SLOVAK REPUBLIC

NATIONAL INVENTORY REPORT 2011

GREENHOUSE GAS EMISSION INVENTORY 1990–2009

SUBMISSION UNDER THE UNFCCC INCLUDING REPORTING ELEMENTS UNDER THE KYOTO PROTOCOL

Bratislava, April 15, 2011

Slovak
Hydrometeorological Institute

Ministry of the Environment
of the Slovak Republic

The National Inventory Report was prepared in accordance with UNFCCC related to *FCCC/CP/2002/8* from March 28 2003 – UNFCCC Guidelines on Reporting and Review and in accordance with reporting guidelines under Article 7 (decision 15/CMP.1) with the respect of the Annotated outline of the National Inventory Report including reporting elements under the Kyoto Protocol.

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PREFACE

National Inventory Report of the Slovak Republic (NIR) under the UNFCCC (United Nations Framework Convention on Climate Change) and the Kyoto Protocol (in accordance with decision 15/CMP.1) contains the following parts:

- National greenhouse gas emission inventory report of the Slovak Republic 1990 – 2009 (NIR) prepared using the reporting guidelines (UNFCCC 2006) and relevant parts of the Guidelines for the preparation of the information required under Article 7 of the Kyoto Protocol. IPCC and other methods applied to the calculation of the emissions are described, as well as the changes to the previous submission. Several summary tables and graphs of the emission data and emission trends for the years 1990 – 2009 are included.
- CRF (Common Reporting Format) data tables of the Slovak Republic's greenhouse gas emissions for the years 1990 – 2009. The CFR tables are compiled with the latest UNFCCC CRF Reporter software (version 3.5), xml file with the databases, country specific variables and unit's lists.
- SEF tables for reporting of Kyoto units (AAU, ERU, CER, t-CER. l-CER, RMU) in the registry of 31st December 2010 and transfers of the units during the year 2010.

The Slovak Hydrometeorological Institute (Stanislava Morova, Michaela Kollarova, Eva Gogova, Monika Kosecova, Jozef Uhlik, Martina Juskova and Janka Szemesova), Profing (Jan Judak), Ecosys (Jiri Balajka), the National Forest Centre Zvolen (Tibor Priwitzer), the Centrum of Transport Research Brno Czech Republic (Jiri Dufek), the Slovak Agricultural University Nitra (Bernard Siska), the Slovak Technical University Bratislava (Vladimir Danielik), the Faculty of Mathematics, Physics & Informatics Bratislava (Martin Gera), the Slovak Energy Agency, Slovak cooling and air conditions association (Peter Tomlein), SPIRIT Information Systems (Jozef Skakala) and veQ s.r.o. (Juraj Farkas) are involved in the process of development and have made the inventory calculations, as well as the description of the methodologies and other information included in the national inventory report. The Slovak Hydrometeorological Institute – the Department of Emissions is the Single National Entity with the overall responsibility of the compilation and finalisation of inventory reports and their submission to the UNFCCC Secretariat and the European Commission according the official journal: Vestnik, Ministry of Environment, XV, 3, 2007, page 19. The Slovak Hydrometeorological Institute – the Department of Emissions is the coordinator of the National Inventory system.

All relevant documents have to be approved by the National Focal Point to the UNFCCC, which is the Department of Climate Change and Economic Instruments of the Ministry of Environment of the Slovak Republic headed by Dr. Helena Princová (email: princova.helena@enviro.gov.sk). The Slovak NIR as well as the CRF tables and other relevant documents can be downloaded from the address: http://ghg-inventory.shmu.sk/ after 15 April 2011. The National Inventory System coordinator, Dr. Janka Szemesová (email: janka.szemesova@shmu.sk) is the contact person at Slovak Hydrometeorological Institute for inventory preparation.

EXECUTIVE SUMMARY

ES.1 Background information on greenhouse gas inventories and climate change

Climate change, caused by increasing anthropogenic emissions of greenhouse gases, represents the most serious environmental issue in the history of humankind. Carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O) are the most important anthropogenic greenhouse gases. The GHGs inventory includes also halogenated hydrocarbons (PFCs, HFCs) and SF_6, which are not controlled by the Montreal Protocol. Photochemical active gases such as carbon monoxide (CO), nitrogen oxides (NO_x) and non-methane volatile organic hydrocarbons (NM VOCs) are not greenhouse gases, but they contribute indirectly to the greenhouse effect in the atmosphere. These gases are generally referred to ozone precursors because they affect the creation and destruction of ozone in the troposphere. Precursors of sulphates - sulphur dioxide (SO_2) and aerosol - reduce the greenhouse effect.

The unfavourable development and balance of GHG emission generation since 1992 have created a demand to adopt an additional and effective instrument that would involve the participation of developing countries. In 1997, the Parties to the Convention agreed to endorse the Kyoto Protocol (KP) that defines reduction objectives and instruments to achieve them for the countries included in Annex I to the Convention. Developed countries defined in Annex B to the KP should reduce emissions of six GHGs (CO_2, CH_4, N_2O, HFCs, PFCs and SF_6) individually or together by 5.2% on average compared to the year 1990 during the first commitment period 2008 – 2012. The Slovak Republic, as a Member State of the EU (the EU commitment was adopted in the form of so-called burden sharing agreement) committed to an 8% reduction of emissions compared to the base year 1990. The Slovak Republic and the EU Member States ratified the Kyoto Protocol on 31st May 2002.[1]

According to global climatologic classification, the Slovak Republic is in the mild climate zone category with precipitation uniformly distributed over the whole year. The Atlantic Ocean impacts the west part of the Slovak Republic, while a continental influence is typical for the east part. A regular rotation of four seasons and variable weather throughout the year are typical for this country.

The Slovak Republic has 5.435273 million inhabitants (as of 31st December 2010). The average population density is 110.5 inhabitants per km². The population is concentrated in cities in lowlands and the main basins. Mountains areas are randomly populated. 47.8% of inhabitants in the Slovak Republic are economically active. The largest city is Bratislava with 431 061 inhabitants (as of 31st December 2010). It is the capital of the Slovak Republic.

The Ministry of Environment of the Slovak Republic (www.enviro.gov.sk) is responsible for national environmental policy including climate change and air protection issues. It has the responsibility to develop acts and amendments to existing legislation. Legislative proposals are commented by all ministries and other relevant bodies. Following the commenting process, the proposed acts are negotiated in the Legislative Council of the Government, approved by the Government, and finally by the Parliament.

Supporting institutions founded by the Ministry of Environment play an important role. These include the Slovak Hydrometeorological Institute (www.shmu.sk), the Water Research Institute, and the Slovak Environmental Agency. Academic and research institutions (i.e. the Ecology and Forestry Research Agency Zvolen, the Transportation Research Institute Žilina, the Slovak Agricultural University Nitra, the Slovak Technical University Bratislava, the Faculty of Mathematics, Physics & Informatics,

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[1] *Kyoto Protocol came into force on February 14th, 2005*

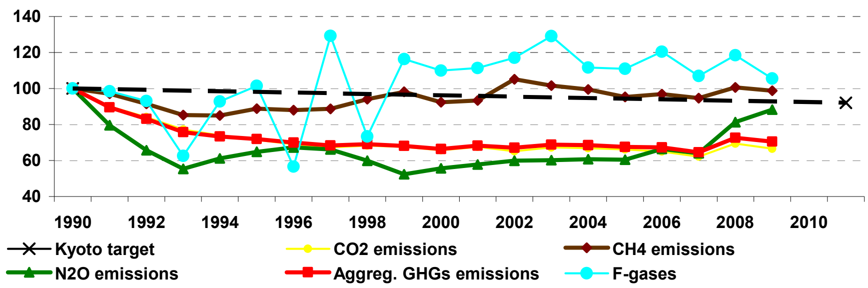
Commenius University Bratislava, and the Slovak Academy of Science), non-governmental organizations, and associations of interested groups (the SEA - the Slovak Energy Agency, PROFING – energy consulting company, SZCHKT – the Association for Air Conditioning and Cooling Technique, Detox – solvent use, SPIRIT – information systems, Ecosys – consulting company for energy projections) are involved in the process of development and implementation of policy and measures aimed to mitigate climate change impacts.

Since 2000, macroeconomic development of the Slovak Republic had been influenced by the implementation of measures with respect to the preparation of the country for the EU membership. Several important measures were implemented, in particular the elimination of price distortions, the changes in indirect taxes, and the adjustment of public financing mechanisms. In 2001, the growth of GDP reached 3.3%. In 2003, the Slovak economy continued in its positive development, and the growth of GDP at constant prices reached 6.0%. This result was comparable to the growth in the most developed economies in transition and reached the double of the growth in the EU-27 Member States.

ES.2 Summary of trends in national emissions and removals

The GHG emissions presented in the National Inventory Report 2011 were updated and converted by using the newest available methods, national conditions and data published by the Slovak Statistical Office. The recommendations of the Expert Review Team from the last centralised review of the Slovak Republic (took place from 13th to 18th September 2010) were taken into account by the inventory compilation 2010, but the recommendations included in the Annual Review Report 2010 were not fully implemented due to short time between the 2011 submission and publication of the report (see Table 10.2). Total GHG emissions were 43 426.07 Gg in 2009 (without LULUCF). This represents a reduction by 41.44% in comparison with the reference (base) year 1990. In comparison with 2008, the emissions decreased by almost 10%. Total GHG emissions in the Slovak Republic are decreasing due to the recession, but it is expected increase in the following years due to the increase of economic activities, the increase in transport category and expected increase in actual emissions of F–gases (mainly HFCs and SF_6). Total GHG emissions excluding LULUCF sector have been decreasing continually from the base year with the moderate decrease in the recent years. Significant changes in methodologies and emission factors are implemented in the frame of trying to keep consistency with the European Trade System (ETS). Table ES.1 shows the aggregated GHG emissions. In the period 1990 – 2009, the total greenhouse gas emissions in the Slovak Republic did not exceed the level of the base year 1990. Figure ES.1 shows trends in the gases without LULUCF comparable to the Kyoto target (92%) in relative expression.

Figure ES.1: GHG emission trends compared with the Kyoto target (%) in the Slovak Republic



GHG emissions without LULUCF; emissions are determined as of 15.04.2011

This important reduction of emissions has resulted above all from the strong although temporary decrease in economy activities, followed by restructuring of economy joined with implementing new, more effective technologies, reducing the share of intensive energy industry and increasing the share of services in the GDP generation. Transport (mostly the road transport), with increasing emissions is an important exception. The continuous pressure is being made in formulating the effective strategy and policy to achieve further reduction of the emissions.

Table ES.1: Total anthropogenic greenhouse gas emissions by gases without LULUCF

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Gases	**CO_2 equivalent (Gg)**									
CO2 with LULUCF	59 784,23	52 581,69	47 081,61	43 645,65	42 537,80	41 481,54	40 162,62	39 743,78	39 902,16	39 641,88
CO2 without LULUCF	62 765,04	56 406,10	52 798,56	48 468,91	46 341,77	44 840,32	43 300,15	42 198,58	42 797,95	42 338,63
CH4 with LULUCF	4 824,97	4 676,46	4 411,18	4 110,06	4 098,38	4 283,51	4 243,01	4 275,19	4 536,74	4 736,56
CH4 without LULUCF	4 810,88	4 667,50	4 403,16	4 101,96	4 089,86	4 273,95	4 232,78	4 263,92	4 525,46	4 723,76
N2O with LULUCF	6 319,55	5 023,47	4 167,68	3 522,08	3 858,89	4 093,10	4 247,23	4 170,84	3 775,32	3 304,76
N2O without LULUCF	6 307,46	5 017,45	4 141,52	3 490,95	3 855,70	4 089,59	4 237,84	4 167,65	3 774,30	3 301,56
HFCs	NA,NO	NA,NO	NA,NO	NA,NO	2,91	22,15	37,58	61,13	40,96	65,12
PFCs	271,37	266,94	248,42	155,42	132,06	114,32	34,51	34,62	25,40	13,60
SF6	0,03	0,03	0,04	0,06	9,27	9,91	10,76	11,34	12,24	12,69
Total (with LULUCF)	**71 200,15**	**62 548,60**	**55 908,94**	**51 433,27**	**50 639,31**	**50 004,53**	**48 735,71**	**48 296,91**	**48 292,82**	**47 774,61**
Total (without LULUCF)	**74 154,78**	**66 358,02**	**61 591,69**	**56 217,30**	**54 431,56**	**53 350,25**	**51 853,62**	**50 737,24**	**51 176,31**	**50 455,36**
	2000	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**
Gases	**CO_2 equivalent (Gg)**									
CO2 with LULUCF	38 063,04	36 067,33	34 305,49	36 334,11	36 851,20	40 045,19	36 633,54	35 015,63	35 897,24	31 610,11
CO2 without LULUCF	41 183,45	42 379,12	40 826,29	42 165,51	41 974,80	41 502,56	40 786,65	39 001,93	39 096,30	35 086,92
CH4 with LULUCF	4 455,12	4 501,54	5 068,66	4 899,62	4 803,43	4 611,16	4 678,23	4 570,53	4 713,98	4 370,00
CH4 without LULUCF	4 443,36	4 487,26	5 054,62	4 884,50	4 786,23	4 588,73	4 659,33	4 551,79	4 692,93	4 349,23
N2O with LULUCF	3 545,45	3 646,06	3 772,95	3 797,18	3 830,46	3 816,74	4 193,96	4 045,27	4 081,49	3 660,20
N2O without LULUCF	3 508,16	3 642,87	3 771,62	3 790,89	3 826,06	3 811,40	4 190,79	4 037,10	4 079,65	3 653,16
HFCs	75,59	82,43	102,35	131,96	152,88	172,34	198,90	226,99	264,43	299,61
PFCs	11,65	15,59	13,75	21,65	19,91	20,25	35,82	24,88	36,16	17,76
SF6	13,25	13,84	14,78	15,39	15,89	16,61	17,15	17,44	18,51	19,39
Total (with LULUCF)	**46 164,10**	**44 326,79**	**43 277,98**	**45 199,91**	**45 673,76**	**48 682,29**	**45 757,60**	**43 900,74**	**45 011,81**	**39 977,06**
Total (without LULUCF)	**49 235,46**	**50 621,11**	**49 783,41**	**51 009,90**	**50 775,77**	**50 111,88**	**49 888,64**	**47 860,13**	**48 187,97**	**43 426,07**

**Total aggregated GHGs emission without LULUCF, emissions are determined as of 15.04.2011*

ES.3 Overview of source and sink category

The energy sector (including transport) with the share of 66.1% was the main contributor to total GHG emissions in 2009. Within this sector, transport with 21.6% share contributes significantly to the GHG emissions and it shows the most increasing trend. The share of transport in total emissions has increased by 12.6% since 1990. In addition to fuel combustion in stationary sources of pollution, also the pollution from small sources of residential heating systems and fugitive methane emissions from transport, processing and distribution of oil and natural gas contribute significantly to the total GHG emissions. Sector industrial processes was the second important sector in 2009 with its 21.6% share in total GHG emissions, producing mainly technological emissions from processing mineral products, chemical production and steel and iron production. The efficient reduction of emissions from technological processes is very expensive, therefore the emissions have remained on the same level since the reference year and they have been influenced only by the size of production in industrial processes. In 2009, the share of sector agriculture in total GHG emissions was 7.0% and the trend of emissions has remained relatively stable since 1999. The most significant reduction of emissions from agriculture was achieved at the beginning of nineties and it was caused by the reduction of breeding livestock and the restricted use of fertilizers. Sector waste contributed by 5.0% to total GHG emissions. Introduction of more exact methodology for the evaluation of methane emissions from solid waste disposal on sites resulted in continual increase of emissions by more than 97% compared to the base year 1990. Similar trend is expected to remain in the future, although only with slight increase in emissions. The amount of emissions from landfills depends, to a large extent, on the methodology adopted to evaluate landfills and on the implementation of energy recovery of landfill gases by landfill operators. Sector solvents use is the least significant sector with respects to the generation of GHG emissions in the Slovak Republic. Its contribution to the total GHG emissions was less than 1%. The shares of individual sectors in total GHG emissions have not been changed significantly compared to the base year 1990. The increase in transport and the decreased share of stationary sources of pollution in sector energy are noticeable.

Combustion and transformation of fossil fuels, which account for about 95% of the total CO_2 emissions in the Slovak Republic, are the most important anthropogenic source of CO_2 emissions (Table ES.2).

Table ES.2: Total anthropogenic greenhouse gas emissions by sectors

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Sectors	**CO_2 equivalent (Gg)**									
1. Energy	55 321,29	50 364,84	46 955,68	42 596,55	39 921,78	38 420,69	37 240,87	35 865,19	35 808,94	34 891,66
2. Industrial Processes	10 530,85	8 782,21	8 439,07	8 131,59	9 120,24	9 297,37	9 077,92	9 314,00	9 779,53	9 973,34
3. Solvent Use	147,15	126,64	110,00	101,65	102,96	121,53	115,50	97,62	94,45	90,52
4. Agriculture	7 064,14	5 978,43	4 976,98	4 268,48	4 111,56	4 277,96	4 125,71	3 969,74	3 664,45	3 406,53
5. LULUCF	-2 954,62	-3 809,43	-5 682,76	-4 784,03	-3 792,25	-3 345,72	-3 117,92	-2 440,32	-2 883,49	-2 680,75
6. Waste	1 091,33	1 105,90	1 109,98	1 119,03	1 175,03	1 232,71	1 293,62	1 490,69	1 828,93	2 093,32
7. Other	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Total (with LULUCF)	**71 200,15**	**62 548,60**	**55 908,94**	**51 433,27**	**50 639,31**	**50 004,53**	**48 735,71**	**48 296,91**	**48 292,82**	**47 774,61**
	2000	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**
Sectors	**CO_2 equivalent (Gg)**									
1. Energy	34 054,04	35 173,69	33 071,09	34 515,82	33 430,32	33 156,13	32 386,85	30 598,89	31 320,49	28 694,32
2. Industrial Processes	9 879,99	10 087,76	10 471,20	10 472,50	11 498,04	11 228,68	11 640,25	11 468,90	11 182,71	9 389,31
3. Solvent Use	85,04	99,74	131,92	137,35	163,49	171,54	170,59	166,25	166,59	164,38
4. Agriculture	3 441,39	3 450,74	3 526,96	3 385,09	3 219,89	3 213,16	3 162,43	3 267,68	3 152,56	3 018,59
5. LULUCF	-3 071,36	-6 294,32	-6 505,43	-5 809,99	-5 102,00	-1 429,59	-4 131,04	-3 959,40	-3 176,16	-3 449,01
6. Waste	1 774,99	1 809,18	2 582,25	2 499,15	2 464,02	2 342,36	2 528,53	2 358,42	2 365,62	2 159,46
7. Other	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Total (with LULUCF)	**46 164,10**	**44 326,79**	**43 277,98**	**45 199,91**	**45 673,76**	**48 682,29**	**45 757,60**	**43 900,74**	**45 011,81**	**39 977,06**

Emissions are determined as of 15.04.2011

ES.4 Background information and summary of emission and removals from KP-LULUCF activities

According to the *"Report on the estimation of assigned amounts under the Kyoto Protocol-revised version according to the IRR from July, 2007"* the Slovak Republic has officially declared the following statement: In order to report under Article 3.3 (ARD activities: afforestation, reforestation and deforestation), the Slovak Republic has selected the following threshold values for the forest definition: forest land includes land with minimum tree crown cover of 20% for trees capable to reach minimum height of 5 m in situ. The minimum area for forest is 0.3 ha. Temporarily unstock areas are included (forest regeneration areas). For linear formations, a minimum width of 20 m is applied. This definition would be applicable also for reporting, under Article 3.4. However, the Slovak Republic has decided not to use Article 3.4 activities to meet its commitments under the first commitment period. The selected threshold values are consistent with the values used in the reporting to the Food and Agriculture Organisation of the United Nations (the GFRA 2005, National Forest Inventory, and MCPFE criteria and indicators of sustainable forest management). The Slovak Republic has decided not to use any activities under Article 3.4 (forest management, cropland management, grazing land management and revegetation) to meet its commitment under the first commitment period of the Kyoto Protocol. The Slovak Republic has chosen to account for the activities under Article 3.3 (afforestation, reforestation and deforestation) for the whole commitment period. In 2009, total CO_2 removals from afforestation/reforestation activities were -469.23 Gg of CO_2 (changes in 29.21 kha to the end of 2009). Total CO_2 emissions from deforestation were 280.11 Gg of CO_2 (changes in 6.98 kha to the end of 2009). In 2009, total emissions under the Article 3.3 of the KP 460.85 Gg with the changed area of 37.7 kha.

Table ES.3: Emissions and removals resulting from the activities under Article 3.3 of the KP

Activities	**2008**	**2009**	**Total**
	Net CO_2 (Gg)		
A. Article 3.3 activities			
A.1. Afforestation and Reforestation	-453,04	-469,23	**-922,26**
A.1.1. Units of land not harvested since the beginning of the commitment period	-453,04	-469,23	**-922,26**
A.1.2. Units of land harvested since the beginning of the commitment period	NA	NA	**NA**
A.2. Deforestation	180,74	280,11	**460,85**

ES.5 Indirect greenhouse gases

A major source of SO_2, NO_x and CO emissions is power and heat generation. The contribution of transport to NO_x and CO emissions is still growing. Metallurgy is an important source of CO emissions. Emissions of NM VOC are regularly estimated within the National Program of NM VOC Emissions Reduction in the Slovak Republic. Within this Program, the emission factors for asphalt paving and residential plants combustion were revised (total decrease in emissions was by about 45% in 1990). The year 1990 was used as a starting point and updating was carried out for the years 1993, 1996 – 1999 and 2006. NM VOC emissions come from the use of solvents, transport, refinery/storage and transport of crude oil and petrol. The categories of emission sources in the National Emission Information System (NEIS) are based on Act no. 478/2002 Coll. on Air Pollution and they do not correspond exactly to the structure of sources according to the CRF requirements. Therefore, it is impossible to provide information on emissions and emission factors according to the classification required by standard tables. NM VOC emissions increase easily in sector solvent and other product use in consequence of increasing industrial production, especially in engineering, but also due to increasing consumption of print's ink and import of solvent paints. New emission factors respect that asphalt mixture contains 5.5% of asphalt and others are creating by aggregate.

The last update of the emission inventory and projections was performed in 2009. Major recalculations were made for all pollutants in road transport. The recalculation of the emissions from road transport for the period of 2000 – 2008 was based on the updated model COPERT IV. Model COPERT IV was used also for the calculation of emissions in 2009. Minor recalculations for NO_x, NM VOC, heavy metal emissions from stationary sources were performed in 2009 (only for sector energy - category 1A1a), due to the changes in operators´ statistics in the database of NEIS (National Emission Information System). The recalculations regarding solid waste disposal on landfills and waste incineration (healthcare waste industrial waste and municipal waste) were performed back to the year 1990. NMVOC and heavy metals (HMs) were recalculated back to year 2000 due to the corrections of activity data. Recalculations for $PM_{2.5}$ and PM_{10} emissions were performed for stationary sources in 2007 (only for sector energy - category 1A1a), due to the change in the plant statistics of operators accrued from the database NEIS. The recalculation was performed for sector agriculture in category synthetic N-fertilizers for NH_3 emissions up to year 2000. The recalculation was performed for sector agriculture in category synthetic N-fertilizers for NH_3 emissions up to year 2000.

Table ES.4: Anthropogenic emissions of NO_x, CO, NM VOC and SO_2 (Gg) in 1990 – 2009

Year	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
CO	**511,58**	**488,08**	**444,64**	**455,88**	**431,04**	**419,66**	**363,78**	**363,56**	**346,19**	**335,37**	**308,24**	**314,77**	**296,02**	**299,80**	**303,06**	**289,80**	**275,88**	**256,27**	**251,30**	**216,94**
Stationary	351,26	340,23	299,99	301,05	272,63	258,90	208,18	205,61	187,61	185,36	185,16	175,59	165,14	184,20	189,56	181,39	193,51	183,33	178,41	148,05
Transport	154,20	142,87	140,62	150,68	154,80	156,74	151,13	153,22	153,95	144,65	117,22	133,25	125,03	109,13	106,38	99,05	74,43	65,01	64,18	60,16
Other*	6,12	4,97	4,03	4,16	3,60	4,02	4,46	4,74	4,64	5,36	5,86	5,92	5,85	6,47	7,11	9,36	7,94	7,93	8,71	8,73
NO_x	**221,96**	**201,22**	**188,63**	**180,31**	**170,00**	**177,94**	**134,95**	**127,51**	**133,11**	**121,13**	**107,41**	**107,84**	**100,25**	**96,34**	**100,07**	**104,05**	**98,70**	**96,51**	**95,04**	**84,82**
Stationary	160,46	150,21	141,73	135,26	122,39	128,01	89,42	82,10	86,43	77,41	70,32	67,58	59,70	58,37	56,51	55,39	52,09	46,84	45,79	41,08
Transport	56,85	47,51	43,74	42,36	43,54	45,45	45,04	44,92	46,21	43,22	36,55	39,72	40,02	37,40	42,92	47,85	45,89	48,95	48,50	42,93
Other*	4,66	3,50	3,16	2,70	4,07	4,48	0,49	0,50	0,47	0,49	0,54	0,54	0,53	0,57	0,64	0,80	0,73	0,72	0,75	0,82
NM VOC	**141,44**	**NA,NE**	**NA,NE**	**107,91**	**NA,NE**	**101,08**	**97,20**	**91,87**	**88,41**	**82,47**	**69,11**	**72,83**	**71,53**	**72,55**	**72,73**	**75,96**	**70,65**	**69,23**	**68,75**	**65,40**
Energy	41,02	NA,NE	NA,NE	34,43	NA,NE	27,52	28,30	27,28	24,09	22,85	21,97	22,48	20,29	21,33	23,00	24,87	22,77	22,25	22,12	21,37
Industry	8,79	NA,NE	NA,NE	5,87	NA,NE	2,82	2,68	2,67	1,58	1,51	1,37	1,32	1,39	1,68	1,69	1,59	1,56	1,53	1,38	1,26
Transport	33,56	NA,NE	NA,NE	30,88	NA,NE	32,97	31,84	32,04	31,90	29,07	17,92	19,55	17,81	16,08	14,40	14,96	10,74	11,05	10,42	8,67
Solvent Use	52,87	NA,NE	NA,NE	34,97	NA,NE	37,07	33,80	29,29	30,18	28,41	26,98	28,72	31,02	32,27	32,76	33,56	34,63	33,58	33,78	33,33
Agriculture	0,65	NA,NE	NA,NE	0,44	NA,NE	0,44	0,44	0,44	0,44	0,44	0,44	0,44	0,44	0,44	0,44	0,44	0,44	0,44	0,44	0,44
Waste	4,54	NA,NE	NA,NE	1,34	NA,NE	0,26	0,15	0,15	0,23	0,18	0,43	0,32	0,58	0,76	0,45	0,54	0,51	0,38	0,61	0,33
SO_2	**526,11**	**445,50**	**389,63**	**328,22**	**245,22**	**246,29**	**230,59**	**204,69**	**184,11**	**172,96**	**126,95**	**131,11**	**103,35**	**105,50**	**96,19**	**89,01**	**87,75**	**70,56**	**69,41**	**64,08**
Stationary	522,69	442,77	387,24	326,04	242,91	243,80	228,06	202,14	181,39	171,88	126,08	130,23	102,53	105,26	95,95	88,77	87,53	70,30	69,14	63,84
Transport	3,42	2,73	2,39	2,17	2,31	2,49	2,54	2,55	2,72	1,09	0,86	0,87	0,80	0,21	0,22	0,24	0,22	0,25	0,26	0,24

**Biomass burning and forest fires, emissions are determined as of 15.02.2011.*

PART 1:
Annual Inventory Submission

CHAPTER 1: INTRODUCTION

1.1 Background information on greenhouse gas inventories and climate change

1.1.1 Climate change

From 1881 to the present days, the average annual air temperature had increased by about 1.6°C (more in the season from January to August) and the annual atmospheric precipitation totals decreased by about 3.4%, in the Slovak Republic (in the south of the territory the decrease was more than 10%; in the north and northeast of the territory the increase was sporadically up to 3%). A significant decrease in the relative air humidity was recorded (in the south of the territory it had been by about 5% from 1900 and less than 5% elsewhere in the Slovak Republic), as well as the decrease in snow cover at the altitude up to 1,000 m almost over the whole territory (the increase in higher altitude). Also the characteristics of potential and actual evapotranspiration, soil humidity and net radiation confirm a gradual desertification, in particular in the south of Slovakia (the increase in potential evapotranspiration and the decrease in soil moisture). However, characteristics of sun radiation had not been changed significantly (except for a transitional decrease in the period from 1965 to 1985). Similar trend continues also after 2000.[2]

The greenhouse effect of the atmosphere is similar to the effect that may be observed in greenhouses, however the function of glass in the atmosphere is taken over by the "greenhouse gases" (international abbreviation GHGs). Short wave solar radiation is transmitted freely through the greenhouse gases, falling to the earth's surface and heating it. Long wave (infrared) radiation, emitted by the earth's surface, is caught by these gases in the major way and partly reemitted towards the earth's surface. Because of this effect, the average temperature of the surface atmosphere by 33°C warmer than it would be without the greenhouse gases. Finally, this enables the life on our planet.

The most important greenhouse gas in the atmosphere is water vapour (H_2O), which is responsible for approximately two thirds of the total greenhouse effect. Its content in the atmosphere is not directly affected by human activity, in principle it is determined by the natural water cycle, expressed in a very simple way, as the difference between evaporation and precipitation. Carbon dioxide (CO_2) contributes to the greenhouse effect by 30%, methane (CH_4), nitrous oxide (N_2O) and ozone (O_3), all three together contribute by 3%. The group of synthetic (artificial) substances - chlorofluorocarbons (CFCs), their substitutes, hydrofluorocarbons (HCFCs, HFCs) and others such as fluorocarbons (PFCs) and SF_6, also belong to the greenhouse gases. There are other photochemical active gases as well, such as carbon monoxide (CO), oxides of nitrogen (NO_x) and non-methane organic compounds (NM VOC), which do not belong to the greenhouse gases, but contribute indirectly to the greenhouse effect of the atmosphere. They are registered together as the precursors of ozone in the atmosphere, as they influence the formation and disintegration of ozone in the atmosphere.

Whilst mentioning the emissions of greenhouse gases, we must also include CO_2, CH_4 N_2O and F-gases, as they are defined in the Kyoto Protocol. Though they belong to natural components of the ambient air, their present content in the atmosphere is significantly affected by human activity. The growth in concentrations of greenhouse gases in the atmosphere (caused by anthropogenic emission) leads to the strengthening of the greenhouse gas effect and thus to the additional warming of the

[2] *The Fifth National Communication of the Slovak Republic on Climate Change, 2009*

atmosphere. Concentrations of greenhouse gases in the atmosphere are formed by the difference between their emission (release into the atmosphere) and sink. It follows then that the increase of their content in the atmosphere operates by two mechanisms:

- Emissions into the atmosphere.
- Weakening of natural sink mechanisms.

Globally (Climate Change, 1995) the annual anthropogenic emission of carbon dioxide ranges between 4–8 billion tons of carbon (about 4t of CO_2 per capita in the globe). Fossil fuel combustion and cement production are the most important sources of "new" carbon dioxide. CO_2 is also released from the soil (deforestation, forest fires and conversion of grasslands into agricultural soil), but this contribution is more difficult to quantify. Carbon dioxide is very stable in the atmosphere; its residence time is tens of years (60–200 yrs.) and is removed from the atmosphere by a complex of natural sink mechanisms. It is expected that 40% of carbon dioxide presently emitted will be absorbed by the oceans. Photosynthesis by vegetation and sea plankton is another important sink mechanism, though only a transitional one, because after the death (eating) of a plant, carbon dioxide is released again. The level of methane in the ambient air is affected by human activity in more ways. Land transformation into an agricultural one (mainly rice fields), animal husbandry, coal mining, natural gas mining, its transport and use as well as the biomass burning, these all are the anthropogenic activities. The natural methane sources have not been fully investigated yet fully investigated and thus the role of methane in the climate change mechanism is not quite clear. As distinct from CO_2, the disintegration of methane in the atmosphere is via chemical reactions (by OH radical). Residence time of methane in the atmosphere is 10–12 years. At present, the annual total anthropogenic methane emission is said to be approximately 0.4 billion tons, emission from natural sources is about 0.16 billion tons (IPCC[3] 1995). PFCs, HCFCs, HFCs (perfluorocarbons, hydrochloroflourocarbons, hydrofluorocarbons, etc.) and SF_6 are entering the atmosphere only because of human activity. They are used as carrier gases for sprays, fillings in cooling and extinguishing systems, as insulating substances, as solvents at the production of semiconductors etc. Apart from the fact that they attack atmospheric ozone, they are very "high-powered" inert greenhouse gases having a residence time e.g. perfluoromethane (CF_4) of 50 000 years. It means that even minor emissions have a great negative effect. The ground level ozone concentrations are growing as a consequence of CO, NO_x and NM VOC emissions. They have very important source in exhaust gases, fossil fuel combustion and as far as NM VOCs are considered, the use of solvents, as well. N_2O enters the atmosphere from several small sources. The most important source seems to be the emission from soil (nitrogen surpluses because of intensive fertilizing and inconvenient agriculture-technical procedures). Fuel combustion, some industrial technologies, large-scale livestock breeding and sewage are the sources of N_2O emissions. Global anthropogenic emission is estimated to be 3 – 7 million tons of nitrogen per year. Natural sources are approximately twice as large as anthropogenic ones. The N_2O is disintegrated mainly photo chemically in the stratosphere.

1.1.2 Greenhouse gas inventories

According to the emission inventory of April 2011, in 2009 the Slovak Republic has achieved the reduction of total anthropogenic emissions of greenhouse gasses expressed as CO_2 equivalent, by 41.44% without LULUCF compared with the base year 1990. This achievement is the result of several processes and factors, mainly:

- Higher share of services in the generation of the GDP. Restructuring of industries.
- Higher share of gas fuels in the primary energy resources consumption.

[3] *Intergovernmental panel was established in 1988 commonly by ECE (UNEP) and the World Meteorological Organisation (WMO). Its task is to reach the authoritative international consensus in the scientific opinions on climate change. The working groups of IPCC prepare regular updated information for COP, where the latest knowledge in association with the global warming is included.*

- Gradual decrease in energy demands in certain heavy energy demanding sectors (except for metallurgy).
- The impact of air protection legislative measures influencing directly or indirectly the generation of greenhouse gas emissions.
- The impact of the global economic and financial crises started in 2009 and the short term crises in oil and natural gas supply from Ukraine at the beginning of 2009 (January-February).

A comparison of the GDP trend with the trend of aggregate emissions of greenhouse gasses shows that the Slovak Republic is one of few countries where the trend of emissions has been decoupled from the GDP increase. However, by international comparison, the generation of greenhouse gasses per capita still remains one of the highest in the Europe.

Without introduction of effective measures, the Slovak Republic will contribute to further increase of GHG emissions due to the anticipated growth of the GDP and the recovery of economic activities. Therefore, the investment strategy to tackle GHG emissions is one of the most important objectives.

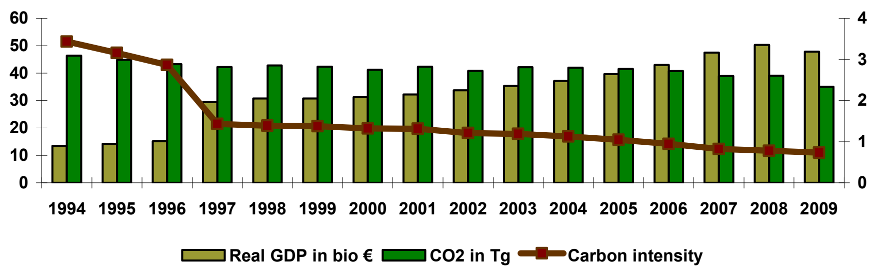
In May 2004, the Slovak Republic joined the European Union. Relevant European legislation has brought additional positive direct and indirect effects to the reduction of GHG emissions, mainly in energy sector. The introduction of emission trading scheme will allow the implementation of further reduction measures.

Table 1.1: Development of carbon intensity per GDP from 1994 in the Slovak Republic

Year	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Real GDP in bio €	13,50	14,20	15,10	29,46	30,74	30,76	31,18	32,26	33,74	35,35	37,14	39,61	42,98	47,50	50,27	47,86
CO_2 in Tg	46,34	44,84	43,30	42,20	42,80	42,34	41,18	42,38	40,83	42,17	41,97	41,50	40,79	39,00	39,10	35,09
Carbon intensity	3,43	3,16	2,87	1,43	1,39	1,38	1,32	1,31	1,21	1,19	1,13	1,05	0,95	0,82	0,78	0,73

The values are absolute, GDP after recalculation in 2009 up to 1997, data before 1994 are not available

Figure 1.1: Comparison of CO_2 emissions per GDP (carbon intensity)



Statistical Office of the SR recalculates GDP and Value Added only up to year 1997.

1.1.3 International agreements

Global climate change due to the anthropogenic emissions of greenhouse gases is the most important environmental problem in the history of humankind. The instrument to tackle the problem of climate change is the UN Framework Convention on Climate Change adopted in 1992. The aim of the Convention is to stabilize the atmospheric concentrations of greenhouse gases to a safe level. Currently, there are 185 countries or international communities, including the Slovak Republic, and the EU that are Parties to the Convention. The Convention requires the adoption of measures that aim to reducing the GHG emission to the level of the year 1990.

The Framework Convention on Climate Change (UN FCCC) - the basic international legal instrument to protect global climate was adopted at the UN Conference on the Environment and Development (Rio de Janeiro, 1992). The final goal of the Convention is to achieve the stabilisation of greenhouse gas concentrations in the atmosphere at a level would not cause any dangerous interference in the climate system. In the Slovak Republic, the Convention came into force on November 23rd, 1994. The Slovak Republic accepted all the commitments of the Convention, including the reduction of GHG emissions by 2000 to the 1990 level. One of the commitments, resulting from the Convention, is to provide a regularly greenhouse gas emission inventory.

The unfavourable development and balance of GHG emissions generation since 1992 have created a need to adopt an additional and effective instrument. In 1997, the Parties to the Convention agreed to endorse the Kyoto Protocol (KP) that defines reduction targets for countries of the Annex I to the Convention. Developed countries defined in Annex B of the Kyoto Protocol should reduce emissions of six GHG individually or together on average by 5.2% on average compared to the level of the year 1990 during the first commitment period 2008 – 2012. The reduction target of the Slovak Republic is the 8% reduction of emissions compared to the base year 1990. The Kyoto Protocol has generally extended the options of the countries to choose the way and the instruments that are most appropriate for the achievement of their reduction targets, taking into account the specific circumstances of the country. The common feature of new mechanisms is the effort to achieve the maximum reduction potential in the most effective way. The Slovak Republic and the EU countries ratified the Kyoto Protocol on 31st May 2002.[4]

In the context of joining of the Slovak Republic the European Union (May 1st, 2004), raised new legislative requirements in the field of air protection. The European Union considers the area of climate change for the one of the four environmental priorities.[5] The Slovak Republic submits the data about GHG emissions in relevant extent by January 15th each year, according to Decision No 280/2004/EC of the European Parliament and of the Council concerning a mechanism for monitoring Community GHG emissions and for implementing the Kyoto Protocol.[6] Basic criteria for the implementation of the Decision are as follows:

- Monitoring of all anthropogenic emissions of GHGs in the EU Member States.
- Ensure the progress in fulfilling the reduction targets under the UNFCCC and the Kyoto Protocol.
- Implement the Convention and the Kyoto Protocol in view of national programs, GHGs inventory, national systems and register of the EU and the Member States.
- Ensure completeness, transparency, consistency, accuracy, comparability and the timing in the EC reporting.

The results of resent scientific and economic analyses indicate the urgent need to implement reduction measures, as well as the adaptation measures. The time shift of their implementation increases the risk of significant and irreversible changes and might increase the costs to eliminate them. In view of urgency and need to solve problems of climate change, energy security and adaptation to adverse impacts of climate change, the heads of states and governments adopted a political decision regarding middle-term objectives in March 2007, as follows:

- Unilateral 20% reduction of GHG emissions by 2020 compared to 1990, or the reduction by 30% in case of achieving international convention.
- Increase of energy efficiency by 20% by 2020.
- Achieving 20% share of renewable resources in final energy consumption, including, 10% share of biofuels in gasoline and diesel oil consumption by 2020.

Integrated Climate and Energy Package (CEP) is a principal, comprehensive and ambitious solution, which will influence significantly the economic development of the Slovak Republic within the middle-

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[4] *The Kyoto Protocol came into force on February 14th, 2005*

[5] *New environmental action program: Environment 2010 Our Future, Our Choice*

[6] *OJ L 49, 19.2.2004, p. 1*

term horizon. By its approval in December 2009, the legal framework of the issue was distinctly strengthened. The CEP is an important impulse for more active perception of climate change and adaptation at the level of the Slovak Republic Government and general public, together with international negotiations on future cooperation of countries in this agenda after the year 2012.

1.2 Brief description of the institutional arrangements for inventory preparation

1.2.1 National Inventory System of the Slovak Republic for GHG inventory

Articles 4 and 12 of the UNFCCC require that Parties to the UNFCCC develop, periodically update, publish, and make available to the Conference of the Parties national inventories of anthropogenic emissions by sources and removals by sinks of all greenhouse gases not controlled under the Montreal Protocol. Moreover, the commitments require estimating emissions and removals as a part of ensuring that Parties are in compliance with emission limits, that they have a national system for estimating sources and sinks of greenhouse gases, that they submit an inventory annually, and that they formulate national programs to improve the quality of emission factors, activity data, or methods.

The obligation of the Slovak Republic to create and maintain the national inventory system (NIS) which enables continual monitoring of greenhouse gases emissions is given by Article 5, paragraph 1 of the Kyoto Protocol to the United Nations Framework Convention on Climate Change.

Setting up the National Inventory System of emissions in compliance with the Kyoto Protocol and Council Decision 280/2004/EC was the priority of capacity development in the Slovak Republic at all levels identified also as a middle-term objective of the Climate Change Strategy of the Slovak Republic. The basic characteristics of the capacity building the NIS were as follows:

- To operate the National Inventory System (institutions, competences), which groups the experts from all sectors according to IPCC (NFP, SNE, scientific institutions, universities, research institutes, private sector, non-governmental organisations, Statistic Office...).
- To establish an independent working unit entitled the Single National Entity (SNE – according to a COP recommendation), which coordinates the NIS and has competencies and responsibilities stipulated by law. The SNE is controlled directly by the NFP (MŽP SR), including financial resources.
- To interlink all stakeholders at the horizontal level with regard to expert, financial, legal and information issues. The SNE is responsible for achieving the commitments under the UNFCCC and KP in the field of reporting, assessment and providing information to all stakeholders, administration of national databases (NEIS, IPPC – air, NEC directive, EPER), implementation of QA/QC process, accreditation and certification, organisation of „cross-country“ meetings and communication with international organizations.
- To appoint experts or organisations for each IPCC sector or gas, and explicitly determine their responsibilities; to appoint a team for the work on national communications, modeling and projections of emissions (GAINS, CAFE) in the sense of keeping consistency, reproducibility and transparency.
- To obtain allocated finances from the State budget continuously for achieving the commitments under the UNFCCC and the KP on annual basis and in a sufficient amount (according to actual needs and analysis).
- To determine the competencies of the NIS and the operators of polluting sources with regard to the dissemination of information.

The National Inventory System (http://ghg-inventory.shmu.sk/) has been established and officially announced by Decision of the Ministry of Environment of the Slovak Republic on 1st January 2007 in the official bulletin: Vestnik, Ministry of Environment, XV, 3, 2007, page 19 (http://www.enviro.gov.sk/

servlets/files/16715).[7] In agreement with paragraph 30(f) of Annex to decision 15/CMP.1 which gives the definitions of all qualitative parameters for the national inventory systems, the description of quality assurance and quality control plan according to Article 5, paragraph 1 is also required.

The revised report of the National Inventory System dated on November 2008 is focused on the changes in the institutional arrangement, quality assurance/quality control plan and planned improvements.

The Ministry of Environment of the Slovak Republic (MŽP) (www.enviro.gov.sk) is responsible for national environmental policy including climate change and air protection issues as the National Focal Point. It has the responsibility to develop acts and amendments to existing legislation. All ministries and other relevant bodies comment legislative proposals. Following the commenting process, proposed acts are negotiated in the Legislative Council of the Government, approved by the Government and finally by the Parliament. The Ministry of Environment cooperates with other ministries, such as the Ministry of Economy, the Ministry of Agriculture, the Ministry of Finance, the Ministry of Transport, Posts and Telecommunications, the Ministry of Foreign Affairs, and the Ministry of Construction and Regional Development.

District and regional environmental offices are decision-making bodies according to Act 525/2003 Coll. These are located at 8 regional and 46 district administration offices. Inspection and enforcement activities are carried out by the 4 inspectorates of the Slovak Environmental Inspection. According to the 478/2002 Coll. on Air Protection, competencies and decision-making process concerning large, medium and small pollution sources are given to regional and district levels and municipalities.

Act 572/2004 Coll. on Emission Allowance Trading is the first legal instrument directly oriented towards the control of GHG emissions. According to this Act, competencies with respect to emission allowance trading are given to the Ministry of Environment and the regional and district environmental offices.

The Slovak Hydrometeorological Institute (SHMÚ) www.shmu.sk is authorised by the Ministry of Environment of the Slovak Republic to provide environmental services, including annual GHG inventories according to the approved statute (http://www.shmu.sk/File/statut.pdf). The range of services, competencies, time schedule and financial budget are updated and agreed annually. All details of the SHMÚ activities are described in the Plan of Main Projects. The plan, commented by all stakeholders and after the approval it is published at the website of the SHMÚ http://www.shmu.sk/File/Kontrakt_2010.pdf. Deadline for the approval of this plan by the ministry is 31st December each year.

Structural changes occurred after the 1st of January 2008 at the SHMÚ (the new structure of SHMÚ is presented at http://www.shmu.sk/sk/?page=1025) established the Department of Emissions (OE) as the Single National Entity with delegated responsibilities. The process of preparing and management of emission inventories is the main workload of the OE. Permanent staff of emission experts working at the Department is complemented by several external experts working on annual contracts renewed each year. Emission experts cooperate also with the other units of the SHMÚ (the Department of Climatology, the Department of Meteorology and Water Management) and other institutions and the state administration.

The contracts with external sectoral experts and other institutions are fully the competence of the SHMÚ. The Department of Emissions uses the resources that are generated by projects. The Department of Emissions has usually three projects per year: Emission Inventory of GHGs, Emission Inventory of Other Pollutants and National Emission Information System. From the 1st January until 15th February at the latest the contracts have to be signed after previous assessment both by the

[7] *"Vestnik" (Official Journal of the Ministry of Environment), XV, 3, 2007, page 19: National inventory system of the Slovak republic for the GHG emissions and sinks under the Article 5, of the Kyoto Protocol*

SHMÚ and the experts. Specific workshop on this issue is another regular activity, organised usually at the beginning of February, in which the sectoral experts, the SHMÚ and the Ministry of Environment participate. The workshop is an official forum for closing and summing up the previous year according to the SHMÚ's projects and to introduce the tasks and responsibilities for the next year.

The SHMÚ is responsible for developing and maintaining the National Emission Inventory System (NEIS) – the database of stationary sources to monitor the development of SO_2, NO_x, CO emissions at regional level and to fulfil reporting commitments under the national regulations and EU Directives (http://www.spirit.sk/ie_home.html). The NEIS software product is constructed as a multi-module system, corresponding fully to the requirements of current legislation. The NEIS database contains also some technical information about the sources like fuel consumption and use for the estimation of sectoral approach.

The SHMÚ updates annually the incoming information and activity data using the corresponding statistical information from the Statistical Office of the Slovak Republic and other national statistics.

Until the year 2007, the final draft of annual inventory as prepared by the national experts used to be assessed by the cross-ministerial working group. The working group consists of the experts from the Ministry of Environment, the Ministry of Economy, the Ministry of Agriculture, the Ministry of Transport, the Ministry of Construction and Regional Development, the Ministry of Finance and the Ministry of Foreign Affairs. A new co-ordination body, the High Level Committee on Climate and Energy Package, was established on June 2008 under Resolution of the Slovak Government No 416/2008 from 18th June 2008 (the competent body to define specific tasks and means necessary for further analyses to develop national strategies and particular measures in tackling climate change, adaptation and support of renewable energy sources). An expert group responsible for preparing all practical inputs and studies as required for further progress works under this Committee. This new, two stages structure has the final responsibility to asses the draft of annual inventory and to propose further steps to improve it.

The National Focal Point to the UNFCCC and the KP at the Ministry of Environment is the director of the Department of Climate Change and Economic Instruments at the Ministry of Environment of the Slovak Republic. The Department has two divisions (Climate Change and Economic Instruments) and is under the responsibility of the Section of Environmental Policy and Foreign Affairs. Further to the negotiation within the European Union about legislative proposals for the Climate and Energy Package and point B.2 of Slovak Government Resolution No. 413/2008, the Commission on Climate and Energy Package (CEP) was established in August 2008. The Commission consists of the state secretaries of all concerned ministries. In addition to the co-ordination and development of the strategy for attaining the objectives of the CEP in the Slovak Republic, the Commission deals also with climate change and adaptation in a broader context of fulfilling the international commitment of the Slovak Republic in this field. The Commission on the CEP will take part in the process of approving the GHG emission inventory submissions. An expert group for preparing documents and proposals for policies and measures in climate change was created under the Commission on the CEP the. This expert group includes experts from other relevant ministries and the Ministry of Environment.

