third countries are:

- Does the option affect the emission of greenhouse gases (e.g. carbon dioxide, methane etc) into the atmosphere?
- Does the option affect the emission of ozone-depleting substances (CFCs, HCFCs etc)?
- Does the option affect our ability to adapt to climate change?
- Does the option have an impact on the environment in third countries that would be relevant for overarching EU policies, such as development policy?

If third countries are likely to be affected, the impact assessment should analyse in greater detail what the specific impacts may be, how undesired effects can be avoided or minimised, or mitigated, how the policy options compare in this respect and what trade-offs have to be addressed in the final policy choice.

Consulting interested parties is an obligation for every impact assessment and all affected stakeholders should be engaged, using the most appropriate timing, format and tools to reach them. Appropriate consultation tools can be consultative committees, expert groups, open hearings, ad hoc meetings, consultation via Internet, questionnaires, focus groups or seminars/workshops. Existing international policy dialogues are also be used to keep third countries fully informed of forthcoming initiatives, and as a means of exchanging information, data and results of preparatory studies with partner countries and other external stakeholders.

The EU's 6th national communication provides a detailed overview of the European policies and measures to mitigate GHG emissions in all sectors.. All key strategies and climate policies have been subject to impact assessments as described above. All impact assessments and all opinions of the Impact Assessment Board are published online (see http://ec.europa.eu/smart-regulation/impact/ia_carried_out/cia_2014_en.htm). In addition to the general approach described above to address adverse social, environmental and economic impacts, more specific ways to minimize impacts depend on the respective policies and measures implemented. As the reporting obligation related to Article 3, paragraph 14 does not include an obligation to report on each specific mitigation policy, the EU chooses the approach to provide some specific examples for a more complete overview on the ways how the EU is striving to minimize adverse impacts.

Major EU policies such as the Directive on the promotion of the use of renewable energy (Directive 2009/28/EC, in particular its relation to biomass and biofuels, are presented in more detail as examples in this chapter, because the related impact assessments identified potential impacts on third countries. Furthermore, updates of EU policies which should lead to a low carbon strategy and energy efficient economy are also addressed in more detail in the following subchapters.

Directive on the promotion of the use of renewable energy - Promotion of biomass and biofuels

The Directive on renewable energy (Directive 2009/28/EC), a part of the EU's climate and energy package, sets ambitious targets for all Member States, such that the EU will reach a 20% share of energy from renewable sources in the overall energy consumption by 2020 (with individual targets for each Member State) and a 10% share of renewable energy specifically in the transport sector, which includes liquid biofuels, biogas, hydrogen and electricity from renewables. The impact assessments related to enhanced biofuel and biomass use in the EU showed that the cultivation of energy crops have both potential positive and negative impacts. To address the risk of potentially negative impacts, Article 17 of the EU's Directive on renewable energy sources creates pioneering "sustainability criteria", applicable to all biofuels (biomass used in the transport sector) and bioliquids. The sustainability criteria adopted include:

- establish a threshold for GHG emission reductions that have to be achieved from the use of biofuels;
- exclude the use of biofuels from land with high biodiversity value (primary forest and wooded land, protected areas or highly biodiverse grasslands),
- exclude the use of biofuels from land with high C stocks, such as wetlands, peatlands or continuously forested areas.

Developing country representatives as well as other stakeholder were extensively consulted during the development of the sustainability criteria and preparation of the directive and the extensive consultation process has been documented.

In October 2012 a new Commission proposal was published to limit global land conversion for biofuel production, and raise the climate benefits of biofuels used in the EU (European Comission 2012a). The Commission is therefore proposing to amend the current legislation on biofuels through the Renewable Energy and the Fuel Quality Directives and in particular:

- To increase the minimum greenhouse gas saving threshold for new installations to 60% in order to improve the efficiency of biofuel production processes as well as discouraging further investments in installations with low greenhouse gas performance.
- To include indirect land use change (ILUC) factors in the reporting by fuel suppliers and Member States of greenhouse gas savings of biofuels and bioliquids;
- To limit the amount of food crop-based biofuels and bioliquids that can be counted towards the EU's 10% target for renewable energy in the transport sector by 2020, to the current consumption level, 5% up to 2020, while keeping the overall renewable energy and carbon intensity reduction targets;
- To provide additional market incentives to the eixsing ones for biofuels with no or low indirect land use change emissions, and in particular the 2nd and 3rd generation biofuels produced from feedstock that do not create an additional demand for land, including algae, straw, and various types of waste, as they will contribute more towards the 10% renewable energy in transport target of the Renewable Energy Directive.

With these new measures, the Commission wants to promote stronger biofuels that help achieving substantial emission cuts, do not directly compete with food and are more sustainable at the same time. While the current proposal does not affect the possibility for Member States to provide financial incentives for biofuels, the Commission considers that in the period after 2020 biofuels should only receive financial support if they lead to substantial greenhouse gas savings and are not produced from crops used for food and feed. The Impact Assessment of the proposal for a Directive is analysing social, economic and environmental impacts on third countries in detail. The legislative proposal is now with the colegislators in the European Parliament and the Council.

The Directive also ensures that the Commission reports every two years, in respect to both third countries and Member States which constitute a significant source of biofuels or of raw material for biofuels consumed within the Union, on national measures taken to respect the sustainability criteria for soil, water and air protection. On 27 March 2013, the European Commission published its first Renewable Energy Progress Report (European Commission 2013a) under the framework of the 2009

Renewable Energy Directive, which also includes information on biofuels and bioliquids sustainability criteria. The report and its accompanying staff working document analyses *inter alia* the origin of biofuel foodstock consumed in the EU, whereby 83% of EU consumed biodiesel in 2010 was produced within the EU and 80% of the EU consumed bioethanol was produced in the EU. In 2010, imports of biodiesel came primarily from Argentina (10%), Indonesia (3%), Malaysia (1%) and China (1%), while Brazil (8%), USA (4%), Peru (1%), Kazakhstan (1%) and Bolivia (1%) were the top five importers of bioethanol. The report states that key export countries (Argentina, Brazil, Indonesia, and Malaysia) have adopted new regulatory measures to improve their environmental practices in biofuels related areas.

Whilst imported mineral oil still constitutes the vast bulk of fuel used in the transport sector, the 4.7% share of biofuels is estimated to have generated 25.5 Mt CO_2eq savings, based on national reporting (22.6 Mt CO_2eq based on the application of global default values), not taking into account indirect land use change effects.

The same report finds that the transposition and implementation of the biofuel sustainability criteria in many Member States is still not complete or correct. The Commission continues to assess Member State progress in implementation of the renewable energy Directive and legal measures are being taken in those cases where the transposition is incomplete.

In addition, the Commission reported on the effects on food prices, on land use rights and on the need for specific measures for air, soil and water protection, all of which concluded that notwithstanding current lack of major issues, future monitoring on these parameters should continue.