The Department of Emissions at the SHMÚ is responsible for the coordination of the National Inventory System for the KP under Article 5.1 as the Single National Entity. The Department Emissions has seven full-time experts. The Department of Emissions is responsible for the following activities:

- *GHG emissions estimation and reporting (UNFCCC, KP).*
- *Emission projections evaluation and reporting.*
- *Basic and other pollutants estimation and reporting (CLRTAP).*
- *Reporting under EU requirements (NECD, LCP, VOCD, ePRTR, IPPC).*

– *National Focal Point to the EEA (air and climate change).*

– *National reporting for other institutions at national level.*

The sectoral expert for transport has been employed on full-time at the Department of Emissions since January 2008. The cooperation with the Transport Research Centre in Brno is based on the consultations in road transport issues (recalculations COPERT IV, disaggregation of vehicles, emission factors).

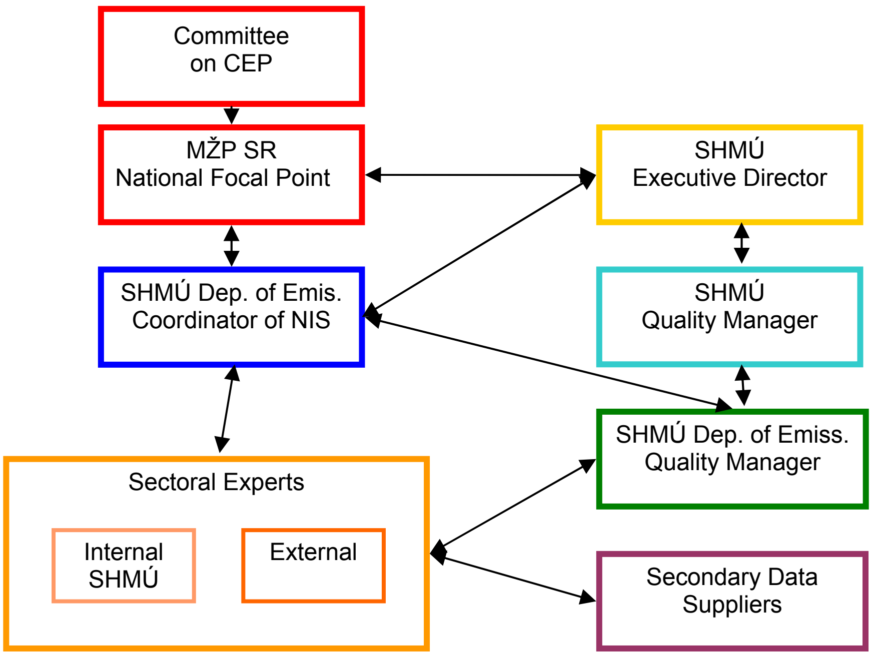
The sectoral expert for LULUCF has been strengthened by the cooperation with the National Forest Centre in Zvolen, especially for the Kyoto Protocol reporting requirements under Article 3.3. The cooperation continues also in 2010. The Ministry of Agriculture participates in legal and technical agenda of the KP LULUCF submission.

Table 1.2: List of sectoral experts in the National Inventory System of the Slovak Republic

External Experts (NIS)				
Name	**Contact**	**Phone**	**E-mail**	**Responsibility**
Jiří BALAJKA	Ecosys Slovakia	004212 / 259415346	ecosys@orangemail.sk	Projections Consultant
Lubica HANUSTIAKOVA	Dexia banka Slovensko a.s.	0042141 / 5111909	lhanustiakova@dexia.sk	National Registry
Jan JUDAK	Profing s.r.o.	004212 / 53634861	judak@profing.eu	Energy Expert
Jozef SKAKALA	Spirit Inc.	004212 / 54789744	skakala@spirit.sk	NEIS Provider
Jiri DUFEK	Centrum of Transport Research	00420 / 549429305	jiri.dufek@cdv.cz	Transport Consultant
Maria LEXOVA	Slovak Statistical Office	004212 / 50236273	maria.lexova@statistics.sk	Energy Statistics
Vladimir DANIELIK	FCHPT	004212 / 59325523	vladimir.danielik@stuba.sk	IP Expert
Peter TOMLEIN	ZChKT	004212 / 45646971	zvazchkt@isternet.sk	F-Gases Expert
Bernard SISKA	FZKI SPU	0042137 / 6415244	bernard.siska@uniang.sk	Agriculture Expert
Jozef MINDAS	EFRA	0042145 / 484344260	jozef.mindas@lesy.sk	LULUCF Expert
Tibor PRIWITZER	National Forest Centre	0042145 / 5314203	priw itzer@nlcsk.org	LULUCF KP Expert
Juraj FARKAS	veQ	00421 / 903419229	jfarkaš@integrated-skills.com	Waste Expert
Martin GERA	FMFI	004212 / 60295863	mgera@fmph.uniba.sk	Expert for Uncertainty

Internal Experts (SHMÚ - Department of Emissions)				
Name	**Contact**	**Phone**	**E-mail**	**Responsibility**
Eva GOGOVA	SHMÚ	004212 / 59415 405	eva.gogova@shmu.sk	NMVOC Expert
Martina JUSKOVA	SHMÚ	004212 / 59415 396	martina.jusková@shmu.sk	Quality Manager
Michaela KOLLAROVA	SHMÚ	004212 / 59415 463	michaela.kollárová@shmu.sk	Transport Expert
Monika KOSECOVA	SHMÚ	004212 / 59415 414	monika.kosecová@shmu.sk	NEIS Expert
Stanislava MOROVA	SHMÚ	004212 / 59415 345	stanislava.morová@shmu.sk	Projections Expert
Janka SZEMESOVA	SHMÚ	004212 / 59415 346	janka.szemesová@shmu.sk	Coordinator NIS, Head of Dep.
Jozef UHLIK	SHMÚ	004212 / 59415 108	jozef.uhlik@shmu.sk	NEIS Dbase Administrator

Figure 1.2: Structure and responsibilities of the National Inventory System of the Slovak Republic



The project implementing Quality Management System according to ISO 9001:2008 for the National Inventory System of the Slovak Republic was started in March 2009 and the certification process was closed in March 2010.

1.2.2 National Registry of the Slovak Republic

The National Registry of the Slovak Republic is equipped with French software Seringas™, which is updated regularly (currently the version 4.2.1.0. is used and the version 5.0 is being prepared). The National Registry testing with ITL and CITL was finished successfully and the administrator authorised the National Registry of the Slovak Republic allowing the operation from 19th October 2009. The NR was successfully connected to ITL between other EU countries in October 2008 and since it has been functional. The National Registry is available through the internet address http://co2.dexia.sk in English and Slovak versions. Clients can enter the public internet page through user's name and password and browse also in secure protocols.

Table 1.3: Administration of the National Registry of the Slovak Republic

Name	Dexia Banka Slovensko, a.s.
Address	Hodzova 11
City	Žilina
Postcode	1011
Country	Slovak Republic
Telephone number	00421 41 5111 909, 914
Facsimile number	00421 41 5111 910
E-mail	co2@dexia.sk

1.3 Brief description of inventory preparation and planning

A comprehensive description of the inventory preparation for GHG emissions is described in methodologies for individual sectors. The methodologies are updated annually within the QA/QC plan and they are archived after formal approval at the web page of the National Inventory System http://ghg-inventory.shmu.sk/.

The preparation of emission inventories within the National Inventory System for GHG emissions is decentralised according to the definition of Article 5.1 of the KP. Individual sectors are fully under the responsibilities of sectoral experts, who are authorised to evaluate the emission inventory within the delegated sectors.

The compilation of the emission inventory starts with the collection of activity data, where the nominated sectoral experts cooperate with the Statistical Office of the Slovak Republic, major operators of air pollution sources, relevant ministries and their organizations, expert and professional associations. The database NEIS is the most important source of emission data on fuels and other characteristics of stationary air pollution sources. NEIS is operated by the Department of Emissions of the SHMÚ. Collected input data are compared with international statistics (Eurostat, IAE, FAO and others). In some cases, the collected input data are compared with the results from models (e.g. in road transport it is model COPERT).

Since 2005, the reports of participants in the scheme for GHG emission allowance trading integrated within the National Allocation Plan have been the most important sources of input data for the emission inventory. Sectoral experts for energy and industry have access to the reports of operators and auditors. Data received directly from measurements in operational units are harmonised with data entering the emission balance. Verified emissions are compared with the results of calculations and then they are harmonized.

Based upon the approved plan for improving emission inventories within the quality management, i.e. quality assurance and quality control (QA/QC), further improvements of emission factors and methodologies are planed annually. The majority of key sources are balanced according to higher methodologies (tier 2 and higher). Used emission factors are also re-evaluated and standard emission factors are replaced by the national specific ones. The national emission factors for the most important fuels in sectors energy and industry are updated annually. Certified measurements of emission factors are available also for natural gas (http://www.spp.sk/o-zemnom-plyne/emisie/), hard coal (energetic, cooking coal, blast furnace coal), lignite, brown coal of various origin, gaseous fuels and other, from monthly protocols.

The assessment of uncertainty of input data, emission factors and other input parameters is the final step in the preparation of emission inventory. The assessment of uncertainty is done annually for all relevant categories by methodology tier 1 and for certain selected categories by methodology tier 2 – Monte Carlo (1.A.1 Fuel combustion in energy, 6.A Municipal waste disposal sites, sector 2 Industrial processes and sector 3 Solvent use). The results are published annually in papers and in the National Inventory Report to the emission inventory.

The emission balances prepared by the external experts for individual sectors are gathered at the Department of Emissions of the SHMÚ, where they are checked, reported and archived. Members of the Committee for the Climate and Energy Package comment on the emission inventory each year. External experts from the Czech Republic make comments occasionally.

According to the COP decision 7/CP.11 the countries of Annex I are obliged to use the program CRF Reporter in reporting GHG emission inventory. The Slovak Republic uses the actual version of the program and reports the emissions according to approved methodology.

1.4 Brief general description of methodologies and data sources used

The methodologies used for the preparation of greenhouse gas inventory in the Slovak Republic are consistent with the Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories (IPCC 1997) and the IPCC Good Practice Guidance (IPCC 2000) and the IPCC Good Practice Guidance for Land Use, Land Use Change and Forestry (IPCC 2003). In line with the recommendations of the expert review teams under the UNFCCC, several methodologies and parameters have been implemented gradually in accordance with the IPCC 2006 Guidelines. Detailed descriptions of used methodologies can be found as sector specific ones in Chapters 3 to 9.

Documents and emission inventories are archived at three levels. Official documents, methodologies and reports are archived and stored at the web page of the National Inventory System. The access to sensitive documents is through the user's name and password. Statistics and calculations are archived at the level of sectoral experts. All other relevant documents, papers and reports are stored in electronic and printed forms at the Department of Emissions of the SHMÚ.

Table 1.4: List of important information sources for inventory preparation

Sector	Source of input data
Energy	Energy Statistics of the SR, w w w .statistics.sk, NEIS - w w w .air.sk, w w w .spp.sk, w w w .transpetrol.sk
Industrial Processes	Association of cement and lime producers, Association of refrigeration and air conditioning engineers, Association of paper producers
Solvent Use	Asiciation for coating and adhesives, solvent distributors, Research institute for drude oil, w w w .vurup.sk
Agriculture	Green Report of the Ministry of Agriculture of the SR - Agriculture, http://w w w .land.gov.sk/sk/index.php?navID=122&id=1964
LULUCF	Green Report of the Ministry of Agriculture of the SR - Forest, http://w w w .land.gov.sk/sk/index.php?navID=123&id=2102
Waste	Dbase RISO http://w w w .sazp.sk/slovak/struktura/COH/oim/data/index.htm

Additional sources of activity data for major sectors are as follows:

Energy:

- *Energ. P 2-01:* Yearly company statement on energy process of fuel enrichment.
- *Energ. P 3-01:* Yearly company statement on the consumption of fuels, electricity and heat for production of selected commodities.
- *Energ. P 4-01:* Yearly company statement on the production of heat and electricity.
- *Energ. P 5-01:* Yearly company statement of retail trade in solid fuels.
- *Energ. P 6-01:* Yearly company statement on sources and distribution of fuels.
- *Energ. P 1-01:* Yearly company statement of manufacture branches.

Transport:

- *SLOVNAFT a.s. Bratislava and PETROCHEMA a.s. Dubová*: Production and selling of gasoline and diesel fuel.
- *The Statistical Office of the Slovak Republic:* Import and export of gasoline and diesel fuel from the EU Member States.
- *The Customs Directorate of the Slovak Republic:* Import and export of gasoline and diesel fuel from the countries outside the EU.
- *Probugas a.s. Bratislava, Progas s.r.o. Bratislava, Flaga Slovplyn s.r.o. Pezinok, Flavia s.r.o. Vranov n/Topľou, Slovnaft a.s. Bratislava, 1. SPS, Autoplyn Danka Chovancová, Žilina:* Selling of LPG gas for road vehicles delivered into net of gas stations.
- *Slovak Gas Trading Company SPP Inc.:* Selling of compressed natural gas at gas stations.
- *SAD, a.s. Zvolen, SAD a.s. Nitra, SAD a.s. Michalovce, DP mesta Košice a.s. Košice, DPMB a.s. Bratislava:* Bus transportation companies provide data concerning of CNG consumption of gas driven busses.
- *Presidium of the Police Force of the Slovak Republic, the Department of Documents and Registration of the Presidium:* Data concerning numbers of new registrations, changes in the registration and deregistration of road vehicles at the end of the year in relation to the emission inventory.
- *The Association of car industry of the Slovak Republic:* Detailed data concerning structure of all type of cars sold in the Slovak Republic during actual year.

Data concerning GHG emissions inventory produced by railway traffic are provided by:

- *Železničná spoločnosť Slovensko, a. s.:* It provides fuel consumption data and selected operation capacity of combustion engine driven locomotives in personnel railway transport.
- *Železničná spoločnosť Cargo Slovakia, a. s.:* It provides fuel consumption data and selected operation capacity of combustion engine driven locomotives in railway freight service.

Data concerning GHG emissions inventory produced by water-borne transport are provided by:

- *State water-borne administration Bratislava*: It provides data concerning numbers of driving ships on the Slovak section of the Danube.
- *Slovak navigation and harbours Inc. Bratislava*: It provides data about selling of diesel oil from custom storage to navigation companies in Slovak harbors.

Data concerning GHG emissions inventory produced by aviation sector are provided by:

- *Aero servis Košice, ESSO Bratislava and Bratislava airport:* They provide data about sales of aviation fuels to airlines at important airports in the Slovak Republic.

– *Bratislava Airport, Košice Airport, Poprad – Tatry, Sliač Airport, Piešťany Airport and Žilina Airport:* They provide total numbers of LTO cycles at particular airports. These data are partially used as additional data for the national GHG inventory compilation. The data are used to determine the air pollution from the airports.

Waste:

– *COHEM SAZP (Waste Management Centre of the Slovak Environmental Agency):* Industrial solid waste data.

– *Terrasystems Banska Bystrica:* Data on methane recovered from SWDSs.

– *ACE (the Association of Experts on Waste Water Treatment):* Data on sewage sludge management.

– *Duslo a.s.:* Data on ISW incineration.

– Websites of several companies and institutions are also used for the inventory: *OLO, KOSIT, Slovnaft, Duslo, NsP Prievidza, Fecupral, Ecorec.*

1.5 Brief description of key categories

Key categories were assessed by the level of emissions and the trend in emissions and those key categories have been chosen, whose cumulative contribution is less than 95% and are enclosed in the excel file followed the Good Practice Guidance (IPCC, 2000 and 2003). Using tables 7.1 and 5.4.1 of IPCC (2000) and IPCC (2003) as a basis, the key category analysis consists of a hundred of category-gas combinations. The identification includes all reported greenhouse gases CO_2, CH_4, N_2O, HFCs, PFCs and SF_6 and all IPCC source categories with or without LULUCF performed with the detailed categorization of the CRF categories. The detailed key source analyses were assessed based on the recommendation of the ERT during in-country review on annual inventory 2010.

In 2009, the Slovak Republic determined 27 key source categories by the level assessment with LULUCF and 23 key source categories without LULUCF. The trend assessment determined 32 key source categories with LULUCF and 27 key source categories without LULUCF in 2009. The most important key source categories are fuel combustion, road transport and the emissions of N_2O from agricultural soil and methane emissions from SWDS etc (Table 1.5).

1.6 Information on the QA/QC plan including verification

The Ministry of Environment of the Slovak Republic made a contract with consulting company ISO Management for the project “Implementation Process for QA/QC Model and QMS ISO 9001”. The Project started in March 2009 and was separated into two parts: Part I Implementation Process for QA/QC Model and Part II Implementing QMS according to ISO 9001:2008. The QMS was certified in March 2010. Preparatory phase of Part I of the Project was aimed at the QA/QC plan for internal and external procedurals steps concerning GHG emission inventory. The QA/QC plan for sectors will be updated and evaluated annually by the quality manager of NIS. The project was finalized at the meeting and workshop for the experts involved in the National Inventory System on 13th January 2010.

Table 1.5: Summary of the key sources by level and trend assessment in 2009

Category	Gas	Level Assessment with LULUCF	Level Assessment	Trend Assessment with LULUCF	Trend Assessment
1.A.1 Energy Industries - gaseous	CO_2	x	x	x	x
1.A.1 Energy Industries - liquid	CO_2	x	x	x	x
1.A.1 Energy Industries - solid	CO_2	x	x	x	x
1.A.2 Manufacturing Industries and Construction - gaseous	CO_2	x	x	x	x
1.A.2 Manufacturing Industries and Construction - liquid	CO_2	x	x	x	x
1.A.2 Manufacturing Industries and Construction - solid	CO_2	x	x	x	x
1.A.3.b Transport - Road Transportation - liquid	CO_2	x	x	x	x
1.A.4 Other sector - gaseous	CO_2	x	x	x	x
1.A.4 Other sector - solid	CO_2	x	x	x	x
1.A.5.a Other non-specified - gaseous	CO_2	x	x	x	x
1.B.1.a Coal Mining and Handling	CH_4	x	x	x	x
1.B.1.b Fugitive Emission from Oil, Natural Gas and Other	CH_4	x	x	x	x
2(I).A.1 Cement Production	CO_2	x	x	x	x
2(I).A.2 Lime Production	CO_2	x	x	x	x
2(I).A.7.2 Magnezite Production	CO_2			x	x
2(I).B.1 Ammonia Production	CO_2	x	x	x	x
2(I).B.2 Nitric Acid Production	N_2O	x	x	x	x
2(I).B.4 Carbide Production	CO_2			x	x
2(I).C.1 Iron and Steel Production	CO_2	x	x	x	x
2(I).C.3 Aluminium Production	CO_2			x	x
2(I).F HFCs emissions	HFCs	x		x	x
4.A Enteric Fermentation - Cattle	CH_4	x	x	x	x
4.B Manure Management	N_2O	x	x	x	x
4.D Agricultural Soils - direct	N_2O	x	x	x	x
4.D Agricultural Soils - indirect	N_2O	x	x	x	x
5.A Forest Land	CO_2	x		x	
5.B Cropland	CO_2	x		x	
5.C Grassland	CO_2	x		x	
5.E Settlements	CO_2			x	
5.F Other Land	CO_2			x	
6.A Solid Waste Disposal on Land	CH_4	x	x	x	x
6.B Wastew ater Handling	CH_4	x	x	x	x

1.6.1 QA/QC procedures

The Slovak Hydrometeorological Institute has built and introduced the quality management system (QMS) according to the requirements of EN ISO 9001:2008 standard of conformity for the following activities (http://www.shmu.sk/File/cert_slovak.gif):

- Monitoring of the determinants characterising the state of air and waters in the Slovak Republic.
- Assessment, archiving and interpretation of data and information on the state and regime of air and waters.
- Providing data and information on the state and regime of air and waters.
- Study and description of the atmosphere and hydrosphere phenomena.
- Education and training within the activity of the Institute.

In the frame of introducing the QMS for the SHMÚ as a global standard, the certification itself proceeds according to the partial processes inside of the SHMÚ structure. The process of Emission Inventories was the subject of internal and external audits during the March 2010 by the certification body ACERT accredited by Slovak National Accreditation Service. Nowadays, the Department of Emissions (OE) formally fulfils the QMS requirements in the area of controlled documents and records in accordance with the QMS of the SHMÚ. The controlled documents and records are available at the quality manager at the Department of Emissions in Slovak language. The quality manager at the OE has completed several trainings regarding the QMS and controlled documents.

Sectoral experts apply the QA/QC methodology according to the Quality Manual, collect data from providers and process emission inventory for a given sector – they provide partial reports with information on quality and reliability of data on activities and emissions. These partial conclusions serve as a basis to estimate total uncertainties in emission inventories by a coordinator for uncertainties for all sectors. In some cases Tier 2 – Monte Carlo methodology (wastes, energy and industry) which requires detailed review of quality of each input parameter, works out uncertainty analysis.

The QA/QC plans (external and internal), proposed and approved in the phase of preparation for the certification, are included in Tables 1.6 and 1.7. Detail information about QA/QC plan and activities inside sectors are included in the Chapters 3 – 9.

Table 1.6: Quality Assurance/Quality Control Plan - External

	Procedural step	Who	Check-in	Time schedule	Record
1	Annual Report submission 280/2004/EC, Article 3.1 (a)-(k): a) Emission GHG inventory for year X-2 b) National Inventory System information c) Annual Report for year X-2.	NIS coordinator	Ministry of Environment (NFP)	15. January	CDR (Central Data Repository) upload: http://cdr.eionet.europa.eu/sk/eu
2	Inter-ministerial annotation of GHG inventory and NIR for year X-2:	NIS coordinator	Ministry of Environment (NFP)	15. January - 15. March	Comments
	- Publishing of draft on website,		Expert group CEP		Final version of NIR
	- Assessment and revising				
3	Biennial Report submission 280/2004/EC, Article 3.2 (a)-(d): a) Biennial Report b) GHG emission projections	NIS coordinator	Ministry of Environment (NFP)	15. March	CDR upload
4	Annual Report submission 280/2004/EC, Article 3.1: a) Emission GHG inventory for year X-2 b) National Inventory Report for year X-2	NIS coordinator	Ministry of Environment (NFP)	15. March	CDR upload
5	Submission to the secretariat UNFCCC: a) Emission GHG inventory for year X-2 b) National Inventory Report for year X-2 c) Key source and uncertainty analyses d) KP – LULUCF for year X-2 e) National Registry information for year X-1.	NIS coordinator National Registry (e)	Ministry of Environment (NFP)	15. April	UNFCCC submission upload: https://unfccc.int/submissionportal/webportal/SubmissionStatusComponent.jsp
6	National GHG emission inventory publishing on the official website of the NIS.	NIS coordinator	Ministry of Environment (NFP)	30. April	NIS website upload: http://ghg-inventory.shmu.sk/
7	Revising based on findings in UNFCCC (Annual Status Report)	NIS coordinator	Ministry of Environment (NFP)	27. May	Resubmission ASR UNFCCC
8	Uploading emission information to the Statistical Office of the SR.	NIS coordinator	Ministry of Environment (NFP)	31. August	Statistical report
	Publishing of the NIR for the year X-2 to the relevant national institutions.		Expert group CEP		Emission inventory
	Preparing of the Report on air quality and climate change (SHMU).		Statistical Office SHMU		Report on air quality and climate change (SHMU)
9	UNFCCC review.	NIS coordinator Sectoral	Ministry of Environment (NFP)	July - October	Comments to UNFCCC Annual Review Report UNFCCC
10	Sectoral improvement plan for increasing quality of the inventory process (based on the results of UNFCCC review).	NIS coordinator Sectoral experts of NIS	NIS coordinator Expert group CEP	30. June - 30. November	Assessment, improvements steps
11	Submission of National Communication UNFCCC 10/CP.13	NIS coordinator Sectoral experts of NIS	Ministry of Environment (NFP)	31. December	Publishing on UNFCCC website.

Table 1.7: Quality Assurance/Quality Control Plan - Internal

	Procedural step	Who	Check-in	Time schedule	Record
1	Closing of contracts or annexes to the contracts, actualization of the research subjects in sectors.	NIS coordinator Sectoral experts of NIS	SHMU Director	31. January	Frame contracts
					Annexes for actual year
					Nominations for experts
2	Final inventory data for year X-2	Sectoral experts of NIS	NIS coordinator	28. February	Verification Protocol
					Recalculation Protocol
3	Uncertainty assessment of final data for sectors for year X-2	Uncertainty expert Sectoral experts of NIS	NIS coordinator	28. February	Report on uncertainty assessment
4	UNFCCC review process participation	Sectoral experts of NIS	NIS coordinator	May - October	Comments on sector
5	Draft inventory for year X-1.	Sectoral experts of NIS	NIS coordinator	31. August	Minutes from w orkshop
	Update of the sectoral methodological guidebooks				
6	Final sectoral reports and final inventory data.	Sectoral experts of NIS	NIS coordinator	30. November	Sectoral Reports
					http://unfccc.int/files/national_reports/annex_i_ghg_inventories/reporting_requirements/application/pdf/annotated_nir_outline.pdf
7	Worshop – sectoral experts, ministry of environment and coordinator of NIS	Sectoral experts of NIS	Ministry of Environment (NFP)	31. December	Program
	Program: assessment of final results for the year X-2, assessment of QA/QC improvements plan, proposal of w ork for next year	NIS coordinator			Minutes from w orkshop

1.6.2 Verification activities

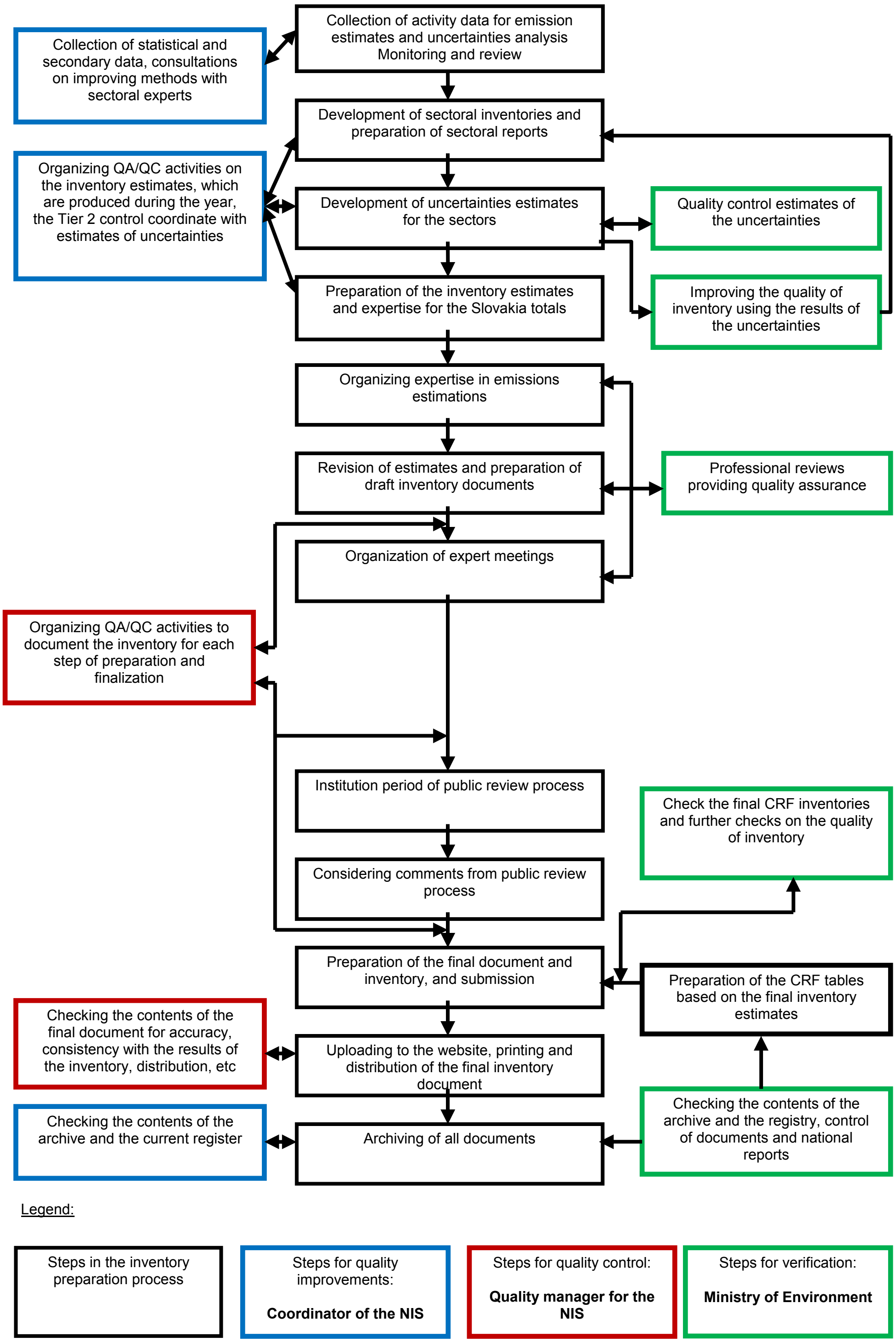
Figure 1.3 shows a model proposed by the Certification Company for the timeline of steps provided in the inventory process, QA/QC activities and verification procedures. Experts involved in the National Inventory System are nominated by the National Focal Point. Nomination letters are included in the list of controlled documentation and administrate by the quality manager for the NIS. The steps in QA/QC activities are managed and documented in several protocols (verification protocol, recalculation protocol, contracts or sectoral reports). All documents are approved and archived. Verification procedures are provided by competent authorities in several steps. The quality manager has the overall responsibility for documentation, formal contact with sectoral experts and approval activities, taking over the sectoral reports and archiving them.

1.6.3 Archiving

Archiving of inventory documents and database is in the competence of the quality manager for NIS.

The archiving is controlled by rules for archiving systems in organizations at the SHMÚ level. The documents are archived in electronic and printed forms. Electronic archiving of sectoral reports, inventory submissions and other specific documents (ERT reports, ARR, National Reports etc.) is at webpage http://ghg-inventory.shmu.sk/, with password (all details for experts) and without password (less detailed information for public). The electronic archiving of documents needed for the quality management systems are archived in electronic form at the webpage of the SHMÚ (intranet). Printed documents are archiving in central archive of the SHMÚ and at the Department of Emissions.

Figure 1.3: Model of QA/QC activities and uncertainty analysis in the process of inventory preparation



1.7 General uncertainty evaluation

The uncertainty assessment by Tier 1 is enclosed in an excel file. Quantification of emission's uncertainty by level and trend assessment was calculated by using Tier 1 method published in Good Practice Guidance (IPCC, 2000). The Tier 1 estimated the 13.8% level uncertainty and the 8.2% trend uncertainty in 2009.

The uncertainty assessment by using the more sophisticated Tier 2 Monte Carlo method was prepared with cooperation of the Faculty of Mathematics, Physics & Informatics.

According to the most recent results, the Tier 2 uncertainty for methane emissions from solid waste disposal sites in waste sector was estimated in the range of confidence interval -76.54, +78.24% in 2009.

The Tier 2 uncertainty analyses for fuel combustion in energy sector according to the fuels classification was estimated in the range of confidence interval - 2.33%, 3.42% in 2009.

The Tier 2 uncertainty analyses for industrial processes sector including solvent and other product use sector according to the technological emissions was estimated in the range of confidence interval -2.85%, 2.88% in 2009.

Results were published in following papers[8,9] and detail are descript in Chapters 3 – 9 of this report.

1.8 General assessment of the completeness

1.8.1 Completeness by source and sink categories and gases

The Slovak Republic reports all significant IPCC source and sink categories according to the detailed CRF classification. Estimates are provided for the following gases: CO_2, N_2O CH_4, F-gases (HFC, PFC and SF_6), NMVOC, NO_x, CO and SO_2.

In accordance with the IPCC Guidelines, international aviation fuel emissions are not included in national totals. Emissions from water transportation are exclusively included in international bunkers because of international character of the Danube river transportation through the Slovak territory (transit). In the GHG national inventory submission 2011 reports the Slovak Republic gases or source/sink categories that are not estimated (NE) and categories, that are included elsewhere (IE), as they are explained in Tables 9(a) CRF.

According to the recommendations of the ERT during the centralised review for the annual GHG inventory submission 2010 was completed several categories which are not reported in the previous submission and which are the following:

- Energy, Transport - Domestic navigation 1A3d (estimation of CO_2, N_2O and CH_4 emissions from small domestic inland shipping for touristic purposes).
- Industrial Processes – Steel production 2C1.5 (CO_2 emissions from consumed electrodes for steel production in electric arc furnaces (EAF)).

No NE categories are occurring in 2011 submission for 2009. The IE categories and gases are explained in Table 9(a) CRF and the description will be included in the NIR 2011.

The additional GHG emissions are not reported. No additional sources or sinks have been identified. The sources and sinks not considered in the inventory but included in the IPCC Guidelines are clearly indicated, the reasons for such exclusion are explained. In addition, the notation keys “NA” and “IE” are used to fill in the blanks in all the tables in the CRF. Notation keys used in the NIR are consistent with those reported in the CRF. Notation keys are used according to the UNFCCC guidelines on reporting and review (FCCC/CP/2002/8).

[8] *J. Szemesova, M. Gera: Contributions to Geophysics & Geodesy,37/3, 2007*

[9] *Szemesová J., Gera M. Uncertainty analysis for estimation of landfill emissions and data sensitivity for the input variation, Climatic Change DOI 10.1007/s10584-010-9919-1, 2010*

1.8.2 Completeness by geographical coverage

Both direct GHGs as well as precursor gases are covered by the inventory of the Slovak Republic. The geographic coverage is complete; the whole territory of the Slovak Republic is covered by the inventory.

1.8.3 Completeness by timely coverage

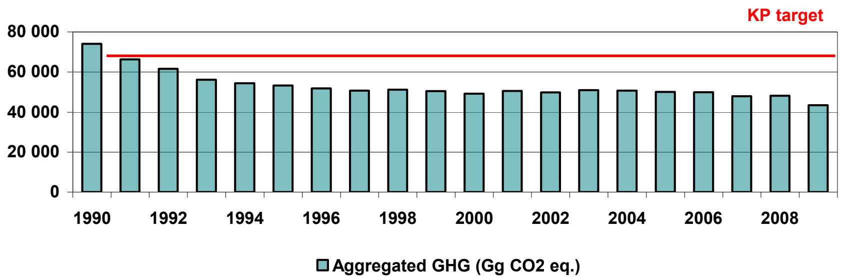
A complete set of CRF tables are provided for all years and the estimates are calculated in a consistent manner. The detail information is provided in Annex 5.

CHAPTER 2: TRENDS IN GREENHOUSE GAS EMISSIONS

2.1 Description and interpretation of emission trends for aggregated greenhouse gas emissions

The GHG emissions presented in the National Inventory Report 2011 were updated and converted by using the newest available methods, national conditions and data published by the Slovak Statistical Office. The recommendations of the Expert Review Team from the last centralised review of the Slovak Republic (took place from 13 to 18 September 2010 in Bonn) were taken into account only partly by the inventory compilation 2011 because of late delivery of the Annual Review Report 2010 (March 2011). Total GHG emissions were 43 426.07 Gg in 2009 (without LULUCF). This represents a reduction by 41.44% in comparison with the reference (base) year 1990. In comparison with 2008, the emissions decreased by almost 10%. Total GHG emissions in the Slovak Republic are sharply decreased due to the economic and financial crises started in 2009 and gas and oil crises in delivery from the Ukraine at the beginning of 2009. Total GHG emissions excluding LULUCF sector have been decreasing continually from the base year with the moderate decrease in the recent years. Significant changes in methodologies and emission factors are implemented in the frame of trying to keep consistency with the European Trade System (ETS). Table 2.1 shows the aggregated GHG emissions. In the period 1990 – 2009, the total greenhouse gas emissions in the Slovak Republic did not exceed the level of the base year 1990. Figure 2.1 shows trends in the gases without LULUCF comparable to the Kyoto target (92%) in relative expression.

Figure 2.1: The aggregated GHG emission trends compared with the Kyoto target (%)



Aggregated GHG emissions without LULUCF; emissions are determined as of 15.04.2011

This important reduction of emissions has resulted above all from the strong although temporary decrease in economy activities, followed by restructuring of economy joined with implementing new and more effective technologies, reducing the share of the intensive energy industry and increasing the share of services in GDP generation. Transport (mostly the road transport), with increasing emissions is an important exception.

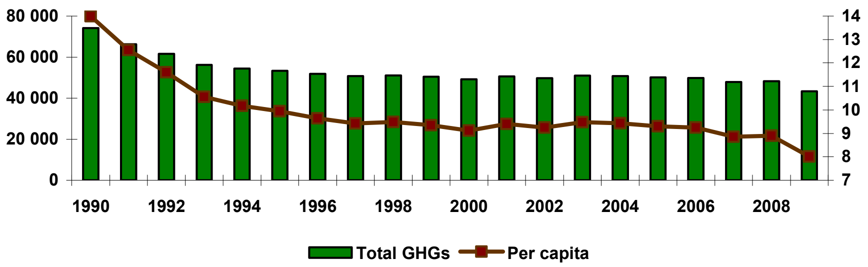
Table 2.1: Total anthropogenic greenhouse gas emissions by gases without LULUCF

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Gases	**CO_2 equivalent (Gg)**									
CO2 with LULUCF	59 784,23	52 581,69	47 081,61	43 645,65	42 537,80	41 481,54	40 162,62	39 743,78	39 902,16	39 641,88
CO2 without LULUCF	62 765,04	56 406,10	52 798,56	48 468,91	46 341,77	44 840,32	43 300,15	42 198,58	42 797,95	42 338,63
CH4 with LULUCF	4 824,97	4 676,46	4 411,18	4 110,06	4 098,38	4 283,51	4 243,01	4 275,19	4 536,74	4 736,56
CH4 without LULUCF	4 810,88	4 667,50	4 403,16	4 101,96	4 089,86	4 273,95	4 232,78	4 263,92	4 525,46	4 723,76
N2O with LULUCF	6 319,55	5 023,47	4 167,68	3 522,08	3 858,89	4 093,10	4 247,23	4 170,84	3 775,32	3 304,76
N2O without LULUCF	6 307,46	5 017,45	4 141,52	3 490,95	3 855,70	4 089,59	4 237,84	4 167,65	3 774,30	3 301,56
HFCs	NA,NO	NA,NO	NA,NO	NA,NO	2,91	22,15	37,58	61,13	40,96	65,12
PFCs	271,37	266,94	248,42	155,42	132,06	114,32	34,51	34,62	25,40	13,60
SF6	0,03	0,03	0,04	0,06	9,27	9,91	10,76	11,34	12,24	12,69
Total (with LULUCF)	**71 200,15**	**62 548,60**	**55 908,94**	**51 433,27**	**50 639,31**	**50 004,53**	**48 735,71**	**48 296,91**	**48 292,82**	**47 774,61**
Total (without LULUCF)	**74 154,78**	**66 358,02**	**61 591,69**	**56 217,30**	**54 431,56**	**53 350,25**	**51 853,62**	**50 737,24**	**51 176,31**	**50 455,36**
	2000	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**
Gases	**CO_2 equivalent (Gg)**									
CO2 with LULUCF	38 063,04	36 067,33	34 305,49	36 334,11	36 851,20	40 045,19	36 633,54	35 015,63	35 897,24	31 610,11
CO2 without LULUCF	41 183,45	42 379,12	40 826,29	42 165,51	41 974,80	41 502,56	40 786,65	39 001,93	39 096,30	35 086,92
CH4 with LULUCF	4 455,12	4 501,54	5 068,66	4 899,62	4 803,43	4 611,16	4 678,23	4 570,53	4 713,98	4 370,00
CH4 without LULUCF	4 443,36	4 487,26	5 054,62	4 884,50	4 786,23	4 588,73	4 659,33	4 551,79	4 692,93	4 349,23
N2O with LULUCF	3 545,45	3 646,06	3 772,95	3 797,18	3 830,46	3 816,74	4 193,96	4 045,27	4 081,49	3 660,20
N2O without LULUCF	3 508,16	3 642,87	3 771,62	3 790,89	3 826,06	3 811,40	4 190,79	4 037,10	4 079,65	3 653,16
HFCs	75,59	82,43	102,35	131,96	152,88	172,34	198,90	226,99	264,43	299,61
PFCs	11,65	15,59	13,75	21,65	19,91	20,25	35,82	24,88	36,16	17,76
SF6	13,25	13,84	14,78	15,39	15,89	16,61	17,15	17,44	18,51	19,39
Total (with LULUCF)	**46 164,10**	**44 326,79**	**43 277,98**	**45 199,91**	**45 673,76**	**48 682,29**	**45 757,60**	**43 900,74**	**45 011,81**	**39 977,06**
Total (without LULUCF)	**49 235,46**	**50 621,11**	**49 783,41**	**51 009,90**	**50 775,77**	**50 111,88**	**49 888,64**	**47 860,13**	**48 187,97**	**43 426,07**

**Total aggregated GHGs emission without LULUCF, emissions are determined as of 15.04.2011*

Continuous pressure is being put on formulating the effective strategy and policy to achieve further reduction of the emissions. While the indicator of carbon intensity can be changed much more rapidly in the situation of a high dynamic of economic growth, GHG per capita is a different case where you can get very impressive results even without measures, just by higher population growth rate. But this is not the case of the Slovak Republic just now. It will take much longer time to change numerator by the impact of new technologies implementation namely in combination with high dynamic of development in the energy intensive industries.

Figure 2.2: Total GHG per capita in 1990 – 2009



2.2 Description and interpretation of emission trends by gas

Total anthropogenic emissions of carbon dioxide excluding LULUCF have decreased by 44.1% compared to the base year (1990). Nowadays the amount is 35 086.92 Gg of CO_2. Compared to the previous inventory year, the decrease is visible. The reason for the decrease in CO_2 emissions in 2009 is caused mainly by decreasing CO_2 emissions in energy and industrial processes sectors. In 2009, CO_2 emissions including LULUCF sector decreased by 47.1% compared to the base year, and they decreased by approximately 4 000 Gg compared to the previous year. In 2009, CO_2 emissions decreased mainly due to the decrease of industrial production and the increase in LULUCF sinks.

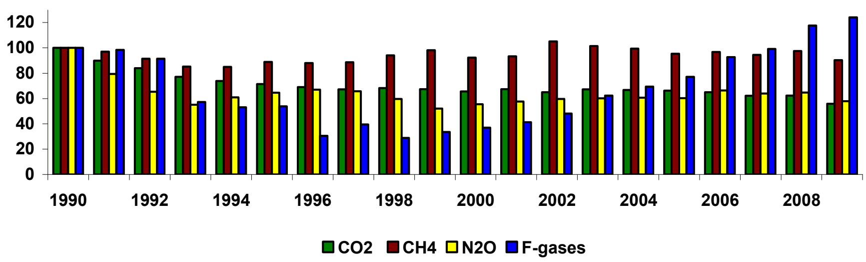
Total anthropogenic emissions of methane without LULUCF decreased compared to the base year (1990) by 9.6% and currently the emissions are 4 349.23 Gg of CO_2 equivalents. In absolute value, CH_4 emissions were 207.11 Gg without LULUCF. Methane emissions from LULUCF sector are 0.99

Gg of CH_4 caused by forest fires. The trend has been relative stable during the last years with a slight decrease in the last year due to the emission decrease from category energy and industrial processes sectors. Methane emissions peaked in 2002 due to the implementation of new waste legislation and increasing emissions from solid waste disposal sites in the Slovak Republic.

Total anthropogenic emissions of N_2O without LULUCF decreased compared to the base year (1990) by 42.1% and currently the emissions are 3 653.16 Gg of CO_2 equivalents. Emissions of N_2O in absolute value were 11.78 Gg without LULUCF. Emissions of N_2O from LULUCF sector are 0.02 Gg from forest fires. Emissions decreased compared to the previous year 2008 due to the decrease in energy and industrial processes sectors. Overall decreasing trend is mainly driven by the decrease in agriculture due to declining number of animals and making use of fertilizers. The trend depends on the nitric acid production.

Total anthropogenic emissions of F-gases were 336.75: 299.61 Gg of HFCs, 17.76 Gg of PFCs and 19.39 Gg of SF_6. Emissions of HFCs have been increased since 1995 due to the increase in consumption and the replacement of PFCs substances. Emission trend of PFCs is decreasing and emissions of SF_6 are slightly increasing due to the increasing consumption in industry.

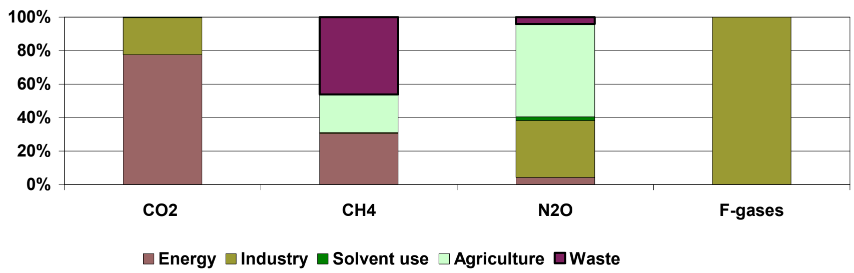
Figure 2.3: Emission trends by gas for the years 2000 – 2009 relative to the 1990 level (100%)



2.3 Description and interpretation of emission trends by category

The major share of CO_2 emissions comes from the energy sector (fuel combustion, transport) with the 77.6% share from the total carbon dioxide emissions in 2009 inventory, 22.2% of CO_2 is produced in industrial processes and negligible amount is produced in waste and solvent use sectors. More than 46.1% of CH_4 emissions is produced in waste sector (SWDS), 30.6% of methane emissions is produced in energy sector and 22.8% in agriculture sector. More than 55.5% of N_2O emissions are produced in agriculture sector (fermentation), 34.1% in industrial processes sector and more than 4% in energy sector. F-gases are produced exclusively in sector industrial processes (Figure 2.4).

Figure 2.4: Emission trends by gas in sectors in 2009



Aggregated GHG emissions from energy sector based on sectoral approach data in 2009 were estimated to be 28 694.32 Gg of CO_2 equivalents including transport emissions (6 207.65 Gg of CO_2 equivalents), which represent the decrease by 48.13% compared to the base year and 8.4% decrease in comparison with 2008. Transport sub-sector decreased by 7.4% compared to 2008 and in comparison with the base year it raised by 23.3%.

Total emissions from industrial processes sector were 9 389.31 Gg of CO_2 equivalents in 2009, which was decrease by 16% compared to the previous year and the decrease by 10.8% compared to the base year. Intensive increase of industrial production has caused the increase in emissions. Total emissions from sector of solvent use were estimated to be 164.38 Gg of CO_2 equivalents, which is the decrease by about 1.3% compared to the previous year The time series have been completed, but the period of 1990 – 1993 (before the Slovak Republic formation) is has not been covered by statistical data sufficiency (the lack of the national statistics data). Based on expert judgment, the constant values for this period were reported. Nowadays, the comparison with the base year is possible and the increase is 11.7%.

Emissions from agriculture sector were estimated to be 3 018.59 Gg of CO_2 equivalents. It is 57.3% decrease in comparison with the base year and 4.2% decrease in comparison to the previous year. The agriculture sector is the most decreasing sector compared to the base year 1990, because of decreasing trend in the cattle numbers.

Emissions from waste sector were estimated to be 2 159.46 Gg of CO_2 equivalents. The decrease is 8.7% compared to the previous inventory year and the time series are stable for last years. Compared to the base year, the increase was 97.9%, because of increased methane emissions from solid waste disposal sites. The emissions from waste incineration with energy use are including into energy sector, category 1.A.1a – energy industries, other fuels. The reallocation of methane emissions from waste incineration was the main driving force for the trend of changes in the last submissions.

Structural changes in sector energy and the implementation of economic instruments have played an important role in achieving the current status, when the trend of GHG emissions does not copy the fast GDP growth. In this context, the most important measure seems to be the adoption of the national legislation on air quality, which was approved in 1999 and it has initiated the positive trend in the reduction of the emissions of basic air pollutants and indirectly also GHG emissions. At the same time, the consumption of primary energy resources as well as total energy has decreased.

Table 2.2: Total anthropogenic greenhouse gas emissions by sectors

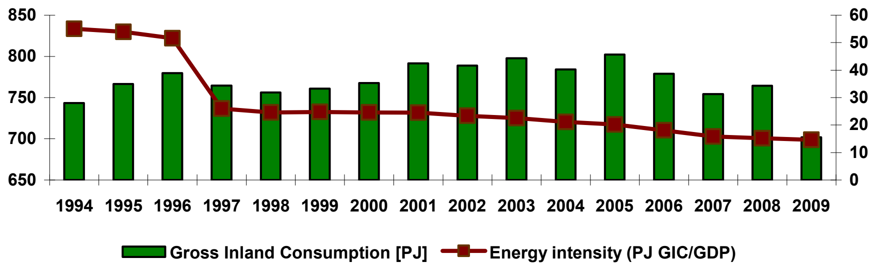
	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Sectors	**CO_2 equivalent (Gg)**									
1. Energy	55 321,29	50 364,84	46 955,68	42 596,55	39 921,78	38 420,69	37 240,87	35 865,19	35 808,94	34 891,66
2. Industrial Processes	10 530,85	8 782,21	8 439,07	8 131,59	9 120,24	9 297,37	9 077,92	9 314,00	9 779,53	9 973,34
3. Solvent Use	147,15	126,64	110,00	101,65	102,96	121,53	115,50	97,62	94,45	90,52
4. Agriculture	7 064,14	5 978,43	4 976,98	4 268,48	4 111,56	4 277,96	4 125,71	3 969,74	3 664,45	3 406,53
5. LULUCF	-2 954,62	-3 809,43	-5 682,76	-4 784,03	-3 792,25	-3 345,72	-3 117,92	-2 440,32	-2 883,49	-2 680,75
6. Waste	1 091,33	1 105,90	1 109,98	1 119,03	1 175,03	1 232,71	1 293,62	1 490,69	1 828,93	2 093,32
7. Other	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Total (with LULUCF)	**71 200,15**	**62 548,60**	**55 908,94**	**51 433,27**	**50 639,31**	**50 004,53**	**48 735,71**	**48 296,91**	**48 292,82**	**47 774,61**
	2000	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**
Sectors	**CO_2 equivalent (Gg)**									
1. Energy	34 054,04	35 173,69	33 071,09	34 515,82	33 430,32	33 156,13	32 386,85	30 598,89	31 320,49	28 694,32
2. Industrial Processes	9 879,99	10 087,76	10 471,20	10 472,50	11 498,04	11 228,68	11 640,25	11 468,90	11 182,71	9 389,31
3. Solvent Use	85,04	99,74	131,92	137,35	163,49	171,54	170,59	166,25	166,59	164,38
4. Agriculture	3 441,39	3 450,74	3 526,96	3 385,09	3 219,89	3 213,16	3 162,43	3 267,68	3 152,56	3 018,59
5. LULUCF	-3 071,36	-6 294,32	-6 505,43	-5 809,99	-5 102,00	-1 429,59	-4 131,04	-3 959,40	-3 176,16	-3 449,01
6. Waste	1 774,99	1 809,18	2 582,25	2 499,15	2 464,02	2 342,36	2 528,53	2 358,42	2 365,62	2 159,46
7. Other	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Total (with LULUCF)	**46 164,10**	**44 326,79**	**43 277,98**	**45 199,91**	**45 673,76**	**48 682,29**	**45 757,60**	**43 900,74**	**45 011,81**	**39 977,06**

Emissions are determined as of 15.04.2011

According to the statistical information from the Statistical Office information database Slovstat, energy industry (production and distribution of electricity, natural gas and water) reached 7.9% share in total GDP of the Slovak Republic in 2009. Energy intensity is still higher than the average in the EU-15, in spite of its continual decrease. Reason for that is the adversely high share of energy intensive industry in GDP. This trend can be presented also by the indicator comparing the gross inland consumption

(GIC) of energy resources with the GDP growth. Energy intensity is expressed in PJ/Bio Euro. The significant decrease in gross inland consumption was the result of gas crises from the beginning of 2009 and followed by the lack of resources in energy and iron and steel industry (coke production).

Figure 2.5: The trend of energy intensity (right y axis) in the period 1994 – 2009 (after formation of the Slovak Republic)



Transport is a significant source of emissions in sector energy, with 7.5% share in total GDP in the Slovak Republic. The proportion of transport is growing each year and the adopted policies and measures have no positive impact on increasing trend of emissions from transport. Emission balances in road transport are modelled according to method COPERT IV version 7. Due to harmonization of emission factors for N_2O emissions, time series in road transport have been recalculated since 2000. GHG emissions from non-road transport are balanced by the use of EMEP/EEA 2008 methodology according to individual transport types (air, water and rail). The share of rail and water transports is decreasing from year to year, while the share of air transport is increasing rapidly, especially due to the increasing activity of low cost airlines.

Fugitive methane emissions from the extraction and distribution of fossil fuels are important as the Slovak Republic is an important transit country regarding the transport of oil and natural gas from the former Soviet Union countries to Europe. Raw materials are transported through high pressure pipelines and distribution network and they are pumped in pipeline compressors.

Sector of industrial processes includes all GHG emissions generated from technological processes producing raw materials and products. Within the preparation of the GHG emission balance in the Slovak Republic, consistent emphasis is put on the analysis of individual technological processes and distinction between the emissions from fuel combustion in heat and energy production and the emissions from technological processes and production. Most important emission sources are balanced separately, emission and oxidation factors are re-evaluated, as well as other parameters entering the balancing equations and the results are compared with the verified emissions in the Slovak National Registry for CO_2 emissions.

Fundamental emission inventory is based on the balance of non-methane volatile organic compounds (NMVOC) according to EMEP/EEA 2008 methodology. Emissions are recalculated according to stochiometric coefficients to CO_2 emissions.

Sector agriculture is the main source of methane and N_2O emissions in the GHG emissions balance in the Slovak Republic. The emission balance is compiled annually on the basis of sectoral statistics and in recent years on the basis of a new regionalisation of agricultural areas of the Slovak Republic. The Ministry of Agriculture of the Slovak Republic issues annual statistics “Green Report”, part agriculture and food industry on a yearly basis.

The area of forest land in the Slovak Republic covers 40% of the territory and wood harvesting is historically an important economic activity. Since 1990, sinks from sector LULUCF have remained at the level of 8-10% of total GHG emissions. Historically stable trend was disrupted in 2004 by a wind calamity in the High Tatras, which resulted in increased harvest of wood damaged by the calamity and pests and consequently in the decrease in total sinks to the half of earlier volumes.

Several significant changes and re-evaluations of the applied methods have been carried out in sector waste, followed by recalculations in all categories of waste treatment. Methane emissions from solid waste disposal sites (SWDS) have the largest share in total emissions from the sector. Waste balance methodology has been revised and tier 2 approach FOD (First Order Decay) methodology has been used for the recalculations of the time series since 1960. The trend of methane emissions has been increasing depending on the adopted values for parameters of municipal waste landfills. A more detailed description of the methodology as well as with the Monte Carlo uncertainty analysis are described in the references.[10]

The disaggregation of emissions from municipal waste incineration into two groups, i.e. waste incineration with and without energy utilisation, was another important change with respect to the quality improvement of the emission inventory. The emissions from waste incineration with energy utilisation were reported under energy sector, sub-category 1.A.1.a (other fuels). The emissions from waste incineration without energy utilisation are reported within sector waste.

2.4 Description and interpretation of emission trends for indirect greenhouse gases and SO_2

Power and heat generation is a major source of SO_2, NO_x and CO emissions. The contribution of transport to NO_x and CO emissions is still growing. Metallurgy is another important source of CO emissions. Emissions of NM VOC are regularly estimated within the National Program of NM VOC Emissions Reduction in the Slovak Republic. Emission factors for asphalt paving and residential plants combustion were revised within the Program (total emission's decrease in 1990 by 45%). The year 1990 was used as a starting point and the data has been updated for the years 1993, 1996 – 1999 and 2006. A major source of NM VOC emissions come from the use of solvents, transport, refinery/storage and transport of crude oil and petrol. The categories of emission sources in the National Emission Information System (NEIS) are based on Air Pollution Act (478/2002) and they do not correspond exactly to the structure of sources according to the CRF requirements. Therefore, it is impossible to provide the information on emissions and emission factors according to the classification requested in standard tables.

The NM VOC emissions easily increase in sector solvent and other product use in consequence of increasing industrial production especially in engineering but also increasing print's ink consumption and import of solvent paints. New emission factors respect that asphalt mixture contains 5.5% of asphalt and others are created by aggregate.

The last update of emission inventory and projections was performed in year 2010. In 2010 major recalculations were done in road transport for all pollutants. The recalculation of emissions from road transport for years 2000 – 2008 was based on the updated model COPERT IV version 7. This model was used also for the preparation of emissions in 2009.

Minor recalculation of NO_x, NMVOC, heavy metals emissions in stationary sources in 2008 was performed (only for sector energy - category 1A1a), due to the changes in operators´ statistics in database NEIS (National Emission Information System).

The recalculations in solid waste disposal on land and waste incineration (healthcare, industrial and municipal waste) were performed back to 1990 for NMVOC and heavy metals (HMs) back to 2000 because of the corrections in activity data.

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[10] *Szemesová J., M. Gera Emission estimation of solid waste disposal sites according to the uncertainty analysis methodology, Bioclimatology and Natural Hazards, ISBN 978-80-228-17-60*

Recalculations for $PM_{2.5}$ and PM_{10} emissions were performed for stationary sources in 2009 (only for sector energy - category 1A1a), due to the change in plant statistics of operator accrued in database NEIS. The recalculation was performed for sector agriculture in category synthetic N-fertilizers for NH_3 emissions up to year 2000.

Table 2.3: The anthropogenic emissions of NO_x, CO, NM VOC and SO_2 (Gg) in 1990 – 2009

Year	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
CO	**511,58**	**488,08**	**444,64**	**455,88**	**431,04**	**419,66**	**363,78**	**363,56**	**346,19**	**335,37**	**308,24**	**314,77**	**296,02**	**299,80**	**303,06**	**289,80**	**275,88**	**256,27**	**251,30**	**216,94**
Stationary	351,26	340,23	299,99	301,05	272,63	258,90	208,18	205,61	187,61	185,36	185,16	175,59	165,14	184,20	189,56	181,39	193,51	183,33	178,41	148,05
Transport	154,20	142,87	140,62	150,68	154,80	156,74	151,13	153,22	153,95	144,65	117,22	133,25	125,03	109,13	106,38	99,05	74,43	65,01	64,18	60,16
Other*	6,12	4,97	4,03	4,16	3,60	4,02	4,46	4,74	4,64	5,36	5,86	5,92	5,85	6,47	7,11	9,36	7,94	7,93	8,71	8,73
NO_x	**221,96**	**201,22**	**188,63**	**180,31**	**170,00**	**177,94**	**134,95**	**127,51**	**133,11**	**121,13**	**107,41**	**107,84**	**100,25**	**96,34**	**100,07**	**104,05**	**98,70**	**96,51**	**95,04**	**84,82**
Stationary	160,46	150,21	141,73	135,26	122,39	128,01	89,42	82,10	86,43	77,41	70,32	67,58	59,70	58,37	56,51	55,39	52,09	46,84	45,79	41,08
Transport	56,85	47,51	43,74	42,36	43,54	45,45	45,04	44,92	46,21	43,22	36,55	39,72	40,02	37,40	42,92	47,85	45,89	48,95	48,50	42,93
Other*	4,66	3,50	3,16	2,70	4,07	4,48	0,49	0,50	0,47	0,49	0,54	0,54	0,53	0,57	0,64	0,80	0,73	0,72	0,75	0,82
NM VOC	**141,44**	**NA,NE**	**NA,NE**	**107,91**	**NA,NE**	**101,08**	**97,20**	**91,87**	**88,41**	**82,47**	**69,11**	**72,83**	**71,53**	**72,55**	**72,73**	**75,96**	**70,65**	**69,23**	**68,75**	**65,40**
Energy	41,02	NA,NE	NA,NE	34,43	NA,NE	27,52	28,30	27,28	24,09	22,85	21,97	22,48	20,29	21,33	23,00	24,87	22,77	22,25	22,12	21,37
Industry	8,79	NA,NE	NA,NE	5,87	NA,NE	2,82	2,68	2,67	1,58	1,51	1,37	1,32	1,39	1,68	1,69	1,59	1,56	1,53	1,38	1,26
Transport	33,56	NA,NE	NA,NE	30,88	NA,NE	32,97	31,84	32,04	31,90	29,07	17,92	19,55	17,81	16,08	14,40	14,96	10,74	11,05	10,42	8,67
Solvent Use	52,87	NA,NE	NA,NE	34,97	NA,NE	37,07	33,80	29,29	30,18	28,41	26,98	28,72	31,02	32,27	32,76	33,56	34,63	33,58	33,78	33,33
Agriculture	0,65	NA,NE	NA,NE	0,44	NA,NE	0,44	0,44	0,44	0,44	0,44	0,44	0,44	0,44	0,44	0,44	0,44	0,44	0,44	0,44	0,44
Waste	4,54	NA,NE	NA,NE	1,34	NA,NE	0,26	0,15	0,15	0,23	0,18	0,43	0,32	0,58	0,76	0,45	0,54	0,51	0,38	0,61	0,33
SO_2	**526,11**	**445,50**	**389,63**	**328,22**	**245,22**	**246,29**	**230,59**	**204,69**	**184,11**	**172,96**	**126,95**	**131,11**	**103,35**	**105,50**	**96,19**	**89,01**	**87,75**	**70,56**	**69,41**	**64,08**
Stationary	522,69	442,77	387,24	326,04	242,91	243,80	228,06	202,14	181,39	171,88	126,08	130,23	102,53	105,26	95,95	88,77	87,53	70,30	69,14	63,84
Transport	3,42	2,73	2,39	2,17	2,31	2,49	2,54	2,55	2,72	1,09	0,86	0,87	0,80	0,21	0,22	0,24	0,22	0,25	0,26	0,24

**Biomass burning and forest fires, emissions are determined as of 15.02.2011*

Although air quality management programs are focused on the reduction of basic pollutants, they contribute significantly also to the decrease in GHG emissions. Currently, there are 18 air quality management areas in 2 agglomerations and 8 specially observed zones due to the air quality in the Slovak Republic. Exceeding of daily limit value for sulphur dioxide has occurred in the district of Prievidza, exceeding of limit values for nitrogen oxide has occurred in Bratislava – the capital of the Slovak Republic. Both areas belong to the air quality management areas. For all these areas programs on air quality management have been developed with clearly specified measures for individual sources to improve local air quality. All programs are published at the internet web page of the Ministry of Environment (www.enviro.gov.sk). Furthermore, action plans containing short time measures have been developed.

Programs and plans have been developed according to Act 478/2002 on Air Protection as amended and Decree of the Ministry of Environment of the Slovak Republic No. 705/2002 on air quality. EU Directives 1999/96/EC, 2002/3/EC, 1999/30/EC and 2000/69/EC were transposed by this act and decree.

2.5 Description and interpretation of emission trends for KP-LULUCF inventory

National GHG emission inventory for the year 2009 includes information required by the Kyoto Protocol - Land use, land use change and forestry, Article 3.3 and this information is included in the set of the CRF tables.

According to the *"Report on the estimation of assigned amounts under the Kyoto Protocol-revised version according to the IRR from July, 2007"* the Slovak Republic has officially declared the following statement:

In order to report under Article 3.3 (ARD activities: afforestation, reforestation and deforestation), the Slovak Republic has selected the following threshold values for the forest definition: forest land includes land with minimum tree crown cover of 20% for trees capable to reach minimum height of 5 m in situ. The minimum area for forest is 0.3 ha. Temporarily unstuck areas are included (forest regeneration areas). For linear formations, a minimum width of 20 m is applied. This definition would be applicable also for reporting, under Article 3.4. However, the Slovak Republic has decided not to use Article 3.4 activities to meet its commitments under the first commitment period.

The selected threshold values are consistent with the values used in the reporting to the Food and Agriculture Organisation of the United Nations (the GFRA 2005, National Forest Inventory, and MCPFE criteria and indicators of sustainable forest management).

The Slovak Republic has decided not to use any activities under Article 3.4 (forest management, cropland management, grazing land management and revegetation) to meet its commitment under the first commitment period of the Kyoto Protocol.

The Slovak Republic has chosen to account for the activities under Article 3.3 (afforestation, reforestation and deforestation) for the whole commitment period. In 2009, total CO_2 removals from afforestation/reforestation activities were -469.23 Gg of CO_2 (changes in 29.21 kha to the end of 2009). Total CO_2 emissions from deforestation were 280.11 Gg of CO_2 (changes in 6.98 kha to the end of 2009). In 2009, total emissions under the Article 3.3 of the KP 460.85 Gg with the changed area of 37.7 kha.

Table 2.4: Emissions and removals resulting from activities 3.3 of the KP in 2008 and 2009

Activities	2008	2009	Total
	Net CO_2 (Gg)		
A. Article 3.3 activities			
A.1. Afforestation and Reforestation	-453,04	-469,23	**-922,26**
A.1.1. Units of land not harvested since the beginning of the commitment period	-453,04	-469,23	**-922,26**
A.1.2. Units of land harvested since the beginning of the commitment period	NA	NA	**NA**
A.2. Deforestation	180,74	280,11	**460,85**

Table 2.5: Total areas and changes in 2009

		Article 3.3 activities		Article 3.4 activities				Other	Total area at the beginning of the current inventory year
		AF	D	FM	CM	GLM	R		
		(kha)							
Article 3.3 activities	AR	29,21	NO						**29,21**
	D		6,98						**6,98**
Article 3.4 activities	FM		NA	NA					**NA**
	CM	NA	NA		NA	NA	NA		**NA**
	GLM	NA	NA		NA	NA	NA		**NA**
	R	NA			NA	NA	NA		**NA**
Other		1,05	0,46	NA	NA	NA	NA	4 866,10	**4 867,61**
Total area at the end of the current inventory year		**30,26**	**7,44**	**NA**	**NA**	**NA**	**NA**	**4 866,10**	**4 903,80**

Emissions are determined as of 15.04.2011

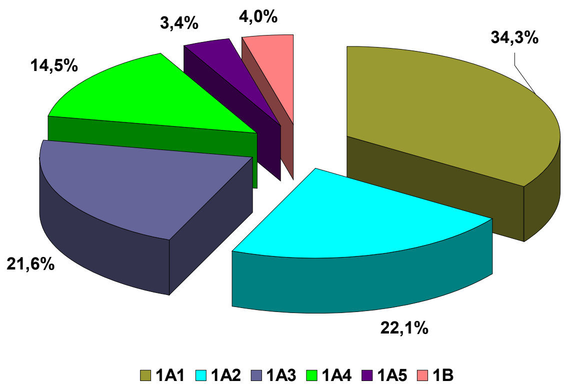
CHAPTER 3: ENERGY (CRF 1)

3.1 Overview of sector (CRF 1)

Energy sector is the main contributor to overall GHG emissions with its share of 66.1% and 28 694.32 Gg of CO_2 equivalents in 2009. Within this sector, transport contributes 22.5% significantly to GHG emissions and it shows the most increasing trend. The share of transport in total emissions has increased since 1990 and was 14.3% in 2009. In addition to fuel combustion in stationary sources of pollution, also the pollution from small sources of residential heating systems and fugitive methane emissions from transport, processing and distribution of oil and natural gas contribute significantly to total GHG emissions.

Energy sector covers emissions from fossil fuel combustion (CRF 1.A) and fugitive emissions from oil and natural gas (CRF 1.B). The inventory of emissions from fuel combustion includes direct GHG emissions (CO_2, CH_4, N_2O) and indirect (NO_x, CO, NMVOCs) GHG emissions, as well SO_2 emissions from fuel combustion. Point sources, transport and other fuel combustion are included. The inventory of fugitive emissions from oil and natural gas includes CO_2, CH_4, N_2O and NMVOCs emissions from oil and natural gas refining and storage, the emissions from venting and flaring at oil refineries as well as, the emissions from natural gas transmission and distribution. The emissions from international bunkers (CO_2, CH_4, N_2O, SO_2 and indirect gases) and CO_2 emissions from biomass are included in memo items.

Figure 3.1: The share of aggregated emissions by categories within energy sector in 2009

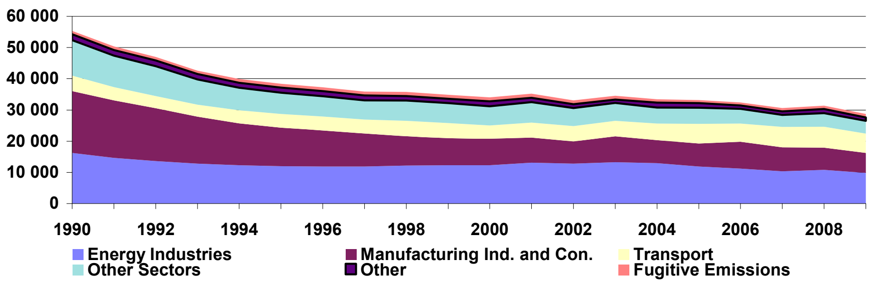


1A1	Energy Industries	34,31%
1A2	Manufacturing Industries and Construction	22,11%
1A3	Transport	21,63%
1A4	Other Sectors	14,50%
1A5	Other	3,44%
1B	Fugitive Emissions from Fuels	4,00%

Table 3.1: The share of GHG emissions by categories within energy sector in 1990 – 2009

	CO_2/Gg			CH_4/Gg			N_2O/Gg		
	1 Energy	1A Sectoral Approach	1B Fugitive Emissions	1 Energy	1A Sectoral Approach	1B Fugitive Emissions	1 Energy	1A Sectoral Approach	1B Fugitive Emissions
1990	**53 493,32**	53 493,17	0,15	**73,44**	21,79	51,65	**0,92**	0,92	2,05E-05
1991	**48 546,17**	48 546,04	0,13	**74,76**	20,97	53,79	**0,80**	0,80	1,45E-05
1992	**45 193,87**	45 193,74	0,13	**73,40**	19,22	54,18	**0,71**	0,71	1,28E-05
1993	**40 913,48**	40 913,34	0,13	**70,45**	16,75	53,70	**0,66**	0,66	1,17E-05
1994	**38 228,86**	38 228,71	0,14	**71,15**	14,65	56,50	**0,64**	0,64	1,33E-05
1995	**36 695,65**	36 695,49	0,15	**72,46**	13,63	58,83	**0,66**	0,66	1,59E-05
1996	**35 511,21**	35 511,05	0,16	**72,42**	12,62	59,80	**0,67**	0,67	1,45E-05
1997	**34 155,88**	34 155,72	0,16	**71,30**	10,71	60,59	**0,68**	0,68	1,33E-05
1998	**34 022,68**	34 022,51	0,17	**74,40**	11,22	63,18	**0,72**	0,72	1,20E-05
1999	**33 151,98**	33 151,81	0,17	**72,08**	10,60	61,49	**0,73**	0,73	9,84E-06
2000	**32 344,28**	32 344,10	0,18	**74,21**	11,33	62,88	**0,49**	0,49	8,00E-06
2001	**33 485,58**	33 485,39	0,19	**72,58**	11,39	61,19	**0,53**	0,53	9,05E-06
2002	**31 467,08**	31 466,90	0,18	**68,68**	9,24	59,44	**0,52**	0,52	8,18E-06
2003	**32 945,83**	32 945,63	0,19	**66,59**	9,55	57,04	**0,55**	0,55	1,08E-05
2004	**31 912,65**	31 912,46	0,18	**64,40**	10,31	54,09	**0,53**	0,53	7,61E-06
2005	**31 695,20**	31 695,03	0,17	**60,77**	12,64	48,13	**0,60**	0,60	6,78E-06
2006	**30 980,81**	30 980,63	0,17	**58,71**	11,91	46,80	**0,56**	0,56	8,94E-06
2007	**29 188,76**	29 188,61	0,15	**59,37**	10,41	48,96	**0,53**	0,53	5,91E-06
2008	**29 691,69**	29 691,54	0,15	**68,11**	17,26	50,86	**0,64**	0,64	4,70E-06
2009	**27 210,85**	27 210,61	0,24	**63,33**	8,64	54,69	**0,50**	0,50	4,75E-06

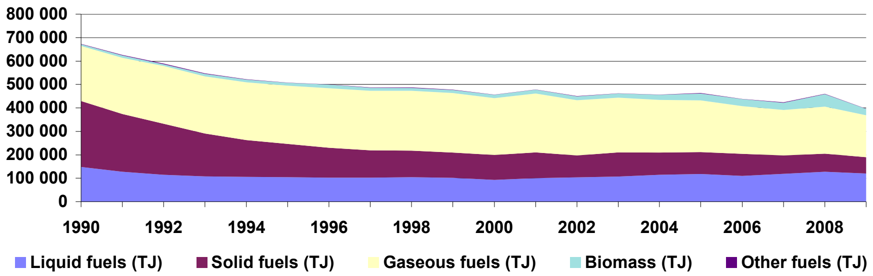
Figure 3.2: Trend in aggregated emissions by categories within energy sector in 1990 – 2009



In 2009, the consumption of brown coal was only 6% of the consumption in 1990, light fuel oil consumption decreased by 92% and heavy fuel oil by 72% compared to 1990. An example of the Slovak Republic is as follows: the production of liquid steel increased by 27.7% from 1990 to 2005, while the consumption of coal energy production decreased by 2.3%. Carbon intensity per metric ton of liquid steel has been improved by 5.2% during the same period. There is a lot of further technological and innovation steps made by individual operators to increase production intensity and to meet strict environmental requirements.

The most indicative trend in emissions and GDP decoupling is visible in sector energy in fossil fuel consumption. The decrease in the consumption of solid fuels is more than 72% in comparison with the base year 1990. The consumption of liquid fuels decreased by almost 7% and the decreasing in gaseous fuels is 14%. By comparison, the consumption of biomass was 5 times higher in 2009 than in 1990. General trend in total consumption of fossil fuels is declining due to the increase in energy efficiency. The emissions from municipal and industrial waste incineration with energy use and methane cogeneration from mines are included in other fuels category.

Figure 3.3: Trend in fuels consumption within energy sector in 1990 – 2009



3.1.1 Emissions from fuel combustion (CRF 1.A)

Fossil fuels combustion in energy (including transport) and industry sectors is the most important source of emissions in the Slovak Republic. The emissions represent more than 80% share in total GHGs emission in CO_2 equivalents. It is especially public energy providing for power and heat supplying, industrial energy – energy production for technological processes, road transport and last but not least district heating – heat supply for block of flats and dwelling houses, public equipment and services, objects of non-productive sphere.

Total aggregated emissions from fuel combustion, including transport, based on sectoral approach methodology represented 27 545.65 Gg of CO_2 equivalents in 2009. This amount decreased by almost 9% compared to the previous year and decreased by 49% compared to the base year. The following sub-sectors of the IPCC categories according to the IPCC 1996 Guidelines are relevant for the Slovak Republic in sectoral approach.

High level of dependency on import of primary energy sources (PES) is a limiting factor for the energy sector and subsequently for the whole economic development. Net imports of PES are covered by almost 90%, together with nuclear fuel, from the Russian Federation as the exclusive supplier. The share of fossil fuels in the PES is relatively high, reaching the level of 80%.

The energy intensity of the Slovak economy is gradually decreasing but it is still almost twice higher than the EU average. In January 2004, the transitional period for price subsidies ended and the Regulatory Office for Network Industries removed the subsidies of electricity, gas and heat for industry and households, in order to change energy consumption pattern.

In 2001, the Slovak Republic started transformation and privatization of regional distribution companies. In 2002, the biggest producer of electricity, Slovenské elektrárne – a member of ENEL group was transformed and split up (http://www.seas.sk/en).

Since then, the Slovak electricity transmission system, Plc. (Slovenská elektrizačná prenosová sústava, a.s.) has been registered and it acts as the transmission system operator including also the energy dispatch (http://www.sepsas.sk/seps/en_index.asp).

Table 3.2: Reported emissions in category fuel combustion within energy sector in 2009

	Category	Description	Emissions reported
1.A.1	**Energy industry**		
1.A.1.a	Public Electricity and Heat Production	electricity, combined heat and pow er generation	CO_2, CH_4, N_2O
1.A.1.b	Petroleum Refining	refineries, petrochemical oil processing	CO_2, CH_4, N_2O
1.A.1.c	Manufacture of Solid Fuels and Other Energy Industries	coke production, coal manufacturing, charcoal production	CO_2, CH_4, N_2O
1.A.2	**Manufacturing Industries and Construction**		
1.A.2.a	Iron and Steel	iron, steel and ferroalloy production, manufacturing of iron ore	CO_2, CH_4, N_2O
1.A.2.b	Non-Ferrous Metals	non ferrous metals production, casting	CO_2, CH_4, N_2O
1.A.2.c	Chemicals	chemical products manufacturing and production	CO_2, CH_4, N_2O
1.A.2.d	Pulp, Paper and Print	Paper and pulp production, printing,	CO_2, CH_4, N_2O
1.A.2.e	Food Processing, Beverages and Tobacco	food industry	CO_2, CH_4, N_2O
1.A.2.f	Other	glass, cement, lime and magnesite production, w ood manufacturing, brickw orks, asphalt mixing plant, bating and electroplating	CO_2, CH_4, N_2O
1.A.3	**Transport**		
1.A.3.a	Civil Aviation		CO_2, CH_4, N_2O
1.A.3.b	Road Transportation		CO_2, CH_4, N_2O
1.A.3.c	Railw ays		CO_2, CH_4, N_2O
1.A.3.d	Navigation	new estimation	CO_2, CH_4, N_2O
1.A.3.e	Other Transportation	military aviation	CO_2, CH_4, N_2O
1.A.4	**Other Sectors**		
1.A.4.a	Commercial/Institutional	commercial and institutional building, hospitals, schools,	CO_2, CH_4, N_2O
1.A.4.b	Residential	sale fuels for households	CO_2, CH_4, N_2O
1.A.4.c	Agriculture/Forestry/Fisheries	farms and forest organisations, slaughters	CO_2, CH_4, N_2O
1.A.5	**Other**		
1.A.5.a	Stationary	compress and petrol stations, paint shops, w astew ater treatment plants, crematory	CO_2, CH_4, N_2O
1.A.5.b	Mobile		NA

The Slovak Republic makes use of the sectoral approach based on bottom-up methodology for emission estimation as the most appropriate method for energy balance. The sectoral approach is based on direct information from stationary sources of pollution from every district in the country. The information about fuels, technology used, parameters of fuels and other important information are stored in robust database system – the National Emission Information System (NEIS). Sectoral approach is compared with the reference approach based on top-down data from the Statistical Office of the Slovak Republic. The inter-annual fluctuation is very low and small discrepancies can occur in the fuel characteristics and using average values by the Statistic Office.

3.1.2 Fugitive emissions from fuels (CRF 1.B)

Fugitive emissions from 1.B.1 Solid fuel (coal mining and handling) and 1.B.2 Oil and natural gas, as key categories, are important sources of methane emissions in the national GHGs inventory. Only emissions of NM VOC from coke production are included in the category 1.B.1.B Solid fuel transformation.

In 2009, total aggregated fugitive emissions in category 1.B represented 1 148.73 Gg of CO_2 equivalents. This amount increased by almost 8% comparable to the previous year and increased by 6% comparable to the base year. Compared to other categories, the trend is almost stable and has not been influenced by changes in last decades. Fugitive emissions from the extraction and distribution of fossil fuels are important as the Slovak Republic is an important transit country regarding the transport of oil and natural gas from the former Soviet Union countries to Europe. Raw materials are transported through high pressure pipelines and distribution network and they are pumped by pipeline compressors. Trend in fugitive emissions from the transport and distribution of oil and natural gas in the Slovak Republic was stabilized and since 2000 it has slightly decreased. The increase in the past was caused by the expansion of the distribution system for natural gas and growth of its consumption. Since 2000, fugitive emissions from oil have decreased due to the decrease in production and distribution. Fugitive methane emissions in the period 1990 – 2009 were calculated based on the coal production from underground mines, obtained from official statistical sources and companies HBP, a.s., Baňa Dolina, a.s. a Baňa Čáry, a.s., and the Ministry of Economy of the Slovak Republic. According to the IPCC 1996 Guidelines, the following sub-sectors of the IPCC categories are relevant for the Slovak Republic in category 1.B.

Table 3.3: GHG emissions within category coal mining and handling in 1990 – 2009

	CH_4/Gg		
	1B1A1 Underground Mines	1B1A11 Mining Activities	1B1A12 Post-Mining Activities
1990	**27,1976**	25,1137	2,0840
1991	**28,8267**	26,6179	2,2088
1992	**29,9324**	27,6388	2,2935
1993	**28,6121**	26,4327	2,1794
1994	**29,9119**	27,6538	2,2581
1995	**29,7041**	27,4374	2,2667
1996	**30,0758**	27,7602	2,3156
1997	**30,6130**	28,2527	2,3603
1998	**31,1677**	28,7852	2,3825
1999	**29,4960**	27,2007	2,2953
2000	**28,8208**	26,6203	2,2005
2001	**26,3301**	24,2654	2,0647
2002	**25,6938**	23,6430	2,0508
2003	**21,1140**	19,2597	1,8544
2004	**19,7726**	17,9926	1,7800
2005	**16,1726**	14,6584	1,5142
2006	**14,6709**	13,3405	1,3304
2007	**13,5181**	12,2732	1,2449
2008	**15,9487**	14,4876	1,4611
2009	**16,9240**	15,3731	1,5509

Table 3.4: Reported emissions in category fugitive emissions within energy sector in 2009

	Category	Description	Emissions reported
1.B.1	**Solid Fuels**		
1.B.1.A	Coal Mining and Handling - 1.B.1.A.1.1 Mining activities	underground mines for brow n coal	CH_4
	Coal Mining and Handling - 1.B.1.A.1.2 Post-mining activities	brow n coal processing	CH_4
1.B.2	**Oil and natural Gas**		
1.B.2.A	Oil - 1.B.2.A.1 Exploration	Not occuring in the SR	NO
	Oil - 1.B.2.A.2 Production		CO_2, CH_4
	Oil - 1.B.2.A.3 Transport		CO_2, CH_4
	Oil - 1.B.2.A.4 Refining/Storage		CO_2, CH_4
	Oil - 1.B.2.A.5 Distribution of Oil Products	Not occuring in the SR	NO
	Oil - 1.B.2.A.6 Other	Not occuring in the SR	NO
1.B.2.B	Natural Gas - 1.B.2.B.1 Exploration	Not occuring in the SR	NO
	Natural Gas - 1.B.2.B.2 Production / Processing		CO_2, CH_4
	Natural Gas - 1.B.2.B.3 Transmission		CO_2, CH_4
	Natural Gas - 1.B.2.B.4 Distribution		CO_2, CH_4
	Natural Gas - 1.B.2.B.5 Other Leakage	included in Transmission and Distribution	IE
1.B.2.C	Venting and Flaring - 1.B.2.C.1.1 Venting of Oil		CO_2, CH_4
	Venting and Flaring - 1.B.2.C.1.2 Venting of NG		CO_2, CH_4
	Venting and Flaring - 1.B.2.C.1.3 Combined	Not occuring in the SR	NO
	Venting and Flaring - 1.B.2.C.2.1 Flaring of Oil		CO_2, CH_4
	Venting and Flaring - 1.B.2.C.2.2 Flaring of NG		CO_2, CH_4
	Venting and Flaring - 1.B.2.C.2.3 Combined	Not occuring in the SR	NO
1.B.2.D	Other - Storage of Natural Gas		CO_2, CH_4, N_2O

Table 3.5: The share of GHG emissions by categories within sectoral approach in 1990 – 2009

	CO_2/Gg						CH_4/Gg	N_2O/Gg
	1A Fuel Combustion (Sectoral Approach)	1A1 Energy Industries	1A2 Manufacturing Industries and Construction	1A3 Transport	1A4 Other Sectors	1A5 Other	1A Fuel Combustion (Sectoral Approach)	1A Fuel Combustion (Sectoral Approach)
1990	**53 493,173**	16 107,714	19 712,348	4 892,47034	10 908,113	1 872,529	21,789	0,92180
1991	**48 546,039**	14 609,126	18 339,156	4 120,57629	9 654,098	1 823,082	20,966	0,80238
1992	**45 193,742**	13 505,395	16 885,951	3 794,34184	9 235,728	1 772,327	19,225	0,71096
1993	**40 913,344**	12 725,775	14 989,288	3 772,20848	7 703,350	1 722,723	16,749	0,65694
1994	**38 229,216**	12 213,785	13 407,359	4 013,24210	6 919,984	1 674,345	14,654	0,64122
1995	**36 695,811**	11 936,807	12 291,591	4 258,51058	6 581,313	1 627,270	13,626	0,65624
1996	**35 511,428**	11 848,424	11 532,846	4 312,85895	6 235,352	1 581,571	12,622	0,67339
1997	**34 156,044**	11 869,909	10 348,272	4 479,99366	5 920,218	1 537,325	10,708	0,68390
1998	**34 022,836**	12 117,681	9 384,687	4 762,34446	6 263,190	1 494,606	11,219	0,72210
1999	**33 155,622**	12 260,873	8 580,296	4 651,88912	6 205,262	1 453,491	10,597	0,72881
2000	**32 344,099**	12 247,095	8 480,387	4 124,98167	5 979,302	1 512,333	11,326	0,48838
2001	**33 485,391**	13 028,262	8 008,573	4 696,30258	6 360,540	1 391,714	11,393	0,52856
2002	**31 466,899**	12 682,021	7 140,729	4 835,88518	5 638,910	1 169,354	9,242	0,52167
2003	**32 945,634**	13 188,272	8 243,487	4 932,04852	5 507,043	1 074,784	9,551	0,55331
2004	**31 912,464**	12 863,610	7 380,205	5 219,59188	4 943,076	1 505,981	10,311	0,53298
2005	**31 695,025**	11 843,140	7 326,100	6 170,23357	4 924,131	1 431,422	12,641	0,59600
2006	**30 980,631**	11 166,997	8 558,127	5 694,91386	4 507,114	1 053,479	11,914	0,55826
2007	**29 188,611**	10 285,647	7 657,427	6 460,76991	3 640,765	1 144,002	10,410	0,52662
2008	**29 691,543**	10 792,056	7 030,542	6 620,53447	3 938,730	1 309,680	17,257	0,64001
2009	**27 210,611**	9 808,337	6 311,258	6 119,81448	3 986,657	984,545	8,642	0,49515

According to several recommendations of the ERT during previous in-country reviews under UNFCCC in 2007 and 2009, the estimation of CH_4 fugitive emissions followed the estimation of CO_2 and N_2O fugitive emissions.

Table 3.6: GHG emissions within category fugitive emissions from oil and NG in 1990 – 2009

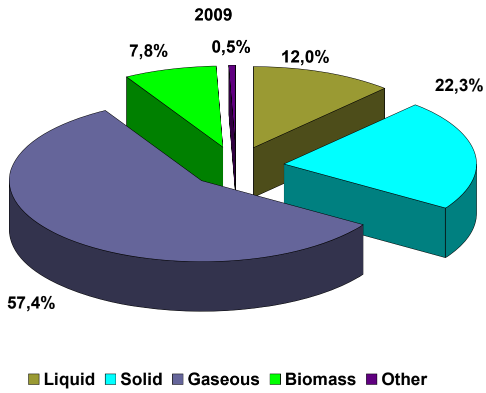
	CH_4/Gg							CH_4/Gg	CO_2/Gg	N_2O/t
	1B2A Oil			1B2B NG				1B2	1B2	1B2
	1B2A Oil	1B2C11 Venting	1B2C21 Flaring	1B2B NG	1B2C12 Venting	1B2C22 Flaring	1B2D Storage			
1990	0,2168	0,0197	0,0197	21,3546	2,7216	0,1155	0,0042	**24,4522**	**0,1457**	**0,0205**
1991	0,2077	0,0193	0,0193	21,8585	2,7216	0,1350	0,0042	**24,9657**	**0,1326**	**0,0145**
1992	0,1893	0,0166	0,0166	21,1759	2,7216	0,1191	0,0042	**24,2434**	**0,1288**	**0,0128**
1993	0,1978	0,0180	0,0180	22,0190	2,7216	0,1092	0,0042	**25,0877**	**0,1332**	**0,0117**
1994	0,2002	0,0181	0,0181	23,2014	2,7216	0,1243	0,2999	**26,5837**	**0,1412**	**0,0133**
1995	0,2085	0,0200	0,0200	25,3393	2,7216	0,1479	0,6695	**29,1270**	**0,1547**	**0,0159**
1996	0,2038	0,0193	0,0193	25,9680	2,7216	0,1350	0,6594	**29,7264**	**0,1579**	**0,0145**
1997	0,1847	0,0173	0,0173	26,6172	2,7216	0,1243	0,2965	**29,9789**	**0,1592**	**0,0133**
1998	0,1795	0,0162	0,0162	28,3762	2,7216	0,1118	0,5922	**32,0137**	**0,1700**	**0,0120**
1999	0,1844	0,0178	0,0178	28,5436	2,7216	0,0916	0,4133	**31,9901**	**0,1699**	**0,0098**
2000	0,1678	0,0159	0,0159	28,8636	2,7216	0,0744	2,2021	**34,0613**	**0,1809**	**0,0080**
2001	0,1636	0,0149	0,0149	30,0348	2,7216	0,0843	1,8262	**34,8601**	**0,1852**	**0,0091**
2002	0,1593	0,0140	0,0140	30,0084	2,7216	0,0648	0,7623	**33,7444**	**0,1793**	**0,0082**
2003	0,1471	0,0113	0,0113	32,7841	2,7216	0,1165	0,1367	**35,9287**	**0,1909**	**0,0108**
2004	0,1438	0,0103	0,0103	29,7567	2,7216	0,0250	1,6506	**34,3182**	**0,1824**	**0,0076**
2005	0,1340	0,0084	0,0084	28,8685	2,7240	0,0035	0,2100	**31,9567**	**0,1697**	**0,0068**
2006	0,1332	0,0076	0,0076	29,1543	2,7240	0,0555	0,0462	**32,1283**	**0,1747**	**0,0089**
2007	0,1323	0,0076	0,0076	32,4274	2,7240	0,1476	NO	**35,4465**	**0,1497**	**0,0059**
2008	0,1165	0,0049	0,0049	31,4210	2,7240	0,1076	0,5292	**34,9081**	**0,1474**	**0,0047**
2009	0,1111	0,0041	0,0041	32,4254	2,7240	0,1075	2,3898	**37,7659**	**0,2411**	**0,0047**

3.2 Energy industries (CRF 1.AA.1), Manufacturing industries and combustion (CRF 1.AA.2), Other sectors (CRF 1.AA.4) and Other (CRF 1.AA.5)

3.2.1 Source category description

Energy industries (CRF 1.AA.1), Manufacturing industries and construction (CRF 1.AA.2), Other sectors (CRF 1.AA.4) and Other (CRF 1.AA.5) categories include emissions from fuel combustion in large and medium point sources in energy production and industrial sectors (power plants, boilers and industrial plants with boilers and/or other combustion installations). The emissions according to the relevant subcategories and gases in 1990 – 2009 are presented in Table 3.7.

Figure 3.4: The share of different fuels consumption within energy sector's categories in 2009



Subsector 1.AA Fuel Combustion without Transport	TJ	Share
Liquid	37 364,17	12,00%
Solid	69 359,18	22,28%
Gaseous	178 660,24	57,39%
Biomass	24 392,89	7,84%
Other	1 554,26	0,50%
Total	**311 330,75**	**100,00%**

The share of fuel consumption of subsectors 1.AA.1, 1.AA.2, 1.AA.4 and 1.AA.5 in total fuel consumption of sectoral approach balance was more than 80% in 2009. The highest share represents category CRF 1.AA.1.A – Public electricity and heat production followed by category 1.AA.4.B – Residential and category 1.AA.2.F – Other. Detailed emission trends by gases and categories are presented in Table 3.7.

Table 3.7: GHG emissions within energy sector's categories in 1990 – 2009

	CO_2/Gg							
	CRF 1A1 + 1A2 + 1A4 + 1A5	1A1A Public Electricity and Heat Production	1A1B Petroleum Refining	1A1C Manufact. of Solid Fuels	1A2A Iron and Steel Prod.	1A2B Non-Ferrous Metal	1A2C Chemicals	1A2D Pulp, Paper and Print
1990	**48 600,70**	14 834,84	1 262,39	10,48	4 559,08	1 240,12	4 699,25	2 278,26
1991	**44 425,46**	12 781,04	1 565,08	263,01	4 130,29	1 045,42	4 985,66	2 079,15
1992	**41 399,40**	11 205,64	1 813,64	486,11	3 598,25	877,90	5 096,36	1 890,75
1993	**37 141,14**	10 051,53	1 992,40	681,85	2 594,22	735,12	5 055,96	1 713,57
1994	**34 215,47**	9 252,09	2 110,00	851,69	1 871,58	614,94	4 887,92	1 548,08
1995	**32 436,98**	8 764,59	2 175,11	997,11	1 576,98	515,22	4 615,70	1 394,75
1996	**31 198,19**	8 532,49	2 196,36	1 119,57	1 596,48	433,82	4 262,77	1 254,06
1997	**29 675,72**	8 466,95	2 182,41	1 220,54	1 142,43	368,61	3 852,58	1 126,47
1998	**29 260,17**	8 674,27	2 141,92	1 301,50	856,87	317,44	3 408,60	1 012,45
1999	**28 499,92**	8 813,45	2 083,52	1 363,90	673,20	278,16	2 954,29	912,48
2000	**28 219,12**	9 147,89	1 615,05	1 484,15	817,46	225,96	2 619,96	840,26
2001	**28 789,09**	9 908,46	1 688,02	1 431,79	949,84	232,41	2 140,53	682,86
2002	**26 631,01**	9 499,73	1 674,13	1 508,16	847,34	231,77	1 592,42	728,17
2003	**28 013,59**	9 867,16	1 719,06	1 602,05	1 387,54	204,07	1 564,13	696,61
2004	**26 692,87**	9 315,45	2 091,23	1 456,93	1 180,00	164,65	1 521,84	580,56
2005	**25 524,79**	8 775,95	1 587,13	1 480,07	1 564,78	151,68	1 465,59	645,59
2006	**25 285,72**	8 251,03	1 459,49	1 456,48	2 496,07	172,70	1 450,93	632,34
2007	**22 727,84**	7 277,79	1 548,06	1 459,79	1 757,01	159,56	1 783,00	571,06
2008	**23 071,01**	7 597,23	1 856,59	1 338,23	1 520,17	179,00	1 790,73	537,46
2009	**21 090,80**	6 662,68	1 831,39	1 314,27	1 437,17	155,66	1 615,88	632,46

	CO_2/Gg						CH_4/Gg	N_2O/Gg
	1A2E Food, Beverage and Tabacco	1A2F Other	1A4A Commer./ Institutional	1A4B Residen.	1A4C Agri./ Forestry/ Fishery	1A5A Stationary	CRF 1A1 + 1A2 + 1A4 + 1A5	CRF 1A1 + 1A2 + 1A4 + 1A5
1990	1 140,36	5 795,28	3 327,77	7 535,10	45,24	1 872,53	20,759	0,527
1991	1 040,56	5 058,08	2 922,07	6 690,00	42,03	1 823,08	20,023	0,482
1992	953,95	4 468,74	2 567,66	6 626,19	41,88	1 772,33	18,303	0,428
1993	879,12	4 011,30	2 260,38	5 398,45	44,52	1 722,72	15,752	0,390
1994	814,83	3 670,01	1 996,51	4 873,95	49,53	1 674,35	13,582	0,354
1995	759,84	3 429,09	1 772,33	4 752,51	56,47	1 627,27	12,487	0,330
1996	712,93	3 272,79	1 584,12	4 586,32	64,91	1 581,57	11,454	0,319
1997	672,86	3 185,32	1 428,16	4 417,63	74,43	1 537,32	9,479	0,294
1998	638,39	3 150,94	1 300,72	4 877,89	84,58	1 494,61	9,916	0,290
1999	608,30	3 153,86	1 198,09	4 912,23	94,94	1 453,49	9,313	0,285
2000	568,26	3 408,50	1 054,74	4 818,21	106,35	1 512,33	10,484	0,280
2001	560,84	3 442,10	1 112,18	5 130,27	118,09	1 391,71	10,447	0,292
2002	552,03	3 189,01	1 021,84	4 493,02	124,04	1 169,35	8,389	0,298
2003	493,51	3 897,63	935,12	4 467,33	104,59	1 074,78	8,748	0,333
2004	475,73	3 457,43	842,39	3 987,11	113,57	1 505,98	9,528	0,306
2005	438,52	3 059,93	943,25	3 786,07	194,80	1 431,42	11,839	0,343
2006	424,06	3 382,03	844,17	3 553,21	109,73	1 053,48	11,286	0,327
2007	368,23	3 018,56	696,60	2 853,74	90,43	1 144,00	9,751	0,291
2008	346,48	2 656,70	819,29	3 015,71	103,73	1 309,68	16,577	0,405
2009	315,48	2 154,61	762,72	3 035,49	188,45	984,54	8,004	0,257

3.2.2 Methodological issues – methods

The sectoral approach (SA) (bottom up), estimation of subsectors 1.AA.1, 1.AA.2, 1.AA.4 and 1.AA.5, is based on the National Emission Information System (NEIS), the database of stationary sources, which collects the data on fuel consumptions from the major sources of air pollution in the Slovak Republic. These data are available in consistent series since 2000, when the system NEIS was put in operation. It replaced an old system EAPSI (Emission and Air Pollution Source Inventory) system. These systems are comparable only at the national level. The comparison of individual parts of EAPSI (EAPSI 1 and EAPSI 2) with the NEIS module (large and medium-size sources), or the comparison of individual sources in both systems is difficult. According to the Act 137/2010 Coll. (article 33, paragraph 3, letters g, m) as amended, district environmental offices are obliged to elaborate yearly reports about operational characteristics of air pollution sources in their districts and provide them to the SHMÚ central dbase in electronic form (in the NEIS BU format) for the next processing. The SHMÚ is authorized by the Ministry of Environment to manage the database NEIS CU and process the data at the national level (Decree no. 357/2010). The first collection and processing of data by module NEIS was realized in 2001 at the Department of Emissions of the SHMÚ. In 2009, the new system contained 837 (714 of it in operation) large point sources collected from 79 the NEIS BU district databases. The sources of 50 MW and above are included to the registration of large point sources. In year 2009, the NEIS system registered 12 809 (10 947 of it in operation) medium sources of the heating output of 0.3-50 MW. The emission balances in 2000 – 2009 were processed in the NEIS CU module by the same calculation. The input data (fuel amounts, according to the types, sold for households and retail consumers, and quality marks) necessary for the emission balance were collected from the regional offices by means of the NEIS BU module. The sources below 0.3 MW (category 1.AA.4.B – Residential) are qualified as small sources and the emission balance is being processed within the system NEIS CU and is based on the data about the selling of solid fuels for households and retail users (in 2001 – 2003 according to Decree no. 144/2000, since 2004 according to Decree no. 53/2004), the consumption of natural gas for the inhabitants and annually specified emission factors. Local furnaces are assessed as local sources at the level of district. In 2004, the emission balance of small sources has been revised followed by the emission recalculation since 1990. Within the revision, the emission factors were updated (in conformity with the effective legislation on air protection), as well as the qualitative features of solid fuels (in sense of standard OTN ZP 2008). Wood combustion emissions were additionally recalculated as its consumption was not included in the balance before 2004. In the past, the balances were not carried out regularly (EAPSI 3 system had been updated annually only until 1997), the data of missing years were estimated additionally. In such a way, the consistent data time series since 1990 have been obtained. The statistics has been completed by the consumption of natural gas for inhabitants (from the records of the Slovak Gas Industry LtD. www.spp.sk) and corresponding emission factors. The changes were occurred in context with the revision of the codebook of fuels in accordance with the approved legislation (Regulation of the Ministry of Environment no.706/2002 Regulation of the Ministry of Environment no.129/2004 amending Regulation of the Ministry of Environment no. 284/2001 Coll. on Waste Catalogue and Directive 200/76/EC on Waste Incineration).