In addition to the official progress report, the Commission contracted a consortium led by Ecofys to perform support activities concerning the assessment of progress in renewable energy and sustainability of biofuels (Ecofys and consortium 2012). The Ecofys study revealed *inter alia* that:

- In 2010, the use of renewable energy in transport was 4.70%, consisting of:
  - 13.0 Mtoe of sustainable biofuels or 4.27%;
  - 1.3 Mtoe of renewable electricity, or 0.43%;
- Between 2008 and 2010, the volume of biofuels consumed in the EU increased by 39%, whereas the volume of petroleum fuels consumed in road transport decreased with 3.5%;
- The role of the EU in the global biofuel market has remained constant in the last years. The EU remained in 2010 by far the largest producer of biodiesel in the world with 8.5 Mtoe (55% of global market share) compared to global production of 15.5 Mtoe. Brazil and Argentina have significantly increased the production of biodiesel in recent years, whereas the production of biodiesel in the USA decreased by almost more than half compared to 2008. In the rest of the world, bioethanol plays a much larger role. World bioethanol production reached 43.8 Mtoe in 2010, of which only 2.0 Mtoe or 5% were produced in the EU. The USA is the world's largest ethanol producer since 2006 (24,929 Mtoe produced in 2010), followed by Brazil. Net EU trade in the global biofuels market is therefore fairly insignificant;
- The most important feedstock for biodiesel is rapeseed originating from the EU, followed by Argentinean soy, Indonesian and Malaysian palm oil, and rapeseed from Canada and Ukraine. EU-produced biodiesel is partially produced from imported feedstock (palm oil, soy and part of the rapeseed);

- EU-produced bioethanol is mainly produced from EU feedstock, with only small shares of wheat and maize originating from Switzerland, Ukraine and a few other countries. Sugar cane and maize play a role via the bioethanol supplying countries – Brazil and the USA mainly;
- Statistical analysis reveals that the total land use worldwide, to produce the feedstock for EU-consumed biofuels in 2010, is about 5.7 Mha. Of this, 3.2 Mha (57%) is within the EU and 2.4 Mha (43%) resides outside the EU. True valuation of co-products would yield a lower figure;
- In most of the non-EU countries, the land dedicated to the production of feedstock for EU biofuels is less than 1% of the cropland. Notable exceptions are Argentina and Paraguay, where 3% and 4% of the total cropland produces soybean for EU biodiesel in 2010;
- Back-casting scenario analysis of the global agricultural market development clearly shows that EU-27 expanding biofuel use has contributed only little to the historical cereal price increases from 2007 to 2010, resulting in a wheat and coarse grain price increase of about 1-2%. The impact was more substantial for price increases of non-cereal food commodities by about 4%, notably through its demand for vegetable oil in the production of biodiesel;
- Estimates of the effects of EU biofuels consumption on global employment vary widely and are not often easy to determine. Still, based on on estimates and projections of the Global Renewable Fuels Association global ethanol and biodiesel production supports nearly 1.4 million jobs in all sectors of the global economy in 2010.

The EU's biofuel sustainability criteria form the first global initiative to address the climate change and sustainability issues surrounding crop production.

The recent Communication from the Commission on voluntary schemes and default values in the EU biofuels and bioliquids sustainability scheme (2010/C 160/01)[65] sets up a system for certifying sustainable biofuels, including those imported into the EU. It lays down rules that such schemes must adhere to if they are to be recognized by the Commission. This will ensure that the EU's requirements that biofuels deliver substantial reductions in greenhouse gas emissions and that biofuels do not result from forests, wetlands and nature protection areas.

The European Commission has so far (April 2014) recognised **15** voluntary schemes: International Sustainability and Carbon Certification (ISCC), Bonsucro EU, Round Table on Responsible Soy (RTRS EU RED), Roundtable of Sustainable Biofuels (RSB EU RED), Biomass Biofuels voluntary scheme (2BSvs), Abengoa RED Bioenergy Sustainability Assurance (RSBA), Greenergy Brazilian Bioethanol verification programme, Ensus voluntary scheme under RED for Ensus bioethanol production, Red Tractor Farm Assurance Combinable Crops & Sugar Beet Scheme, SQC (Scottish Quality Farm Assured Combinable Crops (SQC) scheme), Red Cert, NTA 8080 and RSPO RED (Roundtable on Sustainable Palm Oil RED), Biograce GHG calculation tool and HVO Renewable Diesel Scheme for Verification of Compliance with the RED sustainability criteria for biofuels[66].

In line with Article 19(4) of Directive 2009/28/EC on the promotion of the use of energy from renewable sources[67] the Commission published in 2010 a report on the feasibility of drawing up lists of areas in third countries with low greenhouse gas emissions from cultivation (COM(2010) 427 final) concluding that, "while desirable, it is not yet feasible to set up legally binding lists of areas for third countries where a major component of the underlying calculation is uncertain and can easily be

65 OJ C160, 19.6.2010, p.1

66 http://ec.europa.eu/energy/renewables/biofuels/sustainability_schemes_en.htm

67 OJ L 140, 5.6.2009, p. 16

questioned, and where third countries have had no possibility to contribute on the methodology and data used. It is therefore not appropriate, at least at this stage, to produce legislative lists for third countries based on the current modelling of N_2O emissions from agriculture. However, it is important to enhance the understanding of the topic and survey the data used in view of a new assessment in 2012. The Commission has thus published the preliminary results of the JRC work together with all necessary data and description of methodology to support such a process on the webpage of the JRC. It will use this as the basis for a discussion with third countries in the framework of its dialogue and exchange with them under Article 23(2) of the Renewable Energy Directive."

Another way the EU will strive to minimize potential adverse impacts of biomass use is to promote second generation biomass technologies. Within the renewable energy Directive, second generation biofuels are promoted through Article 21, paragraph 2 which establishes that the contribution made by biofuels produced from wastes, residues, non-food cellulosic material, and ligno-cellulosic material shall be considered to be twice that made by other biofuels for the purposes of demonstrating compliance with national renewable energy targets; and EU research also has a major focus on bioenergy technologies. The goal of second generation biofuel processes is to extend the amount of biofuel that can be produced sustainably by using biomass consisting of the residual non-food parts of current crops, such as stems, leaves and husks that are left behind once the food crop has been extracted, as well as other crops that are not used for food purposes (non food crops) and also industry waste such as woodchips, skins and pulp from fruit pressing. Second generation biofuels are expected to expand the biomass feedstock available for biofuel production. Further research and impact assessments in this area are necessary to assess e.g. the long-term effects of the energy use of non-food parts of crops compared to their existing use. The Commission continues the efforts to promote second and third generation biofuels, shifting away from food-crop based fuels. In this light, it recently put forth a proposal to limit to 5% the use of food-based fuels in meeting the EU renewable energy target in transport (see discussion above on Proposal from October 2012).