Modules of NEIS:

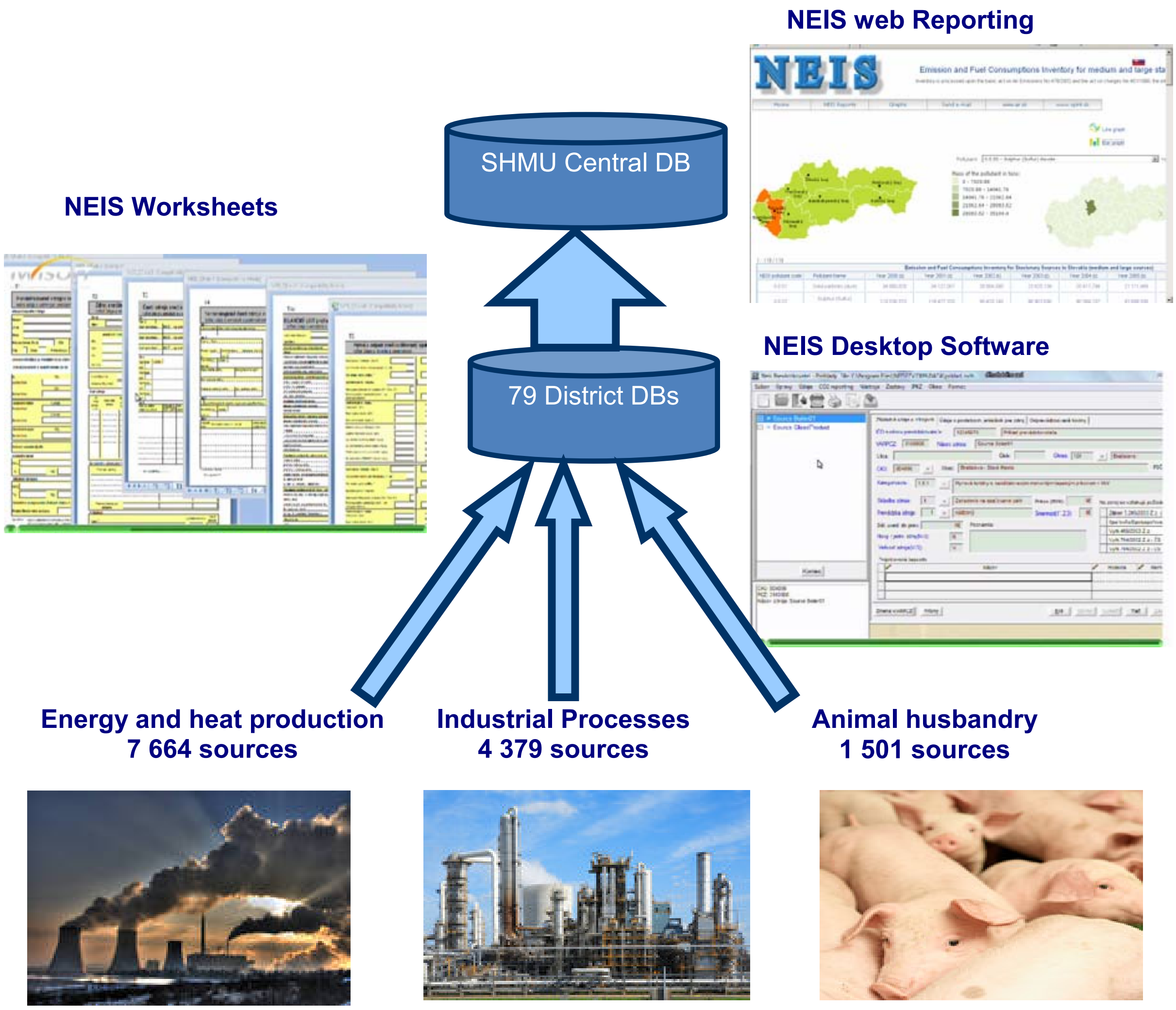
- NEIS QF printed questionnaire form for air pollution sources reporting (used by 6 300 operators).
- NEIS PZ electronic questionnaire form for air pollution sources reporting (used by 160 operators).
- NEIS BU basic unit – the module for district offices in relation to data collection, data processing, data verifying and printing decisions on air polluting fees.
- NEIS CU central unit – the central database module of the SHMÚ for importing district databases, data verifying, statistical and inventory exports, joining IPPC databases and the export to the internet.
- NEIS WEB presentation module – large data sets at local, regional and national level, including all pollutants, and individual reports.
- NEIS documents are archived at the website: http://www.air.sk.

Special program runs inside of the database NEIS developed for reporting requirements under the UNFCCC for the estimation of emissions by a bottom-up methodology. The program was designed in the cooperation with IT experts to ensure easier allocation of individual sources into IPCC categories. The allocation of all large and medium sources within the current year is performed on the base of NACE codes. The production activity of installations and operators of sources is available at the NEIS CU unit. After automatic allocation of sources, the manual verification and check-in by competent expert take place. The NACE codes are compared with IPCC categories (Table 3.2). Activity data (the quantity of fuel burned in physical units) included in each IPCC category collected in the NEIS database for the actual year are provided in mass units (thousand of m^3 or tones) with corresponding calorific values (GJ/thous.m^3 or GJ/t) and other characteristics of the fuel. Operators are under the state control and they guarantee the quality assurance and the data control.

The outputs from a special program under NEIS database is verified by the database administrator of the SHMÚ and forwarded in a special report to the sectoral expert for energy. Then the emission estimation is performed in excel sheets according to the IPCC 2000 GPG. The sectoral energy balance bottom-up makes use of the IPCC more detailed method Tier 2 and national plant specific (CO_2) or default emission factors (mostly for non-CO_2 gases).

The consumption of biomass is not included in the total CO_2 emission balance, but is provided. Information provided by operators was allocated according to the IPCC methodology into appropriate categories. Several sources were divided into more than one category due to the types of production or technological equipments.

Figure 3.5: The structure of NEIS database and data flows



3.2.3 Methodological issues – emission factors and other parameters

The calorific values of the fuels are announced annually by the Statistical Office. The variations depend on fuel characteristics, which are published in the Statistical Yearbook annually. If an operator uses the plant specific calorific values, he has the obligation to provide the measurements to the NEIS database and relevant competent authority.

According to the quantity of fuels and their calorific values, the calculation of fuel consumption in an energy unit (TJ) is provided. For each fuel type the default or national emission factor is used and the corresponding emissions of CO_2, CH_4 and N_2O are calculated. The emission factors for the non-CO_2 are default (IPCC). The emission factors for CO_2 were improved based on plant specific information from the Emission Trading Scheme and are annually updated.

Carbon emission factors (t C/TJ) are estimated for individual fuel types based on the international methodology (IPCC, OECD, IAEA) and national measurements (expert judgment, Profing Ltd., sectoral expert). Carbon emission factors are estimated from known fuel composition and available average low heating values of the most applied fuels. Carbon emission factors may vary considerably both among and within primary fuel types. National emission factors for CO_2 have been used for natural gas since 2000, for coal since 2000, for brown coal according the source (Slovak, Ukraine, the Czech Republic) since 2000, for coke since 2000 and for coke gas since 2000. The revised emission factors are depending on net calorific values and slightly vary from year to year and across IPCC categories. The emission factors for natural gas and other important fuels are based on preciously measurements and calculation published every month by Slovak Gas Industry Ltd, Slovak Energy Industry LtD. and U.S. Steel Company for iron and steel production. These EFs are in use for the installations joined the Emission Trading Scheme and for the requirements of the Ministry of Environment of the Slovak Republic. Carbon content per unit of energy is usually lesser for light refined products, such as gasoline, than for heavier products such as residual fuel oil.

Table 3.8: Overview of selected country-specific emission factors for CO_2 in 2009

Gas	Fuel	EF	Unit	NCV	Unit	IPCC Category
CO_2	Coal (energy)	99,23	tCO2/TJ	25,518	tC/TJ	1A1A
CO_2	Coal (for coke)	94,80	tCO2/TJ	29,553	tC/TJ	1A2A
CO_2	Coal	98,51	tCO2/TJ	25,812	tC/TJ	other
CO_2	Coke	110,63	tCO2/TJ	26,106	GJ/t	all
CO_2	Brown Coal (SR)	103,67	tCO2/TJ	10,185	tC/TJ	all
CO_2	Brown Coal (CR)	96,85-100,85	tCO2/TJ	13,83-18,70	tC/TJ	vary depending on NCV
CO_2	Natural Gas	55,20	tCO2/TJ	34,403	GJ/tis.m3	all
CO_2	Coke Gas	47,36	tCO2/TJ	17,110	tC/TJ	all
CO_2	Lignite	98,42	tCO2/TJ	10,510	tC/TJ	all
CO_2	Wood	100,25	tCO2/TJ	12,860	tC/TJ	all
CO_2	Heavy Heating Oil	75,98	tCO2/TJ	40,500	tC/TJ	all
CO_2	Light Heating Oil	76,30	tCO2/TJ	41,000	tC/TJ	all
CO_2	Refinery Gas	66,40	tCO2/TJ	50,613	tC/TJ	all
CO_2	Blast-Furnace Gas	261,22	tCO2/TJ	3,405	tC/TJ	all

For natural gas, the carbon emission factor depends on the composition of the gas (in its delivered state it is primarily methane, but it can include also small quantities of ethane, propane, butane, and heavier hydrocarbons). Natural gas flared at the production site is usually "wet", i.e., it contains much more non-methane hydrocarbons. Identically, the carbon emission factor is correspondingly different. In the Slovak Republic, the emission factors for natural gas (of the Russian origin) are based on precise measurements and calculation published every month by Slovak Gas Industry since 1st January 2000. Nowadays, these EFs are used for the installations covered by the European Trading Scheme (ETS) that comply with the requirements of the Ministry of Environment of the Slovak Republic. The emission factors are published at the http://www.spp.sk/download/emisie/Kvalita_ZP_emisny_faktor_sk_2009.pdf (Tables 3.9, 3.10). The complete set of consumption, emission factors, NCVs and emissions (CO_2, CH_4 and N_2O) by allocation of fuels according to the IPCC categories are included in Annex 3 Table A3.1.

Table 3.9: Parameters of natural gas published by Slovak Gas Industry on-line in 2009

2009	Natural gas [mol %]										
Month	CH_4	C_2H_6	C_3H_8	$i\text{-}C_4H_{10}$	$n\text{-}C_4H_{10}$	$i\text{-}C_5H_{12}$	$n\text{-}C_5H_{12}$	C_6H_{14}	CO_2	N_2	MJ/m^{-3}	tCO_2/TJ
I.	97,27	1,18	0,37	0,06	0,06	0,01	0,01	0,01	0,18	0,84	34,32	55,01
II.	97,02	1,31	0,41	0,06	0,07	0,01	0,01	0,02	0,22	0,86	34,36	55,06
III.	96,82	1,42	0,44	0,06	0,07	0,02	0,01	0,13	0,26	0,87	34,40	55,51
IV.	96,37	1,69	0,52	0,08	0,09	0,02	0,01	0,02	0,30	0,90	34,52	55,20
V.	96,73	1,55	0,51	0,08	0,08	0,02	0,01	0,01	0,19	0,82	34,53	55,12
VI.	96,20	1,81	0,57	0,08	0,09	0,02	0,01	0,02	0,30	0,88	34,60	55,24
VII.	96,79	1,49	0,49	0,07	0,08	0,02	0,01	0,01	0,18	0,84	34,49	55,10
VIII.	97,12	1,31	0,45	0,07	0,07	0,01	0,01	0,01	0,12	0,82	34,44	55,02
IX.	96,62	1,57	0,50	0,07	0,08	0,02	0,01	0,01	0,24	0,88	34,49	55,14
X.	96,67	1,52	0,46	0,06	0,07	0,02	0,01	0,02	0,29	0,88	34,42	55,14
XI.	97,07	1,32	0,40	0,06	0,06	0,01	0,01	0,01	0,22	0,84	34,35	55,33
XII.	96,99	1,37	0,42	0,06	0,07	0,01	0,01	0,01	0,21	0,84	34,39	55,34
Average	**96,81**	**1,46**	**0,46**	**0,07**	**0,07**	**0,02**	**0,01**	**0,02**	**0,23**	**0,86**	**34,40**	**55,20**

Table 3.10: Overview of EF CO_2 and NCV for natural gas [15°C; 101,325 kPa] (the NCV and EF for CO_2 parameters are weighted average)

2009	Natural gas						
Month	Relative Density	Density	NCV	Combustion Heat	Wobbe Number	Sulphur Content	EF CO_2
	[mol %]	[kg.m^{-3}]	[kWh.m^{-3}]	[MJ.m^{-3}]	[kWh.m^{-3}]	[mg.m^{-3}]	[t/TJ]
I.	0,5719	0,7008	34,315	38,052	13,98	0,06	55,01
II.	0,5737	0,7030	34,362	38,102	13,97	0,06	55,06
III.	0,5751	0,7047	34,398	38,142	13,97	0,06	55,51
IV.	0,5782	0,7085	34,520	38,272	13,98	0,06	55,20
V.	0,5758	0,7056	34,531	38,282	14,01	0,01	55,12
VI.	0,5794	0,7100	34,596	38,351	13,99	0,00	55,24
VII.	0,5752	0,7049	34,492	38,239	14,00	0,01	55,10
VIII.	0,5730	0,7021	34,438	38,185	14,01	0,01	55,02
IX.	0,5764	0,7063	34,488	38,236	13,99	0,03	55,14
X.	0,5760	0,7058	34,420	38,164	13,97	0,04	55,14
XI.	0,5731	0,7023	34,355	38,095	13,98	0,03	55,33
XII.	0,5737	0,7031	34,387	38,131	13,98	0,04	55,34
Average	**0,5751**	**0,7048**	**34,403**	**38,188**	**13,99**	**0,03**	**55,20**

3.2.4 Activity data

Activity data collected in the NEIS central database are allocated according to the IPCC categorization for solid, liquid, gaseous fuels, biomass and other fuels. The fuels are listed in Table 3.11.

Table 3.11: List of fuels according to the categories in sectoral approach in 2009

Solid	Liquid	Gaseous	Biomass	Other
Lignite	Propan-Butan	Natural Gas	Wood	Waste Other
Coke	Diesel Oil	Blast-Furnace Gas	Biogas	Waste Municipal
Coal	Refinery Gas	Coke Gas		Waste Industrial
Braun Coal (CZ)	Heavy Heating Oil	Other Gaseous		Cogeneration Gas
Braun Coal (SR,Ukr)	Light Heating Oil			
Briquettes	Other Liquid			
Other Solid				

Category 1A1A – Public electricity and heat production

Total volume of fuels in this category represented 85 458 TJ in 2009. Total CO_2 emissions were 6 662.68 Gg, total CH_4 emissions were 0.15 Gg and total N_2O emissions were 0.10 Gg in this category. The fuels are allocated among solid, liquid and gaseous fuels, biomass and other fuels´ categories. The other fuel category consists of three different sources of emissions that are used for electricity and heat production (Table 3.12):

- Methane combusted by cogeneration of gases from mines (1B1A Coal mining and handling).
- Municipal solid waste incineration with energy use (6C2 Municipal waste burning).
- Industrial solid waste incineration with energy use (6C3 Industrial waste burning).

Category 1A1B – Petroleum refining

Total volume of fuels in this category explicated in energy units represented 27 814 TJ in 2009. Total CO_2 emissions were 1 831.39 Gg, total CH_4 emissions were 0.12 Gg and total N_2O emissions were 0.005 Gg in this category. The fuels are allocated among solid, liquid and gaseous fuels´ categories.

Category 1A1C – Manufacture of solid fuels and other energy industries

The total volume of fuels in this category explicated in energy units represented 7 430 TJ in 2009. Total CO_2 emissions were 1 314.27 Gg, total CH_4 emissions were 0.03 Gg and total N_2O emissions were 0.001 Gg in this category. The fuels are allocated among solid and gaseous and biomass fuels´ categories.

Table 3.12: The activities included in category 1A1A Other fuel in 2009

	Cogeneration (mining)				MSW Incineration			IW Incineration		
	Consumption	CO_2	CH_4	N_2O	Consumption	CO_2	N_2O (t)	Consumption	CO_2	N_2O
	[TJ]	[t]	[t]	[t]	[TJ]	[Gg]	[t]	[TJ]	[Gg]	[t]
1990	NO	NO	NO	NO	1 307,04	43,00	4,60	IE	127,30	11,20
1991	NO	NO	NO	NO	1 307,04	43,00	4,60	IE	127,30	11,20
1992	NO	NO	NO	NO	1 503,09	44,36	4,00	IE	127,30	11,20
1993	NO	NO	NO	NO	1 614,28	47,64	4,64	IE	127,30	11,20
1994	NO	NO	NO	NO	1 409,03	41,58	3,50	IE	127,30	11,20
1995	NO	NO	NO	NO	1 314,20	38,78	3,10	IE	127,30	11,20
1996	NO	NO	NO	NO	1 289,15	38,04	3,05	IE	127,30	11,20
1997	NO	NO	NO	NO	1 404,66	41,45	3,35	IE	91,70	9,80
1998	NO	NO	NO	NO	1 567,06	46,25	3,69	IE	184,90	9,90
1999	NO	NO	NO	NO	1 520,48	44,87	3,59	IE	128,80	10,70
2000	NO	NO	NO	NO	1 816,22	53,60	4,27	IE	127,20	9,80
2001	NO	NO	NO	NO	1 142,09	33,70	2,71	IE	105,80	10,90
2002	NO	NO	NO	NO	1 363,66	40,24	3,20	IE	85,70	38,10
2003	NO	NO	NO	NO	1 416,04	41,79	2,54	IE	70,20	56,80
2004	NO	NO	NO	NO	1 604,26	47,34	2,79	IE	51,60	22,80
2005	NO	NO	NO	NO	1 593,28	47,02	2,26	IE	16,10	30,40
2006	NO	NO	NO	NO	1 655,52	48,86	2,43	IE	15,30	26,50
2007	11,59	639,53	0,012	0,001	1 570,34	46,34	2,26	IE	17,90	16,20
2008	9,36	514,89	0,009	0,001	1 370,62	40,45	1,91	IE	20,80	42,90
2009	5,44	300,40	0,005	0,001	1 548,82	45,71	2,26	IE	22,90	16,90

Category 1A2A – Iron and steel

Total volume of fuels in this category explicated in energy units represented 12 786 TJ in 2009. Total CO_2 emissions were 1 437.17 Gg, total CH_4 emissions were 0.25 Gg and total N_2O emissions were 0.02 Gg in this category. The fuels are allocated among solid and gaseous fuels´ categories. To avoid double counting of the primary and secondary fuels from iron and steel industry, the study was prepared during last year by consulting company in energy tasks (Profing LtD.). The study is not publicly available, because of sensitive and confidential information included in the calculation about the one of the biggest iron and steel company in the Slovak Republic (U.S. Steel). Total emissions of CO_2 included into the energy sector without double counting can be expressed with the following formula:

$$CO_2\ t = MKoP*QKoP*EF(CO_2)KoP + MVPP*QVPP*EF(CO_2)VPP + MKonP*QKonP*EF(CO_2)KonP + MZP*QZP*EF(CO_2)ZP + MČU_{energ}*QČU_{energ}*EF(CO_2)ČU_{energ} + MKOKS_{agl}*QKOKS_{agl}*EF(CO_2)KOKS_{agl}$$

M = quantity of fuel in weight units (t, mil m^3), KoP = Coke oven gas, KonP = Coventry gas, VPP = Blast-Furnace Gas, ZP = Natural gas, ČUenerg = Antracite, KOKSagl – Coke (agglomerated)

Fuels produced as secondary energy sources during technology processes, such as heavy heating oil, coal (blast-furnace) and coke (blast-furnace) have been excluded from this calculation. These amounts of fuels are known and can be extracted from the energy balance of category 2A2A - coal (blast-furnace) and coke (blast-furnace) and from category 2A2F (heavy heating oil). The reason behind this is in the nationally approved methodology when different parts of iron and steel plants in the Slovak Republic are included in three categories: 1A1C (coke production), 2A2A (iron and steel production and 2A2F (any other installations inside the plant). This material balance was compared with the direct material balance reported by plants in the ETS. The identification of the fuels included into the balance second time was possible for the years 2005 – 2009. The study could be done only because of availability of data from ETS, directly from the operators included in the National Allocation Plan I for 2005 – 2007 and in the National Allocation Plan II for 2008 – 2009. For the completeness of calculation, the emissions from limestone used are included into the category 2A3 (limestone and dolomite used) and technological emissions from steel production are included in category 2C1 (iron and steel production) according to the technology.

According to the recommendations of the ERT during the in-country review in 2009, the data on the consumption of coke might be extrapolated back into 1990 and CO_2 emissions should be reallocated into sector Industrial processes, category 2C1. In older inventories, CO_2 emissions from pig iron production were reported separately. In the period 1990 – 1996, the data on the consumption of coke for technological purposes (iron and steel production) were not available. Only the data on the total consumption of the coal and coke in the plant were known. The data include also plants for other purposes, such as heating plants or similar once. Therefore, all CO_2 emissions originated from coke consumption were reported in 1A2A Iron and steel – solid fuels. The amount of consumed coke was adjusted by the amount of carbon which penetrated into pig iron. Therefore, the recalculation has been made since 1990. The data that should be reallocated from 1A2A Iron and steel (solid fuels) are summarized in Table 3.13. It should be mentioned that CO_2 emissions originated by coke production are still included in energy sector according to the recommendations of IPCC 2006 GL.

Table 3.13: Activity data and CO_2 emissions in category 1A2A in 1990 – 2009

Year	Solid Fuels total [TJ]	Solid Fuels for pig iron [TJ]	Solid Fuels 1A2A [TJ]	CO_2 Emissions from Solid Fuels total [kt]	CO_2 Emissions from Solid Fuels for pig iron [kt]	CO_2 Emissions from Solid Fuels 1A2A [kt]	CO_2 Emissions 1A2A total [kt]
1990	45 552,27	27 099,01	18 453,26	7 671,86	4 578,38	3 093,48	4 559,08
1991	40 373,67	24 069,88	16 303,79	6 877,82	4 066,61	2 811,21	4 130,29
1992	35 972,92	22 464,43	13 508,49	6 196,38	3 795,37	2 401,01	3 598,25
1993	32 673,53	24 389,44	8 284,09	5 638,25	4 120,60	1 517,66	2 594,22
1994	30 370,70	25 340,54	5 030,16	5 194,39	4 281,28	913,11	1 871,58
1995	28 959,64	24 404,66	4 554,98	4 855,74	4 123,17	732,57	1 576,98
1996	28 335,56	22 211,07	6 124,49	4 613,24	3 752,56	860,68	1 596,48
1997	28 393,66	23 376,64	5 017,02	4 457,85	3 949,48	508,37	1 142,43
1998	29 029,14	23 867,12	5 162,02	4 380,51	4 032,35	348,16	856,87
1999	30 137,22	26 374,36	3 762,86	4 772,17	4 455,95	316,22	673,20
2000	30 213,84	27 070,54	3 143,30	4 841,44	4 573,57	267,87	817,46
2001	30 485,78	26 886,39	3 599,39	4 862,99	4 542,46	320,54	949,84
2002	31 663,50	28 696,96	2 966,54	5 109,44	4 848,35	261,09	847,34
2003	35 287,65	29 778,68	5 508,97	5 794,95	5 031,11	763,84	1 387,54
2004	34 146,53	29 370,13	4 776,40	5 474,63	4 962,08	512,54	1 180,00
2005	35 804,55	28 746,69	7 057,86	5 719,14	4 856,75	862,38	1 564,78
2006	39 132,37	28 266,15	10 866,22	6 349,65	4 775,57	1 574,09	2 496,07
2007	34 837,91	28 457,75	6 380,16	5 885,90	4 807,94	1 077,97	1 757,01
2008	31 024,27	26 297,05	4 727,22	5 269,65	4 442,89	826,77	1 520,17
2009	26 437,13	22 268,11	4 169,02	4 599,63	3 762,20	837,44	1 437,17

Category 1A2B – Non-ferrous metals

Total volume of fuels in this category explicated in energy units represented 2 165 TJ in 2009. Total CO_2 emissions were 156 Gg, total CH_4 emissions were 0.015 Gg and total N_2O emissions were 0.001 Gg in this category. The fuels are allocated among solid, liquid and gaseous fuels´ categories.

Category 1A2C – Chemicals

Total volume of fuels in this category explicated in energy units represented 23 138 TJ in 2009. Total CO_2 emissions were 1 616 Gg, total CH_4 emissions were 0.085 Gg and total N_2O emissions were 0.011 Gg in this category. The fuels are allocated among solid, liquid, gaseous and biomass fuels´ categories.

Category 1A2D – Pulp, paper and print

Total volume of fuels in this category explicated in energy units represented 7 666 TJ in 2009. Total CO_2 emissions were 632 Gg, total CH_4 emissions were 0.069 Gg and total N_2O emissions were 0.008 Gg in this category. The fuels are allocated among solid, liquid, gaseous and biomass fuels´ categories.

Category 1A2E – Food processing, beverage and tobacco

Total volume of fuels in this category explicated in energy units represented 5 407 TJ in 2009. Total CO_2 emissions were 315 Gg, total CH_4 emissions were 0.029 Gg and total N_2O emissions were 0.001 Gg in this category. The fuels are allocated among solid, liquid, gaseous and biomass fuels´ categories.

Category 1A2F – Other

Total volume of fuels in this category explicated in energy units represented 32 278 TJ in 2009. Total CO_2 emissions were 2 155 Gg, total CH_4 emissions were 0.229 Gg and total N_2O emissions were 0.020 Gg in this category. The fuels are allocated among solid, liquid, gaseous and biomass fuels´ categories.

Category 1A4A – Commercial/Institutional

Total volume of fuels in this category explicated in energy units represented 13 952 TJ in 2009. Total CO_2 emissions were 763 Gg, total CH_4 emissions were 0.233 Gg and total N_2O emissions in this category were 0.005 Gg in this category. The fuels are allocated among solid, liquid, gaseous and biomass fuels´ categories.

Category 1A4B – Residential

Total volume of fuels in this category explicated in energy units represented 71 704 TJ in 2009. Total CO_2 emissions were 3 035 Gg, total CH_4 emissions were 6.663 Gg and total N_2O emissions were 0.084 Gg in this category. The fuels are allocated among solid (coal, coke, brown coal, and briquettes), gaseous (NG) and biomass (wood) fuels´ categories.

The activity data collected in this category are summarized in the NEIS central database as small sources according to the information from the sale of solid fuels for households and retail users. The consumption of natural gas for inhabitants is announced by Slovak Gas Industry (SPP, a.s.).

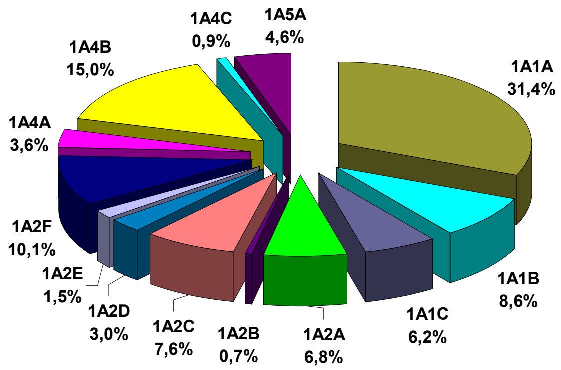
Category 1A4C – Agriculture, forestry and fisheries

Total volume of fuels in this category explicated in energy units represented 3 4029 TJ in 2009. Total CO_2 emissions were 188 Gg, total CH_4 emissions were 0.037 Gg and total N_2O emissions were 0.001 Gg in this category. The fuels are allocated among solid, liquid, gaseous and biomass fuels´ categories.

Category 1A5A – Other stationary

Total volume of fuels in this category explicated in energy units represented 18 107 TJ in 2009. Total CO_2 emissions were 985 Gg, total CH_4 emissions were 0.095 Gg and total N_2O emissions were 0.003 Gg in this category. The fuels are allocated among solid, liquid, gaseous and biomass fuels´ categories.

Figure 3.6: Summary of categories 1A1, 1A2, 1A4 and 1A5 and their shares



IPCC Category	GHG (CO_2 eq.)
1A1A	6 695,47
1A4B	3 201,46
1A2F	2 165,60
1A1B	1 835,41
1A2C	1 621,02
1A2A	1 449,05
1A1C	1 315,20
1A5A	987,52
1A4A	769,12
1A2D	636,48
1A2E	316,44
1A4C	189,40
1A2B	156,36

3.2.5 Uncertainties and time-series consistency

CO_2 emissions from categories 1A1, 1A2, 1A4 and 1A5 (liquid, solid and gaseous fuel's combustion) are the most important key sources and they have a decisive effect on the management of level and trend uncertainties. The emission balance of other GHGs (CH_4, N_2O) from these categories were estimated by using IPCC default methodology (IPCC, 1996) and default emission factors consistent with previous reporting. These categories are not key sources. For emission uncertainty assessment AD, caloric value, EF and their uncertainties are available in the energy sector. From expert analysis, the predetermined values for uncertainty are known. It helps us to verify the rightness of computation of aggregated uncertainty. From the background data structure, the differences between the Tier 1 and the Tier 2 method for uncertainty estimation are concentrated to the correlation among inputs parameters; formulas which are applied in the Tier 2 method use only multiplication and addition operation. The Tier 2 method is computed without correlation dependency; therefore Tier 1 and Tier 2 are well comparable. The Tier 2 method offers more reliable statistical results; it shows more information about statistical structure of analyzed uncertainty. With Tier 2 approach the category's uncertainty is constructed by Monte Carlo method and consecutive aggregate uncertainty is computed for energy sector – sectoral approach, combustion of fuel from 1A1, 1A2, 1A4 and 1A5. From our knowledge and experiences, the most difficult part of uncertainty analysis is the constructing of the PDF (or CDF) for AD and EF. In the some cases the construction of empirical form of PDF are necessary to satisfy the expert statistical criterions (to keep mean value and confidence interval). For this reason special software packages have been developed. The work with wide collection of analytical PDF is supported by this software. The following statistical distributions are implemented: Gumbel, Exponential, Weibull, Lognormal, Uniform, Triangular, Beta, Binomial, Negative binomial, Chi-square, Noncentral chi-square, F, Noncentral F, Gamma, T, Noncentral T, Normal and Poisson. Despite this fact the empirical distribution has to be constructed in some situations. The methodology of empirical function creation is based upon four equations with N-4 degree of freedom (N represents the number of values of data sets). These free parameters are applied for the construction of PDF (shape, kurtosis). These equations contain information about the requirements for mean value and confidence interval. Aggregate uncertainty is computed from partial uncertainties. For energy sector (combustion of fuel) the combination of AD, EF and caloric values are utilized. Emission for specific source is computed:

$$Em_i = AD_i * NCV_i * EF_i / 1000 \quad (1)$$

where Em_i represents the emissions from source (i) marked as subscript, AD_i are activity data, EF_i are emission factors and NCV_i represent caloric values. Including uncertainty the previous formula is extended to the form:

$$Emn_i = (AD_i + a\delta_i) * (NCV_i + n\delta_i) * (EF_i + e\delta_i) / 1000 \quad (2)$$

where $a\delta_i$ represents uncertainty of AD, $e\delta_i$ represents uncertainty of EF and $n\delta_i$ represents uncertainty for caloric value. From theory it is known, that direct computation of aggregate uncertainty is difficult to compute in many cases. For this reason, a statistical approach has been chosen. The Monte Carlo method has been utilizes. It induces the construction of PDF for all input parameters. We create the probability density function for variables $a\delta_i$, $e\delta_i$ and $n\delta_i$. In some cases the absence of direct measurement were solved by expert contributions. Mean value and confidence interval have usually background in measured data or in empirical relations. On the other hand, uncertainty shapes of input parameters are usually estimated by expert impressions. For this reason, we follow suggestions and we play with normal, triangular and lognormal analytical distributions. An input data empirical PDF has been applied only in the problematic cases. Consecutive, the aggregate uncertainty is computed as the sum of partial emission uncertainties.

$$\mathbf{E} = \sum_{i=1}^{Z} Emn_i \quad (3)$$

where Z represents the number of source inputs. The results for every category are generated from 60 000 trials, with random number generator of random numbers for adequate PDF.

From presented results obtained by Monte Carlo simulation it seems that the mean value is 22 308 833.803 tons. Confidence interval (95%) is within the range: <21 789 734.274, 23 071 473.523>, which represents the uncertainty by relative values to the mean value: - 2.327%, 3.419%. The following tables and graphs described calculated results of uncertainty analyses.

Table 3.14: Selected statistical characteristics for energy sector – sectoral approach except transport, median, mean value, standard deviation, minimum, maximum of emissions and percentiles

Median	Average	Standard dev.	2,50%	97,50%
22 261 562,79	22 308 833,80	328 920,53	21 789 734,27	23 071 473,52
Min	**Max**		**Per_2,5**	**Per_97,5**
21 129 169,58	23 627 220,17		-2,33%	3,42%

Figure 3.7: Probability density function for energy sector – sectoral approach except transport in tons of CO_2

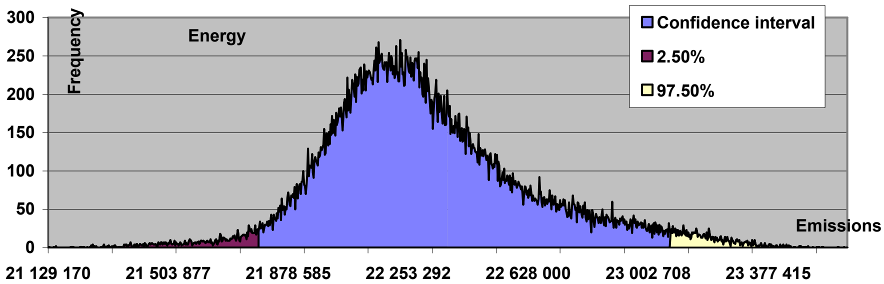


Table 3.15: Selected statistical characteristics for category 1A1A, median, mean value, standard deviation, minimum, maximum of emissions and percentiles

Median	Average	Standard dev.	2,50%	97,50%
6 797 153,89	6 831 371,92	165 428,15	6 585 298,02	7 256 630,35
Min	**Max**		**Per_2,5**	**Per_97,5**
6 299 739,75	7 493 215,15		-3,60%	6,23%

Figure 3.8: Probability density function for category 1A1A in tons of CO_2

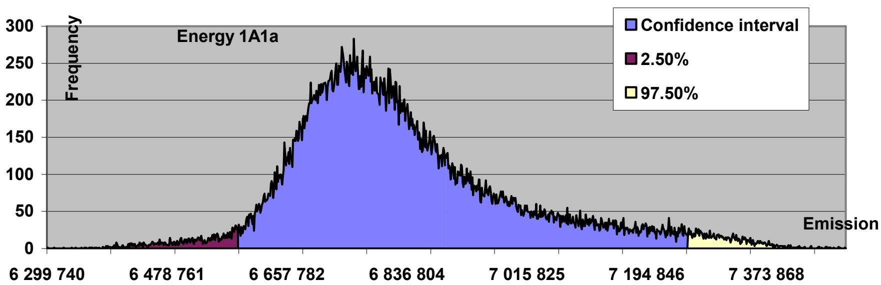


Figure 3.9: Cumulative probability density function for category 1A1A in tons of CO_2

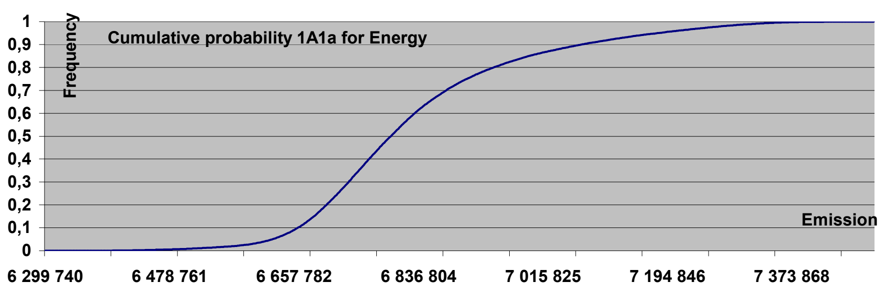


Table 3.16: Selected statistical characteristics for category 1A1B, median, mean value, standard deviation, minimum, maximum of emissions and percentiles

Median	Average	Standard dev.	2,50%	97,50%
1 831 307,05	1 831 679,11	37 036,20	1 760 277,87	1 904 627,00
Min	**Max**		**Per_2,5**	**Per_97,5**
1 654 759,89	1 991 734,90		-3,90%	3,98%

Figure 3.10: Probability density function for category 1A1B in tons of CO_2

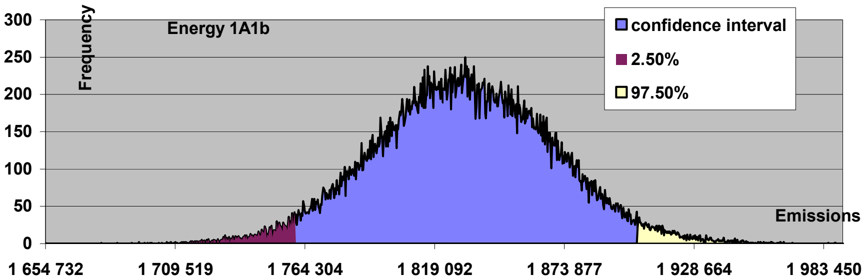


Table 3.17: Selected statistical characteristics for category 1A1C, median, mean value, standard deviation, minimum, maximum of emissions and percentiles

Median	Average	Standard dev.	2,50%	97,50%
1 314 700,98	1 315 044,28	29 397,59	1 257 930,73	1 373 537,77
Min	**Max**		**Per_2,5**	**Per_97,5**
1 197 198,57	1 439 511,61		-4,34%	4,45%

Figure 3.11: Probability density function for category 1A1C in tons of CO_2

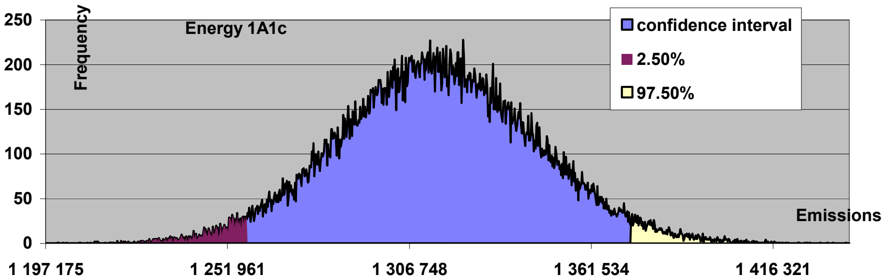


Table 3.18: Selected statistical characteristics for category 1A2A, median, mean value, standard deviation, minimum, maximum of emissions and percentiles

Median	Average	Standard dev.	2,50%	97,50%
5 199 231,41	5 199 646,01	85 255,92	5 033 559,01	5 369 875,35
Min	**Max**		**Per_2,5**	**Per_97,5**
4 865 450,18	5 589 074,55		-3,19%	3,27%

Figure 3.12: Probability density function for category 1A2A in tons of CO_2

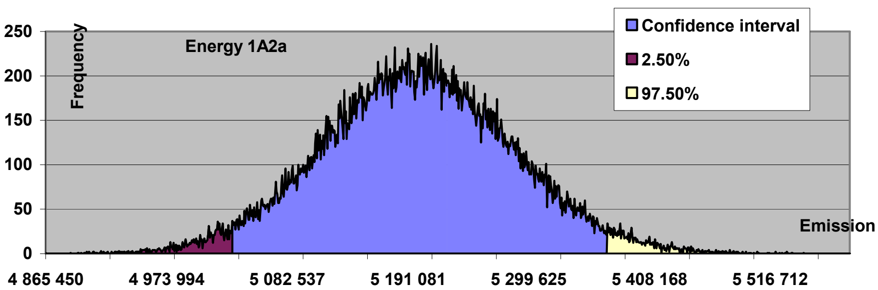


Table 3.19: Selected statistical characteristics for category 1A2B, median, mean value, standard deviation, minimum, maximum of emissions and percentiles

Median	Average	Standard dev.	2,50%	97,50%
155 451,90	155 664,33	3 162,77	149 966,22	162 451,54
Min	**Max**		**Per_2,5**	**Per_97,5**
141 214,49	169 395,85		-3,66%	4,36%

Figure 3.13: Probability density function for category 1A2B in tons of CO_2

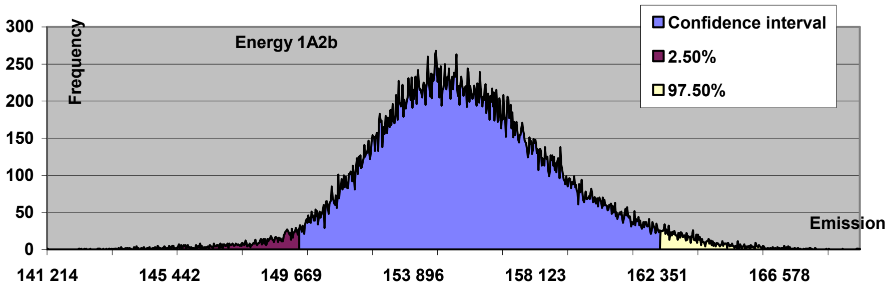


Table 3.20: Selected statistical characteristics for category 1A2C, median, mean value, standard deviation, minimum, maximum of emissions and percentiles

Median	Average	Standard dev.	2,50%	97,50%
1 616 719,48	1 616 977,83	28 632,46	1 561 606,31	1 673 907,18
Min	**Max**		**Per_2,5**	**Per_97,5**
1 498 332,64	1 758 515,66		-3,42%	3,52%

Figure 3.14: Probability density function for category 1A2C in tons of CO_2

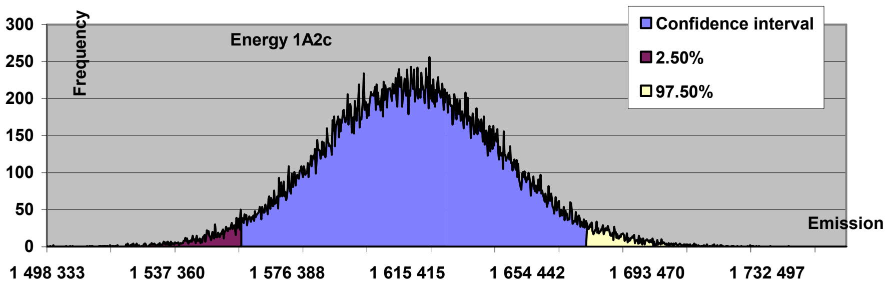


Table 3.21: Selected statistical characteristics for category 1A2D, median, mean value, standard deviation, minimum, maximum of emissions and percentiles

Median	Average	Standard dev.	2,50%	97,50%
660 873,31	661 838,88	14 614,48	636 396,29	692 996,35
Min	**Max**		**Per_2,5**	**Per_97,5**
605 427,86	730 670,74		-3,84%	4,71%

Figure 3.15: Probability density function for category 1A2D in tons of CO_2

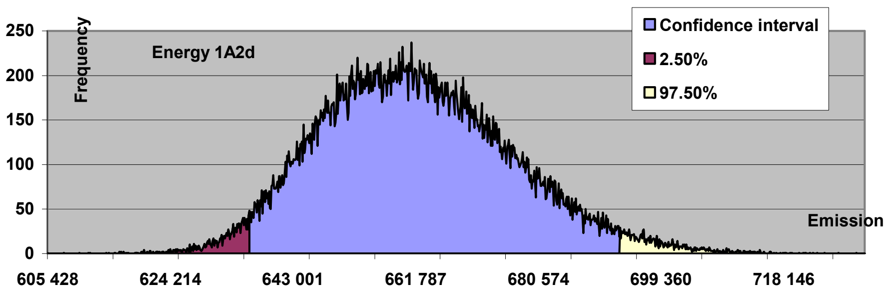


Table 3.22: Selected statistical characteristics for category 1A2E, median, mean value, standard deviation, minimum, maximum of emissions and percentiles

Median	Average	Standard dev.	2,50%	97,50%
317 157,73	317 249,07	8 633,55	300 464,30	334 184,00
Min	**Max**		**Per_2,5**	**Per_97,5**
279 822,96	358 381,44		-5,29%	5,34%

Figure 3.16: Probability density function for category 1A2E in tons of CO_2

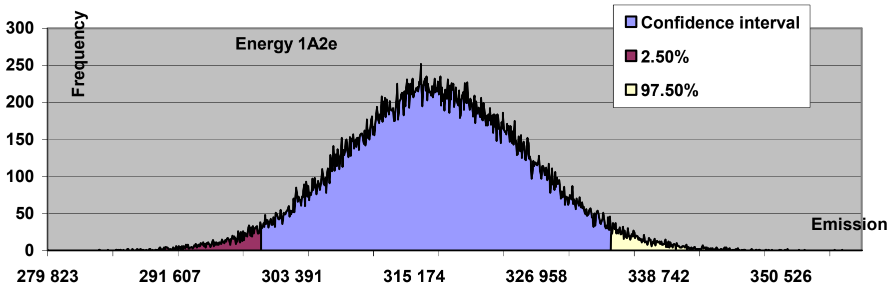


Table 3.23: Selected statistical characteristics for category 1A2F, median, mean value, standard deviation, minimum, maximum of emissions and percentiles

Median	Average	Standard dev.	2,50%	97,50%
2 329 221,72	2 334 795,15	47 516,23	2 253 024,52	2 441 494,18
Min	**Max**		**Per_2,5**	**Per_97,5**
2 130 990,28	2 551 529,14		-3,50%	4,57%

Figure 3.17: Probability density function for category 1A2F in tons of CO_2

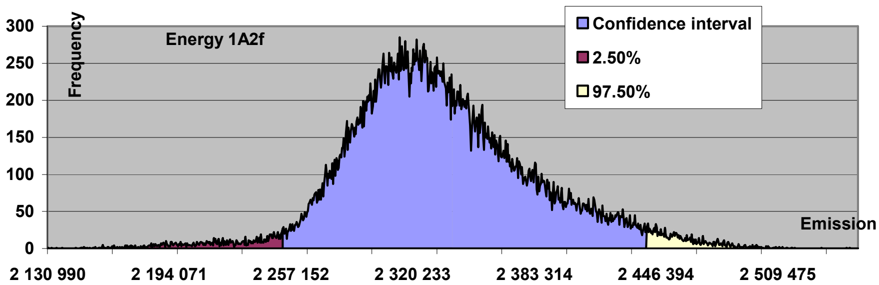


Table 3.24: Selected statistical characteristics for category 1A4A, median, mean value, standard deviation, minimum, maximum of emissions and percentiles

Median	Average	Standard dev.	2,50%	97,50%
829 805,02	831 377,13	20 905,36	793 875,85	875 850,83
Min	**Max**		**Per_2,5**	**Per_97,5**
729 520,59	915 538,57		-4,51%	5,35%

Figure 3.18: Probability density function for category 1A4A in tons of CO_2

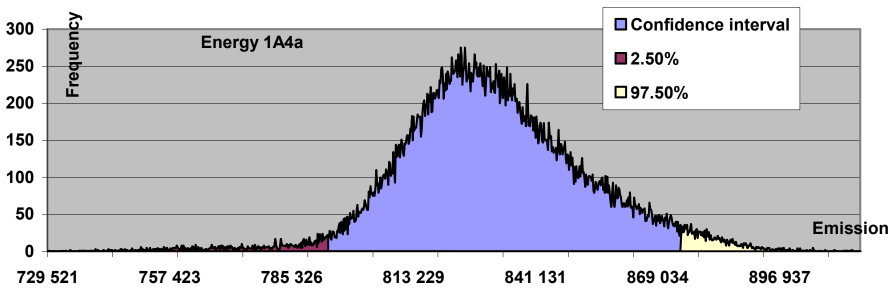


Table 3.25: Selected statistical characteristics for category 1A4C, median, mean value, standard deviation, minimum, maximum of emissions and percentiles

Median	Average	Standard dev.	2,50%	97,50%
191 214,86	191 591,05	5 270,63	182 119,28	202 719,23
Min	**Max**		**Per_2,5**	**Per_97,5**
164 422,53	213 850,63		-4,94%	5,81%

Figure 3.19: Probability density function for category 1A4C in tons of CO_2

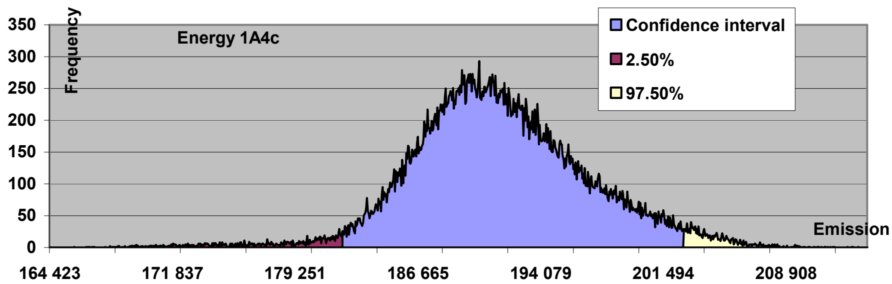
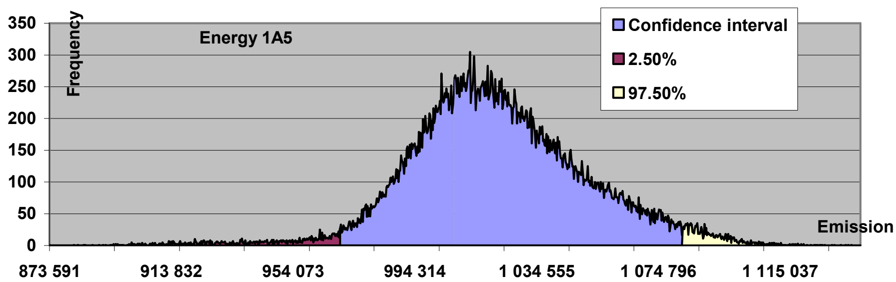


Table 3.26: Selected statistical characteristics for category 1A5A, median, mean value, standard deviation, minimum, maximum of emissions and percentiles

Median	Average	Standard dev.	2,50%	97,50%
1 019 471,31	1 021 599,04	28 882,05	969 879,36	1 082 792,16
Min	**Max**		**Per_2,5**	**Per_97,5**
873 591,07	1 141 864,76		-5,06%	5,99%

Figure 3.20: Probability density function for category 1A5A in tons of CO_2



Since 2007, complete time series have been evaluating by checking in order to remove possible inconsistencies in earlier inventories caused by missing data of some plants, changing classifications and reallocation of fuels between energy and industrial processes sectors. Most of these corrections can be done on the basis of data from the ETS (from 2005 – 2007 and 2008 – 2009). Overall, methodologies and data sources are as consistent as possible at this stage. The data before 2000 are available in the NEIS database and the allocations of fuels for 1990 – 1999 into detailed categories were provided manually.

3.2.6 Source specific QA/QC and verification

The Slovak inventory team in cooperation with Profing Ltd. (Mr. Jan Judak is the sectoral expert for energy and fugitive emissions) have provided the emission estimation according to the methodology used from the base year and official statistics. The verification process of the NEIS database is running at two levels. The first level is represented by regional environmental offices according to the national law and the second level is provided by the SHMÚ, the Department of Emissions. The process of data verification in the NEIS database must be completed by the end of July for the data year -1. After closing the verification process the operators of installations receive issued decisions according to effective legislation about the payments for the emissions of basic pollutants. The verification process is based on cross-checking the input data from the NEIS database and comparison with the sectoral statistical indicators from the Ministry of Economy and the Statistical Office of the Slovak Republic. The background documents are archived by sectoral experts and in central archiving system of SNE at SHMÚ.

Since 2005, the energy balances from the most significant sources of air pollution have been included in the National Allocation Plan and monitored within Directive 2003/87/EC establishing a scheme for GHG emission allowances trading, which has been transposed into Act 527/2004 Coll. on emission trading scheme (ETS). In order to comply with the quality management criteria and data harmonization between ETS and the national emission balance at sectoral level, emission factors of the most important fuels have been re-evaluated and new methods have been implemented at the level of source operators. By comparison and correct allocation of CO_2 emissions in sector energy, it can be concluded that the balance is in a good compliance with the emissions verified within ETS. The comparison of the years 2005 – 2007 was carried out based on the National Allocation Plan I and the comparison of years 2008 – 2009 were carried out based on the National Allocation Plan II. The results are shown in Figure 3.21. The trend of differences was slightly increasing during the first NAP (2005 – 2007) (99.44%, 96.83%, 94.41%), but in the second NAP (2008, 2009), the difference was stabilized (97.79%, 97.84%). It can be explained by non-compatibility of source allocation, different definitions of technological and energy emissions according to the Act 572/2004 Coll. as amended and allocation of polluting sources according to the IPCC methodology in the NAP I. The improvement in the NAP II depended also on the revision of the directive 2003/87/EC. The comparison was provided for most important sources (energy and technology) (Table 3.27), but also only for energy sources (Figure 3.21). For the comparison study, 26 biggest emitters were taken, which represent more than 90% of all allocated emissions in the Slovak Republic.

Figure 3.21: Comparison of CO_2 emissions from energy sources (in Gg) allocated in ETS and estimated by sectoral approach from the dbase NEIS for 2005 – 2009

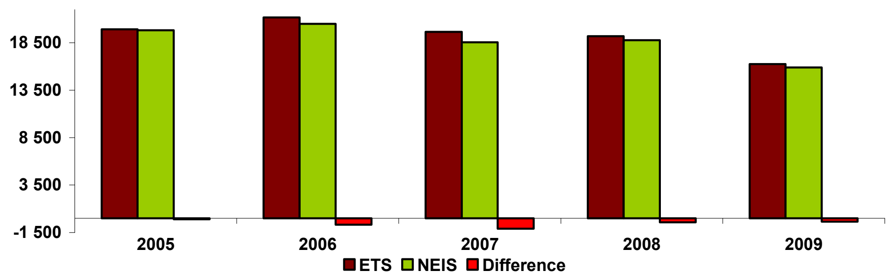


Table 3.27: Comparison of CO_2 emissions (in Gg) allocated in ETS and estimated by sectoral approach from dbase NEIS for 2005 – 2009

	Energy + Technology (CO_2 Gg)					Energy (CO_2 Gg)				
	NAP I			NAP II		NAP I			NAP II	
	2005	2006	2007	2008	2009	2005	2006	2007	2008	2009
ETS	21 487,27	22 684,75	21 033,72	20 567,60	17 916,09	19 937,20	21 166,72	19 652,88	19 197,17	16 251,32
NEIS	19 825,35	20 496,39	18 554,39	18 772,50	15 900,96	19 825,35	20 496,39	18 554,39	18 772,50	15 900,96
Difference	-1 661,93	-2 188,36	-2 479,33	-1 795,10	-2 015,12	-111,85	-670,33	-1 098,49	-424,66	-350,35
Difference	92,27%	90,35%	88,21%	91,27%	88,75%	99,44%	96,83%	94,41%	97,79%	97,84%

3.2.7 Source specific recalculations

The correction of activity data for light heating oil in the category 1A2c was applied in year 2008. The corrected value is 10.4799 TJ of LHO in 2011 submission (instead of 10 479.9 TJ of LHO in 2010 submission).

Table 3.28: Impact of recalculation of LHO consumption on emissions in 2008

Liquid fuels in category 1A2c in 2008			
	Emissions (tons)		
Submission	CO_2	CH_4	N_2O
2010	1 883 274,28	54,79	14,16
2011	1 084 455,17	33,85	7,88
Decrease	57,58%	61,78%	55,63%

3.2.8 Source specific planned improvements

Several important changes have been successfully implemented for the 2010 submission and they are described in SVK NIR 2010. The planned improvement for the next submissions in sectoral approach is repeating from the previous submissions. The disaggregation and allocation of the category 1A2F according to the detailed industry characteristics was not performed during last inventory year due to capacity reason. The category 1A2F Other includes now all other industries not included in other categories. According to the recommendations of the EU review process, a minor improvement will be focused on the reallocation of blast-furnace gas and coke gas from gaseous to solid fuels´ category. This will not influence emissions, but should be done back to the base year. The further improvements are planned for the revision of CH_4 and N_2O emission factors.

3.3 Transport (CRF 1.AA.3)

3.3.1 Source category description

The emissions from category 1A3 Transport include the Civil aviation (1A3A), the Road transportation (1A3B), the Railways (1A3C), the Navigation (1A3D) and the Other transportation – Military aviation (1A3E) sources in the Slovak Republic in year 2009. The emissions from road and non-road transport were calculated by using models and default methods and the consistent data series from 1990 to 2009 are presented in CRF tables.

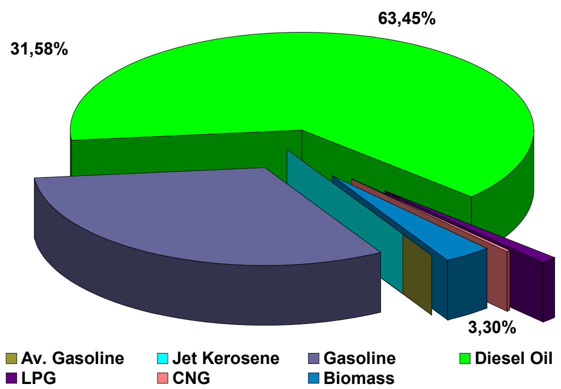
The GHG emission inventory of category transport is connected with the estimation of basic pollutants (CO, NO_x, SO_2) and solid particles (TSP, PM10, PM2.5), ammonia emissions and heavy metals, emissions of persistent organic substances (POPs), non-methane volatile organic compounds (NMVOC) and greenhouse gases (CO_2, CH_4, N_2O) emitted in the Slovak Republic in year 2009. The balance of pollutant and heavy metal emissions was evaluated according to the EMEP/CORINAIR Emission Inventory Guidebook methodology and by using the software product COPERT IV version 7.1. The emissions from road transport were recalculated from the year 2000 year by using updated version COPERT IV version 7.1 (2000 – 2008). The recalculation of emissions before 2000 was not provided, but the consistency of time series is ensured by the fact, that before 2000 the use of EURO V and IV engines was not relevant in the Slovak Republic. Total GHG emissions in category transport were 6 207.07 Gg of CO_2 equivalents in 2009. The share of road transportation was 98.3%, railways 1.6%, civil aviation represents 0.1%, other military aviation 0.03% and navigation 0.001%. Total energy consumption was 85 737 TJ of consummated fuels in category transport. According to the fuels, the most important are liquid fuels (diesel oil - 63.45%, gasoline - 31.58% and LPG - 1.27%, followed by jet kerosene - 0.12%, aviation gasoline - 0.01% and biomass - 3.3%) and gaseous fuel (CNG - 0.28%). No solid fuels are used in category transport. The complete time series of GHG emissions are presented in Table 3.29. All emissions from navigation are included in international bunkers.

Table 3.29: GHG emissions within category transport and subcategories in 1990 – 2009

	Civil Aviation				Road Transportation				Railways			
	Consumption	CO_2	CH_4	N_2O	Consumption	CO_2	CH_4	N_2O (t)	Consumption	CO_2	CH_4	N_2O
	[TJ]	[t]	[t]	[t]	[TJ]	[Gg]	[t]	[t]	[TJ]	[t]	[t]	[t]
1990	105,83	7 736,80	1,00	0,80	61 177,20	4 500,94	999,00	231,00	5 022,82	376 770,60	29,50	161,91
1991	98,39	7 192,90	0,93	0,75	52 002,20	3 823,95	919,00	197,00	3 778,29	283 416,40	22,20	121,79
1992	90,95	6 649,10	0,86	0,69	48 282,60	3 548,76	902,00	181,00	3 117,25	233 830,20	18,30	100,49
1993	88,56	6 473,70	0,82	0,67	48 446,20	3 558,85	980,00	179,00	2 676,24	200 749,40	15,70	86,27
1994	75,17	5 495,50	0,71	0,57	51 895,88	3 812,03	1 059,63	204,12	2 526,24	189 497,90	11,30	81,40
1995	75,03	5 484,70	0,69	0,57	55 026,90	4 042,52	1 125,41	237,08	2 720,51	204 070,26	12,20	87,70
1996	87,94	6 427,90	0,79	0,67	55 816,90	4 100,59	1 155,48	267,09	2 669,71	200 259,50	11,90	86,10
1997	77,90	5 694,50	0,70	0,60	58 315,83	4 283,39	1 216,41	308,08	2 508,63	188 176,80	11,20	80,90
1998	71,60	5 233,50	0,63	0,55	62 395,33	4 582,44	1 291,41	357,08	2 301,29	172 623,70	10,30	74,20
1999	72,58	5 305,70	0,65	0,55	61 133,61	4 487,21	1 273,83	374,90	2 106,64	158 023,10	9,40	67,90
2000	75,21	5 498,50	0,73	0,57	54 677,67	3 962,02	831,36	140,97	2 076,36	155 751,50	9,30	66,90
2001	71,52	5 228,80	0,72	0,54	62 475,70	4 534,83	936,11	169,34	2 047,83	153 611,50	9,20	66,00
2002	74,58	5 453,20	0,76	0,56	64 422,59	4 685,07	843,88	161,42	1 902,30	142 694,80	8,50	61,30
2003	95,59	6 987,50	0,88	0,73	66 306,39	4 809,32	795,31	170,44	1 521,51	114 130,70	6,80	49,00
2004	124,11	9 069,50	0,95	0,97	69 997,09	5 099,50	776,25	179,27	1 459,14	109 452,32	6,52	47,04
2005	144,16	10 534,90	1,11	1,13	82 767,94	6 051,22	794,19	205,92	1 420,98	106 590,00	6,00	46,00
2006	160,68	11 741,71	1,20	1,26	77 054,15	5 568,04	620,37	180,88	1 509,61	113 238,58	6,75	48,66
2007	184,85	13 507,06	1,32	1,46	88 751,90	6 336,15	651,15	187,25	1 448,70	108 669,63	6,48	46,70
2008	206,50	15 087,88	1,39	1,65	91 291,19	6 503,58	673,06	189,85	1 329,78	99 749,60	5,94	42,87
2009	85,78	6 244,02	0,68	0,67	84 484,41	6 026,09	631,74	200,50	1 145,21	85 903,85	5,12	36,92

	Navigation				Military Aviation				Transport			
	Consumption	CO_2	CH_4	N_2O	Consumption	CO_3	CH_5	N_2O	Consumption	CO_4	CH_6	N_2O
	[TJ]	[t]	[t]	[t]	[TJ]	[t]	[t]	[t]	[TJ]	[Gg]	[Gg]	[Gg]
1990	0,30	22,7507	0,0012	0,0092	95,86	7 003,06	0,56	0,78	66 402,02	4 892,47	1,03	0,39
1991	0,26	19,4349	0,0010	0,0079	82,07	5 995,17	0,48	0,67	55 961,21	4 120,58	0,94	0,32
1992	0,24	18,1287	0,0010	0,0073	69,64	5 087,23	0,40	0,57	51 560,68	3 794,34	0,92	0,28
1993	0,25	18,4735	0,0010	0,0075	83,68	6 112,87	0,49	0,68	51 294,92	3 772,21	1,00	0,27
1994	0,26	19,6198	0,0010	0,0079	84,92	6 203,38	0,49	0,69	54 582,47	4 013,24	1,07	0,29
1995	0,28	20,7660	0,0011	0,0084	87,76	6 411,04	0,51	0,71	57 910,47	4 258,51	1,14	0,33
1996	0,30	22,2078	0,0012	0,0090	76,06	5 556,21	0,44	0,62	58 650,90	4 312,86	1,17	0,35
1997	0,31	23,1796	0,0012	0,0094	37,12	2 711,82	0,22	0,30	60 939,80	4 479,99	1,23	0,39
1998	0,32	24,1978	0,0013	0,0098	27,73	2 025,59	0,16	0,23	64 796,27	4 762,34	1,30	0,43
1999	0,32	24,2053	0,0013	0,0098	18,19	1 328,93	0,11	0,15	63 331,36	4 651,89	1,28	0,44
2000	0,33	24,5339	0,0013	0,0099	23,03	1 682,50	0,13	0,19	56 852,60	4 124,98	0,84	0,21
2001	0,34	25,3686	0,0014	0,0103	35,63	2 602,85	0,21	0,29	64 631,02	4 696,30	0,95	0,24
2002	0,35	26,5741	0,0014	0,0108	36,20	2 644,71	0,21	0,29	66 436,03	4 835,89	0,85	0,22
2003	0,37	27,8323	0,0015	0,0113	21,68	1 583,52	0,13	0,18	67 945,54	4 932,05	0,80	0,22
2004	0,39	29,2670	0,0016	0,0118	21,10	1 541,08	0,12	0,17	71 601,81	5 219,59	0,78	0,23
2005	0,42	31,1828	0,0017	0,0126	25,48	1 861,61	0,15	0,21	84 358,98	6 170,23	0,80	0,25
2006	0,45	33,8322	0,0018	0,0137	25,43	1 857,88	0,15	0,21	78 750,33	5 694,91	0,63	0,23
2007	0,50	37,3585	0,0020	0,0151	32,88	2 401,75	0,19	0,27	90 418,83	6 460,77	0,66	0,24
2008	0,54	40,8758	0,0022	0,0165	28,38	2 073,04	0,16	0,23	92 856,40	6 620,53	0,68	0,23
2009	0,52	38,9212	0,0021	0,0157	21,02	1 535,46	0,12	0,17	85 736,93	6 119,81	0,64	0,24

Figure 3.22: The share of different fuels within transport category 1A3 in 2009



Fuel	Consumption (TJ)	Share (%)
Diesel Oil	54 402,19	63,45
Gasoline	27 075,85	31,58
Biomass	2 827,43	3,30
LPG	1 088,21	1,27
CNG	236,46	0,28
Jet Kerosene	101,90	0,12
Av. Gasoline	4,89	0,01

3.3.2 Source subcategory description – Civil aviation (CRF 1.AA.3.A)

The inventory evaluation of GHG emissions in subcategory of civil aviation was performed for all GHGs and precursors as well as air pollutants. In the absence of data on the exact numbers of domestic LTO cycles (only total number of LTO cycles is available) and according to the recommendations of ERT final findings in 2008, followed by IPCC GPG 2000, the emission estimation was based on the fuel sold to national and international civil flights (Tier 1 method). The estimation of GHG emissions was based on the fuel sold at the important Slovak airports (Bratislava, Košice, Poprad, Sliač, Piešťany and Žilina). The fuel sold decreased by 15% in the period 1990 – 2009 and compared to the previous year decreased dramatically by 60% due to the economic crises. Total GHG emissions from domestic aviation represented 6.46 Gg of CO_2 equivalents in 2009. The increasing trend of emissions has been visible in 2000 – 2008 and according to the economic crises the decrease in 2009 was estimated. But according to the recent projections the trend will be continuously rising again. The airports are managed by the Slovak Management of Airports, except for the airport in Žilina, where exercises with light aircrafts of the Žilina University predominate. Other smaller civil airports (Nitra, Prievidza, Ružomberok, Lučenec) are operated by aero-clubs with predominating character of sport flights. Currently, the extensive reconstruction and rebuilding of terminals of Bratislava airport are finish and the increasing of LTO is expected in 2011.

Since 2002, air transport in the Slovak Republic has been positively affected by the penetrating enter of low cost companies, like Sky Europe Airlines, Seagle Air and Danube Wings to the Slovak market. The airports in Bratislava and Košice are the most important and the busiest airports. It is very difficult to estimate future development in air transport due to current unstable situation in this sector.

3.3.2.1 Methodological issues – methods

The Slovak Republic has used the Tier 1 methodology for the estimation of emissions from aviation, both for aviation gasoline and jet kerosene, based on sold fuels. The information of LTO cycles are known (33 078) and they have been used for air pollutants inventory, not divided into national and international flights. The emission estimation is based on fuel consumption and the international rule for national and international flights based on expert judgment was evaluated.

Statistic methodology for the airport traffic is determined only by the origin of air operator for domestic and international flights. It means that no direct information about numbers of domestic and internationally operated flights is known for the period 1990 – 2009. The average division of consumed fuel was executed by an expert estimation. Based on the expert estimation and discussion during the centralised review 2010 on the total sale of jet kerosene it was stated, that the domestic consumption was estimated to be 5% and the international consumption was 95% of the total amount. Approximately opposite ratio was applied in the consumption of aviation gasoline: 90% for domestic flights and 10% for international flights.

3.3.2.2 Methodological issues – emission factors and other parameters

Emission factors for CO_2 (jet kerosene and aviation gasoline) are constant values taken from EMEP/CORINAIR EIG. Emission factors for CH_4 and N_2O represent the average emission factors, including all phases of flight (LTO (cycles), (climb), (cruise), descent). The emission factors for CH_4 and N_2O are provided for a representative aircraft matching to the average flight distance in the international and domestic air traffic. Data on fuel consumption and emissions in different phases of the flight of the representative aircraft, set out in Annexes of EMEP/CORINAIR EIG, are used for the determination of emission factors.

Table 3.30: Starting conditions for the estimation of mixed EFs in civil aviation for jet kerosene

Parameter	International Flights	National Flights
Fuel	Jet Kerosene	
Representative Aircraft	B 737-500, (400,100)	EMB-120, Saab 340B
Average Flight Distance	1 365 km	375 km
Average Flight Duration	1,75 hour	0,75 hour
Average Speed	780 km/hour	500 km/hour

According to the above presented starting information and other relevant facts from the EMEP/CORINAIR EIG the following mixed emission factors were used.

Table 3.31: Mixed emission factors for the GHG emission balance in civil aviation according Tier 1 method based on fuel consumption

Parameter	Emission Factor (g/kg of fuel)	
	International Flights	National Flights
GHGs	Jet Kerosene	
CO_2	3 150	3 150
N_2O	0,104	0,35
CH_4	0,05	0,25
GHGs	Avation Gasoline	
CO_2	3 150	
N_2O	0,1	
CH_4	1,9	

It is generally known, that in the period 1990 – 2009 the technological development of aircraft industry took place and the emissions were decreasing from air traffic per one LTO cycles and per fuel consumption. The use of mixed EFs based on recent knowledge about parameters of aircrafts could cause the underestimation of emissions in the previous period and the base year. It is historically proved, that in the earlier 90-ties, the obsolete aircrafts were used. Because no relevant information estimating time series is known from the previous period, the problem cannot be solved satisfactorily.

3.3.2.3 Activity data

The number of realized LTO cycles during the year at the monitored airports, the types of aircrafts and the carrying capacity of the airports are basic input information used for the emission estimation from civil aviation. The aircrafts are divided into two weight categories: under 5.7 t and over 5.7 t. The innovated method uses the emission factors for the each aircraft type and weight category. The number of the LTO cycles in the inventory year 2009 was 33 078 cycles. Total consumption of jet kerosene was 1 868 t and the consumption of aviation gasoline was 114 t on national flights.

The overview of fuel sale according to the type (aviation gasoline and jet kerosene) during 1990 – 2009 was revaluated. For the period 1994 – 2009 the data come directly from airport statistical processing information based on annual bases. The data for the period 1990 – 1993 on the sale of fuel are based on the expert estimation according the real LTO cycles in this period. The overview of fuels quantity sold (fill in) at the Slovak airports during 1990 – 2009 is showed in Table 3.32.

3.3.2.4 Uncertainties and time-series consistency

The Tier 1 uncertainties analyse was performed according to the IPCC 2000 GPG. The Tier 2 uncertainty estimation has not been provided for the subcategory civil aviation for the present. Lack of input data is the most facing issue.

Since 2002, the development of civil aviation in the Slovak Republic has been influenced by fast entering of low-cost airlines on market (mostly Sky Europe Airlines) Bratislava and Košice are the heaviest airports. Other airports have only local character for domestic and sport flights.

In the period 1990 – 2009, the sale of aviation fuels at Slovak airports was influenced mostly by prices and other conditions on fuel market at neighbouring airports. The consistency of time series is well ensured.

Table 3.32: The quantity of fuels sold at the Slovak airports and GHG emissions during 1990 – 2009 for national flights

	Aviation Gasoline					Jet Kerosene				
	Consumption	Consumption	CO_2	CH_4	N_2O	Consumption	Consumption	CO_2	CH_4	N_2O
	[TJ]	[t]	[t]	[t]	[t]	[TJ]	[t]	[t]	[t]	[t]
1990	9,98	233,10	734,30	0,44	0,02	95,86	2 223,00	7 002,50	0,56	0,78
1991	9,26	216,45	681,80	0,41	0,02	89,13	2 067,00	6 511,10	0,52	0,72
1992	8,55	199,80	629,40	0,38	0,02	82,40	1 911,00	6 019,70	0,48	0,67
1993	7,84	183,15	576,90	0,35	0,02	80,72	1 872,00	5 896,80	0,47	0,66
1994	7,16	167,31	527,00	0,32	0,02	68,01	1 577,32	4 968,50	0,39	0,55
1995	6,60	154,25	485,90	0,29	0,02	68,43	1 586,91	4 998,80	0,40	0,56
1996	7,17	167,62	528,00	0,32	0,02	80,76	1 872,97	5 899,90	0,47	0,66
1997	6,37	148,93	469,10	0,28	0,02	71,53	1 658,87	5 225,40	0,42	0,58
1998	5,64	131,80	415,20	0,25	0,01	65,96	1 529,62	4 818,30	0,38	0,54
1999	6,03	140,95	444,00	0,27	0,01	66,55	1 543,40	4 861,70	0,39	0,54
2000	7,61	177,71	559,80	0,34	0,02	67,61	1 567,85	4 938,70	0,39	0,55
2001	7,94	185,53	584,40	0,35	0,02	63,58	1 474,40	4 644,40	0,37	0,52
2002	8,58	200,54	631,70	0,38	0,02	66,00	1 537,82	4 821,50	0,38	0,54
2003	8,30	194,01	611,10	0,37	0,02	87,29	2 024,27	6 376,40	0,51	0,71
2004	6,03	140,86	443,70	0,27	0,01	118,08	2 738,34	8 625,80	0,69	0,96
2005	7,14	166,87	525,70	0,32	0,02	137,02	3 177,53	10 009,20	0,79	1,11
2006	7,01	163,89	516,26	0,31	0,02	153,66	3 563,64	11 225,46	0,89	1,25
2007	6,37	148,88	468,96	0,28	0,02	178,48	4 139,08	13 038,10	1,03	1,45
2008	4,90	114,51	360,70	0,22	0,01	201,60	4 675,29	14 727,18	1,17	1,64
2009	4,89	114,36	360,24	0,22	0,01	80,88	1 867,87	5 883,78	0,47	0,65

3.3.2.5 Source specific QA/QC and verification

The emission inventory of civil aviation was determined by the SHMÚ in cooperation with external experts from the Centrum of Transport Research in Brno (the Czech Republic) and the Transport University in Žilina. A new expert trained for the transport emission inventory and projections Ms. Michaela Kollarová, joined the Department of Emissions at the SHMÚ in 2008.

The verification process is based on cross-checking of input data from the Slovak airports by sectoral expert and the comparison with the sectoral statistical indicators from the Ministry of Transport. The background documents are archived by sectoral experts and in the central archiving system at the SHMÚ. The responsibility is for the verification, approval of process and archiving lies on quality manager at the Department of Emissions.

3.3.2.6 Source specific recalculations

No recalculations in the submission 2011 focused on the base year 1990 or the other inventory years were provided.

3.3.2.7 Source specific planned improvements

The implementation of Tier 2 methodology is in preparation in combination with the fuel sold and the number of movements with the differentiation for national and international flights. The discussions are continued in the cooperation with the Ministry of Transport – the Department of Civil Aviation and the Bratislava Airport for the first estimation. The initiative regarding the preparation of a new methodology for including the aviation in emission trading system after 2012 has been increased. The first preliminary results show, that the expert judgment setting of splitting flights to national and international was correct.

3.3.3 Source subcategory description – Road Transportation (CRF 1.AA.3.B)

Short distance passenger transport is an important part of road transport. It is the most exploited type of transport in the Slovak Republic due to a high density of roads, quality of road network and interconnection of all municipalities. In the past 10 years, road transport has expanded significantly in the transport of goods and persons. In 2009, the transport network included 391 km of highways, 203.9 km of motorways and 3 482.4 km of the category I roads .Total roads network includes 17 937 km of roads in the Slovak Republic in 2009.

Road transportation is the most important category with the highest share of emissions and increasing trend. Total aggregated emissions from road transportation reached 6 102 Gg of CO_2 equivalents in 2009. The decrease is by 7% compared to 2008, but the 32% increase compared to the base year is significant. The major share belongs to duty vehicles and passenger cars. Total blended emissions of CO_2 were 6 234.94 Gg in 2009. After separation of biomass content, the final CO_2 balance was 6 026.09 Gg. The biomass content represented 209 Gg of CO_2.

Table 3.33: Overview of total GHG emission balance according to the type of vehicles without separation of fossil and biomass contents in fuels in 2009

Category of Road Vehicles	Emissions (t)			Category of Road Vehicles	Emissions (t)		
	CO_2	CH_4	N_2O		CO_2	CH_4	N_2O
Passenger Cars	**2 302 071**	**456,99**	**126,42**	diesel >32 t	12 223	0,07	0,21
gasoline < 1.4 l	1 083 447	268,01	70,18	diesel 14 - 20 t	391 646	20,86	5,14
gasoline 1.4 l–2.0 l	579 326	141,49	46,81	diesel 20 - 28 t	311 520	10,58	3,19
gasoline > 2.0 l	106 658	18,13	5,26	diesel 28 - 34 t	511 180	11,03	7,65
diesel < 2.0 l	373 181	9,55	12,24	diesel 34 - 40 t	39 716	0,63	0,29
diesel > 2.0 l	86 132	1,74	2,18	**Buses**	**455 871**	**58,59**	**2,89**
LPG	73 224	18,05	2,75	City buses CNG	19 262	40,36	0,00
Two stroke engine	103	0,02	0,00	City buses Midi <=15 t	14 785	0,62	0,08
Light Duty Vehicles	**636 547**	**24,78**	**22,92**	City buese Stand. 15-18 t	53 757	1,47	0,23
gasoline < 3.5 t	245 824	19,15	13,70	City buses >18 t	45 547	1,35	0,15
diesel < 3.5 t	390 722	5,63	9,22	Long - line buses	322 521	14,78	2,43
Heavy Duty Vehicles	**2 833 208**	**102,06**	**41,66**	**Motorcycles**	**7 238**	**8,18**	**0,10**
diesel <=7,5 t	517 544	21,10	12,88	< 50 cm^3 (mopeds)	1 651	2,77	0,02
diesel 7,5 - 12 t	120 470	2,79	1,48	Two stroke engine > 50 cm^3	3 057	2,98	0,05
diesel 12 - 14 t	85 504	1,80	1,34	Four stroke engine < 250 cm^3	563	0,74	0,01
diesel 14 - 20 t	334 924	17,55	4,50	Four stroke engine 250 - 750 cm^3	854	0,93	0,01
diesel 20 - 26 t	222 016	6,84	2,00	Four stroke engine > 750 cm^3	1 114	0,75	0,01
diesel 26 - 28 t	165 779	5,39	1,54	**Total Road Transport**	**6 234 936**	**650,60**	**207,00**
diesel 28 - 32 t	120 686	3,43	1,45	***Total Blended Emissions***			

3.3.3.1 Methodological issues – methods

The calculation of GHG emissions in the annual inventory 2009 was made according to the EMEP/CORINAIR EIG methodology, with the software product COPERT IV version 7.1. Therefore, it is often referred to the name of the methodology consistently with the name of the program COPERT. Road transport emissions have been recalculated since 2000 by COPERT IV version 7.1 software. The procedure for calculating the CO_2 under this methodology is based on Tier 2 or bottom-up according to the IPCC 2000 GPG equals 2.5 a 2.6 in Chapter 2.3.1.1.

The model COPERT IV defined new vehicle categories for the calculation of CH_4 and N_2O emissions with the disaggregation into the 6 base categories and 250 subcategories. Further disaggregation was applied according to the operation of road vehicles in the agglomeration, road and highway traffic mode. In COPERT IV buses have been broken down into 8 sub-districts and the 2 subgroups (urban and coaches). Heavy duty vehicles are divided into 2 basic groups (rigid and articulated) and solid vehicles are further divided by weight into 8 subgroups and articulated into 6 subgroups. This methodology for the calculation of emissions used the technical parameters on the types of vehicles and the country characteristics, for example, the composition of car fleet, the age of the cars, the parameters of operation and fuels or climate conditions. The estimation is provided for the main 5 types of input data:

- Total fuel consumption
- Composition of vehicles fleet
- Driving mode
- Emission factors

Based on these input parameters and additional information (the age of automobiles) the emissions can be estimated.

COPERT IV version 7.1 includes new EFs for hot emissions in category motorcycles. The EFs are based on project ARTEMIS experimental results. The EFs for Euro 3 – 6 for LPG and gasoline were updated in the category passenger cars. These improvements followed improvements in catalytic systems in vehicles.

Table 3.34: Overview of input data in COPERT IV version 7.1 program

Category of Road Vehicles	Activity data			Category of Road Vehicles	Activity data		
	Number	Average consumption (l/100km)	Average mileage (km/veh.)		Number	Average consumption (l/100km)	Average mileage (km/veh.)
Passenger Cars	**1 589 044,00**	**8,68**	**10 143,67**	diesel >32 t	286,00	30,65	61 468,53
gasoline < 1.4 l	846 066,00	7,21	7 657,16	diesel 14 - 20 t	23 878,00	21,80	29 009,51
gasoline 1.4 l–2.0 l	489 410,00	8,36	8 275,40	diesel 20 - 28 t	7 780,00	26,71	56 821,21
gasoline > 2.0 l	39 127,00	10,13	11 099,63	diesel 28 - 34 t	11 098,00	27,65	63 595,56
diesel < 2.0 l	131 977,00	6,19	16 305,05	diesel 34 - 40 t	2 138,00	30,82	66 681,34
diesel > 2.0 l	24 842,00	7,98	15 577,36	**Buses**	**9 400,00**	**32,93**	**49 350,39**
LPG	57 495,00	10,00	8 991,11	City buses CNG	296,00	49,00	47 710,02
Two stroke engine	127,00	10,90	3 100,00	City buses Midi <=15 t	555,00	21,95	40 598,20
Light Duty Vehicles	**190 824,00**	**10,79**	**12 345,30**	City buese Stand. 15-18 t	1 307,00	29,40	52 215,76
gasoline < 3.5 t	73 464,00	12,21	11 972,05	City buses >18 t	872,00	37,83	52 498,97
diesel < 3.5 t	117 360,00	9,36	12 718,55	Long - line buses	6 370,00	26,46	53 729,00
Heavy Duty Vehicles	**133 965,00**	**25,03**	**48 489,49**	**Motorcycles**	**102 570,00**	**3,93**	**1 998,09**
diesel <=7,5 t	50 604,00	13,23	29 791,95	< 50 cm^3 (mopeds)	47 057,00	2,59	784,22
diesel 7,5 - 12 t	7 869,00	19,05	31 087,90	Two stroke engine > 50 cm^3	40 824,00	3,74	1 250,13
diesel 12 - 14 t	5 069,00	20,54	31 327,38	Four stroke engine < 250 cm^3	5 231,00	3,63	2 324,77
diesel 14 - 20 t	12 865,00	23,72	41 165,02	Four stroke engine 250 - 750 cm^3	4 876,00	4,21	2 663,88
diesel 20 - 26 t	5 562,00	26,28	54 429,25	Four stroke engine > 750 cm^3	4 582,00	5,49	2 967,44
diesel 26 - 28 t	4 173,00	27,90	57 026,72	**Total Road Transport**	**2 025 803,00**	**16,27**	**122 326,94**
diesel 28 - 32 t	2 643,00	32,02	59 469,54				

3.3.3.2 Methodological issues – emission factors and other parameters

The EFs values for CH_4 and N_2O in COPERT IV version 7.1 are defined separately for the different types of fuels, types of vehicles and the different technological level of cars. In the case of CH_4 emissions, the balance is based also on the average speed and drive mode for certain passenger cars. The emission factors for the group of pollutants such as CO_2, SO_2, N_2O, NH_3, PM and partially also CH_4 can be obtained by the simple formula of driving mode and consumed fuel. This value is constant for different vehicles categories. Emission factors are calculated automatically by COPERT IV based on the input parameters such as the average speed, the quality of fuels, the age of vehicles, the weight of vehicles and the volume of cylinders.

3.3.3.3 Activity data

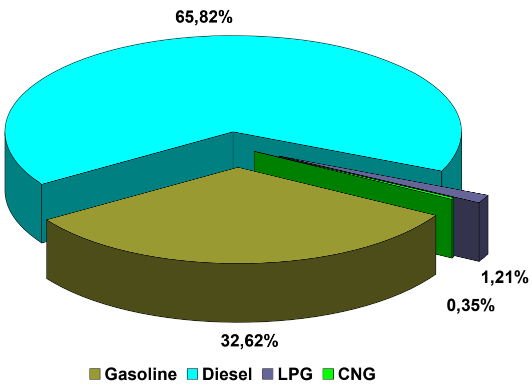
The emissions from this sector have an increasing tendency every year and they are the key source in level and trend assessment for uncertainty management. The revision of EF for CNG according EMEP/CORINAIR EIG 2008 and new disaggregation of buses to the EURO categories was provided in 2009. The emission inventory of road transport in 2009 included also the emissions from light and heavy-duty vehicles, buses operated by CNG (compressed natural gas). The input parameters for CNG buses are known only from the year 2000. It is assumed, that before year 2000 the use of CNG was negligible. The consumption of CNG as fuel can neither be used for a diesel engine nor for a gasoline one without modifications. The CNG busses may have completely different combustion and after treatment technology despite using the same fuel. Hence, their emission performance may vary significantly. But the CNG busses also need to fulfill a specific emission standard (Euro II, Euro III, etc.). Due to the low NO_x and PM performance compared to diesel, an additional emission standard has been set for CNG vehicles, known as the standard for Enhanced Environmental Vehicles (EEV). The emission limits imposed for EEV are even below Euro V and usually EEVs are benefited from taxation waivers and free entrance to low emission zones. New stoichiometry buses are able to fulfill the EEV requirements, while older busses were usually registered as Euro II or Euro III, Euro IV.

Table 3.35: Results from COPERT IV in distribution for agglomeration mode (CO_2 emissions are from blended fuels with bio-component)

	Emissions (t)		
Traffic	**CO_2**	**CH_4**	**N_2O**
City	2 612 573	370,87	100,55
Road	2 716 652	205,33	81,17
Highway	905 711	74,40	25,28
Sum in the SR	**6 234 936**	**650,60**	**207,00**

Important information about the import, production, distribution and sale of gasoline and diesel oil were received from domestic producers of fuels – Slovnaft Ltd. Bratislava and Petrochema Ltd. Dubová, from the Customs Directory of the Slovak Republic and the Statistical Office of the Slovak Republic. The data about the distribution and the sale of gaseous fuels (LPG and CNG) were obtained from exclusive dealers and Slovak Gas Industry Ltd. All materials are in Slovak language and they are official. The statistical information about fuels sold in the Slovak Republic is checked by the results of the COPERT IV model and the differences are not higher than 2%. According to the statistical information the diesel oil represents the major share in fuel with 66% share, followed by gasoline with 33% share. The minor consumptions were balanced for LPG (1.21%) and CNG (0.35%).

Figure 3.23: Fuels balance from statistics and COPERT IV model results in 2009



Fuel	Statistical (t)	Calculated (t)	Deviation (%)
Gasoline	642 863,00	649 856,46	1,01
Diesel	1 297 198,00	1 307 340,88	1,01
LPG	23 786,00	24 218,06	1,02
CNG	6 920,00	6 977,23	1,01

3.3.3.4 Biomass consumption, blending

According to the recommendations of the ERT in the previous review process, blending of biomass in liquid fuels was considered and the emission data were recalculated. The information was obtained from Slovnaft Ltd. Bratislava, which is exclusive distributor of fuels in the Slovak Republic. In terms of implementing directive 2003/30/EC on the replacement of fossil fuels with bio-component:

- In 2005, the content of bio-component in fuel was value near 0%.
- In 2006, it was 1.04%.
- In 2007, it was 2.5%.
- In 2008, it was 2.6%.
- In 2009, it was 3.4%.

In 2009, the target of 3.4% of all the energy equivalent of gasoline and diesel oil was achieved in the Slovak Republic. Requirements for the quality of motor fuels containing bio-component must be at the level of the specifications listed in the STN EN 228:2004 and STN EN 590:2004, respectively. The quality of blending in bio-liquid fuels must meet the requirements specified in the STN EN 14 214, STN EN 15376.

Table 3.36: Estimated activity data of gasoline and diesel oil with their emissions and biomass share

Gasoline Blended TJ				Diesel Oil Blended TJ			
2006	**2007**	**2008**	**2009**	**2006**	**2007**	**2008**	**2009**
27 281,70	28 927,16	29 301,79	28 028,83	48 478,63	58 660,84	60 480,13	55 130,92
Biomass share %				**Biomass share %**			
1,04%	2,50%	2,60%	3,40%	1,04%	2,50%	2,60%	3,40%
Biomass TJ				**Biomass TJ**			
283,73	723,18	761,85	952,98	504,18	1 466,52	1 572,48	1 874,45
Gasoline Fossil TJ				**Diesel Oil Fossil TJ**			
26 997,97	28 203,98	28 539,95	27 075,85	47 974,46	57 194,32	58 907,65	53 256,46
Biomass TJ Total				**Biomass TJ Total**			
787,91	2 189,70	2 334,33	2 827,43	524,39	1 518,36	1 626,75	1 943,22

CO_2 Gasoline Blended Gg				CO_2 Diesel Oil Blended Gg			
2006	**2007**	**2008**	**2009**	**2006**	**2007**	**2008**	**2009**
1 943,17	2 073,41	2 087,06	2 022,60	3 594,63	4 342,64	4 484,53	4 119,85
Biomass share %				**Biomass share %**			
1,04%	2,50%	2,60%	3,40%	1,04%	2,50%	2,60%	3,40%
Biomass CO_2 Gg				**Biomass CO_2 Gg**			
20,21	51,84	54,26	68,77	37,38	108,57	116,60	140,08
CO_2 Gasoline Fossil Gg				**CO_2 Diesel Oil Fossil Gg**			
1 922,96	2 021,58	2 032,79	1 953,83	3 557,25	4 234,08	4 367,93	3 979,78
Biomass CO_2 Gg Total				**Biomass CO_2 Gg Total**			
57,59	160,40	170,86	208,84	94,98	268,97	287,46	348,92

CH_4 Gasoline Blended Gg				CH_4 Diesel Oil Blended Gg			
2006	**2007**	**2008**	**2009**	**2006**	**2007**	**2008**	**2009**
0,42	0,42	0,45	0,42	0,16	0,18	0,17	0,14
Biomass share %				**Biomass share %**			
1,04%	2,50%	2,60%	3,40%	1,04%	2,50%	2,60%	3,40%
Biomass CO_2 Gg				**Biomass CO_2 Gg**			
0,00	0,01	0,01	0,01	0,0017	0,0044	0,0044	0,0047
CO_2 Gasoline Fossil Gg				**CO_2 Diesel Oil Fossil Gg**			
0,41	0,41	0,44	0,40	0,16	0,17	0,17	0,13
N_2O Gasoline Blended Gg				**N_2O Diesel Oil Blended Gg**			
2006	**2007**	**2008**	**2009**	**2006**	**2007**	**2008**	**2009**
0,11	0,11	0,11	0,12	0,07	0,08	0,07	0,07
Biomass share %				**Biomass share %**			
1,04%	2,50%	2,60%	3,40%	1,04%	2,50%	2,60%	3,40%
Biomass CO_2 Gg				**Biomass CO_2 Gg**			
0,0011	0,0027	0,0029	0,0042	0,0007	0,0019	0,0019	0,0023
N_2O Gasoline Fossil Gg				**N_2O Diesel Oil Fossil Gg**			
0,11	0,10	0,11	0,12	0,07	0,08	0,07	0,07

3.3.3.5 Uncertainties and time-series consistency

The Tier 1 uncertainties analyze was performed according to the IPCC 2000 GPG. The Tier 2 uncertainty estimation was not provided for subcategory road transportation this time. Lack of input data is the most facing issue.

The trend in the production of CO_2 and N_2O emissions from road transportation correspond with the consumption of the fuels. The emission factors are constant during the time series. In the period 2007 – 2008 gasoline consumption rose by 1.3% and diesel consumption also rose by 3.1%. This was caused by the variation of fuel prices, the development of construction, commercial, industrial activity, economic development and, of course, by the trend of increasing numbers of new cars within the commercial market of the Slovak Republic, which significantly determines the development of the emissions from transport.

In 2009, the number of new cars with engines over 2 000 cm^3 increased. Emissions of N_2O decreased, given that emission factors decreased in newer vehicles. Regarding CH_4 emissions, the alteration of vehicles to vehicles with better environmental and energetic parameters (mostly personal cars with catalysts) is primarily important. It can be concluded that CH_4 emission production slightly increased by

0.55% compared to the previous year. The elimination of negative influences of road transport continues with the increase of LPG and CNG vehicles (mostly buses and duty vehicles).

Increasing quality of the emission inventory from transport depends closely on the reduction and removal of the following uncertainties:

- The uncertainties joint with the COPERT IV methodology.
- The uncertainties joint with the collection, preparation and application of the input data.

The quality of calculated results by COPERT IV has been influenced significantly by the uncertainty of the following statistics information:

- Statistic information about consumption of the fuels.
- Allocation of total number of vehicles among all the categories according to the methodology.
- The average yearly overrun kilometers.
- The average speed in the traffic mode.
- The average temperatures.
- The beta-factor.

COPERT IV requires the determination of CH_4 emission factors and the calculation of CH_4 emissions accumulated, respectively, in order to determine:

- Data on the numbers of road vehicles in the Slovak Republic in current year, broken down into categories prescribed by the methodology.
- Data on average monthly temperatures in current year.
- The average speed of vehicle categories in city, road and highway driving modes.
- The annual km – will take place between categories of vehicles, broken down into urban, road and highway traffic.

The consistency of time series is influenced by the use of two different versions of COPERT model. COPERT III was used from 1990 to 1999 and COPERT IV version 7.1 was used from 2000 – 2009. When comparing the results from testing recalculation of the year 1999 with version IV, no differences were recognised. The reason is that the changes between the versions of COPERT model are significant only for new vehicles, putting into operation in the Slovak Republic mostly after 2000. The detailed disaggregation of vehicles required for the version IV was not available in the Statistics of the Police Force Presidium of the Slovak Republic and thus it is very difficult to recalculate the years before 2000.

3.3.3.6 Source specific QA/QC and verification

The emission inventory of Road transportation was determined by the SHMÚ sectoral expert for transport emission inventory and projections Ms. Michaela Kollárová cooperating with Mgr. Jiří Dufek from the Research Institute of Transport in Brno (Czech Republic).

The process of verification is based on cross-checking of input data from the Slovnaft Ltd. Bratislava (exclusive distributor of fuels in the Slovak Republic) and the comparison with the fuel balance from COPERT IV model. The background documents are archived by sectoral experts and in central archiving system of SNE at SHMU. The list of data providers is included in QA/QC plan:

- Slovnaft Ltd. Bratislava and Petrochema Ltd. Dubová – provide data concerning production and selling of gasoline and diesel fuel.
- Statistical Office of the Slovak Republic – provides data concerning import and export of gasoline and diesel fuel from the EU Member States.
- Customs Directorate of the Slovak Republic – provides data concerning import and export of gasoline and diesel fuel from countries that are not the EU Member States.

- Probugas Ltd. Bratislava, Progas Ltd. Bratislava, Flaga Slovplyn Ltd. Pezinok, Flavia Ltd. Vranov nad Topľou, Slovnaft Ltd. Bratislava, Autoplyn Žilina – provide data concerning selling of LPG for road vehicles delivered into net of gas stations.
- Slovak Gas Trading Company SPP Inc. – provides data concerning selling of compressed natural gas – CNG at gas stations in the Slovak Republic.
- SAD Ltd. Zvolen, SAD Ltd. Nitra, SAD Ltd. Michalovce, DP mesta Košice Ltd. Košice, DPMB Ltd. Bratislava – bus transportation companies providing data concerning CNG consumption of gas driven busses.
- Presidium of the Police Force of the Slovak Republic, the Department of Documents and Registration of Presidium – provides data concerning numbers of new registrations, changes if the registration and deregistration of road vehicles at the end of the year of the emission inventory.
- Association of car industry of the Slovak Republic –detailed data concerning structure of all type of cars sold in the Slovak Republic during actual year can be found in its statistical yearbook.

3.3.3.7 Source specific recalculations

Road transportation emissions since 2000 have been recalculated with COPERT IV version 7.1 (2000 – 2008). Before 2000 the changes are negligible. Emission factors are calculated automatically with COPERT IV version 7.1 based on input parameters – average speed, quality of fuel, age of vehicles, weight of vehicles, and volume of cylinders. The parameter 'Mean_Fleet_Mileage_km' was updated for vehicles categories. The software correction in N_2O, NH_3 and CH_4 calculation for hot and cold emissions was applied. The EFs for urban busses were improved (instead 0.001 g/km to 0.006 g/km).

Major changes and differences are occurred in CH_4 and N_2O emissions due to decreasing emission factors for several types of vehicles. It is visible from the graphs, that the differences are increasing from 2000 to 2008 (CH_4, N_2O), what is caused by the modernization of vehicles park.

The correction of the LPG emission factors for CO_2, CH_4 and N_2O in road transportation was provided for 1994 – 1999 time series. The minor changes occurred and the average EFs were used as follow EF(CO_2) = 66.09 t/TJ, EF(CH_4) = 17.74 t/TJ and EF(N_2O) = 3.31 t/TJ. Recalculated emissions are provided in Table 3.37.