As part of the Communication on a policy framework for climate and energy in the period from 2020 to 2030 (European Commission 2014a) it is proposed not to establish new targets for renewable energy specifically for the transport sector, or the greenhouse gas intensity of fuels used in the transport sector or any other sub-sector after 2020. The priority expressed in the communication is a focus of policy development on improving the efficiency of the transport system, further development and deployment of electric vehicles, second and third generation biofuels and other alternative, sustainable fuels as part of a more holistic and integrated approach. A greenhouse gas reduction target of 40% to be shared between the ETS and non-ETS sector is accompanied by a coherent headline target at EU level for renewable energy of at least of at least 27% with flexibility for Member States to set national objectives.

Inclusion of aviation in the EU emission trading scheme

In 2005 the Commission adopted a Communication entitled "Reducing the Climate Change Impact of Aviation", which evaluated the policy options available to this end and was accompanied by an impact assessment. The impact assessment concluded that, in view of the likely strong future growth in air traffic emissions, further measures are urgently needed. Therefore, the Commission decided to pursue a new market-based approach at EU level and included aviation activities in the EU's scheme for greenhouse gas emission allowance trading.

In April 2013 the EU temporarily suspended enforcement of the EU ETS requirements for flights operated from or to non-European countries, while continuing to apply the legislation to flights within and between countries in Europe. The EU took this initiative to allow time for the International Civil Aviation Organization (ICAO) Assembly in autumn 2013 to reach a global agreement to tackle aviation emissions – something Europe has been seeking for more than 15 years. In October 2013 the EU's hard work paid off when the ICAO Assembly agreed to develop by 2016 a global market-based mechanism (MBM) addressing international aviation emissions and apply it by 2020. Until then countries or groups of countries, such as the EU, can implement interim measures.

In response to the ICAO outcome and to give further momentum to the global discussions, the European Commission has proposed amending the EU ETS[68] so that only the part of a flight that takes place in European regional airspace is covered by the EU ETS. The change would have applied from the beginning of 2014 until the planned global MBM enters into force. In March 2014 the Council of the EU and European Parliament reached an informal agreement on the changes to aviation in the EU ETS.

The regulation in preparation will limit the aviation coverage of EU ETS to emissions from flights within the European Economic Area (EEA) for the period from 2013 to 2016. This applies to all (also third country) aircraft operators. All options are left open for the EU to react to the developments of the ICAO Assembly in 2016 and to re-adjust the scope of the EU ETS from 2017 onwards. The regulation also includes exemptions for small emitters. The legislative process is expected to be concluded in the spring of 2014.

A roadmap for moving to a competitive low carbon economy in 2050

In 2011 the Commission released the Communication "A Roadmap for moving to a competitive low carbon economy in 2050" (COM(2011) 112 final) outlining a strategy to meet the long-term target of reducing domestic emissions by 80 to 95% by 2050 as agreed by European Heads of State and governments. The Roadmap shows how the sectors responsible for Europe's emissions - power generation, industry, transport, buildings and construction, as well as agriculture - can make the transition to a low-carbon economy over the coming decades. The transition towards a competitive low-carbon economy means that the EU should prepare for reductions in its domestic emissions by 80% by 2050 compared to 1990, with cost effective reduction milestones of 40% by 2030 and 60% in 2040..

The shift to a resource-efficient and low-carbon economy should be supported by using all resources, decoupling economic growth from resource and energy use, reducing CO_2 emissions, enhancing competitiveness and promoting greater energy security. A low-carbon economy will mean a much greater use of renewable sources of energy, energy-efficient building materials, hybrid and electric

[68] See Proposal for a Directive of the European Parliament and of the Council amending Directive 2003/87/EC establishing a scheme for greenhouse gas emission allowance trading within the Community, in view of the implementation by 2020 of an international agreement applying a single global market-based measure to international aviation emissions, http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:52013PC0722

cars, 'smart grid' equipment, low-carbon power generation and carbon capture and storage technologies.

Because more locally produced energy would be used in a low-carbon economy, mostly from renewable sources, the EU would be less dependent on imports of oil and gas from outside the EU. On average, the EU could save € 175 - 320 billion annually on fuel costs over the next forty years.

With the shift from fuel expenses (operating costs) to investment expenditure (capital expenditure) in clean technology and clean energy, investments costs will occur in the domestic economy, requiring increased added value and output from a wide range of manufacturing industries (automotive, power generation, industrial and grid equipment, energy–efficient building materials, construction sector etc.), while fuel expenses for fossil fuel imports which are to a large extent flowing to third countries would be reduced.

Communication on a policy framework for climate and energy in the period from 2020 to 2030

In January 2014, the European Commission published a Communication on a policy framework for climate and energy in the period from 2020 to 2030 (COM(2014)15 final) (European Commission 2014a). This Communication develops a framework for the future EU climate and energy policy and proposes to set a greenhouse gas emission reduction target for domestic EU emissions of 40% in 2030 relative to emissions in 1990. The EU level target will be shared between the EU Emissions Trading System (EU ETS) and what the Member States must achieve collectively in the sectors outside of the ETS. The ETS sector would have to deliver a reduction of 43% in GHG in 2030 and the non-ETS sector a reduction of 30% both compared to 2005.

In addition the Commission proposes an EU-level target for the share of renewable energy in the EU of at least 27% in 2030. While binding at the EU level, there would not be binding renewable targets for Member States individually but the objective would be fulfilled through clear commitments decided by the Member States themselves which should be guided by the need to deliver collectively the EU-level target and build upon what each Member State should deliver in relation to their current targets for 2020. While not foreseeing national-level targets, the 2030 framework proposes a new governance framework based on national plans for competitive, secure and sustainable energy. The plans will be prepared by Member States under a common approach to ensure coherence at the EU level.

The EU Emissions Trading System (ETS) will remain an important instrument to bring about the transition to a low carbon economy. A market stability reserve is proposed for the period after 2020 which provides an automatic adjustment of the supply of auctioned allowances based on a pre-defined set of rules with the aim to avoid a large supply/demand imbalances in the ETS.[69]

A stakeholder consultation was carried out in preparation for the 2030 framework. The Communication on the 2030 policy framework follows the Commission's March 2013 “Green Paper on a 2030 framework for climate and energy policies” which was explained in this section of the NIR in the previous inventory submission. The Green paper launched a broadpublic stakeholder

[69] See COM/2014/20 Proposal for a Decision oft he European Parliament and of the Council concerning the establishment and operation of a market stability reserve for the Union greenhouse gas emission trading scheme and amending Directive 2003/87/EC, http://ec.europa.eu/clima/policies/ets/reform/docs/com_2014_20_en.pdf

consultation on the most appropriate range and structure of climate and energy targets for 2030. The public consultation was conducted between March and July 2013 and also addressed relevant stakeholders from outside the EU.

An impact assessment (IA) was conducted for this communication (European Commission 2014b), which gives significant detail on costs and savings achieved on the basis of the proposed policy under different scenarios. All scenarios demonstrate reduced GHG emissions compared to the Reference scenario. All scenarios show reduced energy consumption (both primary and final) compared to the Reference scenario, with more pronounced energy savings and improved energy intensity in scenarios with strong energy efficiency policies, with highest improvements in those scenarios that next to ambitious energy efficiency policies also include a renewables target. Future fuel consumption in the EU will have economic impacts on fuel prices as well as trade effects for fuel exporting countries, therefore the impacts on future fuel use are summarized: With regard to fuel use, the IA analysed that solid fuel consumption declines substantially under all scenarios until 2030. Also oil consumption decreases in all scenarios, but much faster in those with policies that promote transport electrification. Natural gas absolute consumption also declines in all scenarios (in general less harply than oil) but slightly more under the scenarios that include renewable targets. By 2050 in all scenarios natural gas becomes the main fossil fuel. Net energy imports decrease significantly for all scenarios already in 2030 between 4% to 22% below 2010 levels in 2030 and by about 50% in most scenarios in 2050.[70]

The Communication was discussed by the European Council (EU Member States' heads of state and goverments) on 21-24 March 2014, which requested the Council and the Commission to rapidly develop further policy elements, including mechanisms for fair effort sharing. EU leaders agreed to take a final decision on the framework as soon as possible and in October 2014 at the latest.

15.2 Information on how the EU gives priority, in implementing the commitments under Article 3, paragraph 14, to specific actions

The EU reports activities that are related to the actions specified in the subparagraphs (a) to (f) of paragraph 24 of the reporting requirements in the Annex to decision 15/CMP.1. However, no decision was agreed yet that these actions form part of the commitment under Article 3, paragraph 14. For some of the actions specified in the reporting requirements, it seems rather unclear how they relate to the minimization of adverse social, environmental and economic impacts resulting from policies and measures to mitigate GHG emissions, e.g. information related to the cooperation activities requested are activities that help both Annex I and Non-Annex I Parties in reducing emissions from fossil fuel technologies, but they do not directly address the minimization of potential adverse impacts in Annex I Parties.

For the purposes of completeness in reporting, the EU addresses all subparagraphs specified in the reporting requirements, however the main ways how the EU is striving to minimize adverse impacts are described in the previous section.

[70] For a more detailed analysis and explanation on the scenarios, see the Impact Assessment Accompanying the document Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions A policy framework for climate and energy in the period from 2020 up to 2030, available: http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:52014SC0015

a) The progressive reduction or phasing out of market imperfections, fiscal incentives, tax and duty exemptions and subsidies in all greenhouse-gas-emitting sectors, taking into account the need for energy price reforms to reflect market prices and externalities

The actions addressed in subparagraph a) also form part of the commitment to implement policies and measures requested under Article 2, paragraph 1(a) (v), however Article 2 specifies that Annex I Parties shall “implement and/or further elaborate policies and measures in accordance with national circumstances, such as progressive reduction or phasing out of market imperfections, fiscal incentives, tax and duty exemptions and subsidies in all greenhouse gas emitting sectors that run counter to the objective of the Convention and application of market instruments.” Subparagraph a) in the reporting requirements lacks such objective and therefore seems somewhat inconsistent with the commitment under Article 2. The promotion of research, demonstration projects, fiscal incentives or carbon taxes is important instrument to advance the objectives of the Convention, e.g. the use of renewable energies. A progressive reduction of all fiscal incentives or subsidies in all GHG emitting sectors would run counter the objective of the Convention and counter the ability of the EU to meet its commitment under Article 3, paragraph 1 of the Kyoto Protocol. Therefore the EU interprets this reporting requirement in a way consistent with Article 2 paragraph 1(a)(v) that the EU should focus on the progressive reduction or phasing out of market imperfections, fiscal incentives, tax and duty exemptions and subsidies that run counter the objectives of the Convention and application of market instruments.

The 2009 Review of the EU Sustainable Development Strategy assesses that *"the Commission has been mainstreaming the progressive reform of environmentally harmful subsidies into its sectoral policies"*. For instance, environmental concerns have been gradually incorporated into the EU Common Agricultural Policy, including "decoupled" direct payments which have replaced price support; environmental cross compliance; a substantial increase in budget for rural development. As part of 2008 Common Agriculture Policy Health Check, additional part of direct aid has been shifted to climate change, renewable energy, water management, biodiversity, innovation; - transparency of agricultural subsidies has improved. It is important to note that in the other areas most subsidies are within the competence of the Member States and not of the EU, within the limits established by EU state aid rules.

EU policies aim to address market imperfections and to reflect externalities. For example the EU has made significant efforts to liberalise the internal energy market and to create a genuine internal market for energy as one of its priority objectives. The existence of a competitive internal energy market is a strategic instrument both in terms of giving European consumers a choice between different companies supplying gas and electricity at reasonable prices, but also in terms of making the market accessible for all suppliers, especially the smallest and those investing in renewable forms of energy.

With the implementation of the EU Emissions Trading Scheme, the EU uses a market instrument to implement the objective of the Convention and its commitment under Article 3, paragraph 1 of the Kyoto Protocol which aims at creating the right incentives for forward looking low carbon investment decisions by reinforcing a clear, undistorted and long-term carbon price signal.

With respect to financial support provided by the Member States to undertakings, the EU Treaty pronounces a general prohibition of "State aid". This concept encompasses a broad range of financial support measures adopted at national or sub-national level (i.e. not at EU level), and which can take various forms (subsidies, tax relieves, soft loans…). The Treaty provides for exceptions to this general prohibition. When State aid measures can contribute in an appropriate manner to the furtherance of objectives of common interest for the EU, and provided that they comply with certain strict conditions, they may be authorised by the Commission. By complementing the fundamental rules through a series of legislative acts and guidelines, the EU has established a worldwide unique system of rules under which State aid is monitored and assessed in the European Union. This legal framework is regularly reviewed to improve its efficiency. EU State aid control is an essential component of competition policy and a necessary safeguard for effective competition and free trade.

State aid reform in the EU aims to redirect aid to objectives of common interest which are related to the EU Lisbon Treaty, such as R&D&I, risk capital measures, training, and environmental protection. Environmental protection, and in particular, the promotion of renewable energy and the fight against climate change, is considered one of the objectives of common interest for the EU which may, under certain circumstances, justify the granting of State aid.