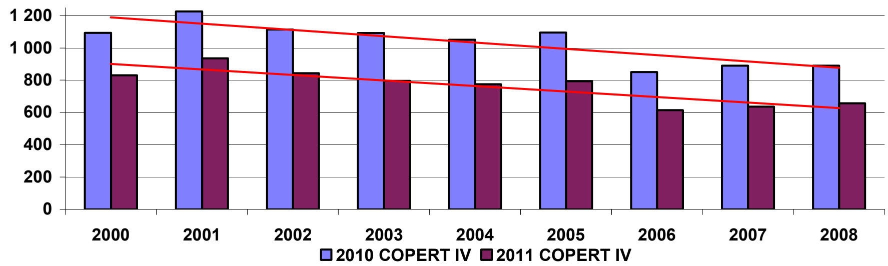
Table 3.37: Recalculated GHG emissions

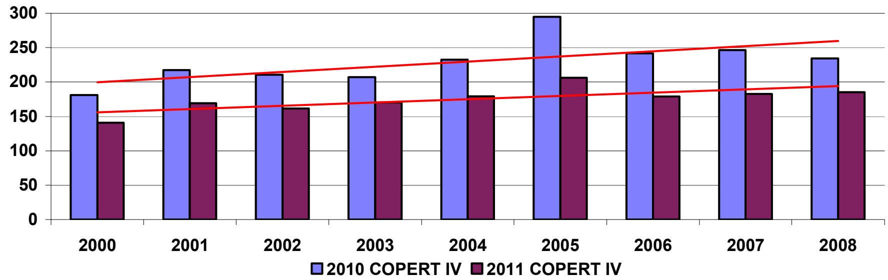
Submission	Fuel	CO_2 (Gg)								
		2000	2001	2002	2003	2004	2005	2006	2006	2008
2010 COPERT IV	**Total**	**3 972,68**	**4 534,83**	**4 693,74**	**4 814,15**	**5 099,50**	**6 045,78**	**5 566,55**	**6 333,82**	**6 500,30**
	Gasoline	1 852,17	2 178,35	1 995,26	2 058,54	1 951,73	2 210,72	1 921,47	2 019,28	2 031,75
	Diesel	2 076,14	2 289,98	2 607,08	2 658,53	3 045,99	3 734,08	3 557,25	4 234,08	4 365,69
	LPG	43,74	65,87	87,75	92,16	92,93	91,01	75,03	65,57	85,73
	CNG	0,63	0,63	3,65	4,92	8,85	9,97	12,80	14,89	17,13
2011 COPERT IV	**Total**	**3 962,02**	**4 534,83**	**4 685,07**	**4 809,32**	**5 099,50**	**6 051,22**	**5 568,04**	**6 336,15**	**6 503,58**
version 7.1	Gasoline	1 842,75	2 179,29	1 988,16	2 058,54	1 951,73	2 215,28	1 922,96	2 021,58	2 032,79
	Diesel	2 074,91	2 289,04	2 607,08	2 651,53	3 045,99	3 734,08	3 557,25	4 234,08	4 367,93
	LPG	43,74	65,87	86,17	92,16	92,93	91,01	75,03	65,57	85,73
	CNG	0,63	0,63	3,65	7,08	8,85	10,85	12,80	14,93	17,13
2011/2010	**Decrease (%)**	**-0,27**	**0,00**	**-0,19**	**-0,10**	**0,00**	**0,09**	**0,03**	**0,04**	**0,05**

Submission	Fuel	CH_4 (t)								
		2000	2001	2002	2003	2004	2005	2006	2007	2008
2010 COPERT IV	**Total**	**1 094,51**	**1 226,69**	**1 114,45**	**1 091,84**	**1 050,73**	**1 095,01**	**851,42**	**891,19**	**891,04**
	Gasoline	906,96	1 009,42	857,66	793,01	742,12	715,88	516,63	499,01	534,38
	Diesel	164,55	186,34	213,69	215,90	251,23	318,26	278,65	316,61	288,22
	LPG	16,73	24,65	32,58	33,83	33,68	32,38	26,23	24,46	31,96
	CNG	6,27	6,27	10,52	49,10	23,70	28,50	29,04	48,70	36,47
2011 COPERT IV	**Total**	**831,36**	**936,11**	**843,88**	**795,31**	**776,25**	**794,19**	**614,33**	**636,23**	**656,90**
version 7.1	Gasoline	707,93	806,07	694,17	640,35	598,39	583,67	411,02	409,37	439,57
	Diesel	104,70	105,44	118,63	115,08	140,09	164,20	162,95	172,51	165,98
	LPG	12,45	18,33	23,50	24,98	24,97	23,66	18,10	18,03	23,86
	CNG	6,27	6,27	7,59	14,90	12,81	22,66	22,27	36,32	27,49
2011/2010	**Decrease (%)**	**-31,65**	**-31,04**	**-32,06**	**-37,29**	**-35,36**	**-37,88**	**-38,59**	**-40,07**	**-35,64**

Submission	Fuel	N_2O (t)								
		2000	2001	2002	2003	2004	2005	2006	2007	2008
2010 COPERT IV	**Total**	**181,27**	**217,43**	**210,74**	**207,18**	**232,53**	**294,85**	**241,70**	**246,44**	**234,48**
	Gasoline	127,08	155,77	137,47	153,75	148,58	165,61	142,95	132,94	135,02
	Diesel	50,96	56,76	66,67	46,69	77,21	122,25	91,16	105,59	94,62
	LPG	3,17	4,85	6,55	6,69	6,70	6,48	5,23	3,58	4,44
	CNG	0,07	0,04	0,05	0,04	0,04	0,52	1,26	1,26	0,40
2011 COPERT IV	**Total**	**140,97**	**169,34**	**161,42**	**170,44**	**179,27**	**205,92**	**179,04**	**182,64**	**185,05**
version 7.1	Gasoline	100,76	123,82	108,16	115,53	118,16	132,25	109,33	104,06	107,38
	Diesel	37,72	41,71	48,36	50,71	55,92	68,68	65,90	75,80	74,18
	LPG	2,49	3,80	4,90	4,20	5,19	4,99	3,80	2,78	3,49
	CNG	NO	NO	NO	NO	NO	NO	NO	NO	NO
2011/2010	**Decrease (%)**	**-28,59**	**-28,40**	**-30,55**	**-21,56**	**-29,71**	**-43,19**	**-35,00**	**-34,93**	**-26,71**

Figure 3.24: Comparison of CH_4 (upper) and N_2O emissions estimated by COPERT IV and version 7.1





3.3.3.8 Source specific planned improvements

No specific improvements are planned for next submission. The comparison study of carbon emission factors per fuel (diesel, gasoline) with default emission factors in the COPERT IV version 7.1 database was recommended by the previous ERT. The study is preparing in cooperation with Slovnaft Ltd. Bratislava petrochemical company, which is responsible for the implementation of Directive 2003/30/EC.

3.3.4 Source subcategory description – Railways (CRF 1.AA.3.C)

Rail transport will be modernised with the support of EU funds. Improved quality and ecology of rail transport and the increase in passengers' number are the objectives of this modernisation.

Modernisation of rail infrastructure will result in the increase of operational speed to 160 km/h and increased safety of passengers. In 2009, the length of managed railways was 3 656 km of which the length of electric railways was 1 577 km.

The railways transport is the second important source of emissions in transport subsector, despite to the fact of decreasing character of this transport mode. The decreasing trend has been stabilized since 2003 and it occurs mostly in freight transportation. Total emissions from railways transport reached 97.46 Gg of CO_2 equivalents in 2009 and they decreased by 14% compared to 2008 and by 80% compared to the base year. Despite the fact of decreasing number of locomotives and fuel consumption, the operational kilometres are rising in 2009. The reason behind is in the increasing of railways efficiency and decreasing of fuel consumption by technical modernisation (new locomotives and wagons).

Table 3.38: Overview of GHG emission inventory in railways in 2009

	Diesel Oil Consumption		Emissions [t]		
	[TJ]	[t]	CO_2	CH_4	N_2O
EFs for the motor locomotives and wagons kg/t diesel oil			*3 188*	*0,19*	*1,37*
Košice	357 642,60	6 936,77	22 114,42	1,32	9,50
Žilina	122 088,90	2 862,53	9 125,74	0,54	3,92
Zvolen	526 627,70	10 424,37	33 232,04	1,98	14,28
Bratislava	323 427,13	6 722,60	21 431,65	1,28	9,21
Public	*542 002,50*	*13 255,26*	*42 256,94*	*2,52*	*18,16*
CARGO	*787 780,00*	*13 691,00*	*43 646,91*	*2,60*	*18,76*
Total SR	**1 329 782,50**	**26 946,26**	**85 903,85**	**5,12**	**36,92**

3.3.4.1 Methodological issues – methods

The railways transport represents the operation of diesel traction using the simple methodology Tier 1 according to the IPCC 2000 GPG. The emissions of greenhouse gases are calculated from the weight of consumed fuel by diesel rail traction multiplied by emission factor.

3.3.4.2 Methodological issues – emission factors and other parameters

The emission factor is the average value for the entire performance spectrum of the driving motor vehicles traction. The emission factors for CH_4 and N_2O are based on the EMEP/CORINAIR EIG Other mobile sources and machinery. The list of used emission factors is in Table 3.40.

3.3.4.3 Activity data

The consumption of diesel oil for the motor traction in the Slovak Republic was obtained from the statistic of the Railways Company, Ltd. for the whole time series. It is assumed that the consumption of the diesel oil in motor traction of railways transportation is equal to the diesel oil sold for the railways. The mobile sources of pollution in the railways transport include vehicles of motor traction of the Railways Company Ltd. of the Slovak Republic (RC SR). This motor traction is divided into 2 basic groups of vehicles: motor locomotives (Traction 70) and motor wagons (Traction 80). The motor traction has been operated by 4 depots in the organization structure of the Railways Company Ltd. since 2002 (Bratislava, Zvolen, Žilina and Košice). Table 3.39 shows basic activity data and statistical information for inventory preparation and Figure 3.25 shows the information on diesel oil consumption.

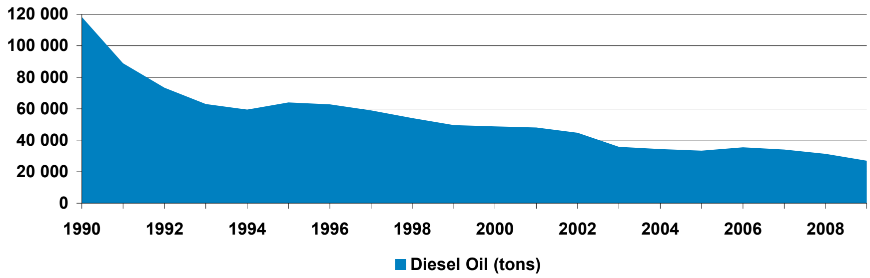
Table 3.39: Overview of activity data used in GHG inventory for railways transport in 2009

Traction 70+80, CARGO+Public 2009							
Year run	Košice	Žilina	Zvolen	Bratislava	*Total public*	*Total CARGO*	Total SR
Number of loco	214	111	175	153	***251***	***402***	**653**
[km per year]	5 737 019	3 679 609	7 043 140	4 759 404	***12 966 933***	***8 252 239***	**21 219 172**
Operations [hrtkm]	390 670 000	202 429 000	1 378 671 000	596 538 000	***1 117 199 000***	***1 451 109 000***	**2 568 308 000**
Consumption [l]	8 258 059	3 407 772	12 409 961	8 003 094	***15 779 572***	***16 299 314***	**32 078 886**
Consumption [t]	6 937	2 863	10 424	6 723	***13 255***	***13 691***	**26 946**

Table 3.40: Overview of emission factors used in GHG inventory for railways transport

Year	Number of Loco	Annual Mileage	Emissions [t]			Electricity Consumption
	[piece]	[km]	CO_2	CH_4	N_2O	[kWhour]
EFs for the motor locomotives and wagons kg/t diesel oil			*3 188*	*0,25*	*1,37*	
1990	1 192	63 432 669	376 771	29,50	161,91	988 025 749
EFs for the motor locomotives and wagons kg/t diesel oil			*3 188*	*0,19*	*1,37*	
1995	1 048	43 939 323	204 070	12,20	87,70	865 433 335
2000	942	33 107 441	155 752	9,30	66,90	771 684 905
2001	897	34 520 572	153 612	9,20	66,00	776 114 735
EFs for the motor locomotives and wagons kg/t diesel oil			*3 188*	*0,19*	*1,37*	
2002	827	32 487 038	142 695	8,50	61,30	750 479 518
2003	827	26 745 426	114 131	6,80	49,00	723 807 222
2004	745	28 181 618	109 452	6,52	47,04	691 844 644
2005	741	22 015 896	106 590	6,00	46,00	697 766 836
2006	710	26 694 902	113 239	6,75	48,66	679 141 999
2007	645	27 299 805	108 670	6,48	46,70	680 115 929
2008	677	25 950 301	99 750	5,94	42,87	591 114 612
2009	653	32 078 886	85 904	5,12	36,92	526 693 646

Figure 3.25: Overview of diesel oil consumption for railways transport in 1990 – 2009



3.3.4.4 Uncertainties and time-series consistency

The inter-annual decrease in diesel oil consumption in motor traction of railways is caused by the reduction of realised operations number in passenger and freight railways transport (decreases: 2007/2008 1.7%, 2006/2007 4.1%, 2005/2006 6.2%, 2004/2005 2.6%, 2003/2004 4.1%, 2002/2003 20%, 2001/2002 7.1%, 2000/2001 0.98%, 1999/2000 1.5 %, 1998/1999 8.5%. The Railways Company, Ltd. has been adopted a new economic and effective policy in the operation of railways transport. The extensive reconstruction of railways transport infrastructure takes place to fulfill international requirements and caused increase of realized operations number in 2009. The methodology, activity data collection and used emission factors for diesel oil are consistent in timeserie.

3.3.4.5 Source specific QA/QC and verification

The emission inventory of railways was determined by the SHMÚ sectoral expert for transport emission inventory and projections Ms. Michaela Kollárová in cooperation with Mgr. Jiří Dufek from the Research Institute of Transport in Brno (the Czech Republic).

The verification process is based on cross-checking the input data from the Railways Company Ltd. and Statistical Office of the Slovak Republic.

Two fundamental changes were made in the values of emission factor for the motor traction in the GHGs emission inventory during the previous submission. Based on the legislation (Regulation of the Ministry of Environment Nr. 144/2001) about the requirements for the quality of fuels, the EFs for diesel oil were revised in the years 1994 and 2002. The emissions and the actual EFs are shown in Table 3.40. Since 1995, the emissions have been dividing according to the types of railways operations (passenger, freight and service transport).

3.3.4.6 *Source specific recalculations*

No recalculations in the submission 2011 focused on the base year 1990 or the other inventory years were provided.

3.3.4.7 *Source specific planned improvements*

The information about fuel consumption in the international public transport corridors will be verified during the future inventory years.

3.3.5 Source subcategory description – Navigation (CRF 1.AA.3.D)

According to the recommendations of the ERT from 2010 centralised review of the Slovak Republic, all emissions from inland shipping category on Danube River are included in category 1.C1B Memo items – International bunkers (Marine), because of international character of shipping transportation on the Danube River. Other inland shipping transportation in the Slovak Republic is negligible and only for tourist purposes, but was estimated for 2011 submission. This type of transport will be described in more detail in this chapter.

Total aggregated emissions from inland shipping excluded international navigation (Danube River) reached 43.85 tons of CO_2 equivalents in 2009, the slight decrease was recognised compared to the previous year 2008 but compared to the base year, the increase is approximately two times.

Table 3.41: Overview of GHG emission inventory in inland shipping in 1990 – 2009

Year	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
HDP bio Euro	27,98	23,90	22,29	22,72	13,50	14,20	15,10	29,46	30,74	30,76
GDP 2008/year (%)	**55,66%**	**47,55%**	**44,35%**	**45,19%**	**48,00%**	**50,80%**	**54,33%**	**56,71%**	**59,20%**	**59,22%**
Total Consumption (kg/year)	7 136,35	6 096,28	5 686,54	5 794,69	6 154,25	6 513,81	6 966,06	7 270,89	7 590,28	7 592,62
Total Consumption (TJ/year)	0,30	0,26	0,24	0,25	0,26	0,28	0,30	0,31	0,32	0,32
CO_2 Emissions (kg/year)	22 750,68	19 434,93	18 128,68	18 473,48	19 619,76	20 766,04	22 207,79	23 179,60	24 197,82	24 205,28
CH_4 Emissions (kg/year)	1,21	1,04	0,97	0,99	1,05	1,11	1,18	1,24	1,29	1,29
N_2O Emissions (kg/year)	9,21	7,86	7,34	7,48	7,94	8,40	8,99	9,38	9,79	9,79
Total CO_2 eq. (t)	25,63	21,89	20,42	20,81	22,10	23,39	25,02	26,11	27,26	27,27

Year	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
HDP bio Euro	31,18	32,26	33,74	35,35	37,14	39,61	42,98	47,50	50,27	47,86
GDP 2008/year (%)	**60,02%**	**62,06%**	**65,01%**	**68,09%**	**71,60%**	**76,29%**	**82,77%**	**91,40%**	**100,00%**	**95,22%**
Total Consumption (kg/year)	7 695,71	7 957,51	8 335,66	8 730,32	9 180,36	9 781,31	10 612,36	11 718,47	12 821,76	12 208,65
Total Consumption (TJ/year)	0,33	0,34	0,35	0,37	0,39	0,42	0,45	0,50	0,54	0,52
CO_2 Emissions (kg/year)	24 533,92	25 368,55	26 574,09	27 832,26	29 266,98	31 182,83	33 832,20	37 358,47	40 875,77	38 921,17
CH_4 Emissions (kg/year)	1,31	1,35	1,42	1,48	1,56	1,66	1,80	1,99	2,18	2,08
N_2O Emissions (kg/year)	9,93	10,27	10,75	11,26	11,84	12,62	13,69	15,12	16,54	15,75
Total CO_2 eq. (t)	27,64	28,58	29,94	31,35	32,97	35,13	38,11	42,09	46,05	43,85

3.3.5.1 *Methodological issues – methods*

The State Navigation Administration was officially requested to check availability of information about the shipping activity in the Slovak Republic except the Danube River. The NIS expert was informed that they register a total number of ships but without information about their activity or fuel consumption. The expert was also informed about the following portal - www.plavba.net, where information about national touristic shipping on rivers and basis in the Slovak Republic is registered. The emissions of greenhouse gases are calculated from the weight of consumed fuel by diesel motor boats multiplied by emission factor.

3.3.5.2 *Methodological issues – emission factors and other parameters*

3.3.5.3 *Activity data*

The activity occurred in the Slovak Republic, however in limited extend. There are three relevant shipping routes in the Slovak Republic, but these activities were not included in the emission inventory:

- River – basin Váh (Piešťany, Trenčín, dam Liptovská Mara),
- Tributary river Váh (dam Oravská priehrada),
- River – basin Bodrog (dam Zemplínska Šírava).

While the public and touristic shipping activities in the Slovak Republic are not very frequent and have expanded only in the last years, it was necessary to propose an appropriate methodological approach for emission estimation. Chosen activity data were:

- The number of trips per year:

The number of trips per year is limited with the daily schedule of trips mostly in summer months (May-October).

- The duration of trips (in hours):

The duration can differ by the type of trips (mostly short or long tour).

- The technical parameters for most populated ships:

The technical parameters of vessels can be found on the webpage. The engines are mostly with 100 kilowatts diameter, which is a common type of engine used in non-road mechanisms, or in agricultural machinery (type Zetor). The engines run on diesel oil.

- The average consumption of diesel oil in liters per hour:

The average consumption is 12 l of diesel oil per hour of work. The consumption of diesel oil in tons was calculated using average density of 0.84 kg/dm^{-3}.

- The average emission factors for CO_2, CH_4 and N_2O emissions:

According to the EMEP/CORINAIR Emission Inventory Guidebook, 2006, Table 8-1, Agriculture (Bulk emission factors for 'Other Mobile Sources and Machinery', diesel engines), the default for methane and N_2O are: EF (CH_4) is 0.17 g/kg and EF (N_2O) is 1.29 g/kg. The default emission factor for CO_2 was taken from IPCC GL 1996, Reference Manual, Table I-40: EF (CO_2) is 3 188 g/kg.

Table 3.42: The emission estimation for domestic navigation (CRF 1A3d) in 2008

2008	Location							
Activity Data	Piestany - long trip	Piestany - short trip	Trencin	Liptovska Mara	Oravska Priehrada - short trip	Oravska Priehrada - long trip	Zemplinska Sirava	Total
Number of Trips (per year)	140	28	48	240	300	300	240	1 296
Duration of Trip (hours)	1,42	0,92	0,58	1,00	0,50	1,50	0,75	
Total Duration (per year)	198,33	25,67	28,00	240,00	150,00	450,00	180,00	1 272,00
Fuel Consumption (l/hour)	12,00	12,00	12,00	12,00	12,00	12,00	12,00	84,00
Total Consumption (l/year)	2 380,00	308,00	336,00	2 880,00	1 800,00	5 400,00	2 160,00	15 264,00
Total Consumption (kg/year)	1 999,20	258,72	282,24	2 419,20	1 512,00	4 536,00	1 814,40	12 821,76
EF CO_2 (g/kg)	*3 188,00*	*3 188,00*	*3 188,00*	*3 188,00*	*3 188,00*	*3 188,00*	*3 188,00*	
CO_2 Emissions (kg/year)	6 373,45	824,80	899,78	7 712,41	4 820,26	14 460,77	5 784,31	40 875,77
EF CH_4 (g/kg)	*0,17*	*0,17*	*0,17*	*0,17*	*0,17*	*0,17*	*0,17*	
CH_4 Emissions (kg/year)	0,34	0,04	0,05	0,41	0,26	0,77	0,31	2,18
EF N_2O (g/kg)	*1,29*	*1,29*	*1,29*	*1,29*	*1,29*	*1,29*	*1,29*	
N_2O Emissions (kg/year)	2,58	0,33	0,36	3,12	1,95	5,85	2,34	16,54
Total GHG in CO_2 eq. (t/year)	**7,18**	**0,93**	**1,01**	**8,69**	**5,43**	**16,29**	**6,52**	**46,05**

- The additional parameters for emission extrapolation to the base year:

The emission estimation for 2008 is summarized in the Table 3.42. The recent information are based on 2008 data, the estimation of year 2009 was corrected by the ration of GDP decrease (95.22% of 2008).

3.3.5.4 Uncertainties and time-series consistency

The time series are consistent and emission inventory was performed based on GDP information with the consistent methodology, activity data collection and using default emission factors for diesel oil fuel and vessels.

3.3.5.5 Source specific QA/QC and verification

The verification of activity data on fuels sold for shipping activities was performed by the sectoral expert and compared with the statistical information from requested institutions and companies.

3.3.5.6 Source specific recalculations

The recalculation for time series 1990 – 2007 was provided by expert estimation based on GDP growth per year and expert judgment, that the touristic activity is influenced by GDP of the country. The Slovak Republic used Tier 1 methodology based on transportation model (fuel consumption by transit transport) for the estimation of emission from inland shipping on the Danube River. National shipping activities have not been occurred (except of few tourists sightseeing journey during summer months). According to the recommendations of ERT final findings and IPCC 2000 GPG, the emission estimation based on fuel consumption and the international rule for inland shipping on the Danube River was evaluated.

3.3.5.7 Source specific planned improvements

The information about on inland tourists shipping in the Slovak Republic can be collected and updated from several lakes and small rivers.

3.3.6 Source subcategory description – Military aviation (CRF 1.AA.3.E)

GHG emissions of s from military aviation, i.e. jet kerosene consumption, have been included into the category 1A3E Other transportation since 1990. The information is directly from the Ministry of Defense of the Slovak Republic. The methodology is comparable with the methodology for the estimation of emissions from civil aviation, based on fuel consumption in military service multiplied by the default emission factor for jet kerosene. The emissions are not key source and they represented 17% of the civil aviation category, i.e. 5.59 Gg of CO_2 equivalents in 2009.

3.3.6.1 Methodological issues – methods

See methodology for civil aviation in section 3.3.2.1

3.3.6.2 Methodological issues – emission factors and other parameters

See the emission factors for jet kerosene in section civil aviation 3.3.2.2.

3.3.6.3 Activity data

Input activity data are based on statistical information from the Ministry of Defense of the Slovak Republic for jet kerosene consumption in military aviation (Table 3.43).

Table 3.43: Overview of activity data used in GHG inventory for military aviation in 1990 – 2009

	Jet Kerosene				
	Consumption	Consumption	CO_2	CH_4	N_2O
	[TJ]	[t]	[t]	[t]	[t]
1990	95,86	2 223,19	7 003,06	0,56	0,78
1991	82,07	1 903,23	5 995,17	0,48	0,67
1992	69,64	1 615,00	5 087,23	0,40	0,57
1993	83,68	1 940,59	6 112,87	0,49	0,68
1994	84,92	1 969,33	6 203,38	0,49	0,69
1995	87,76	2 035,25	6 411,04	0,51	0,71
1996	76,06	1 763,88	5 556,21	0,44	0,62
1997	37,12	860,90	2 711,82	0,22	0,30
1998	27,73	643,04	2 025,59	0,16	0,23
1999	18,19	421,88	1 328,93	0,11	0,15
2000	23,03	534,13	1 682,50	0,13	0,19
2001	35,63	826,30	2 602,85	0,21	0,29
2002	36,20	839,59	2 644,71	0,21	0,29
2003	21,68	502,70	1 583,52	0,13	0,18
2004	21,10	489,23	1 541,08	0,12	0,17
2005	25,48	590,99	1 861,61	0,15	0,21
2006	25,43	589,80	1 857,88	0,15	0,21
2007	32,88	762,46	2 401,75	0,19	0,27
2008	28,38	658,11	2 073,04	0,16	0,23
2009	21,02	487,45	1 535,46	0,12	0,17

3.3.6.4 Uncertainties and time-series consistency

See the section civil aviation 3.3.2.4. The Tier 1 uncertainty was included in total assessment. Time series consistency is ensured.

3.3.6.5 Source specific QA/QC and verification

See the section civil aviation 3.3.2.5.

3.3.6.6 Source specific recalculations

No recalculations in the submission 2011 focused on the base year 1990 or the other inventory years were provided.

3.3.6.7 Source specific planned improvements

No improvements are planned for the next submission.

3.4 Fuel combustion – reference approach (CRF 1.AB)

3.4.1 Source category description

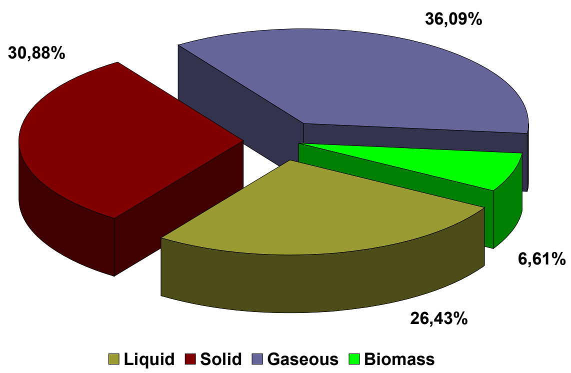
Data gathered and processed by the Statistical Office of the Slovak Republic every year (the annual energy statistic balance) is the base for the calculation of reference approach. Therefore the data is official energy balance data. Company Profing Ltd. Bratislava has prepared preliminary and final energy balances based on documents published by the Statistical Office of the Slovak Republic.

The reference approach balance includes emissions from fuel combustion differentiated according to the gaseous, liquid, solid and biomass categories. The emissions according to the relevant subcategories and gases in 1990 – 2009 are presented in Table 3.44.

The major share (36%) was represented by natural gas consumption, followed by solid fuels (31%) and liquid fuels (26%) in 2009. The share of biomass consumption increased and is more than 6% in total consumption in the Slovak Republic. Total CO_2 emission balanced by reference approach method was 32 437.58 Gg of CO_2 in 2009. Other emissions were not estimated. Detailed emission trend by gases and categories is presented in Table 3.44.

Total CO_2 emissions are without CO_2 emissions stored in feedstock and other products (section 3.6).

Figure 3.26: The share of different fuels consumption within reference approach in 2009



Reference Approach Fuels	TJ	Share (%)
Liquid	135 964,35	26,43%
Solid	158 869,20	30,88%
Gaseous	185 673,71	36,09%
Biomass	33 992,23	6,61%

Table 3.44: GHG emissions within reference approach in 1990 – 2009

CO_2/Gg									
Year	Fuel Combustion (Reference Approach)	Liquid Fuels	Carbon Stored Liquid	Solid Fuels	Carbon Stored Solid	Gaseous Fuels	Carbon Stored Gaseous	Biomass	Feedstocks Total
1990	**56 377,11**	10 596,11	-1 101,40	33 418,32	-85,60	12 362,68	-88,34	1 685,70	**-1 275,34**
1991	**49 719,54**	9 230,58	-955,13	28 711,40	-78,65	11 777,55	-58,64	1 381,72	**-1 092,42**
1992	**44 939,84**	7 845,45	-911,00	25 319,65	-72,78	11 774,73	-65,85	1 253,17	**-1 049,64**
1993	**42 859,62**	6 599,91	-685,97	24 768,15	-71,44	11 491,56	-49,25	720,37	**-806,67**
1994	**39 738,23**	6 966,86	-836,22	21 921,45	-74,11	10 849,91	-69,97	717,30	**-980,30**
1995	**40 881,10**	7 284,38	-969,00	21 599,21	-74,64	11 997,52	-75,41	325,72	**-1 119,05**
1996	**41 379,14**	7 348,46	-914,72	21 477,73	-76,62	12 552,95	-94,65	303,00	**-1 085,99**
1997	**41 478,84**	8 281,41	-821,34	20 411,79	-70,61	12 785,64	-74,32	348,69	**-966,27**
1998	**39 684,99**	8 001,86	-799,86	18 719,50	-62,83	12 963,62	-75,60	302,67	**-938,29**
1999	**38 562,21**	7 338,67	-693,98	18 123,30	-83,73	13 100,24	-75,60	269,48	**-853,32**
2000	**36 392,99**	6 279,16	-792,26	16 943,79	-74,57	13 170,04	-75,63	263,17	**-942,46**
2001	**38 645,78**	7 007,61	-724,32	17 492,38	-81,16	14 145,79	-54,07	1 126,72	**-859,56**
2002	**38 234,07**	7 634,68	-750,03	16 964,23	0,00	13 635,16	0,00	4 191,31	**-750,03**
2003	**38 882,81**	7 386,06	-764,22	18 274,85	0,00	13 221,90	0,00	1 474,73	**-764,22**
2004	**38 149,01**	7 378,39	-772,27	18 133,55	0,00	12 637,07	0,00	593,05	**-772,27**
2005	**37 644,68**	7 419,56	-877,07	16 937,60	-46,11	13 287,53	-80,21	1 459,56	**-1 003,39**
2006	**37 005,84**	7 247,45	-908,35	17 592,00	-44,69	12 166,39	-67,00	1 880,20	**-1 020,03**
2007	**35 234,76**	7 531,34	-904,91	16 369,87	-44,52	11 333,55	-102,39	3 360,48	**-1 051,83**
2008	**35 967,84**	8 417,99	-747,40	15 931,19	-44,71	11 618,66	-60,42	2 419,99	**-852,53**
2009	**32 437,58**	7 272,40	-821,71	15 182,33	-37,78	9 982,85	-61,12	3 194,62	**-920,61**

3.4.2 Methodological issues – methods

Upper level of emissions and sinks of CO_2 from fuel use is determined by using of summary inventory data of the Slovak Republic in form of reference approach table 1.AB (this table provides for data of fuel consumption by type of fuel, their low heating values, emission factors and share of oxidation). This method is called also the top down or the upstream method and is characteristic of minimum requirements on input data. The reference approach provides only aggregate estimates of emissions by fuel type distinguishing between primary and secondary fuels. The aggregate nature of the reference approach estimates means that stationary combustion emissions cannot be distinguished from mobile combustion emissions. The method is applied also as the quickest control and confirmation method. It is necessary to state, that this method does not include so called fugitive emissions, i.e. uncontrolled emissions from mining and post-mining treatment, from transport and other use of fuels.

The reference approach of the Slovak Republic estimates direct CO_2 emissions from the following groups of fuels combusted in energy sector:

- Liquid fuels – primary fuels (Crude Oil, Natural Gas Liquids); secondary fuels (Gasoline, Jet Kerosene, Other Kerosene, Gas/Diesel Oil, Residual Fuel Oil, LPG, Naphtha, Bitumen, Lubricants, Petroleum Coke, Refinery Feedstock, Other Oil).
- Solid fuels – primary fuels (Anthracite, Coking Coal, Other Bit. Coal, Lignite); secondary fuels (BKB & Patent Fuel, Coke Oven/Gas Coke).
- Gaseous fuels – primary fuels (Natural Gas).
- Biomass (solid, liquid, gaseous).

3.4.3 Methodological issues – emission factors and other parameters

In the previous inventory submissions, the emission factors of several important fuels were revised according to national circumstances and according to the direct measurements by sources included in ETS. The CO_2 EF for natural gas, coal, coke, brown coal, lignite and coke oven gas were revised and the values are described in section 1.AA – sectoral approach. The consistency is strictly kept between EFs used in sectoral and reference approach.

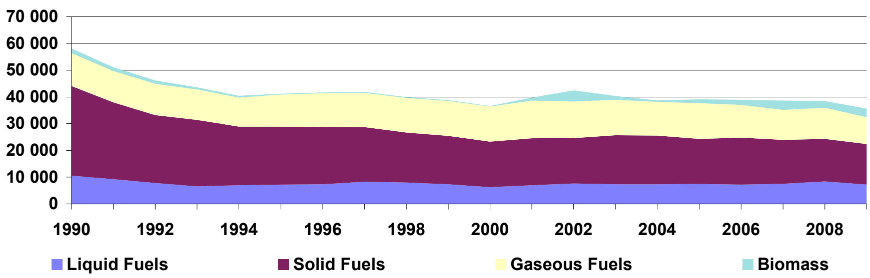
The most significant conclusion is the increasing trend of biomass share since 2006 (interannual 2008/2009 by 32%) and increasing trend of liquid and gaseous fuels and on the other hand, the decreasing trend in the share of solid fuel.

3.4.4 Activity data

The emission inventory based on the reference approach is periodically included into the annual inventory for comparison and verification reasons. The data for preparation of the preliminary energy balance is obtained from the Statistical Office of the Slovak Republic, which is the authority officially organizing and yearly performing statistical findings. Reporting duty to fill the statistical forms is issued by Act No. 322/1992 Coll., § 27 on the National Statistic, as amended. The Statistical Office of the Slovak Republic is performs yearly statistical findings to monitor the consumption of fuels for electricity and heat generation, fuel enrichment processes, the amount of electricity and heat production, sales and distribution of fuels, etc. The results of these findings are used for energy balance calculation as well as for international statistics. Collection of data is performed by using of the following annual statistical forms:

- Energ. P 2-01 Yearly Company Statement on energy process of fuel enrichment.
- Energ. P 3-01 Yearly Company Statement on the consumption of fuels, electricity and heat for production of selected commodities.
- Energ. P 4-01 Yearly Company Statement on the production of heat and electricity.
- Energ. P 5-01 Yearly Company Statement of retail trade in solid fuels.
- Energ. P 6-01 Yearly Company Statement on sources and distribution of fuels.
- Energ. P 1-01 Yearly Company Statement of manufacture branches.

Figure 3.27: The share of different fuels consumption within reference approach in 1990 – 2009



3.4.5 Uncertainties and time-series consistency

Reference approach uncertainties are determined by the methodology of the Statistical Office of the Slovak Republic. The Monte Carlo method was not applied for the CO_2 emissions estimated by reference approach methodology. The methodology is consistent during time series across of the main types of fuels.

3.4.6 Source specific QA/QC and verification

Results of energy statistic that are used for GHG emission inventories are yearly issued in the Statistical Yearbooks and in the publications on energy statistics in physical and caloric values The first preliminary data on the balances of liquid, solid, gaseous fuels and biomass from the previous year in the Slovak Republic are available at the beginning of October. These data are verified by Profing Ltd. Bratislava (comparing the consumption of fuels and production of heat and electricity, discussion with the main producers of heat and electricity and suppliers of fuels, etc.) and used for reference approach.

Profing Ltd. Bratislava (the company for energy research) executed the preliminary energy balance based on the documents published by the Statistical Office. Profing Ltd. Bratislava namely Dr. Ján Judák, the director, is the sectoral expert for energy and the external consultant for energy questions in the Slovak National Inventory System. He is responsible for the preparation of reference approach balance, the fugitives emissions balance from mines, oil and gas industry. The reference approach determines the apparent consumption of individual types of fuels (primary, secondary and biomass) for which the inventory is being prepared. This information is available in energy (TJ) and mass (Gg) units.

3.4.7 Source specific recalculations

No recalculations in the submission 2011 focused on the base year 1990 or the other inventory years were provided.

3.4.8 Source specific planned improvements

According to the newly published EUROSTAT information about NCVs for liquid fuels, the expert comparison will be necessary in the next inventory year.

3.5 Difference – sectoral and reference approach (CRF 1.AC)

3.5.1 Source category description

Complete time series of CO_2, CH_4 and N_2O emissions for reference and sectoral approaches have been estimated since the base year. The higher difference between sectoral and reference approach in the older submissions is caused by the complicated situation in the national database NEIS, the changes in the legislation in air protection and different classification of fuel types in statistical collection of data and national legislation in large combustion plants and other stationary sources. The previous recalculations of sectoral approach were based on the reallocation of the fuel consumption into the separate CRF categories for the years 1991 – 1999 according to appropriate IPCC methodology. The revised EFs for natural gas, coal, brown coal, coke and coke gas were used. Total difference between reference and sectoral approach in CO_2 balance was 19% in 2009. The difference in fuel consumption (in TJ) was 12% in 2009.

Figure 3.28: The difference between reference and sectoral approaches in 1990 – 2009

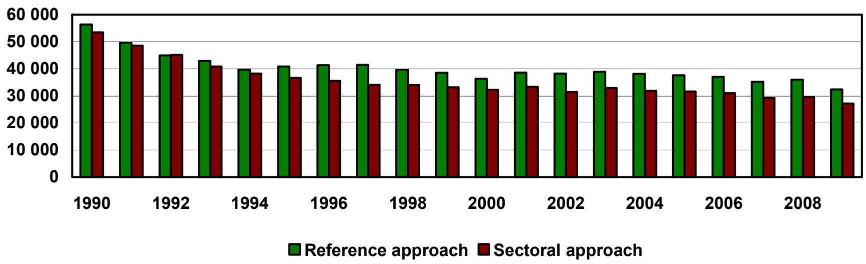
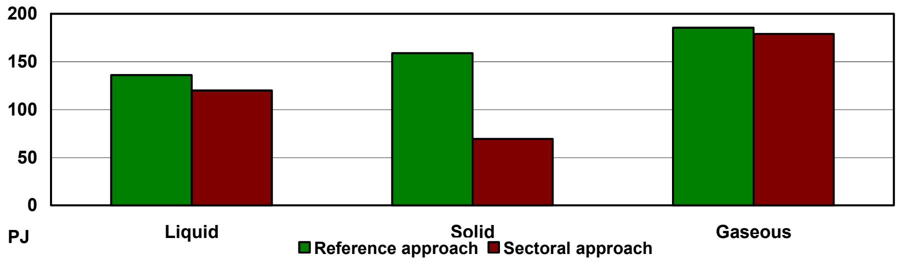
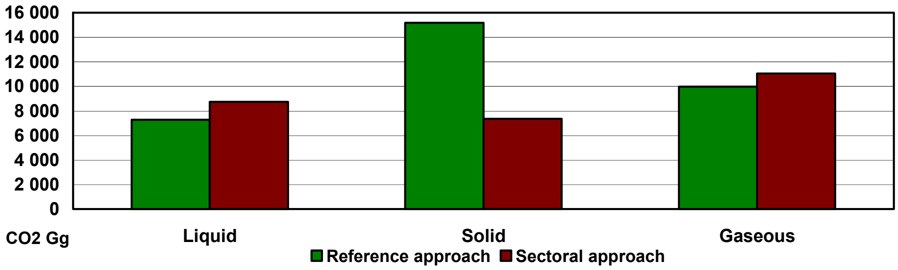


Figure 3.29: The difference between reference and sectoral approaches for fuel consumption in PJ and for CO_2 emissions in 2009





3.5.2 Methodological issues – methods

Reference and sectoral approaches are estimated on fully independent data sets, whereby obtained differences are significant compared to the previous methodology. After recalculation of category 1A2a iron and steel production (see section 3.2) the difference between the top down and the bottom up energy balance was recalculated to the base year and it is increasing. The differences in fuel consumption between these two approaches were caused by the reallocation of the major share of fuels to the industrial processes sector.

The following reallocation of technological fuels and their emissions were performed in 2010 submission:

- Reallocation of CO_2 emissions from cooking coal from category iron and steel 1A2a (energy sector) to category iron and steel production 2C1 (IP sector).
- Reallocation of CO_2 emissions from cooking coal from category chemicals 1A2c (energy sector) to category carbide production 2B4 (IP sector).
- Reallocation of CO_2 emissions from natural gas from category chemicals 1A2c (energy sector) to category ammonia production 2B1 (IP sector).
- Reallocation of CO_2 emissions from coke from category non-ferrous 1A2b (energy sector) to category ferroalloys production 2C2 (IP sector).

Including solid fuels into sectoral approach balance since the base year (only for comparison reason), the estimation and comparison with reference approach was more representative and the differences are showed in the following Table 3.45 and Figures 3.30 and 3.31. The difference in 2009 was estimated as 0.74% for CO_2 emissions.

Table 3.45: The comparison of RA and SA with the inclusion of emissions from technology (reallocated into IP sector) in 1990 – 2009

Year	RA CO_2 emissions [kt]	SA CO_2 emissions [kt]	Difference RA/SA	Cooking Coal Iron&Steel (kt)	Cooking Coal (kt) CaC_2	Natural gas (ammonia)	Ferroalloyl production kt	*SA CO_2 emissions [kt]*	Difference CO_2% RA/SA
1990	**56 377,11**	**53 493,17**	-5,39	7 671,86	NO	616,97	270,04	***62 052,05***	**9,15**
1991	**49 719,54**	**48 546,04**	-2,42	6 877,82	NO	608,44	263,54	***56 295,83***	**11,68**
1992	**44 939,84**	**45 193,74**	0,56	6 196,38	21,90	592,76	255,74	***52 260,52***	**14,01**
1993	**42 859,62**	**40 913,34**	-4,76	5 638,25	54,50	353,38	239,70	***47 199,18***	**9,19**
1994	**39 738,23**	**38 228,71**	-3,95	5 194,39	84,19	595,16	237,19	***44 339,64***	**10,38**
1995	**40 881,10**	**36 695,49**	-11,41	4 855,74	96,51	654,14	214,21	***42 516,09***	**3,85**
1996	**41 379,14**	**35 511,05**	-16,52	4 613,24	103,60	700,83	205,46	***41 134,18***	**-0,60**
1997	**41 478,84**	**34 155,72**	-21,44	4 457,85	110,61	695,36	189,85	***39 609,39***	**-4,72**
1998	**39 684,99**	**34 022,51**	-16,64	4 380,51	101,52	616,38	225,00	***39 345,91***	**-0,86**
1999	**38 562,21**	**33 151,81**	-16,32	4 772,17	92,59	617,04	200,00	***38 833,61***	**0,70**
2000	**36 392,99**	**32 344,10**	-12,52	4 841,44	101,79	683,85	167,41	***38 138,58***	**4,58**
2001	**38 645,78**	**33 485,39**	-15,41	4 862,99	114,10	696,84	152,49	***39 311,82***	**1,69**
2002	**38 234,07**	**31 466,90**	-21,51	5 109,44	114,65	677,41	304,15	***37 672,54***	**-1,49**
2003	**38 882,81**	**32 945,63**	-18,02	5 794,95	115,11	599,49	301,01	***39 756,20***	**2,20**
2004	**38 149,01**	**31 912,46**	-19,54	5 474,63	157,40	690,73	338,52	***38 573,75***	**1,10**
2005	**37 644,68**	**31 695,03**	-18,77	5 719,14	140,21	721,40	206,74	***38 482,51***	**2,18**
2006	**37 005,84**	**30 980,63**	-19,45	6 349,65	149,61	602,65	249,77	***38 332,31***	**3,46**
2007	**35 234,76**	**29 188,61**	-20,71	5 885,90	151,17	614,52	271,68	***36 111,88***	**2,43**
2008	**35 967,84**	**29 691,54**	-21,14	5 269,65	154,04	556,57	237,67	***35 909,47***	**-0,16**
2009	**32 437,58**	**27 210,61**	-19,21	4 599,63	144,72	618,40	104,42	***32 677,78***	**0,74**

Figure 3.30: The difference between RA and SA for CO_2 emissions with the inclusion of emissions from technology (reallocated in IP sector) in 1990 – 2009

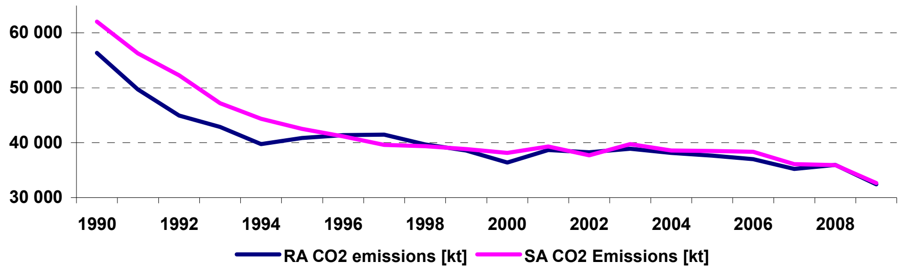
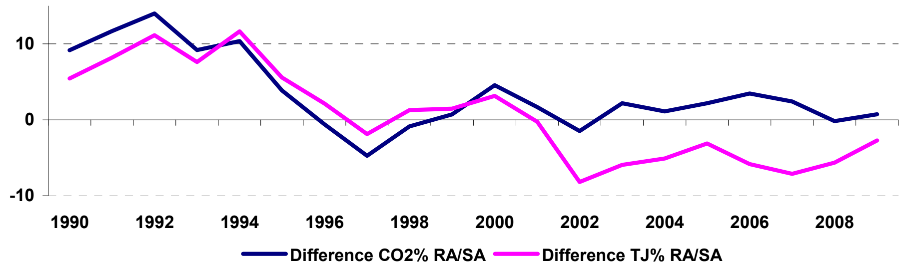


Figure 3.31: Trend in new estimated difference between RA and SA for CO_2 emissions and for fuels consumption with the inclusion of emissions from technology (reallocated in IP sector) in 1990 – 2009



Considering the results of analyses, minor inconsistencies in the trend before 1996 can be realized. The plant specific information before 1996 was not possible to obtain in sufficient extent necessary for the analyses. The expert interpolation took place in several industrial categories in order to produce parameters and emission factors. The consistency is ensured by using the same methodology for the estimation of fuel consumption and emissions. The following Figure shows the trend in time series of differences in fuels and emissions between sectoral and reference approach including the allocation of fuels from IP sector

3.5.3 Methodological issues – emission factors and other parameters

The information on the emission factors are presented in sections on sectoral and reference approach. The minor differences were caused by the use of average NCVs (net calorific values) in reference approach and fuel specific NCVs in sectoral approach. In sectoral approach, the quantities of fuels used in blast furnace (IPCC category 1.AA.2.A – solid fuels and gaseous fuels) were excluded from energy balance and the quantities of residual carbon from combustion, witch stayed in products, were excluded from energy balance (IPCC categories 1.AA.1.C – other fuels and 1.AA.2.C – liquid and gaseous fuels). Since 1990, total fuel combustion decreased significantly and the share of natural gas as an alternatively fuel type increased. After the medium increase in solid fuels in 2001, the decreasing trend in 2002 – 2007 was appeared in energy balance. In the last inventory year 2009 the significant decreasing trend was recognized. The balance of solid fuels consumption is complicated due to the calculation of the stock change. The Statistical Office of the Slovak Republic updates the fuel categories and methodology for stock fuel annually. The quality of data used for bottom-up approach is higher, because this data is checked more time (by operators, providers of NEIS database, sectoral expert and SNE).

3.5.4 Activity data

The information on activity data are presented in sections on sectoral and reference approaches. The comparison is showed in Table 3.46.

Table 3.46: Comparison of fuel consumption by fuel type and CO_2 emissions within reference and sectoral approaches in 2009

	Liquid	Solid	Gaseous	Other	Total
	Fuel Consumption (PJ)				
Reference approach	135,96	158,87	185,67	NA	480,51
Sectoral approach	120,04	69,36	178,90	1,55	369,85
Difference	*-28,98*	*126,25*	*-3,08*	*-100,00*	*12,36*
Apparent energy consumption (excluding non-energy use and feedstocks)	85,25	156,93	173,38	NO	415,56
	CO_2 Emissions (Gg)				
Reference approach	7 272,40	15 182,33	9 982,85	NA	32 437,58
Sectoral approach	8 729,85	7 356,73	11 055,12	68,91	27 210,61
Difference	*-16,70*	*106,37*	*-9,70*	*-100,00*	*19,21*

3.5.5 Uncertainties and time-series consistency

For the uncertainty analysis and time-series consistency see sections on sectoral and reference approaches.

3.5.6 Source specific QA/QC and verification

For the source specific QA/QC and verification see sections on sectoral and reference approaches.

3.5.7 Source specific recalculations

For the source specific recalculation see sections on sectoral and reference approaches.

3.5.8 Source specific planned improvements

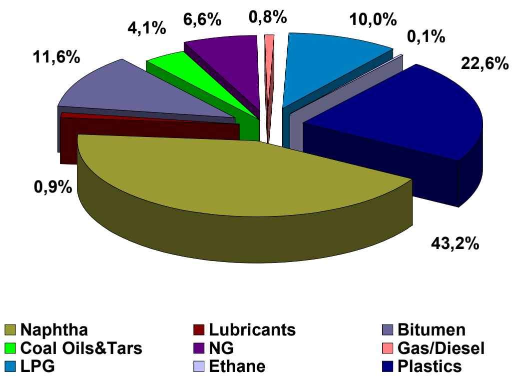
For the planned improvements see sections on sectoral and reference approaches.