Specific “Community Guidelines on State aid for Environmental Protection”[71] have been established. The Guidelines foresee in particular the possibility to authorise State aid for particular environmental purposes, such as for renewable energy sources or energy saving. The European Commission published on 9 April 2014 the “Guidelines on on State aid for environmental protection and energy 2014-2020” that intend to replace the 2008 Guidelines from 1 July 2014. A public consultation process on these draft guidelines has been conducted between December 2013 and February 2014 (European Commission 2014c). The Guidelines set out the conditions under which state aid measures for environmental protection or energy objectives may be declared compatible with the internal market. This proposal includes a list of environmental and energy measures for which state aid under certain conditions may be compatible with the EU Treaty, covering the following areas:

- Aid to energy from renewable sources
- Energy efficiency measures, including cogeneration and district heating and district cooling
- Aid for resource efficiency and in particular aid to waste management
- Aid to Carbon Capture and Storage (CCS)
- Aid in the form of reductions in or exemptions from environmental taxes and in the form of reductions in funding support for electricity from renewable sources
- Aid to energy infrastructure
- Aid for generation adequacy

[71] Official Journal No C 82, 1.4.2008, p.1

- o Aid in the form of tradable permit schemes
- o Aid for the relocation of undertakings

In June 2012, the Commission adopted Guidelines on certain State aid measures in the context of the EU Emissions Trading System (EU ETS). The Guidelines provide a framework under which Member states may compensate some electro-intensive industries, such as steel and aluminium producers, for part of the higher electricity costs expected to result from the application of the harmonised allocation rules to be applied in the EU ETS as from 2013. The rules, subject to state aid scrutiny, ensure that national support measures are designed in a way that preserves the EU objective of decarbonising the European economy and maintains a level playing field among competitors in the internal market. The sectors deemed eligible for compensation include producers of aluminium, copper, fertilisers, steel, paper, cotton, chemicals and some plastics. The Guidelines give a right, not an obligation to provide subsidies to energy intensive industries.

Carbon leakage means that global greenhouse gas emissions increase when companies in the EU shift production outside the EU because they cannot pass on the cost increases induced by the ETS to their customers without a significant loss of market share to third country competitors. Based on the ETS Directive (2003/87/EC as amended by 2009/29/EC), the Commission shall compile a list of sectors and sub-sectors deemed exposed to significant risk of carbon leakage. Sectors on the list will receive a higher share of free allowances. The criteria and thresholds to determine whether a sector is deemed exposed to carbon leakage or not are defined in Article 10a(13-18) of the ETS Directive and focus on additional costs incurred by the ETS Directive and trade intensity. The calculations are based on official Eurostat data and data collected from Member States. It is foreseen that the final carbon leakage list for 2015-19 will be adopted by the Commission before the end of 2014 and applied to free allocation for the first time in 2015.

b) Removing subsidies associated with the use of environmentally unsound and unsafe technologies

There is no clear definition of environmentally unsound and unsafe technologies; therefore the EU interprets this provision in the context of the Kyoto Protocol that unsound and unsafe technologies would be those increasing GHG emissions.

The phase-out of subsidies to fossil fuel production and consumption by 2010 was one of the objectives in the Communication from the Commission "A Sustainable Europe for a Better World: A European Union Strategy for Sustainable Development (Commission's proposal to the Gothenburg European Council, 2001)".[72]

Council Decision 2010/787/EU of 10 December 2010 on State aid to facilitate the closure of uncompetitive coal mines adopted a new coal regulation enabling Member States to grant State aid to facilitate the closure of uncompetitive mines until 2018, following the expiry of the current Coal

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72 See http://eur-lex.europa.eu/LexUriServ/site/en/com/2001/com2001_0264en01.pdf

Regulation (Council Regulation (EC) N° 1407/2002 of 23 July 2002) on 31 December 2010. The decision includes the following main elements:

- the possibility of continuing to grant, under certain conditions, public aid to the coal industry with a view to facilitating the closure of uncompetitive hard coal mines until December 2018;
- the modalities for the phasing-out of the aid, under which the overall amount of aid granted by a member state must follow a downward trend, in order to prevent undesirable effects of distortion of competition in the internal market. Subsidies will have to be lowered by at least 25% until 2013, by 40% until 2015, by 60% by 2016 and by 75% by 2017;
- the obligation for member states granting aid to provide a plan on intended measures to mitigate the environmental impact of the production of coal; and
- the possibility of allowing subsidies, until December 2027, in order to cover exceptional expenditure in connection with the closure of mines that are not related to production, such as social welfare benefits and rehabilitation of sites.

c) Cooperating in the technological development of non-energy uses of fossil fuels, and supporting developing country Parties to this end;

The technological development of non-energy uses of fossil fuels is not a current research priority in the EU, nor a priority of cooperation with developing countries because the EU is not a major producer of oil and gas. Given the long-term depletion of fossil fuel resources and the decline in coal production, the EU's priority in general is the replacement of the use of fossil fuels by renewable resources and the more efficient use of resources.

d) Cooperating in the development, diffusion, and transfer of less-greenhouse-gas-emitting advanced fossil-fuel technologies, and/or technologies, relating to fossil fuels, that capture and store greenhouse gases, and encouraging their wider use; and facilitating the participation of the least developed countries and other non-Annex I Parties in this effort;

In March 2005, the EU and China signed an Action Plan on Clean Coal, which included cooperation on carbon capture and storage. The subsequent 2005 EU-China Summit established the EU-China Climate Change Partnership, which includes a political commitment to develop and demonstrate in China and the EU advanced, near-zero emissions coal (NZEC) technology through carbon capture and storage (CCS) by 2020. Phase I of this cooperation will be completed in 2009. Phase II of NZEC will run from 2010-2012. It will examine the site-specific requirements for and define in detail a demonstration plant and accompanying measures. It will include the technical and cost analysis of different options. Based on this analysis, the site of the power plant as well as the combustion technology (pulverised coal or IGCC), the capture technology and the transport and storage concepts will be determined. Phase II shall also include a detailed roadmap for the construction and operation of the demonstration plant as well as an Environmental Impact Assessment of the demonstration power plant and the carbon storage site. Phase III should commence thereafter and will see the construction and operation of a commercial-scale demonstration plant in China.

In 2009 the European Commission published a Communication on CCS in emerging developing countries (European Commission 2009). The Communication sets out the Commission's plans for establishing an investment scheme to co-finance the design and construction of a power plant to demonstrate carbon capture and storage (CCS) technology in China. The Commission has programmed funding of up to €50 million for the construction and operation phase of the project, out of a total of €60 million that has been earmarked for cooperation with emerging economies on cleaner coal technologies and carbon capture and storage. nt progress in identifying options and constraints for CCS in China. At the 2009 Summit, China and EU jointly agreed to finalise the feasibility (phase II) of a demonstration plant, and a Memorandum of Understanding was signed between the European Commission and the Ministry of Science and Technology (MOST). Implementation is on-going. In 2010 Norway joined the initiative. A call for proposals has been launched in 2013 to select the project and conduct pre-feasibility studies to be finalised in 2014.

The EU is cooperating with other Annex I and Non-Annex I Parties (Australia, Brazil, Canada, China, Denmark, France, Germany, Greece, India, Italy, Japan, Korea, Mexico, Netherlands, New Zealand, Norway, Poland, Russian Federation, Saudi Arabia, South Africa, United Arab Emirates, United Kingdom and USA) in the “Carbon Sequestration Leadership Forum (CSLF)”. The CSLF is a Ministerial-level international climate change initiative that is focused on the development of improved cost-effective technologies for the separation and capture of carbon dioxide (CO_2) for its transport and long-term safe storage. The mission of the CSLF is to facilitate the development and deployment of such technologies via collaborative efforts that address key technical, economic, and environmental obstacles. The CSLF will also promote awareness and champion legal, regulatory, financial, and institutional environments conducive to such technologies. In 2010 a Technology Roadmap was released by the Carbon Sequestration Leadership Forum. This road map indicates that significant international progress has been made in the past year on advancing carbon capture and storage, but that a number of important challenges remain that must be addressed to achieve widespread commercial deployment of CCS. The 2012 Strategic Plan Implementation Report recognized five new CCS projects bringing the total number of CSLF recognized technology demonstrations to 34, including 24 active projects. A number of meetings and workshops were held in 2013 and 2014, such as the 2013 and 2014 CSLF Technical Group Meeting and the 5th CSLF Ministerial Meeting. The CSLF Task Force on Reviewing Best Practices and Standards for Geological Storage and Monitoring of CO_2 published an annual report in 2013 that compiles best practice manuals developed acorss the world, guidelines published related to CCS, and summaries of regulations in place as well as monitoring tools and techniques used in ongoing projects (CSLF 2013). The Task force on Technical Challenges in the Conversion of CO_2-EOR Projects to CO_2 Storage Projects also provided a report in 2013 that concluded that the main impediment in the adoption and deployment of this technology is the unavailability of CO_2 at economic prices at the CO_2-EOR operation sites and the absence of infrastructure to both capture the CO_2 and transport it from CO_2 sources to oil fields suitable for CO_2 –EOR.

e) Strengthening the capacity of developing country Parties identified in Article 4, paragraphs 8 and 9, of the Convention for improving efficiency in upstream and downstream activities relating

to fossil fuels, taking into consideration the need to improve the environmental efficiency of these activities

In the oil and gas industry the upstream sector is a term commonly used to refer to the exploration, drilling, recovery and production of crude oil and natural gas. The downstream sector includes the activities of refining, distillation, cracking, reforming, blending storage, mixing and shipping and distribution.

The EU contributes to strengthening of the capacities of fossil fuel exporting countries in the areas of energy efficiency via the work of the Energy Expert Group of the Gulf Cooperation Council (GCC)[73], in particular in the working sub-group on energy efficiency. As part of the EU's research programme, a project called "EUROGULF" was launched with the objective of analysing EU-GCC relations with respect to oil and gas issues and proposing new policy initiatives and approaches to enhance cooperation between the two regional groupings.

The Commission has recently started a project with the specific objective to create and facilitate the operation of an EU-GCC Clean Energy Network. The network is to be set up to act as a catalyst and element of coordination for development of cooperation on clean energy. A website was created at http://www.eugcc-cleanergy.net where further information on the EU-GCC Clean Energy Network and its recent activities can be found. The Masdar Institute of Science and Technology in Abu Dhabi has been selected as the lead research institution to represent the Gulf Cooperation Council (GCC) in the European Union-GCC Clean Energy Network. A number of discussion groups and training seminars took place, e.g. on solar resource assessment. In January 2013, the EU-GCC Energy Cooperation Conference was held in Abu Dhabi, UAE, as a side event of the "World Future Energy Summit- WFES 2013. The presentation by the high-level team of attendees from the GCC and Europe highlighted the achievements in areas of mutual interest for the two regions including renewables, energy efficiency and demand-side management, electricity interconnections, carbon capture and storage, as well as natural gas. Some of the concrete outcomes that were summarized during the sessions include publications, research work/papers, established partnerships between the GCC and EU, co-operation project ideas, targeted working meetings and training workshops. In 2013 also a Workshop and training seminar on integration of renewables in the grid and on energy efficiency and demand side management was held in Oman and an event related to CCS took place in London. In December 2013, the EU-GCC Energy Experts Group meeting was reconvened and is planned to continue in a fruitful dialogue beyond, with the next meeting planned in 2014. The dialogue focused on energy efficiency and natural gas, and in incuded EU market regulators and the private sector, as well as representatives of the EU-GCC clean energy network.

Energy efficiency activities in the upstream or downstream sector are also candidates for CDM projects. Thus, the development of the CDM under the Kyoto Protocol and the demand of CERs by Annex I Parties under the Kyoto Protocol as well as by operators under the EU ETS have fostered such activities performed by the private sector. Related CDM projects are for example:

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[73] The Gulf Cooperation Council covers Bahrain, Kuwait, Oman, Qatar, Saudi Arabia and the United Arab Emirates.

- Rang Dong Oil Field Associated Gas Recovery and Utilization Project in Vietnam: The purpose of this project activity is the recovery and utilization of gases produced as a by-product of oil production activities at the Rang Dong oil field in Vietnam with the involvement of ConocoPhillips (UK).
- Recovery of associated gas that would otherwise be flared at Kwale oil-gas processing plant in Nigeria involves the capture and utilisation of the majority of associated gas previously sent to flaring at Kwale OGPP plant. The Kwale OGPP plant receives oil with associated gas from oil fields operated by Eni Nigeria Agip Oil Company.
- Recovery and utilization of associated gas produced as by-product of oil recovery activities at the Al-Shaheen oil field in Qatar
- Flare gas recovery and utilisation project at Uran oil and gas processing plant in India which is handling the oil and gas produced in the Mumbai High offshore oil field.
- Flare gas recovery and utilisation project at Hazira gas and condensate processing plant in India.
- Flare gas recovery and utilisation project from Kumchai oil field in India
- Flare gas recovery and utilisation project at the Ovade-Ogharefe oil field operated by Pan Ocean Oil Corporation in Nigeria
- Flare gas recovery and utilisation project at Soroosh and Nowrooz offshore oil fields in Iran.
- Leak reduction in aboveground gas distribution equipment in the KazTransgaz-Tbilisi gas distribution system in Georgia where leakages at gate stations, pressure regulator stations, valves, fittings as well at connection points with consumers are reduced.
- There are currently 21 Coal Mine Methane Utilization Project in China which use coalmine methane previously released to the atmosphere.

Improved energy efficiency in the energy and the transport sector in a more general way is one of the priorities in the EU's development assistance as well as for the EIB (European Investment Bank) and the EBRD (European Bank for Reconstruction and Development). The EIB has also developed other means of financing, such as equity and carbon funds, to further support renewable energy and energy-efficiency projects (see here GEEREF and the Mediterranean Solar Plan, MSP). Related projects and specific activities can be found for example at http://www.eib.org/projects/topics/environment/renewable-energy/index.htm or http://www.ebrd.com/saf/search.html?type=eia

f) Assisting developing country Parties which are highly dependent on the export and consumption of fossil fuels in diversifying their economies.