3.6 Feedstocks and non-energy use of fuels (CRF 1.AD)

3.6.1 Source category description

Using the IPCC methodology (IPCC, 1996), the quantity of residual carbon from combustion which stayed in products (carbon fixed in tar and tar's oils occurring by carbonisation and in petrochemical oil products such as polyethylene, polypropylene, asphalts and lubricants etc., carbon bound in fertilizers) was estimated. Total amount of carbon stored in products was 3 375.57 Gg of CO_2 (920.61 Gg C) in 2009.

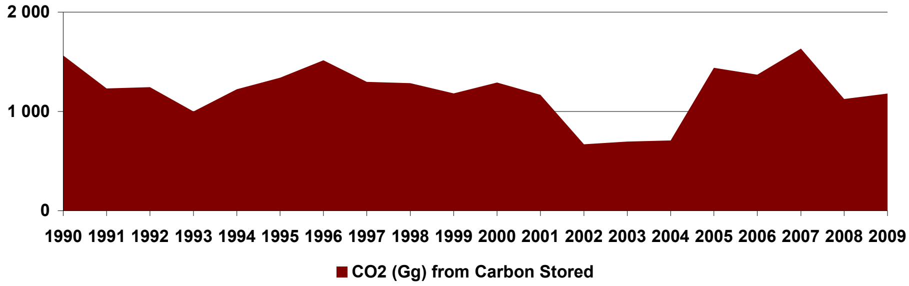
Figure 3.32: The share of different fuel type with the share of carbon stored in 2009



Fuel Type	Carbon Stored (Gg)	Share (%)
Naphtha	397,63	43,19%
Lubricants	8,45	0,92%
Bitumen	106,70	11,59%
Coal Oils&Tars	37,78	4,10%
NG	61,12	6,64%
Gas/Diesel	7,36	0,80%
LPG	92,41	10,04%
Ethane	1,27	0,14%
Plastics	207,88	22,58%
Total	**920,61**	**100,00%**

The major shares of carbon stored represent naphtha (43%) and plastics (23%) fuels.

Figure 3.33: Overview of carbon stored in 1990 – 2009



3.6.2 Methodological issues – methods

The method of determination is based on plant specific information, the expert's judgment (Profing Ltd.) and the balanced items are less significant from the viewpoint of total. The Tier 1 method was applied of the estimation of carbon stored.

Table 3.47: Overview of carbon stocks in fuels in 2009

Fuel Type	Fuel quantity (TJ)	Fraction of carbon stored	EFs (tC/TJ)
Naphtha	24 852,00	0,80	20,00
Lubricants	845,28	0,50	20,00
Bitumen	4 887,92	1,00	21,83
Coal Oils&Tars	1 942,48	0,75	25,93
NG	12 293,86	0,33	15,07
Gas/Diesel	464,40	0,80	19,82
LPG	6 578,00	0,80	17,56
Ethane	94,80	0,80	16,80
Plastics	12 992,19	0,80	20,00

3.6.3 Methodological issues – emission factors and other parameters

The most important criterion for EF and fraction of stored carbon is the consistency with parameters used in reference approach. The IPCC default values for the fractions of stored carbon are used mostly in the inventory.

3.6.4 Activity data

The following fuel types were balanced in the Slovak Republic in 2009 (Table 3.48):

- Fuels used as feed stocks type – Naphtha, Lubricants, Bitumen, Coal Oils and Tars (from Coking Coal), Natural Gas, Gas/Diesel Oil, LPG, Ethane and Plastics under other fuels.

3.6.5 Uncertainties and time-series consistency

The Tier 1 uncertainties analysis was performed according to the IPCC 2000 GPG. The Tier 2 uncertainty estimation has not been provided for the subcategory of civil aviation. The lack of input data is the most facing issue. The methodology is consistent during time series across of main types of fuels.

3.6.6 Source specific QA/QC and verification

The results of energy statistic that are used for GHG emission inventories are yearly issued in the Statistical yearbooks and in energy publications in physical and caloric values. The first preliminary data related to the liquid, solid, gaseous and biomass fuels balance for previous year in the Slovak Republic are available at the beginning of October. These data are verified by Profing Ltd. Bratislava (comparing the consumption of fuels and the production of heat and electricity, the discussion with the main producers of heat and electricity and suppliers of fuels, etc.) and they are used for reference approach.

Table 3.48: Overview of quantity and CO_2 stocks in fuels in the period 1990 – 2009

Fuel	Naphtha (1A2c)		Lubricants (1A1c)		Bitumen (1A1c)		Coal Oils&Tars (1A1c)		NG (1A2c)	
Year	(TJ)	CO_2 (Gg)	(TJ)	CO_2 (Gg)	(TJ)	CO_2 (Gg)	(TJ)	CO_2 (Gg)	(TJ)	CO_2 (Gg)
1990	7 514	441	3 314	122	14 958	1 197	5 139	314	16 658	324
1991	7 210	423	2 231	82	11 942	956	4 722	288	11 058	215
1992	7 578	445	1 864	68	11 104	889	4 369	267	12 417	241
1993	3 842	225	1 349	49	5 992	480	4 289	262	9 288	181
1994	4 367	256	1 360	50	9 553	765	4 449	272	13 194	257
1995	4 312	253	1 561	57	12 151	973	4 481	274	14 220	277
1996	4 706	276	1 634	60	8 380	671	4 600	281	17 848	347
1997	4 715	277	1 740	64	7 081	567	4 239	259	14 015	273
1998	3 181	187	1 809	66	6 832	547	3 772	230	15 739	277
1999	3 181	187	1 525	56	8 118	650	5 027	307	15 358	277
2000	7 085	416	1 721	63	6 832	547	4 477	273	14 261	277
2001	18 679	1 096	2 984	109	4 019	322	4 872	298	10 196	198
2002	14 716	863	2 754	101	4 783	383	NO	NO	NO	NO
2003	15 092	885	2 646	97	3 846	308	NO	NO	NO	NO
2004	25 212	1 479	NO	NO	NO	NO	NO	NO	NO	NO
2005	24 518	1 438	1 881	69	3 441	275	2 378	169	16 139	294
2006	22 719	1 333	2 800	103	4 201	336	2 311	164	13 465	246
2007	24 590	1 443	2 861	105	4 134	331	2 311	163	20 601	375
2008	16 394	962	1 814	67	5 369	430	2 311	164	12 202	222
2009	24 852	1 458	845	31	4 888	391	1 942	139	12 294	224

Fuel	Gas/Diesel (1A1b)		LPG (1A2c)		Ethane (1A1b)		Plastics (1A2c)	
Year	(TJ)	CO_2 (Gg)	(TJ)	CO_2 (Gg)	(TJ)	CO_2 (Gg)	(TJ)	CO_2 (Gg)
1990	14 902	554	1 135	58	33 810	1 666	NO	NO
1991	12 605	469	914	47	30 960	1 526	NO	NO
1992	10 532	392	790	41	30 566	1 506	NO	NO
1993	10 449	388	733	38	27 080	1 335	NO	NO
1994	11 311	421	851	44	31 066	1 531	NO	NO
1995	13 940	518	955	49	34 549	1 703	NO	NO
1996	14 338	533	971	50	35 796	1 764	NO	NO
1997	14 847	552	959	49	30 497	1 503	NO	NO
1998	15 739	585	969	50	30 394	1 498	NO	NO
1999	15 358	571	503	26	21 415	1 055	NO	NO
2000	16 976	631	974	50	24 309	1 198	NO	NO
2001	23 800	885	3 738	193	1 045	51	NO	NO
2002	5 018	294	3 383	174	902	44	15 168	890
2003	4 831	281	6 436	332	893	44	14 582	855
2004	630	37	7 126	367	705	35	15 582	914
2005	633	37	6 575	339	190	9	17 870	1 048
2006	633	37	6 302	325	664	33	19 225	1 128
2007	591	34	7 130	367	569	28	16 629	976
2008	464	27	6 394	329	474	23	14 927	876
2009	464	27	6 578	339	95	5	12 992	762

3.6.7 Source specific recalculations

No recalculations in the submission 2011 focused on the base year 1990 or the other inventory years were provided.

3.6.8 Source specific planned improvements

No further improvements are planned in this source category.

3.7 Fugitive emissions from coal mining and handling (CRF 1.B.1.A) and oil and natural gas (CRF 1.B.2)

3.7.1 Source subcategory description

Detail source category 1B description is included in section 3.1.2.

3.7.2 Source subcategory description - Coal mining and handling (CRF 1.B.1.A)

The Slovak Republic mined 2 571.9 kt of brown coal from underground mines in 2009 mostly for domestic consumption (industry and households). From this quantity 60 kt of assorted coal was sold for households. The coal market is fully liberalized, the domestic production does not cover all demand, because of 780 kt of brown coal is imported (mostly from the Czech Republic). The production of brown coal (mining) was slightly increased by more than 6% compared to the previous year. Total methane emission from the underground coal mining in 2009 was estimated to be 16.92 Gg (15.37 Gg of CH_4 from mining activities, 1.55 Gg of CH_4 from post-mining activity and 0.30 Gg of CO_2 equivalents from methane cogeneration (electricity and heat production) with recovery of 0.11 Gg of CH_4.

3.7.2.1 Methodological issues – methods

Total emission from fugitive sources in coal mining industry can be calculated by the following formula: methane emissions = underground mining emissions + post-mining activity emissions – recovery or flared methane with cogeneration with Tier 2 methodology with the country specific EFs. The amount of mined brown coal (in the raw form) is the most important activity data. The fugitive methane emissions from underground coal mining and post-mining activities in the Slovak Republic were estimated in accordance with the following Tier 2 methodology from IPCC 2000 GPG.

Table 3.49: Overview of fugitive emissions from mining and post-mining activities in 1990 – 2009

Year	Brown Coal [kt]	CH_4 Emissions from Mining [Gg]	CH_4 Recovery from Mining [Gg]	CH_4 Emissions from Post-Mining [Gg]	CH_4 Emissions Total [Gg]
1990	3 456,00	25,114	0,000	2,084	**27,198**
1991	3 663,00	26,618	0,000	2,209	**28,827**
1992	3 803,50	27,639	0,000	2,294	**29,932**
1993	3 614,30	26,433	0,000	2,179	**28,612**
1994	3 744,80	27,654	0,000	2,258	**29,912**
1995	3 759,10	27,437	0,000	2,267	**29,704**
1996	3 840,10	27,760	0,000	2,316	**30,076**
1997	3 914,20	28,253	0,000	2,360	**30,613**
1998	3 951,00	28,785	0,000	2,382	**31,168**
1999	3 806,50	27,201	0,000	2,295	**29,496**
2000	3 649,30	26,620	0,000	2,201	**28,821**
2001	3 424,00	24,265	0,000	2,065	**26,330**
2002	3 401,00	23,643	0,000	2,051	**25,694**
2003	3 075,23	19,260	0,000	1,854	**21,114**
2004	2 951,87	17,993	0,000	1,780	**19,773**
2005	2 511,20	14,658	0,000	1,514	**16,173**
2006	2 206,28	13,340	0,000	1,330	**14,671**
2007	2 064,48	12,273	0,226	1,245	**13,518**
2008	2 423,07	14,488	0,182	1,461	**15,949**
2009	2 571,90	15,373	0,106	1,551	**16,924**

3.7.2.2 Methodological issues – emission factors and other parameters

For the calculation of fugitive methane emissions from mining activities the emission factors from the following sources were used:

- IPCC 1996 Guidance for National Greenhouse Gas Inventories, Fugitive sources, 1.4 Methane Emissions from Coal Mining and Handling Activities.
- IPCC Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories page 2.70, 2.6 Fugitive Emissions from Coal Mining and Handling.

- International Energy Agency – CIAB Global Methane and the Coal Industry (http://spider.iea.org/ciab/).
- Estimation of EF (CH_4) specified of mines operator – HBP Prievidza.

According to the IPCC 1996 Guidance the emission factor is identical for all mines with the values of 10 m^3 CH_4/t for coal mining and 0.9 m^3 CH_4/t for post-mining activities. Both values are on the lower level of the suggested scale. Emission factors based on the International Energy Agency CIAB methodology were assigned according to the depth of the mines for mining within 6 a 13 m^3 CH_4/t and 0.9 m^3 CH_4/t for post-mining activity. The emission factor measured by the mine operators of HBP Prievidza on the base of concentration values of the methane in the air ventilation was assigned for one single mine according to the suggestion of the operators. The emission factors for post–mining activities were used from IPCC 2000 GPG for mining without drainage with known of gas amount (in the coal after mining is present 30% of gas and 10% of gas for mines with pre-drainage). Overview of emission factors are presented in Table 3.50.

Based on the judgment of sectoral expert, it was decided to calculate fugitive methane emissions in the period 1990 – 2009 on the base of coal production from underground mines obtained from official sources and emission factors according to the methodology IEA-CIAB Global Methane and the Coal Industry selected for the depth of the mines (Table 3.50, point 2).

Table 3.50: Coal production, characteristics of mine and the availability of emission factors for mining and post-mining assigned to single mines in the Slovak Republic in 2009

Mine	Mine Novaky	Mine Novaky 6th Logging Place	Mine Cigel	Mine Cigel 7th Logging Place	Mine Handlova	Mine Handlova East Shaft	Mine Dolina	Mine Cary
Coal Production [kt]	1 476,000	0,000	0,000	575,000	0,000	226,000	139,700	155,195
Depth of Mine [m]	200	200	500	500	500-1500	500-1500	600	400
	EF CH_4 [m^3/t]							
1. IPCC 1996 GL								
IPCC Mining Tier 1	10	10	10	10	10	10	10	10
IPCC Post-Mining	0,9	0,9	0,9	0,9	0,9	0,9	0,9	0,9
2. IEA - CIAB Global Methane and the Coal Industry								
CIAB Mining	6	6	13	13	13	13	13	13
CIAB Post-Mining	0,9	0,9	0,9	0,9	0,9	0,9	0,9	0,9
3. Measurements of HBP, a.s.								
HPB Mining	0,92	4,17	0	4,17	0	4,17	0,02	0,02
HPB Post-Mining	0,39	0,46	0	0,46	0	0,46	0,01	0,01

The calculation used the assumption that fugitive methane emissions were partly used for cogeneration of electricity and heat since 2007 in the east shaft of mine Handlová and it continued also in 2009. The amount of methane cogenerated is 2009 was 158.175 kt. The calculation is based on the measurement of gaseous mixture and concentration of methane. The emissions of GHGs from cogeneration are included into category 1.AA.1.A – other fuel (methane cogeneration (mining)) and represents 0.30 Gg of CO_2 equivalents in 2009. The cogeneration activities are expected also in the future. Flaring activity for reducing methane emissions from coal mining in the Slovak Republic is not occurred in 2009. Using emission factors from IEA-CIAB according to the depth of mine, the appropriate EF is estimated for each mine and the total emissions from mining summarise the emissions from mines. The average EF for methane from mining was 6.62 kg/t in 2009.

Table 3.51: Cogeneration of methane from Mine Handlová, the east shaft during 2007 – 2010 (*predictions)*

Methane cogenerated in Mine Handlova		2007	2008	2009	2010*
Mixture Methane + Air	m^3	1 022 730	910 560	925 000	700 000
Average Concentration of CH_4	%	33,06	30	17,1	20
Quantity of CH_4	m^3	338 115	273 168	158 175	140 000
Density of CH_4 (20°C)	kg/m^3	0,668	0,668	0,668	0,668
Quantity of Flared CH_4	t	226	182	106	94

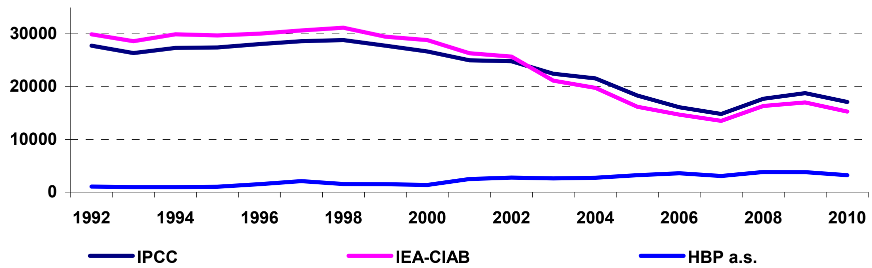
3.7.2.3 Activity data

Five localities of underground mines operated by three companies are in the Slovak Republic. Data of coal production from the underground mines have been obtained from official sources (official statistical sources: the Ministry of Economy of the Slovak Republic and the Statistical Office of the Slovak Republic) and directly from the companies: Hornonitrianske bane Prievidza (HBP), Baňa Dolina Veľký Krtíš (BD) and Baňa Čáry (BC). According to the regulation of the Slovak Office of Mines 21/1988 the mines are differentiated based on gas release as follow:

- HBP, a.s. Prievidza:
  - Mine Cígeľ – non-gaseous (except 7th logging place)
  - Mine Handlová – gaseous
  - Mine Nováky – gaseous
- Baňa Čáry Holíč – gaseous
- Baňa Dolina Veľký Krtíš – gaseous

Figure 3.34 shows the comparison of trends in estimated CH_4 emissions in the Slovak Republic in years 1990 – 2009 (2010 predictions) according to different emission factors of IPCC GPG 2000, IEA-CIAB methodology and EF(CH_4) measured by HBP, a.s. Prievidza. In the case of emissions calculation with using of IPCC emission factors, the trend of fugitive emissions CH_4 is declining in accordance with the reduction of coal mining in the Slovak Republic (Tier 1). The application of EF (CH_4) specified by the mine operator (HBP, a.s.) shows the increasing trend of fugitive emissions CH_4 in contradiction with the decrease in coal mining in the mines. It is due the move of coal mining to parts of mines with coal containing more gas. Using these plant specific emission factors is not in accordance with good practice, because measurements are not certified and they are not carried out continuously. The emissions can be underestimated.

Figure 3.34: Comparison of trends of CH_4 emissions in the Slovak Republic in years 1990 – 2010 (*predictions)*



CH_4 emissions from post-mining activities represent the second part of gaseous methane, which is present in mined coal. This source of emission releases the methane into the atmosphere during the manipulation and storage of coal. The measurement of these emissions are not realised so the emission must be estimated with the default emission factors. It is assumed, that 25–40% of CH_4 is present in the coal. It is recommended to use the emission factor 30% for the mines without drainage and the emission factor 10% for the pre-drainage mines. The average emission factor used for the estimation of emission from post-mining activities based on IEA-CIAB methodology is 0.9 m^3/t (0.603 kg/t).

3.7.2.4 Uncertainties and time-series consistency

The Tier 1 uncertainty analysis was performed according to the IPCC 2000 GPG. The Tier 2 uncertainty estimation was not provided for subcategory civil aviation for the present. Lack of input data availability is the most facing issue. The methodology is consistent during time series across of the main types of fuels.

The amount of methane from underground mining is naturally variable. The direct measurements of the CH_4 emissions from the ventilated air are made with the ±20% accuracy depending on the measurement's installation. The repeatability of the measurements increases the accuracy up to ±5%. For the continual measurement the uncertainty is in the range of ±10–15% for the two weeks repeating.

The emission inventory of fugitive methane emissions from mining activities were revised in the previous years, the chosen emission factors for underground coal mining and handling correspond to the circumstances in the Slovak mining industry. The important reason for this opinion is an occurrence of brown coal underground mines with mainly non-gaseous system in deep shafts.

3.7.2.5 Source specific QA/QC and verification

The Slovak inventory team in cooperation with Profing Ltd. (Mr. Jan Judak is the sectoral expert for energy and fugitive emissions) were provided the emission estimation according to the methodology, which has been used since base year, and official statistics.

The verification process is based on cross-checking of input data from the mining companies and the comparison with the sectoral statistical indicators from the Ministry of Economy and the Statistical Office of the Slovak Republic. The background documents are archived by sectoral experts and in central archiving system of SNE at the SHMÚ.

3.7.2.6 Source specific recalculations

No recalculations in the submission 2011 focused on the base year 1990 or the other inventory years were provided.

3.7.2.7 Source specific planned improvements

The Slovak Republic uses EFs from the international methodology IEA-CIAB, the improvements can be found in the implementation of EFs measured directly from the mines. According to the present measurements, the information about the gas released is not sufficiently accurate and measurements are not continual. Greater effort could be invested into the determination of appropriate national EFs for mining and post-mining activities in the Slovak Republic.

3.7.3 Source subcategory description – Oil and natural gas (CRF 1.B.2)

The production of oil and natural gas from domestic sources are negligible in the Slovak Republic and the major share of these stocks comes from import. These categories are important key sources in level and trend assessment. Total aggregated emissions represented 793.33 Gg of CO_2 equivalents (37.77 Gg CH_4) in 2009. Total CO_2 emissions were 0.241 Gg in 2009 and the estimation was based on the composition of natural gas and carbon content. Total N_2O emissions were 4.7 kg in 2009. The time series since 1990 has been completed. Total emission from oil activities (1B2A) were 2.33 Gg of CO_2 equivalents (0.71 t of CO_2 and 111.08 t of CH_4) in 2009. Total emissions are decreasing continuously due decreasing of production and storage (Table 3.52).

Total emissions from natural gas (1B2B) activities were 681.14 Gg of CO_2 equivalents (207 t of CO_2 and 32.425 Gg of CH_4) in 2009. Since 2003 total emissions fluctuated due to the changes in production and storage. Other leakages at industrial plants and power stations and in residential and commercial sectors are included in transmission and distribution categories and balance according to the length of pipeline.

Table 3.52: Trend in fugitive emissions from oil activities in 1990 – 2009

	Oil Production			Oil Transport			Oil Refining/Storage		
Year	Production [TJ]	CO_2 Emissions [t]	CH_4 Emissions [t]	Production [PJ]	CO_2 Emissions [t]	CH_4 Emissions [t]	Production [PJ]	CO_2 Emissions [t]	CH_4 Emissions [t]
1990	3 046,01	0,58	109,71	565,62	0,39	73,34	259,99	0,18	33,71
1991	2 978,22	0,57	107,27	565,57	0,39	73,34	209,05	0,14	27,11
1992	2 561,61	0,49	92,27	565,55	0,39	73,34	182,50	0,13	23,67
1993	2 769,25	0,53	99,75	565,55	0,39	73,34	190,26	0,13	24,67
1994	2 803,88	0,54	100,82	565,65	0,39	73,34	200,86	0,14	26,05
1995	3 091,86	0,59	111,37	522,75	0,36	67,66	227,97	0,16	29,51
1996	2 970,39	0,57	107,00	522,75	0,36	67,66	224,63	0,15	29,13
1997	2 665,14	0,51	96,00	461,79	0,32	59,89	222,11	0,15	28,80
1998	2 490,25	0,48	90,00	461,79	0,32	59,89	227,48	0,16	29,60
1999	2 739,38	0,53	99,00	431,66	0,30	56,16	224,63	0,16	29,22
2000	2 448,76	0,47	88,50	385,95	0,27	50,22	223,60	0,15	29,10
2001	2 290,75	0,44	82,50	397,80	0,27	51,58	228,30	0,16	29,48
2002	2 132,00	0,41	78,00	387,29	0,27	51,01	229,81	0,16	30,27
2003	1 747,20	0,33	63,00	413,07	0,28	53,62	234,46	0,16	30,43
2004	1 581,00	0,30	57,00	429,57	0,30	55,75	239,41	0,17	31,07
2005	1 277,20	0,25	46,50	439,29	0,31	57,58	228,33	0,16	29,93
2006	1 162,00	0,23	42,00	462,54	0,33	60,19	238,58	0,17	31,04
2007	1 162,00	0,18	42,00	441,44	0,24	57,44	252,86	0,14	32,90
2008	747,00	0,11	27,00	442,25	0,24	57,55	245,68	0,13	31,97
2009	622,50	0,14	22,50	443,44	0,37	57,70	237,34	0,20	30,88

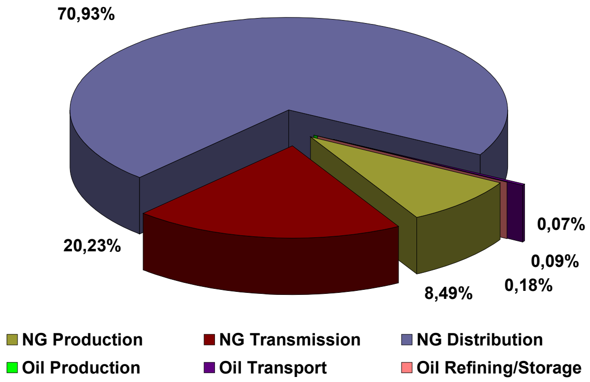
Table 3.53: Trend in fugitive emissions from NG activities in 1990 – 2009

	NG Production			NG Transmission			NG Distribution		
Year	Production [TJ]	CO_2 Emissions [t]	CH_4 Emissions [t]	Transmission [km]	CO_2 Emissions [t]	CH_4 Emissions [t]	Distribution [km]	CO_2 Emissions [t]	CH_4 Emissions [t]
1990	14 905,08	43,50	5 288,99	2 268	34,93	6 577,20	13 364	50,39	9 488,44
1991	10 691,70	30,77	5 792,90	2 268	34,93	6 577,20	13 364	50,39	9 488,44
1992	9 429,08	27,14	5 110,30	2 268	34,93	6 577,20	13 364	50,39	9 488,44
1993	8 602,98	24,89	4 685,98	2 268	34,93	6 577,20	15 149	57,13	10 755,79
1994	9 675,72	28,32	5 331,68	2 268	34,93	6 577,20	15 905	59,98	11 292,55
1995	11 702,88	33,71	6 346,36	2 268	34,93	6 577,20	17 487	65,94	12 415,77
1996	10 704,26	30,77	5 792,90	2 268	34,93	6 577,20	19 152	72,22	13 597,92
1997	9 837,56	28,32	5 331,68	2 268	34,93	6 577,20	20 716	78,12	14 708,36
1998	8 850,40	25,48	4 796,67	2 268	34,93	6 577,20	23 947	90,30	17 002,37
1999	7 274,01	20,87	3 929,58	2 268	34,93	6 577,20	25 404	95,80	18 036,84
2000	5 921,79	16,95	3 191,63	2 268	34,93	6 577,20	26 894	101,42	19 094,74
2001	6 699,28	19,20	3 615,95	2 268	34,93	6 577,20	27 946	105,38	19 841,66
2002	6 049,86	15,07	2 836,90	2 268	34,93	6 577,20	29 006	109,38	20 594,26
2003	8 368,07	25,94	4 883,48	2 268	34,93	6 577,20	30 033	113,25	21 323,43
2004	6 603,00	7,97	1 500,31	2 268	34,93	6 577,20	30 534	115,14	21 679,14
2005	5 288,80	3,10	583,59	2 270	34,93	6 583,00	30 566	115,26	21 701,86
2006	7 368,12	4,73	869,46	2 270	35,81	6 583,00	30 566	118,04	21 701,86
2007	4 550,40	14,58	3 453,15	2 270	27,79	6 583,00	31 537	94,54	22 391,27
2008	4 479,30	8,96	2 122,29	2 270	27,79	6 583,00	31 994	95,91	22 715,74
2009	3 669,90	17,64	2 763,16	2 270	42,03	6 583,00	32 506	147,34	23 079,26

Fugitive emissions from flaring and venting of oil and natural gas and from storage of natural gas are estimated separately. Total emission from oil activities (venting and flaring) were 170.15 t of CO_2 equivalents (0.5 t of CO_2, 8.1 t of CH_4 and 0.01 kg of N_2O) in 2009. Total emission from natural gas activities (venting, flaring and storage) were 109.68 Gg of CO_2 equivalents (33.33 t of CO_2, 5 221 t of CH_4 and 0.026 t of N_2O) in 2009. Total emissions have been decreased since 2003 due decreasing production and storage. Other leakages at industrial plants and power stations and in residential and commercial sectors are included in transmission and distribution categories and balance according to the length of pipeline. Activity data are consistent with activity data used by oil and NG estimation.

The major share belongs to the NG distribution (71%) and NG transmission (20%). Production of natural gas represented 8% from the total fugitive emissions from oil and NG activities.

Figure 3.35: The share of individual activities in fugitive emissions of oil and NG in 2009



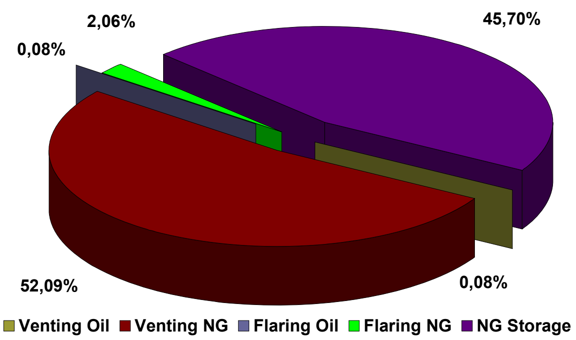
Activity	t CO_2 eq.	Share (%)
NG Production	58 044,07	8,49%
NG Transmission	138 285,03	20,23%
NG Distribution	484 811,80	70,93%
Oil Production	472,64	0,07%
Oil Transport	1 212,08	0,18%
Oil Refining/Storage	648,73	0,09%
Total	**683 474,34**	**100,00%**

Total emissions from storage of natural gas are presented in Table 3.54 and are allocated in category 1B2D other leakages. The major share is distributed between NG storage (46%) and NG venting (52%), the venting and flaring of oil and NG flaring represented 2% from the total fugitive emissions from venting, flaring and storage of oil and NG in 2009.

Table 3.54: Trend in fugitive emissions from venting and flaring activities in 1990 – 2009

	Venting Oil		Venting NG		Flaring Oil			Flaring NG		
Year	CO_2 Emissions [t]	CH_4 Emissions [t]	CO_2 Emissions [t]	CH_4 Emissions [t]	CO_2 Emissions [t]	CH_4 Emissions [t]	N_2O Emissions [t]	CO_2 Emissions [t]	CH_4 Emissions [t]	N_2O Emissions [t]
1990	0,1049	19,7470	14,4549	2 721,60	0,1049	19,7470	0,000047	1,0141	115,5186	0,0093
1991	0,1023	19,3093	14,4549	2 721,60	0,1026	19,3093	0,000046	0,7172	135,0000	0,0066
1992	0,0882	16,6088	14,4549	2 721,60	0,0882	16,6088	0,000039	0,6327	119,1196	0,0058
1993	0,0954	17,9550	14,4549	2 721,60	0,0954	17,9550	0,000043	0,5801	109,2288	0,0053
1994	0,0964	18,1467	14,4549	2 721,60	0,0964	18,1467	0,000043	0,6601	124,2801	0,0061
1995	0,1065	20,0467	14,4549	2 721,60	0,1065	20,0467	0,000048	0,7857	147,9320	0,0072
1996	0,1023	19,2591	14,4549	2 721,60	0,1023	19,2591	0,000046	0,7172	135,0309	0,0066
1997	0,0918	17,2800	14,4549	2 721,60	0,0918	17,2800	0,000041	0,6601	124,2801	0,0061
1998	0,0860	16,2000	14,4549	2 721,60	0,0860	16,2000	0,000038	0,5938	111,8090	0,0055
1999	0,0946	17,8200	14,4549	2 721,60	0,0946	17,8200	0,000042	0,4865	91,5974	0,0045
2000	0,0846	15,9300	14,4549	2 721,60	0,0846	15,9300	0,000038	0,3951	74,3960	0,0036
2001	0,0789	14,8500	14,5486	2 721,60	0,0789	14,8500	0,000035	0,4477	84,2868	0,0041
2002	0,0746	14,0400	14,5486	2 721,60	0,0746	14,0400	0,000033	0,3443	64,8155	0,0037
2003	0,0602	11,3400	14,5486	2 721,60	0,0602	11,3400	0,000027	0,6190	116,5420	0,0049
2004	0,0545	10,2600	14,5486	2 721,60	0,0545	10,2600	0,000024	0,1442	25,0058	0,0035
2005	0,0445	8,3700	14,4676	2 724,00	0,0445	8,3700	0,000020	0,0187	3,5300	0,0031
2006	0,0411	7,5600	14,8162	2 724,00	0,0411	7,5600	0,000018	0,3017	55,4722	0,0041
2007	0,0319	7,5600	11,5012	2 724,00	0,0319	7,5600	0,000018	0,6231	147,5764	0,0027
2008	0,0205	4,8600	11,5012	2 724,00	0,0205	4,8600	0,000012	0,4545	107,6364	0,0021
2009	0,0259	4,0500	17,3898	2 724,00	0,0259	4,0500	0,000010	0,6860	107,4571	0,0022

Figure 3.36: The share of individual activities of venting, flaring and storage of NG in 2009



Activity	t CO_2 eq.	Share (%)
Venting Oil	85,08	0,08%
Venting NG	57 221,39	52,09%
Flaring Oil	85,08	0,08%
Flaring NG	2 257,96	2,06%
NG Storage	50 201,85	45,70%
Total	**109 851,36**	**100,00%**

Table 3.55: Trend in fugitive emissions from storage of NG in 1990 – 2009

	NG Storage			
Year	Storage [TJ]	CO_2 Emissions [t]	CH_4 Emissions [t]	N_2O Emissions [t]
1990	33,57	0,0223	4,2000	0,0111
1991	34,05	0,0223	4,2000	0,0079
1992	34,04	0,0223	4,2000	0,0069
1993	33,87	0,0223	4,2000	0,0064
1994	2 390,47	1,5927	299,8800	0,0072
1995	5 422,79	3,5557	669,4800	0,0086
1996	5 352,13	3,5022	659,4000	0,0079
1997	2 403,22	1,5749	296,5200	0,0072
1998	4 799,64	3,1453	592,2000	0,0065
1999	3 360,39	2,1950	413,2800	0,0053
2000	17 946,79	11,6955	2 202,0600	0,0043
2001	14 861,46	9,6990	1 826,1600	0,0049
2002	6 203,67	4,0487	762,3000	0,0044
2003	1 101,87	0,7259	136,6764	0,0059
2004	13 463,00	8,7767	1 650,6000	0,0041
2005	1 709,70	1,1143	210,0000	0,0037
2006	377,41	0,2513	46,2000	0,0049
2007	NO	NO	NO	NO
2008	4 558,18	2,2344	529,2000	0,0026
2009	19 529,45	15,2563	2 389,8000	0,0026

3.7.3.1 Methodological issues – methods

The fugitive emissions of CH_4 from the transport and the distribution of natural gas in the Slovak Republic have been calculated with IPCC Tier 1 default methodology. The methodology is based on the IPCC 2000 GPG and using new refined emissions factors for methane in Tier 1, based on North America data – IPCC 2000 Good Practice Guidelines, table 2–16 with the applications of high level emission factors (conservative principle). The emissions of CO_2 were estimated based on analyses of natural gas CO_2 content in 2009 (prepared by monthly analyses) with the recalculation value of 6.384 grams CO_2 per kg CH_4.

3.7.3.2 Methodological issues – emission factors and other parameters

For the calculation of fugitive methane emissions the emission factors from the following sources were used:

- IPCC 2000 Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories 2.7 Fugitive Emissions from Oil and gas operation, Table 3 gives of EF used for calculation.

Table 3.56: Activity data, EFs and fugitive emissions from oil and NG production, transport and refining/storage in 2009

Activity	Oil [t]	Oil [PJ]	EF CO_2 [g/kg]	EF CH_4 [Gg/t]	EF N_2O [g/kg]	CO_2 [t]	CH_4 [t]	N_2O [t]
Oil Production	15 000	0,623	4,602	1,50E-03	0,00	0,14364	22,50	NO
Oil Transport	10 685 261	443,438	4,602	5,40E-06	0,00	0,36836	57,70	NO
Oil Refining/Storage	5 719 000	237,339	4,602	5,40E-06	0,00	0,19715	30,88	NO
Oil Venting	15 000	0,623	4,602	2,70E-04	0,00	0,02585	4,05	NO
Oil Flaring	15 000	0,623	4,602	2,70E-04	6,40E-07	0,02585	4,05	9,6E-09
Activity	NG [m^3]	NG [PJ]	EF CO_2 [g/kg]	EF CH_4 [Gg/t]	EF N_2O [g/kg]	CO_2 [t]	CH_4 [t]	N_2O [t]
NG Production	103 000 000	3,670	4,602	2,90E-03	0,00	17,63984	2 763,16	NO
NG Transmission	2 270	km	4,602	2,90E-03	0,00	42,02541	6 583,00	NO
NG Distribution	32 506	km	4,602	7,10E-04	0,00	147,33638	23 079,26	NO
NG Venting	2 270	km	4,602	1,20E-03	0,00	17,38983	2 724,00	NO
NG Flaring	103 000 000	3,670	4,602	1,30E-05	2,10E-08	0,68600	107,64	2,2E-06
NG Storage	569 000 000	19,529	4,602	4,20E-03	2,50E-08	15,25632	2 389,80	2,6E-06

3.7.3.3 Activity data

Activity data of oil production, transport and refining/storage are from Transpetrol Company, the exclusive company for transit and inland oil transportation and storage for its customers and the State Resource Reserves. The activity data were compared with the information of the Slovak Statistical

Office. Activity data of natural gas have been obtained from the Slovak Gas Industry, LtD., the Ministry of Economy of the Slovak Republic and the Statistical Office of the Slovak Republic.

Table 3.57: Activity data for production, export and import NG in the Slovak Republic in 2009

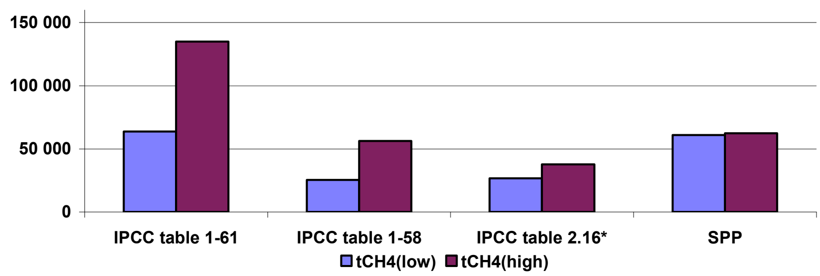
Activity	Natural Gas [m³]	Natural Gas [PJ]	NCV [MJ/m³]
Indigenous Production	103 000 000	3,670	35 630
Associated Gas	13 000 000	0,463	35 630
Non-associated Gas	90 000 000	3,207	35 630
Stock Changes	-569 000 000	-19,563	34 381
Gas Vented	4 000 000	0,143	35 630
Gas Flared	8 000 000	0,285	35 630
Export	15 000 000	0,515	35 630
Import	5 878 000 000	209,434	34 308
Inland Consumption	**5 397 000 000**	**185,238**	**34 322**

The results of the calculated fugitive methane emissions show, that disaggregating of gas and oil industry to main- and sub-categories according to the principles of „good practice“ improved the quality of balances. The results received from the calculation of methane emissions with the applications of new refined EF (CH_4) (high) for Tier 1, based on the North America data are the most real values. The trend of fugitive emissions CH_4 from transport and distribution of natural gas in the Slovak Republic is increasing. It is due to the expansion of distribution system and the growth of NG consumption. The emissions of CO_2 were estimated based on analyses of natural gas CO_2 content in 2009 (prepared by monthly analyses) with the recalculation value of 6.38 grams CO_2 per kg CH_4. The natural gas production category was estimated on the values of fugitive and flaring methane emissions reported data of vented NG – 4 mills. m^3 and flared NG – 8 mills. m^3 (the Statistical Office of the Slovak Republic, 2009).

3.7.3.4 Uncertainties and time-series consistency

The Tier 1 uncertainties analyses were performed according to the IPCC 2000 GPG. The Tier 2 uncertainty estimation was not provided for fugitive emissions from oil and natural gas. Lack of input data is the most facing issue. The methodology is consistent during time series across the activities. The trend of fugitive emissions of CH_4 from transport and distribution of natural gas in the Slovak Republic is increasing due to the expansion of the distribution system and the growth of NG consumption in the Slovak Republic. The fugitive CO_2 emissions from transport and distribution of natural gas were calculated on the base of natural gas composition. The average value of CO_2 content in natural gas was 0.226% mol in 2009. The application of IPCC default EFs for fugitive emissions from NG for the regions of the former USSR and Eastern Europe (IPCC Guidelines, Reference Manual Table I-49) gives too high results 63 803-135 016 t CH_4) and are approximately 2.4-3.6 times higher as the above-mentioned values. For the balance of the fugitive methane emissions from transport and distribution of natural gas in the Slovak Republic was recommend to use values calculated by the applications of new refined EF based on North America data with the conservative approach (using high range of EFs).

*Figure 3.37: The comparison between the methodologies used for the calculation (national approach according the Slovak Gas Industry, LtD. and IPCC) of fugitive methane emissions from transport and distribution of natural gas in the Slovak Republic (*reported emissions)*



3.7.3.5 Source specific QA/QC and verification

The Slovak inventory team in cooperation with Profing Ltd. (Mr. Jan Judak is the sectoral expert for energy and fugitive emissions) were provided the emission estimation according to the methodology, which has been used since base year and official statistics.

The verification process is based on cross-checking the input data from the Transpetrol Company (oil) and the Slovak Gas Company (NG) and the comparison of them with the sectoral statistical indicators from the Ministry of Economy and the Statistical Office of the Slovak Republic. The background documents are archived by sectoral experts and in the central archiving system of SNE at the SHMÚ.

According to the activity and input data resulted from analytical measurements done in accredited laboratories of Slovak Gas Industry, the calculation of so-called recalculation factor for the estimation of CO_2 emissions from NG treatment was evaluated to be 6.38 grams CO_2 per Gg of CH_4.

N_2O emissions have not been estimated (negligible) in total content of natural gas and oil composition by flaring (measurements in the accredited laboratories).

3.7.3.6 Source specific recalculations

No recalculations in the submission 2011 focused on the base year 1990 or the other inventory years were provided.

3.7.3.7 Source specific planned improvements

The Slovak Republic used EFs from the international methodology IEA-CIAB, the improvements can be found in the implementation of EFs measured directly from the companies. According to the present measurements, the information about the natural gas is not sufficiently accurate and measurements are not continual; the measurements are not carried out at the distribution places. Greater effort could be invest into the determination of appropriate national EFs for fugitive emissions from oil and natural gas production, processing and distribution in the Slovak Republic.

3.8 International bunkers (CRF 1.C1), Multilateral operation (CRF 1.C2) and Emissions from biomass CRF 1.C3)

3.8.1 Source category description

Emission inventory from category 1C Memo items includes emissions from international aviation (1C1A), international navigation (1C1B) and biomass (1C3). Multilateral operations (1C2) are not occurred in the Slovak Republic. The emissions are not included in national totals inventory.

3.8.2 Source subcategory description – International aviation (CRF 1.C.1.A)

Since 1990, the Slovak Republic has been estimating the emissions from international aviation based on the expert judgment and according to the information about LTO cycles and fuel consumption. The international aviation is occurred more frequently than the national aviation.

The estimation of GHG emissions was performed based on the total sale of fuels at the important Slovak airports (Bratislava, Košice, Poprad, Sliač, Piešťany and Žilina) in the period 1990 – 2009 and the expert estimation of the share in total national fuels. In 2009, the emissions from international civil aviation decreased back to the level of 2007 and represented 113.01 Gg of CO_2 equivalents. The interannual decreasing of emissions is explained by recession of economy in 2009. According to the recent projections the increasing trend will be continue after 2010.

3.8.2.1 Methodological issues – methods

See methodology for civil aviation in section 3.3.2.1.

The Slovak Republic has used Tier 1 methodology based on fuels sold for the estimation of emissions from aviation transport, both for aviation gasoline and jet kerosene.

Based on the expert estimation oft total sale of jet kerosene it is stated that the international aviation represented 95% from the total sale of the fuel at the airports. The approximately opposite ration is applied for the consumption of aviation gasoline (5% on international flights). The expert estimation was corrected in 2009 and increased by 5% for jet kerosene. The ratio for aviation gasoline was not change and is 90% for national flights and 10% for international flights.

3.8.2.2 Methodological issues – emission factors and other parameters

See the emission factors for jet kerosene and aviation gasoline in section civil aviation 3.3.2.2.

3.8.2.3 Activity data

The number of realized LTO cycles during the year at monitored airports, the types of aircrafts and the carrying capacity of the airports are basic input information used for the estimation of emissions from civil aviation. The aircrafts are divided into two weight categories up to 5.7 t and over 5.7 t. The innovated method uses emission factors for each aircraft type and weight category. The number of LTO cycles was 33 078 cycles in 2009. Total consumption of jet kerosene was 35 489 t and the consumption of aviation gasoline by international flights was 12.71 t.

The overall view of the sale of aviation fuels according to the types (aviation gasoline and jet kerosene) during 1990 – 2009 was estimated. For the period 1994 – 2009 the data came directly from the airport statistical processing information based on annual bases. The data about on the sale of fuels in the period 1990 – 1993 are based on the expert estimation according to the real LTO cycles in this period. The overview of fuels quantity sold (fill in) at the Slovak airports during 1990 – 2009 is showed in Table 3.58.

Table 3.58: Fuel quantities sold at the Slovak airports and GHG emissions during 1990 – 2009 for international flights

	Aviation Gasoline					Jet Kerosene				
	Consumption	Consumption	CO_2	CH_4	N_2O	Consumption	Consumption	CO_2	CH_4	N_2O
	[TJ]	[t]	[t]	[t]	[t]	[TJ]	[t]	[t]	[t]	[t]
1990	1,11	25,90	81,60	0,05	0,003	862,70	20 007,00	63 022,10	1,00	2,08
1991	1,03	24,05	75,80	0,05	0,002	802,16	18 603,00	58 599,50	0,93	1,94
1992	0,95	22,20	69,90	0,04	0,002	741,62	17 199,00	54 176,90	0,86	1,79
1993	0,87	20,35	64,10	0,04	0,002	726,49	16 848,00	53 071,20	0,84	1,75
1994	0,80	18,59	58,60	0,04	0,002	612,13	14 195,85	44 716,90	0,71	1,48
1995	0,73	17,14	54,00	0,03	0,002	615,85	14 282,23	44 989,00	0,71	1,49
1996	0,80	18,62	58,70	0,04	0,002	726,86	16 856,76	53 098,80	0,84	1,75
1997	0,71	16,55	52,10	0,03	0,002	643,77	14 929,80	47 028,90	0,75	1,55
1998	0,63	14,64	46,10	0,03	0,001	593,62	13 766,62	43 364,90	0,69	1,43
1999	0,67	15,66	49,30	0,03	0,002	598,96	13 890,60	43 755,40	0,70	1,45
2000	0,85	19,75	62,20	0,04	0,002	608,45	14 110,69	44 448,70	0,71	1,47
2001	0,88	20,61	64,90	0,04	0,002	572,18	13 269,57	41 799,20	0,66	1,38
2002	0,95	22,28	70,20	0,04	0,002	594,01	13 840,34	43 393,70	0,69	1,43
2003	0,92	21,56	67,90	0,04	0,002	785,58	18 218,41	57 388,00	0,91	1,90
2004	0,67	15,65	49,30	0,03	0,002	1 062,70	24 645,09	77 632,00	1,23	2,56
2005	0,79	18,54	58,40	0,04	0,002	1 233,14	28 597,79	90 083,00	1,43	2,97
2006	0,78	18,21	57,36	0,03	0,002	1 382,98	32 072,73	101 029,10	1,60	3,34
2007	0,71	16,54	52,11	0,03	0,002	1 606,29	37 251,71	117 342,88	1,86	3,87
2008	0,54	12,72	40,08	0,02	0,001	1 814,39	42 077,65	132 544,59	2,10	4,38
2009	0,54	12,71	40,03	0,02	0,001	1 536,73	35 489,44	111 791,75	1,77	3,69

3.8.2.4 Uncertainties and time-series consistency

See the section civil aviation 3.3.2.4. The Tier 1 uncertainty was included in total assessment. Time series consistency is ensured.

3.8.2.5 Source specific QA/QC and verification

See the section civil aviation 3.3.2.5.

3.8.2.6 Source specific recalculations

No recalculations in the submission 2011 focused on the base year 1990 or the other inventory years were provided.

3.8.2.7 Source specific planned improvements

The implementation of Tier 2 methodology has been preparing in combination with the fuel sold and the number of movements with the differentiation into national and international flights. The discussions on the first estimation are going on with the Ministry of Transport – the Department of Civil Aviation and the Bratislava airport. The initiative aimed at the development of a new methodology for including aviation in emission trading system after 2012 has also increased. The first preliminary results show, that the expert judgment introducing the differentiation of the flights into national and international ones was correct.

3.8.3 Source subcategory description – International navigation (CRF 1.C.1.B)

GHG emission inventory of navigation transport in the Slovak Republic is aimed at the calculation of CO_2, CH_4 and N_2O emissions from shipping activities in the Slovak section of the Danube River. The inventory of GHG emissions from inland shipping transport has no direct methodological support in the IPCC 2000 GPG. For this reason and in view of the relationship between river boats and diesel rail transport tractions, the same methodology and the same emission factors were chosen to calculate GHG emissions as in the case of railway transport. The consumption of diesel oil is determined indirectly from the available statistical data on shipping activities in the Slovak section of the Danube River during the year and the technical parameters of the Danube traction vessels.

Total aggregated emissions from inland shipping included in international navigation reached 36.2 Gg of CO_2 equivalents in 2009, the decrease is more than 8% compared to the previous year 2008 and compared to the base year, the decrease is even more significant.