The EU actively undertakes a large number of activities aiming at reducing dependence on the consumption of fossil fuels, in particular the EU support activities for the promotion of renewable energies and energy efficiency in developing countries contribute to reduction of dependence on fossil fuels, meeting rural electricity needs, and the improvement of air quality. As explained in more detail in the EU's 6th national communication and 1st Biennial Report several support programmes exist in this respect. These include:

- ***Cooperation with the EU neighboring countries on renewable electricity production***

In order to support the implementation of the Renewable Energy Directive, the Commission will in September 2013 issue guidance to Member States and potential third country partners on the implementation of cooperation and trade in the renewable energy sector. Cooperation, for example, in deploying solar energy installations in North Africa for domestic consumption as well as export is supported as part of an overall agenda for sustainable growth in a viable regional renewable energy sector. The EU has already supported this development through the "Paving the Way towards a Mediterranean Solar Plan" project as well as member States substantial input into tech Mediterranean solar Plans Technical Working Groups looking at the details of the implementation of closer cooperation. The Mediterranean Solar Plan Project Preparation Initiative (MSP-PPI), an initiative of the European Investment Bank (EIB), together with the European Commission, AFD, KfW, AECID, EBRD and the Union for the Mediterranean, is financed by the EU-funded Neighbourhood Investment Facility, with the aim to accelerate the implementation of renewable energy and energy efficiency projects in 7 Mediterranean partner countries: Algeria, Egypt, Gaza/West Bank, Jordan, Lebanon, Morocco and Tunisia.[74]

Currently an additional study "Bringing Europe and Third countries closer together through renewable Energies" (BETTER) financed by the Commission is further preparing the ground for pilot projects to be put into place.

The European Union, alongside 22 of its Member States, is a member of the International Renewable Energy Agency and as such actively supporting its work, inter alia giving substantial input to the implementation of the UN Secretary's General "Sustainable Energy For All" initiative or conducting renewable energy readiness assessment in Africa, Latin America and the Pacific region. Additionally development cooperation in many areas contributes to technology transfer. The Global Energy Efficiency and Renewable Energy Fund (GEEREF), which is managed by the European Investment Fund (EIF), for example facilitates participation in small-scale private ventures that introduce new technology in the area of renewable energy.

- *Africa, Caribbean and the Pacific (ACP-E) Energy Facility*

The ACP-EU Energy Facility is a contribution under the EU Energy Initiative to increase access to energy services for the poor. The Facility was approved by the joint ACPEU Council of Ministers in June 2005, with an amount of € 220 million. The main activity of the Facility is to co-finance projects that deliver energy services to poor rural areas.

The Energy Facility was mainly implemented through a €198 million Call for Proposals which was launched in June 2006. Out of 307 proposals received, 74 projects have been contracted by the end of 2008 for a total amount of €196 million from the Energy Facility, with a total project cost of €430 million. Since 2008, the Facility has financed around 140 national and cross-border projects in ACP countries for about EUR 300 Million. Almost 13 Million people should benefit of an improved access to energy mostly utilising Renewable Energy technologies. A second Energy Facility (EFII), with a total budget of €200 million, has been established for the period 2009-2013. A €100 million call for proposals, launched in November 2009, resulted in the selection of 65 projects for funding.

[74] http://www.eib.org/infocentre/publications/all/mediterranean-solar-plan-project-preparation-initiative.htm

The main activities performed through Energy Facility projects can be classified into three different groups: (1) energy production, transformation and distribution, (2) extension of existing electricity grids and (3) "soft" activities such as governance, capacity building or feasibility studies. The sources of energy used for electricity generation were mainly renewable energies (77 % of the projects). Only one project using exclusively fossil fuels was funded. In total, € 81 million of commitments have been marked as climate change related under the Energy Facility, covering support to enhance use of renewable energies or increase energy efficiency. A replenishment of the ACP-EU Energy Facility has been decided under the 10th European Development Fund for the period of 2009-2013. Endowed with € 200 Million, it will focus on improving access to safe and sustainable energy services in rural and peri-urban areas. The new Energy Facility will also contribute to the fight against climate change by emphasizing the use of renewable energy sources and energy efficiency measures and by taking into account impacts of climate change on energy systems. The new Facility started being implemented by the end of 2009 and funding guidelines were approved in October 2010. The Second Call for Proposals of the Energy Facility with a budget of EUR 55 million has been launched. The deadline for submission of Concept Notes and Full Applications was 03/06/2013. The second ACP-EU Energy Facility is one of the instruments implementing the Africa-EU Energy Partnership, which is part of the 2011-2013 Joint Africa-EU Strategy. A specific website for the monitoring of the ACP-EU Energy Facility was created under http://www.energyfacilitymonitoring.eu/.

- *Latin America Investment Facility (LAIF)*

The European Commission also established the Latin America Investment Facility (LAIF). The European Commission has foreseen an amount of € 125 million for the period 2009-2013.

The primary objective of LAIF is to finance key infrastructure projects in transport, energy, social and environmental sectors as well as to support private sector development in the Latin American region, in particular small- and medium-sized enterprises (SMEs). The main purpose of the LAIF is to mobilise additional financing to support investment in Latin America, encouraging beneficiary governments and public institutions to carry out essential investment in projects and programmes that could not be otherwise financed either by the market or by development Finance Institutions alone.

As part of its efforts to achieve this objective, LAIF pursues three strategic objectives:

- Improving interconnectivity between and within Latin American countries, in particular establishing better energy and transport infrastructure, including energy efficiency, renewable energy systems and the sustainability of transport and communication networks.
- Increasing the protection of the environment and supporting climate change adaptation and mitigation actions.
- Promoting equitable and sustainable socio-economic development through the improvement of social services infrastructure and support for small- and medium-sized enterprises (SMEs).

The 2012 operational annual report of LAIF reported that the grant contributions approved by the LAIF Board amounted to over € 160 million, leveraging total new investments of about € 4.2 billion. Since 2012, the amount allocated to LAIF increased to € 192.15 million.

- *Global Energy Efficiency and Renewable Energy Fund (GEEREF)*

The European Commission has launched an innovative pilot instrument to involve the private sector. The Global Energy Efficiency and Renewable Energy Fund (GEEREF), launched in 2007, aims to accelerate the transfer, development, use and enforcement of environmentally sound technologies for the world's poorer regions, helping to bring secure, clean and affordable energy to local people. GEEREF invests in regionally-oriented investment schemes and prioritises small investments below €10 million. It particularly focuses on serving the needs of the ACP, which is a group of 79 African, Caribbean and Pacific developing countries. It also invests in Latin America, Asia and neighbouring states of the EU (except for Candidate Countries). Priority is given to investment in countries with policies and regulatory frameworks on energy efficiency and renewable energy:

- €12.5 million investment in Berkeley Energy's Renewable Energy Asia Fund (REAF) for operationally and economically mature wind, hydro, solar, biomass, geothermal and methane recovery projects in India, Philippines, Bangladesh and Nepal.
- €10 million investment in the Evolution One Fund, dedicated to clean energy investment in Southern Africa (SADC countries).
- Furthermore, GEEREF invested €12.5 million in the Clean Tech Latin American Fund (CTLAF II), where the main objective is focused on the areas of renewable energy and clean technologies The CTLAF II is a capital fund investing in private companies and was established as the continued success of Cleantech Fund (I) which is now fully made available. The main geographic focus is Mexico, Brazil, Chile, Peru and Colombia and more information is available http://www.emergingenergy.com/).
- A new Fund called DI Frontier Market Energy and Carbon Fund ("DI") under the GEEREF package committed € 10 million. The main distinguishing feature is an integrated approach to project development, investment, and carbon trade. The Fund has a focus on Eastern and Southern Africa. Core focus countries include: Kenya, Mozambique, Tanzania, Uganda and Zambia. (more information is available under http://www.frontier.dk/).
- Armstrong Asset Management receives commitment of Euro 10 million from GEEREF for their South East Asia Clean Energy Fund.
- Emerging Energy Latin America Fund II receives € 12.5 million from GEEREF which is managed by Emerging Energy & Environment Group which is a regional fund dedicated to small and medium size renewable energy infrastructure in Latin America (more information available under http://www.emergingenergy.com).

In the regions where the two funds operate, there is a lack of equity investment available through the market for these types of projects. It is envisaged that GEEREF will invest in regional sub-funds for the African, Caribbean and Pacific (ACP) region, Neighbourhood, Latin America and Asia. Together the European Commission, Germany and Norway have committed about €112 million to the GEEREF over the period 2009-2013, the majority of which is provided by from the EU budget. It is envisaged that further financing from other public and private sources will be forthcoming. GEEREF will fundraise in 2013 to bring the total funds under management above €200 million. The target funding size for GEEREF is €200-250 million and as of March 2013, GEEREF has secured a total of €112 million.

The EU through Directorate General Development and Cooperation - EuropeAid also supports African, Carribean and Pacific countries in diversifying their economies; however, these activities are not limited to fossil fuel exporting countries, but are open to ACP countries based on Economic partnership agreements (EPAs). EPAs help ACP countries integrate into the global economy and improve the business environment, build up regional markets and promote good economic governance through reinforced regional cooperation in trade related issues. In 2008 the EU signed a comprehensive EPA with 13 CARIFORUM countries. In January 2009, Côte d'Ivoire and Cameroon have signed interim EPAs. Some ACP partners have signed interim economic partnership agreements with the EU as a first step towards comprehensive regional EPAs. The interim agreements secure and improve ACP access to the EU market and provide for more favourable rules of origin. Negotiations are ongoing with the African and Pacific regions to move from interim agreements to comprehensive regional agreements. The negotiations cover regional trade integration, trade in services, investment and trade-related rules. The strategy for private sector development in the ACP recommends the use of horizontal instruments (applicable to all ACP countries) in five priority areas where the Commission has a good experience and comparative advantages:

(1) Improvement of the macroeconomic framework and regulatory environment for enterprise development (Private Sector Enabling Environment Facility of the Business Environment (PSEEF) or BizClim with €20 million for 5 years);

(2) Investment and inter-enterprise co-operation promotion activities (PROINVEST - €110 million for 7 years);

(3) Facilitation of investment financing and development of financial markets (Investment Facility managed by the European Investment Bank (EIB) as revolving fund with €3,137 billion, completed by the EIB own resources with €2 billion for 2008-2013 and financial envelope of €400 million for the interest subsidies and technical assistance);

(4) Support for Small and Medium- sized Enterprises in the form of non-financial services (Centre for the Development of Enterprise (CDE) with €18 million per year, PROINVEST);

(5) Support for micro-enterprises and micro-finance (ACP-EU Microfinance Framework Programme with €15 million for 6 years, in collaboration with Consultative Group to Assist the Poor program (CGAP) and investment in debt and equity for banks and microfinance institutions provided by the EIB Investment Facility).

More specific information related to these activities can be obtained at:
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(DE NIR 2015 (German))

17 UNITS AND ABBREVIATIONS

t	1 tonne (metric) = 1 megagram (Mg) = 106 g
Mg	1 megagram = 106 g = 1 tonne (t)
Gg	1 gigagram = 109 g = 1 kilotonne (kt)
Tg	1 teragram = 1012 g = 1 megatonne (Mt)
TJ	1 terajoule

AWMS	animal waste management systems
BEF	biomass expansion factor
BKB	lignite briquettes
C	confidential
CCC	Climate Change Committee (established under Council Decision No 280/2004/EC)
CH_4	methane
CO_2	carbon dioxide
COP	conference of the parties
CRF	common reporting format
CV	calorific value
EC	European Community
EEA	European Environment Agency
EF	emission factor
Eionet	European environmental information and observation network
EMAS	Ecomanagement and Audit Scheme
ETC/ACC	European Topic Centre on Air and Climate Change
ETS	European Emissions Trading System
EU	European Union

FAO	Food and Agriculture Organisation of the United Nations
GHG	greenhouse gas
GPG	good practice guidance and uncertainty management in national greenhouse gas inventories (IPCC, 2000)
GWP	global warming potential
HFCs	hydrofluorocarbons
JRC	Joint Research Centre
F-gases	fluorinated gases (HFCs, PFCs, SF_6)
IE	included elsewhere
IPCC	Intergovernmental Panel on Climate Change
KP	Kyoto Protocol
LULUCF	land-use, land-use change and forestry
MNP	Milieu-en Natuurplanbureau
MS	Member State
MRG	monitoring and reporting guidelines
N	nitrogen
NH_3	ammonia
N_2O	nitrous oxide
NA	not applicable
NE	not estimated
NFI	national forest inventory
NIR	national inventory report
NO	not occurring
PFCs	perfluorocarbons
QA	quality assurance
QA/QC	quality assurance/quality control
QM	quality management
QMS	quality management system

RIVM	National Institute of Public Health and the Environment (The Netherlands)
SF_6	sulphur hexafluoride
SNE	Single National Entity
UNFCCC	United Nations Framework Convention on Climate Change
VOCs	Volatile Organic Compounds

Abbreviations in the source category tables in Chapters 3 to 9 and 18-24

Methods applied	**EF: methods applied for determining the emission factor**	**AD: methods applied for determining the activity data**	**Estimate: assessment of completeness**	**Quality: assessment of the uncertainty of the estimates**
CR — Corinair	CR — Corinair	AS — associations, business organizations	All — full	H — high
CS — country-specific	CS — country-specific	IS — international statistics	F — full	M — medium
COPERT X — Copert Model X = version	D — default	NS — national statistics	Full — full	L — low
D — default	M — model	PS — plant specific data	IE — included elsewhere	
M — model	MB — mass balance	Q — specific questionnaires, surveys	NE — not estimated	
NA — not applicable	PS — plant-specific	RS — regional statistics	NO — not occurring	
OTH - other				
RA — reference approach			P — partial	
T1 — IPCC Tier 1			Part — partial	
T1a — IPCC Tier 1a				

T1b — IPCC Tier 1b				
T1c — IPCC Tier 1c				
T2 — IPCC Tier 2				
T3 — IPCC Tier 3				