Table 3.59: Overview of GHG emission inventory in inland shipping in 2009

	Diesel Oil Sale		Emissions [t]		
	[TJ]	[kt]	CO_2	CH_4	N_2O
EFs for the boats in kg/t diesel oil			*3 188*	*0,19*	*1,37*
Slovak Shipping and Ports Bratislava	385,60	9 073	28 924,72	1,72	12,43
State Shipping Administration	0	0	0	0,00	0,00
International Shipping Companies	39,74	935	2 980,78	0,18	1,28
Total SR	**425,34**	**10 008**	**31 905,50**	**1,90**	**13,71**

3.8.3.1 Methodological issues – methods

The Slovak Republic used Tier 1 methodology based on transportation model (fuel consumption by transit transport) for the estimation of emission from inland shipping on the Danube River. National shipping activities have not been occurred (except of few tourists sightseeing journey during summer months). According to the recommendations of ERT final findings and IPCC 2000 GPG, the emission estimation based on fuel consumption and the international rule for inland shipping on the Danube River was evaluated.

The emissions of greenhouse gases are calculated from the weight of consumed fuel by diesel motor boats multiplied by emission factor.

3.8.3.2 Methodological issues – emission factors and other parameters

The GHG emissions from the diesel oil consumption sold in the Slovak Republic in important ports Bratislava and Komárno were balanced in the period 1990 – 2009.

Table 3.60 shows the emission balance using EFs for the different type of ships known in the time of estimation for diesel fuel, which is more realistic way of emission estimation and is recommended by sectoral expert.

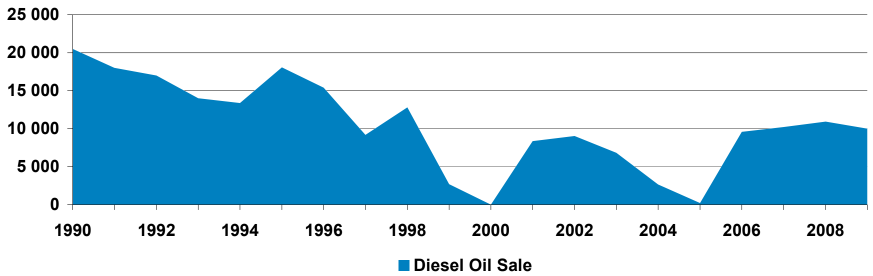
Table 3.60: Emission balance of GHGs from diesel oil sold for shipping companies in the Slovak Republic in 1990 – 2009 based on historical EFs in that time

Year	Emissions [t]			Diesel Oil Sale
	CO_2	CH_4	N_2O	[kt]
EFs for the boats in kg/t diesel oil	*3 188*	*0,25*	*0,10*	
1990	65 354,00	5,13	2,05	20 500
EFs for the boats in kg/t diesel oil	*3 188*	*0,20*	*1,37*	
1995	57 594,40	3,61	24,75	18 066
2000	NO	NO	NO	0
2001	26 670,81	1,67	11,46	8 366
EFs for the boats in kg/t diesel oil	*3 188,00*	*0,19*	*1,37*	
2002	28 778,71	1,72	12,37	9 027
2003	21 793,17	1,30	9,37	6 836
2004	8 483,17	0,51	3,65	2 661
2005	682,23	0,04	0,29	214
2006	30 505,97	1,82	13,11	9 569
2007	32 617,19	1,94	14,02	10 231
2008	34 822,52	2,08	14,96	10 923
2009	31 905,50	1,90	13,71	10 008

3.8.3.3 Activity data

Bratislava and Komárno are two relevant ports on the Danube River taken into consideration for the emission estimation in the Slovak inland international transport. The sources of activity data for the period 1994 – 2009 are the Slovak Shipping and Ports in Bratislava, the State Shipping Administration and other international shipping companies in accordance with the annual providing statistical information in water transport. The activity data for the period 1990 – 1993 are not statistically documented so the expert estimation was performed on the base of the shipping traffic on the Danube River. Emissions for the year 2000 were estimated to be negligible, because of increasing prices of diesel oil fuel in the Slovak Republic and decreasing prices of fuels in the neighbours' counties (market discrepancies).

Figure 3.38: Overview of diesel oil consumption for shipping transport in 1990 – 2009



3.8.3.4 Uncertainties and time-series consistency

The inter-annual fluctuation of diesel oil consumption in motor traction of shipping activities is caused by the price policy of the Slovak Republic and fuels´ sale companies in ports in the Slovak territory. This trend can be also expected in the future. The time series are consistent with the consistent methodology, activity data collection and using default emission factors for diesel oil fuel.

3.8.3.5 Source specific QA/QC and verification

The verification of activity data on fuels sold for shipping activities was performed by the sectoral expert and compared with the statistical information.

3.8.3.6 Source specific recalculations

No recalculations in the submission 2011 focused on the base year 1990 or the other inventory years were provided.

3.8.3.7 Source specific planned improvements

The information about on inland tourists shipping in the Slovak Republic can be collected from several lakes and small rivers. These emissions will be included into the national shipping transportation in the next submission.

3.8.4 Source subcategory description – Emissions from biomass (CRF 1.C.3)

The information on the biomass consumption is included in sectoral approach allocated in appropriate category. CO_2 emissions from biomass are not included in national totals, but they have been estimating since the base year. Total CO_2 emissions have increasing trend and in 2009, they represented 2 660 Gg of CO_2 (53 059 TJ). This is the decrease by 50% compared to the previous year 2008. The fluctuations in trend are expected also in the future due to the household consumption.

Figure 3.39: Trend of CO_2 emissions from biomass in 1990 – 2009

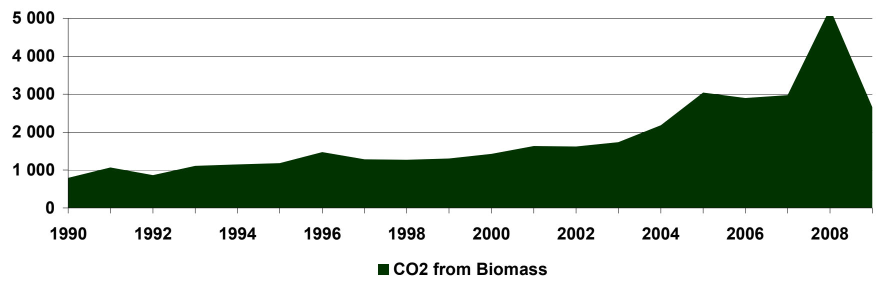


Table 3.61: Trend of CO_2 emissions from biomass in 1990 – 2009

	Consumption	CO_2	CH_4	N_2O
Year	[TJ]	[Gg]	[t]	[t]
1990	7 910,86	793,83	1 646,65	31,64
1991	10 654,83	1 069,08	2 586,42	42,58
1992	8 619,12	865,31	2 074,90	34,49
1993	11 067,05	1 110,96	2 892,45	44,29
1994	11 456,18	1 150,16	3 076,75	45,87
1995	11 783,40	1 183,10	3 228,20	47,12
1996	14 711,43	1 476,75	4 146,64	58,80
1997	12 828,54	1 288,09	3 609,60	51,33
1998	12 677,14	1 273,01	3 580,82	50,75
1999	12 981,49	1 303,63	3 678,61	51,96
2000	14 196,80	1 425,71	4 057,92	56,79
2001	16 248,71	1 632,20	4 627,85	64,99
2002	16 150,68	1 622,36	4 517,70	64,60
2003	17 259,51	1 733,71	4 938,73	69,04
2004	21 737,21	2 182,95	6 226,25	86,95
2005	30 324,66	3 044,58	8 688,99	121,30
2006	29 103,39	2 900,75	8 043,85	115,10
2007	30 227,63	2 976,46	7 519,90	116,76
2008	53 013,68	5 257,42	14 319,31	207,51
2009	27 220,32	2 660,33	5 992,38	104,07

3.8.4.1 Methodological issues – methods

See methodology for sectoral approach in section 3.2.

3.8.4.2 Methodological issues – emission factors and other parameters

See emission factors and other parameters for sectoral approach in section 3.2.

3.8.4.3 Activity data

See collection of activity data for sectoral approach in section 3.2.

3.8.4.4 *Uncertainties and time-series consistency*

See the section sectoral approach 3.2. The Tier 1 uncertainty was included in total assessment. Time series consistency is ensured.

3.8.4.5 *Source specific QA/QC and verification*

See the section sectoral approach 3.2. The Tier 1 uncertainty was included in total assessment. Time series consistency is ensured.

3.8.4.6 *Source specific recalculations*

No recalculations in the submission 2011 focused on the base year 1990 or the other inventory years were provided.

3.8.4.7 *Source specific planned improvements*

No further improvements are planned for the next submission.

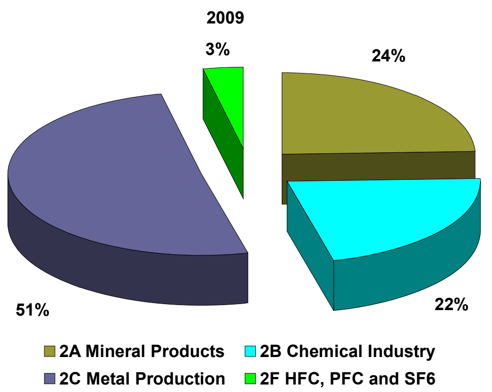
CHAPTER 4: INDUSTRIAL PROCESSES (CRF 2)

4.1 Overview of sector (CRF 2)

Sector of industrial processes includes all GHG emissions generated from technological processes producing raw materials and products. Within the preparation of the GHG emission balance in the Slovak Republic, consistent emphasis is put on the analysis of individual technological processes and distinction between the emissions from fuel combustion in heat and energy production and the emissions from technological processes and production. Most important emission sources are balanced separately, emission and oxidation factors are re-evaluated, as well as other parameters entering the balancing equations and the results are compared with the verified emissions in the Slovak National Registry for CO_2 emissions.

In 2009, total aggregated GHG emissions from industrial processes were 9 389.31 Gg of CO_2 equivalents and they decreased compared to the previous year by 16%. Compared to the reference year 1990 the emissions decreased by 11%. CO_2 is the most important gas with the share of 83% and N_2O emissions with 13.3%. The most important source of GHG emissions are metal production (51%), mineral products (24%), chemical industry (22%) and consumption of halocarbons and SF_6 (3%). The emissions of CO_2 from iron and steel production were reallocated from sector energy (category 1.A.2a) during the previous year and consequently, the time series were revaluated. The most important source of N_2O emissions is nitric acid production, which contributes by 13%, given in CO_2 equivalents, to total emissions in the sector.

Figure 4.1: The share of individual categories in emissions in sector industrial processes in 2009



Category	CO_2 Eq. (Gg)	Share (%)
2A Mineral Products	2 285,89	24,35%
2B Chemical Industry	2 031,51	21,64%
2C Metal Production	4 752,92	50,62%
2F Consumption of Halocarbons and SF_6	318,18	3,39%

The IP sector covers emissions from technological processes in mineral products industry (CRF 2.A), chemical industry (CRF 2.B), metal production (CRF 2.C), other production (CRF 2.D) and emissions from production and consumption of halocarbons and SF_6 (CRF 2.E and 2.F). The inventory of emissions from technological processes includes direct greenhouse gas emissions (CO_2, CH_4, N_2O, halocarbons and SF_6) and indirect greenhouse gas emissions (NO_x, CO, NMVOCs), as well as the emissions of SO_2 from IP.

The internal structure of Slovak industry has been stabilised after the implementation of significant changes prior to the EU membership. The share of mining, distribution of electricity, gas and water has been reduced in the generation of value added and today it is comparable with other developed countries. In 2009, the industrial production indicated a moderate increase in the dynamics of growth by 6.5% in comparison with the base year. This trend has resulted from the increased production in pulp and paper industry, production of plastics and rubber products and predominantly, in car production, with the dynamics of increase above 9%. On the other hand, the decrease in domestic demand has continued in the production of chemicals, chemical products and chemical fibers, foodstuffs, beverages and tobacco products, coke, oil products and nuclear fuel. The industrial production and emissions were influenced by the world economical crises in 2009 and at the beginning of year 2009 (January) also with gas crises. The decrease in almost all industrial categories is visible and represents in general almost 20% reduction against previous year 2008. The decrease in CO_2 emissions is more than 16% and in N_2O emissions more than 18%. The 4% increase in CH_4 emissions was caused by increasing emission in ammonia production. The decrease in mineral product industry is 24%, in chemical industry 10% and in metal industry 16%.

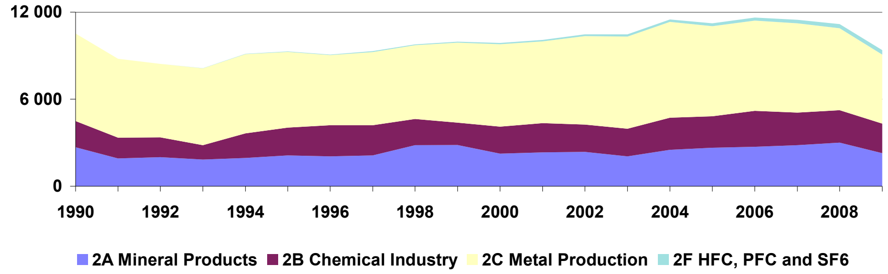
Table 4.1: GHG emissions in individual categories in IP sector in 1990 – 2009

	Sector 2. Industrial Processes			Categories CO_2 *eq.* (Gg)			
Year	CO_2 emissions (Gg)	CH_4 emissions (t)	N_2O emissions (t)	2A Mineral Products	2B Chemical Industry	2C Metal Production	2F HFC, PFC and SF_6
1990	9 078,91	1 170,00	3 728,92	2 690,08	1 797,51	6 043,24	0,03
1991	7 687,63	1 142,70	2 592,27	1 914,70	1 436,04	5 431,44	0,03
1992	7 449,04	1 118,65	2 316,37	2 004,51	1 356,23	5 078,29	0,04
1993	7 408,13	672,42	1 786,63	1 847,18	975,86	5 308,49	0,06
1994	7 964,07	1 150,17	3 186,39	1 955,64	1 691,28	5 461,14	12,18
1995	7 991,44	1 247,35	3 655,96	2 120,49	1 910,19	5 234,63	32,06
1996	7 643,96	1 338,02	4 267,77	2 052,38	2 155,53	4 821,67	48,34
1997	7 926,70	1 332,17	4 039,49	2 121,52	2 086,19	5 032,62	73,67
1998	8 610,90	1 192,64	3 435,43	2 820,29	1 807,75	5 095,53	55,97
1999	9 054,82	1 196,20	2 587,06	2 849,47	1 536,47	5 507,34	80,07
2000	8 711,46	1 317,36	3 356,06	2 243,95	1 853,52	5 693,44	89,08
2001	8 771,57	1 343,56	3 793,90	2 336,66	2 015,16	5 635,51	100,43
2002	9 259,86	1 331,21	3 395,19	2 372,74	1 871,86	6 107,12	119,47
2003	9 115,19	1 191,00	3 752,59	2 061,39	1 902,04	6 360,94	148,12
2004	9 950,95	1 360,36	4 289,84	2 507,03	2 205,82	6 615,85	169,35
2005	9 700,27	1 402,14	4 160,54	2 650,58	2 180,47	6 208,49	189,15
2006	9 669,18	1 168,47	5 466,63	2 715,48	2 471,11	6 237,61	216,05
2007	9 719,37	1 186,51	4 694,50	2 821,93	2 245,72	6 156,82	244,42
2008	9 311,24	1 077,07	4 934,68	2 991,27	2 262,75	5 645,75	281,75
2009	7 784,08	1 091,57	4 017,94	2 285,89	2 031,51	4 752,92	318,18

Energy intensity of industry in the Slovak Republic has been decreasing slowly, but it is still relatively high in comparison with the EU-15 countries. Regarding the final consumption of energy, industry has got the highest share (including construction). The trend in the final consumption of energy in this sector is positive and is characterised by the decrease in total energy consumption. The following branches of industrial sector contribute to fuel and energy consumption: metallurgy 32%, energy industry 32%, chemical industry 11%, pharmaceutical industry 11%, wood processing 4%, machinery 3%, textile 2%, electro-production, glass production and leather and shoemaking approximately 1% for each of them.

Whereas the N_2O emissions come from the nitric acid production only (this category is the key source by level and trend assessment), the cement, lime, limestone and dolomite use and iron & steel production are very important key sources of CO_2 emissions.

Figure 4.2: Trend of individual categories in sector industrial processes in 1990 – 2009



4.2 Uncertainty analyses

Aggregate uncertainty is computed from partial uncertainties. Every subsector is computed from disaggregated data. The data are split by factory or by technology processes. Computed uncertainties are aggregated consecutively to the total uncertainty. The results for every subsector are generated from 60 000 trials, with random number generator of random numbers for adequate PDF. From theory and knowledge it is known, that the direct computation of aggregate uncertainty is difficult in many cases. For this reason a statistical approach has been chosen and the used method is Monte Carlo. It induces the construction of PDF for all input parameters. In some cases the absence of direct measurement were solved by expert contributions. Mean value and confidence interval have the background usually in measured data or in empirical relations. On the other hand, uncertainty shapes of input parameters are usually estimated by expert impressions. For industry sector the following assumptions were applied to compute emissions in the mentioned subsectors.

Figure 4.3: Probability density function for IP sector in tons of CO_2

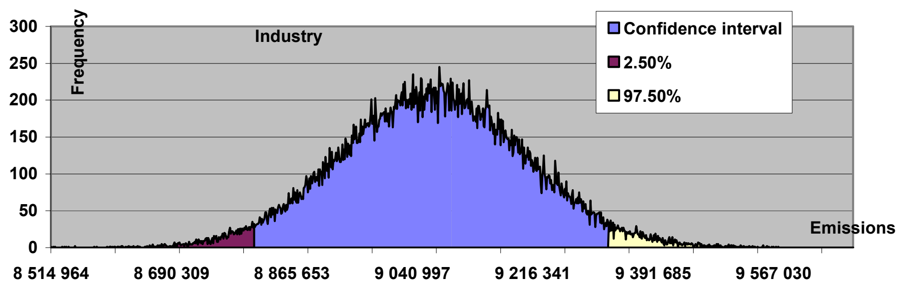


Table 4.2: Selected statistical characteristics for IP sector, median, mean value, standard deviation, minimum, maximum of emissions and percentiles

Median	Average	Standard dev,	2,50%	97,50%
9 070 756,73	9 070 998,31	133 327,20	8 812 264,82	9 332 469,59
Min	Max		Per_2,5	Per_97,5
8 514 964,38	9 683 925,76		-2,85%	2,88%

From the presented results of CO_2 emissions obtained by Monte Carlo simulation it seems that mean value is 9 070 998 ton per year. Confidence interval (95%) is represented by the relative values to the mean: (-2.85%, 2.88%). The normal distribution for every sub-categories have influence to the total uncertainties. The symmetry of aggregate uncertainty is not surprised in this case.

4.3 Mineral products (CRF 2.A)

4.3.1 Source category description

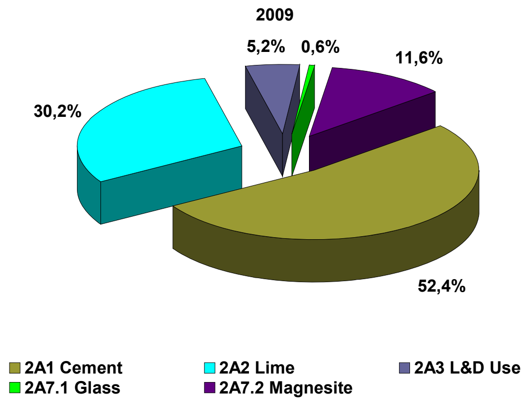
The major share of CO_2 pollution comes from the production and transformation of mineral products. Total emissions were 2 285.89 Gg of CO_2 equivalents in 2009, the decrease by 16% is significant compared to the previous year. The emissions are on year 2000 level. The decrease is more visible in cement production category. Compared to 1990, the decrease is more than 14%.

The major share (52%) of emissions belongs to cement production, 30% belongs to lime production and 12% to magnesite production. The production of magnesite, lime and cement are at the same level as in 1990, with the minor fluctuation in early 90-ties.

Table 4.3: GHG emissions in individual subcategories in 2A category in 1990 – 2009

	Category 2A - CO_2 emissions (Gg)				
Year	2A1 Cement Production	2A2 Lime Production	2A3 Limestone &Dolomity Use	2A7.1 Glass Production	2A7.2 Magnesite Production
1990	1 438,01	770,42	41,83	7,88	431,94
1991	1 019,27	586,40	41,83	9,95	257,24
1992	1 283,22	441,06	48,70	12,03	219,50
1993	1 010,14	520,53	76,18	14,65	225,67
1994	1 094,96	547,74	92,33	16,31	204,31
1995	1 133,75	574,95	99,75	18,01	294,03
1996	1 080,50	547,02	103,67	20,06	301,12
1997	1 192,70	490,46	108,20	19,92	310,25
1998	1 789,44	532,65	102,70	18,99	376,51
1999	1 794,34	543,75	97,39	19,15	394,85
2000	1 168,88	539,57	102,86	22,82	409,82
2001	1 187,43	584,22	110,30	23,08	431,63
2002	1 144,19	657,99	110,62	21,42	438,52
2003	904,99	573,17	110,84	22,44	449,95
2004	1 194,84	672,16	115,98	24,37	499,67
2005	1 233,51	785,83	122,21	33,04	476,00
2006	1 363,98	854,02	124,80	32,06	340,62
2007	1 458,01	897,06	121,68	41,18	304,00
2008	1 581,87	860,18	148,56	23,44	377,22
2009	1 198,66	689,43	118,92	13,19	265,69

Figure 4.4: The share of individual categories in emissions from category 2A mineral products in 2009



Category	CO_2 Eq. (Gg)	Share (%)
2A1 Cement Production	1 198,66	52,44%
2A2 Lime Production	689,43	30,16%
2A3 Limestone&Dolomity Use	118,92	5,20%
2A7.1 Glass Production	13,19	0,58%
2A7.2 Magnesite Production	265,69	11,62%

4.3.2 Source category description – Cement production (CRF 2.A.1)

According to the IPCC Guidelines, it is a good practice that CO_2 emissions are estimated from the mass of produced cement clink from cement. However, in the Slovak Statistical Yearbook only mass of produced Portland cement and Portland cement clinker are published. The cement plants in the Slovak Republic (4 plants), where cement clink is produced, are included into the ETS and the verification reports from the ETS were used for CO_2 emission inventory. Production of cement from clink is based on milling the clink with solid additives. Therefore it is meaningful to balance only clink production. Total CO_2 emissions from cement production were 1 198.66 Gg in 2009 and decreased comparable to the previous year by 24%.

Table 4.4: Activity data and CO_2 emissions in subcategory 2A1 cement production in 1990 – 2009

Category 2A1 Cement Production					
	Cement Clink Production (kt)	CO_2 emissions (Gg)	Cement Production (kt)	CaO Content	Clinker Content
1990	2 835,75	1 438,01	3 781,00	64,60%	74,90%
1991	2 010,00	1 019,27	2 680,00	64,60%	74,90%
1992	2 530,50	1 283,22	3 374,00	64,60%	74,90%
1993	1 992,00	1 010,14	2 656,00	64,60%	74,90%
1994	2 159,25	1 094,96	2 879,00	64,60%	74,90%
1995	2 235,75	1 133,75	2 981,00	64,60%	74,90%
1996	2 130,75	1 080,50	2 841,00	64,60%	74,90%
1997	2 352,00	1 192,70	3 136,00	64,60%	74,90%
1998	3 528,77	1 789,44	4 705,02	64,60%	74,90%
1999	3 538,43	1 794,34	4 717,90	64,60%	74,90%
2000	2 313,71	1 168,88	3 044,92	64,36%	74,90%
2001	2 367,29	1 187,43	3 122,67	63,90%	74,90%
2002	2 259,79	1 144,19	2 922,01	64,50%	77,30%
2003	1 754,73	904,99	2 166,19	65,70%	74,90%
2004	2 271,13	1 194,84	2 982,51	67,02%	75,09%
2005	2 352,68	1 233,51	3 289,20	66,78%	75,17%
2006	2 589,08	1 363,98	3 587,42	67,11%	75,35%
2007	2 825,32	1 458,01	3 749,49	65,74%	74,22%
2008	3 045,25	1 581,87	4 513,36	65,74%	79,11%
2009	2 348,07	1 198,66	3 020,92	65,87%	74,26%

4.3.2.1 Methodological issues – methods

Cement is produced by a high temperature reaction of calcium oxide (CaO) with silica (SiO_2) and with alumina (Al_2O_3). A source of calcium oxide is limestone ($CaCO_3$). As the cement clink is produced at the temperature of 1 450°C the reaction produces carbon dioxide. The other emissions originate from impurities in the raw material (SO_2). On the basis of the information provided into the verified ETS reports, Tier 3 methodology according to the IPCC 2006 Guidelines has been applied since 2002 based on plant specific information. The calculations provided by the cement clinker producers in the ETS reports balanced CO_2 emissions on the basis of cement clink production and CaO and MgO contents. The data required for calculation of CO_2 emissions are summarized in Table 4.5.

Table 4.5: The data necessary for the estimation of CO_2 emissions in 2009

Plant	Raw Material [kt]	Content of CaO	Content of MgO	Correction Factor	CO_2 Emissions [t]
Cemmac	C	0,6468	0,0218	0,9564	198 272
VSH	C	0,6442	0,0357	0,7461	198 511
Holcim – Portland	C	0,6610	0,0232	1,00	454 953
Holcim – w hite	C	0,6894	0,0229	1,00	61 720
Považská cementáreň	C	0,6710	0,0155	1,00	285 204
Total	**2 348,07**	**0,6587***	**0,02383***	**0,9399***	**1 198 660**

C = Confidential, *weighted average

4.3.2.2 Methodological issues – emission factors and other parameters

The content of CaO in cement clinker varies from 64.42% to 68.94% according to the plant specifications with the value of weighted average 65.87% in 2009. The content of MgO in cement clinker varies from 1.55% to 3.57% with the weighted average of 2.38% in 2009. On the basis of data supplied by plants and ETS reports, total CO_2 emissions from cement production were 1 198 660 t and EF was 0.5105 t/1 t of clinker. The EF for cement was 0.4006 t/1 t of cement. Total production of cement clinker decreased interannual (2008/2009) by 25% and was 2 348 071 t in 2009. Correction factors provided in Table 4.5 represent the amount of non-carbonate origin of CaO and MgO (ground granulated blast-furnace slag).

4.3.2.3 Activity data

The Faculty of Chemical and Food Technology of the Slovak Technical University has taken the responsibility for the preparation of emission balance according to the instructions of IPCC methodology and Good Practice Guidance 2000. The information was obtained also from other sources (the Statistical Office of the Slovak Republic, the Ministry of Economy, the Union of Slovak Chemical Industry, plant operators, producers, etc). The obtained information was checked by the SHMÚ through monitored industrial technologies in NEIS database. The ETS reports elaborated directly from the sources included in the National Allocation Plans (I and II) have been the most important sources of activity data since 2005.

4.3.2.4 Uncertainties and time-series consistency

The uncertainties in mass of clink (2.5%), composition of limestone (CaO and MgO content are 2%), composition of clink (2%) and mass of non-reacted limestone (5%) were estimated according to IPCC 2000 GPG for each plant. It follows that the uncertainty of EF (per clink) is 1% and the uncertainty of CO_2 emissions is in interval (-1.68%; +1.68%). To compute the uncertainty for this subsector the following input parameters were applied: the amount of clinker, content of CaO, content of MgO, their emission factors and their uncertainty for both AD and EF (in formula it represent symbol Δ). Formula can be written in the following form:

$$\text{Emissions} = \sum_{I}\left[(\text{clinker} \pm \Delta\text{clinker}) * (\text{content of CaO} \pm \Delta\text{CaO}) * (\text{EFCaO} \pm \Delta\text{EFCaO}) + (\text{clinker} \pm \Delta\text{clinker}) * (\text{content of MgO} \pm \Delta\text{MgO}) * (EF_{MgO} \pm \Delta EF_{MgO})\right] * \text{cor\_f}$$

In the computation of emissions, five sources from four cement producers enter to formula (in previous formula subscript *I* represent number of sources). During the uncertainty computation the relation between the content of CaO and the content of MgO is inspected. It means that the sum of CaO and MgO contents could not exceed the value one in the raw material. This correlation is integrated to the computational procedure. The correction factor below 1 was used in two cases where the exact content of CaO and MgO.

Figure 4.5: Probability density function for category 2A1 in tons of CO_2

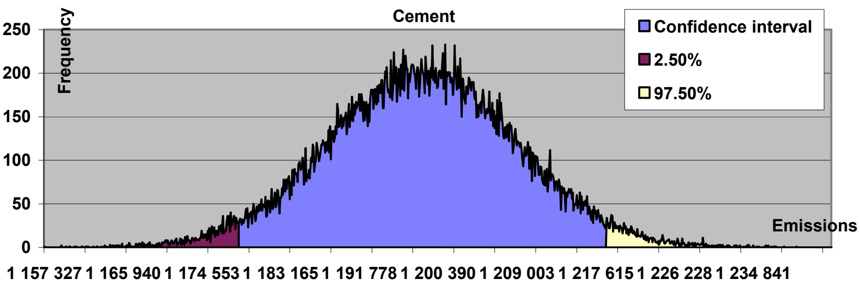


Table 4.6: Selected statistical characteristics for category 2A1, median, mean value, standard deviation, minimum, maximum of emissions and percentiles

Median	Average	Standard dev,	2,50%	97,50%
1 198 678,49	1 198 678,12	10 239,65	1 178 516,97	1 218 792,17
Min	Max		Per_2,5	Per_97,5
1 157 327,34	1 243 453,23		-1,68%	1,68%

4.3.2.5 Source specific QA/QC and verification

Information used for GHG emission inventories of IP sector are directly from questionnaires sent to operators and cement producers in the Slovak Republic. First preliminary data related to the production and the quality of products in the Slovak Republic from the previous year is available at the beginning of October. This data is used for the estimation and verified by Mr. Vladimir Danielik – the sectoral expert for IP sector in the cooperation of the Slovak Technical University in Bratislava, the

Faculty of Chemical and Food Technology. The data is comparing with the information from Statistical Office of the Slovak Republic (cement production) and with the ETS reports.

4.3.2.6 Source specific recalculations

No recalculations in the submission 2011 focused on the base year 1990 or the other inventory years were provided.

4.3.2.7 Source specific planned improvements

No improvements are planned for this category for the next submission.

4.3.3 Source category description – Lime production (CRF 2.A.2)

From a chemical point of view, lime is calcium oxide (CaO). It is produced by the thermal decomposition of limestone at the temperatures of 1 040°C–1 300°C. Carbon dioxide is produced according to the same reaction scheme is shown above in the case of cement production. Total CO_2 emissions from lime production were 689.43 Gg in 2009 and decreased comparable to the previous year by 20%.

Table 4.7: Activity data and CO_2 emissions in subcategory 2A2 lime production in 1990 – 2009

Category 2A2 Lime Production				
	Lime Production (kt)	CO_2 emissions (Gg)	EF (t/t)	CaO Content
1990	1 076,00	770,42	0,716	91,20%
1991	819,00	586,40	0,716	91,20%
1992	616,00	441,06	0,716	91,20%
1993	727,00	520,53	0,716	91,20%
1994	765,00	547,74	0,716	91,20%
1995	803,00	574,95	0,716	91,20%
1996	764,00	547,02	0,716	91,20%
1997	685,00	490,46	0,716	91,20%
1998	743,92	532,65	0,716	91,20%
1999	759,43	543,75	0,716	91,20%
2000	753,59	539,57	0,716	91,20%
2001	815,96	584,22	0,716	91,20%
2002	918,99	657,99	0,716	91,20%
2003	781,69	573,17	0,733	93,41%
2004	908,94	672,16	0,740	94,21%
2005	1 041,71	785,83	0,754	96,10%
2006	1 131,24	854,02	0,755	96,17%
2007	1 158,07	897,06	0,775	98,68%
2008	1 120,33	860,18	0,768	97,51%
2009	916,77	689,43	0,752	89,60%

4.3.3.1 Methodological issues – methods

Tier 3 according to the IPCC 2006 GL has been applied since 2003 with the combination of plant specific activity data and emission factors estimated for each plant. The calculations provided by the lime producers in the ETS reports balanced CO_2 emissions on the basis of raw material used for production (Calmit lime plant) or produced lime (other lime plants) and $CaCO_3$ and $MgCO_3$ contents (Calmit lime plant) and CaO and MgO contents (other lime plants). The data required for calculation of CO_2 emissions are summarized in Table 4.8.

4.3.3.2 Methodological issues – emission factors and other parameters

The emission factor of CO_2 using the data on the purity of lime is 0.752 t CO_2/t of lime. Total CO_2 emissions decreased and were 689.43 Gg in 2009. Correction factor in Table 4.8 represents the fraction of carbonate calcinations (it is determined by analysis of CO_2 in the product).

4.3.3.3 Activity data

Total amount of produced lime was 916 768 t. Total amount of raw material was known only for Calmit lime plant and was 233 279 t in 2009. Activity data are summarized in Table 4.7 and Table 4.8.

Table 4.8: The data necessary for the estimation CO_2 emissions in 2009

Plant	Raw Material [kt]	Lime Production [t]	$CaCO_3$ Content	$MgCO_3$ Content	Correction Factor	CO_2 Emissions [t]
Calmit Tisovec	C	C	0,98	0,02	0,97	68 491,77
Calmit Margecany	C	C	0,88	0,09	0,97	1 576,75
Calmit Žirany	C	C	0,94	0,03	0,96	28 001,90
			0,96537*	**0,02079***	**0,96503***	
			CaO Content	**MgO Content**		
Dolvap Varín		C	0,78	0,14	1,00	83 985,66
Mondi SCP Ružomberok		C	0,93	0,01	1,00	103 437,40
Carmeuse Slavec		C	0,94	0,01	1,00	141 677,70
Carmeuse Košice		C	0,97	0,00	1,00	262 257,10
Total	**233 279,3****	**916 768,3****	**0,8960***	**0,0791***	**1,00***	**689 428,28****

C = Confidential, *weighted average, **Total in Slovakia

4.3.3.4 Uncertainties and time-series consistency

The same algorithm for selected lime producers as in the cement uncertainty estimation was applied. The uncertainties in mass of lime (2%) and the content of CaO and MgO in lime (2%) were estimated according to the IPCC 2000 Good Practice Guidelines for each plant. It follows that the uncertainties of EF and AD are expressed by symbol Δ and the uncertainty of CO_2 emissions is in interval (-1.61%; +1.61%). Formula can be written in the form:

$$\text{Emissions} = \sum_I [(\text{lime} \pm \Delta\text{lime}) * (\text{ content of CaO} \pm \Delta\text{CaO}) * (\text{EFCaO} \pm \Delta\text{EFCaO}) \ +$$

$$+ \ (\text{lime} \pm \Delta \text{ lime})*(\text{content of MgO} \pm \Delta\text{MgO})*(EF_{MgO} \pm \Delta EF_{MgO})]*\text{cor\_f}$$

For other providers the algorithm from previous year is taken for emissions computation, the amount of raw material, content of $CaCO_3$, content of $MgCO_3$, their emission factors and their uncertainty for both AD and EF (in formula it represent symbol Δ) are taken. Formula can be written in the following form:

$$\text{Emissions} = \sum_I [(\text{raw material} \pm \Delta\text{raw}) * (\text{ content of CaCO3} \pm \Delta\text{CaCO3}) * (\text{EFCa} \pm \Delta\text{EFCa}) +$$

$$+ \ (\text{raw material} \pm \Delta\text{raw})*(\text{content of } MgCO_3 \pm \Delta MgCO_3)*(\text{EFMg} \pm \Delta\text{EFMg})]$$

In the computation of emissions the eight sources from four lime producers enter the formula. During the uncertainty computation, the relation between the content of CaO ($CaCO_3$) and the content of MgO ($MgCO_3$) is inspected again. It means that the sum of CaO ($CaCO_3$) and MgO ($MgCO_3$) contents could not exceed the value one in the raw material. This correlation is integrated to the computational procedure.

Figure 4.6: Probability density function for category 2A2 in tons of CO_2

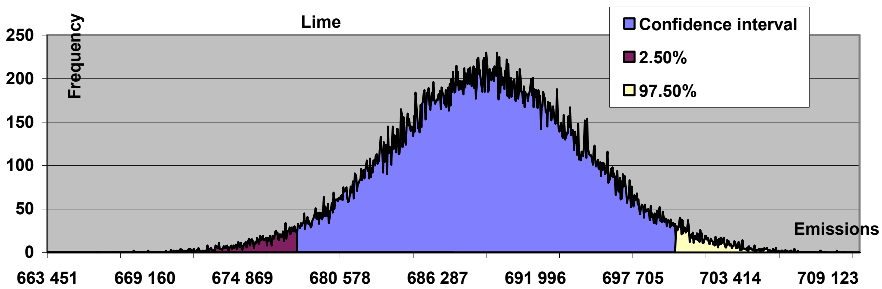


Table 4.9: Selected statistical characteristics for category 2A2, median, mean value, standard deviation, minimum, maximum of emissions and percentiles

Median	Average	Standard dev,	2,50%	97,50%
689 129,43	689 136,35	5 624,83	678 074,21	700 221,43
Min	**Max**		**Per_2,5**	**Per_97,5**
663 450,64	711 026,18		-1,61%	1,61%

4.3.3.5 *Source specific QA/QC and verification*

Information used for GHG emission inventories of IP sector are directly from the questionnaires sent to operators and lime producers in the Slovak Republic. First preliminary data related to the production and the quality of products in the Slovak Republic from the previous year is available at the beginning of October. This data are used for the estimation and verified by Mr. Vladimir Danielik – the sectoral expert for IP sector in the cooperation of the Slovak Technical University in Bratislava, the Faculty of Chemical and Food Technology. The data are compared with the information from the Statistical Office of the Slovak Republic (lime production) and available ETS reports.

4.3.3.6 *Source specific recalculations*

No recalculations in the submission 2011 focused on the base year 1990 or the other inventory years were provided.

4.3.3.7 *Source specific planned improvements*

No improvements are planned for this category for the next submission.

4.3.4 Source category description – Limestone and dolomite use (CRF 2.A.3)

Carbon dioxide is produced at thermal decomposition or chemical reactions of limestone to clink. The maximum value of the emission factor of CO_2 is 440 kg CO_2/t of consumed $CaCO_3$ and 522 kg CO_2/t of consumed $MgCO_3$, which is the recommended value according to the IPCC. The mass of consumed limestone in industrial processes were estimated except of the cement and lime production in the Slovak Republic. In this sub-category the mass of consumed limestone in different industrial processes (calcium carbide production, desulphurization of coal and ceramics) is included.

4.3.4.1 *Methodological issues – methods*

The limestone used in the Slovak Republic often contains a small amount of $MgCO_3$. Emissions are calculated on the basis of carbonates using Tier 3 method according to the IPCC 2000 GPG and the plant specific emission factors from 2004. The amounts of consumed limestone according to the sources and emissions of CO_2 in the period 1990 – 2009 are summarized in Table 4.10.

Table 4.10: Total carbonates used and emission of CO_2 in 1990 – 2009

Year	$CaCO_3$ from CaC_2 Production	Desulphu-risation ($CaCO_3$)	Desulphu-risation ($MgCO_3$)	Ceramics ($CaCO_3$)	Ceramics ($MgCO_3$)	Total Carbonates	CO_2 emissions
	[kt]	[kt]	[kt]	[kt]	[kt]	**[kt]**	**[kt]**
1990	0,00	93,00*	1,75*	NA	NA	**94,75**	**41,83**
1991	0,00	93,00*	1,75*	NA	NA	**94,75**	**41,83**
1992	15,61	93,00*	1,75*	NA	NA	**110,36**	**48,70**
1993	78,07	93,00*	1,75*	NA	NA	**172,82**	**76,18**
1994	114,76	93,00*	1,75*	NA	NA	**209,51**	**92,33**
1995	131,63	93,00*	1,75*	NA	NA	**226,38**	**99,75**
1996	140,53	93,00*	1,75*	NA	NA	**235,28**	**103,67**
1997	150,83	93,00*	1,75*	NA	NA	**245,58**	**108,20**
1998	138,34	93,00*	1,75*	NA	NA	**233,09**	**102,70**
1999	126,26	93,00*	1,75*	NA	NA	**221,01**	**97,39**
2000	138,68	93,00*	1,75*	NA	NA	**233,43**	**102,86**
2001	155,60	93,00*	1,75*	NA	NA	**250,35**	**110,30**
2002	156,34	93,00*	1,75*	NA	NA	**251,09**	**110,62**
2003	156,82	93,00*	1,75*	NA	NA	**251,57**	**110,84**
2004	156,14	92,49	1,73	6,55	5,37	**262,28**	**115,98**
2005	151,50	94,52	1,73	21,80	6,64	**276,19**	**122,21**
2006	151,86	92,84	1,75	30,65	5,25	**282,34**	**124,80**
2007	158,04	72,59	1,24	36,31	6,87	**275,04**	**121,68**
2008	173,08	69,75	1,02	72,47	17,82	**334,13**	**148,56**
2009	156,95	85,82	0,00	19,01	7,16	**268,94**	**118,92**

** Expert judgment*

4.3.4.2 Methodological issues – emission factors and other parameters

Emission factor is based on the stoichiometry of limestone and dolomite in mixtures and it was 0.442 t per ton of used carbonates in 2009.

4.3.4.3 Activity data

Total amount of used limestone and dolomite in industry was 268.94 kt, the activity data are summarized in Table 4.10. The $MgCO_3$ was not used for desulphurization process and the use of carbonates in ceramic industry decreased significantly due to the recession in production in 2009.

4.3.4.4 Uncertainties and time-series consistency

The uncertainties in mass of used limestone and dolomite (2%) and their composition (3%) were estimated according to the IPCC Good Practice Guidelines for each plant. It follows that the uncertainty of EF and AD are expressed by symbol Δ and the uncertainty of CO_2 emissions is in interval (-1.61%; +1.61%). Formula can be written in the following form:

$$\text{Emissions} = \sum_{I} \left[(\text{carbonate amount} \pm \Delta\text{carbonate}) * (\text{EFCarb} \pm \Delta\text{EFCarb})\right.$$

In the computation of emissions the three main processes enter to the calculating procedure. The emissions related to limestone consumption are moved from the subsector carbide production. This fact was applied in the uncertainty computation for 2009. For the reason to achieve desired entered parameter: the amount of $CaCO_3$ and its uncertainty require combination of values the amount of limestone and content of $CaCO_3$ and their uncertainty, which are available in the subsector carbide. The accumulated uncertainty and statistical characteristics for subsector limestone and dolomite use are presented.

Figure 4.7: Probability density function for category 2A3 in tons of CO_2

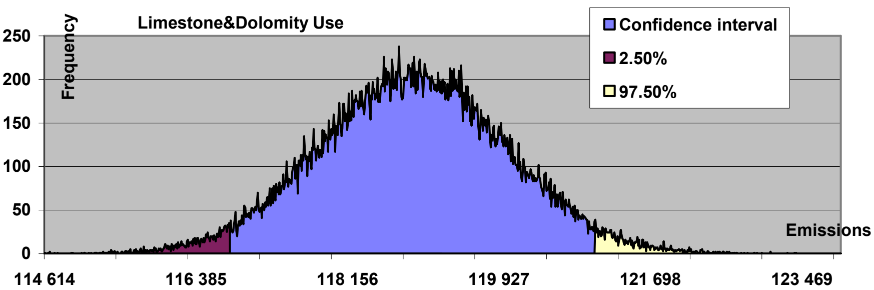


Table 4.11: Selected statistical characteristics for category 2A3, median, mean value, standard deviation, minimum, maximum of emissions and percentiles

Median	Average	Standard dev,	2,50%	97,50%
118 917,26	118 918,28	1 092,09	116 789,49	121 050,01
Min	**Max**		**Per_2,5**	**Per_97,5**
114 613,77	123 934,94		-1,79%	1,79%

4.3.4.5 Source specific QA/QC and verification

Information used for GHG emission inventories of IP sector are directly from the questionnaires sent to operators and lime producers in the Slovak Republic. First preliminary data related to the production and the quality of products in the Slovak Republic from the previous year is available at the beginning of October. This data are used for the estimation and verified by Mr. Vladimir Danielik – the sectoral expert for IP sector in the cooperation of the Slovak Technical University in Bratislava, the Faculty of Chemical and Food Technology. The data are compared with the information from the Statistical Office of the Slovak Republic (lime used) and available ETS reports.

4.3.4.6 Source specific recalculations

No recalculations in the submission 2011 focused on the base year 1990 or the other inventory years were provided.

4.3.4.7 Source specific planned improvements

No improvements are planned for this category for the next submission.

4.3.5 Source category description – Soda ash production and use (CRF 2.A.4)

Soda ash is not produced in the Slovak Republic. The use of soda ash is included in category 1A3 Limestone and dolomite use.

4.3.6 Source category description – Asphalt roofing (CRF 2.A.5)

Asphalt blowing is a part of asphalt roofing production. It is the process of polymerizing and stabilizing asphalt to improve its weathering characteristics.

4.3.6.1 Methodological issues – methods

The emissions originating from asphalt roofing production are NMVOC and CO. According to the IPCC 1996 Guidelines the emission factor of CO is 0.0095 kg CO/t of asphalt.

In Icopal, a.s. Štúrovo, asphalt roofing is produced by saturation without spray (by rolling). Default emission factor according to the IPCC recommendation is in the range from 0.046 to 0.049 kg/t of asphalt. The inventory has assumed the higher value. In the case of afterburner, the emission factor of NMVOC according to the IPCC Guidelines is 0.1 kg/t of asphalt at asphalt blowing. According to the data supplied by Icopal, a.s. Štúrovo, 14.154 kt of asphalt were used in the production of asphalt roofing in 2009. It follows that the emissions of CO and NMVOC were 0.134 t and 2.109 t, respectively. These emissions are included in energy sector category 1A2f. Because no national data are known only IPCC default factors are used.

4.3.7 Source category description – Road paving with asphalt (CRF 2.A.6)

The emissions of NMVOC from road paving with asphalt were estimated according to the EMEP/ CORINAIR methodology.

4.3.7.1 Methodological issues – methods

Total amount of asphalt used for paving the road in 2009 was 123.25 kt. The emission factor for NMVOC was estimated at 0.00647 kg/t and total emissions of NMVOC included in this category were 0.797 tons. The emissions of NO_x, SO_2 and CO are included in the energy sector, category 1A2f.

4.3.8 Source category description – Glass production (CRF 2.A.7.1)

Basic raw material for glass production is silica (SiO_2). Limestone ($CaCO_3$), dolomite ($CaMg(CO_3)_2$), soda ash (Na_2CO_3), potash (K_2CO_3), Pb_3O_4, Al_2O_3, and coloring agents are used in glass production. NMVOC and CO_2 are the most important emissions. Due to the recession in glass production, the emissions from carbonates used decreased interannual (2008/2009) by 44% and were 13.1933 kt in 2009.

4.3.8.1 Methodological issues – methods

The emissions of CO_2 from glass production were reallocated from the category 2A3 Limestone and dolomite use. The mass of used carbonates other than limestone (e.g. Na_2CO_3, K_2CO_3) was calculated on the basis of stoichiometry to the appropriate mass of limestone.

4.3.8.2 Methodological issues – emission factors and other parameters

The emission factor is based on limestone and dolomite stoichiometry in mixtures and it was 0.415 t per ton of used carbonates in 2009.

4.3.8.3 Activity data

In 2009 the glass production in the Slovak Republic was as follows: 65 943 tons of white glass, 74 556 tons of green glass, 109 273 tons of crystal glass and 1 159 tons of leaded glass. Total amount of produced glass was 250 931 t. $SrCO_3$ and Li_2CO_3 were not used for glass production. Total amounts of used carbonates are summarized in Table 4.12 and were 31.8071 kt in 2009.

Table 4.12: Total amounts of carbonates used in glass production in 1990 – 2009

Year	Used Carbonates [t]								Emissions
	$CaCO_3$	K_2CO_3	Na_2CO_3	$BaCO_3$	$MgCO_3$	$SrCO_3$	Li_2CO_3	Total	CO_2 [kt]
1990	17,91	a)	a)	a)	a)	a)	a)	17,91	**7,880**
1991	22,61	a)	a)	a)	a)	a)	a)	22,61	**9,950**
1992	27,34	a)	a)	a)	a)	a)	a)	27,34	**12,030**
1993	33,29	a)	a)	a)	a)	a)	a)	33,29	**14,646**
1994	37,06	a)	a)	a)	a)	a)	a)	37,06	**16,306**
1995	40,93	a)	a)	a)	a)	a)	a)	40,93	**18,007**
1996	45,60	a)	a)	a)	a)	a)	a)	45,60	**20,062**
1997	45,27	a)	a)	a)	a)	a)	a)	45,27	**19,918**
1998	43,15	a)	a)	a)	a)	a)	a)	43,15	**18,988**
1999	43,52	a)	a)	a)	a)	a)	a)	43,52	**19,147**
2000	51,87	a)	a)	a)	a)	a)	a)	51,87	**22,821**
2001	52,46	a)	a)	a)	a)	a)	a)	52,46	**23,081**
2002	48,68	a)	a)	a)	a)	a)	a)	48,68	**21,417**
2003	51,00	a)	a)	a)	a)	a)	a)	51,00	**22,438**
2004	40,59	2,01	13,71	0,83	0,00	0,00	0,00	57,13	**24,371**
2005	55,45	2,75	16,00	0,89	1,76	0,01	0,01	76,87	**33,038**
2006	55,97	2,64	15,35	0,95	0,01	0,03	0,01	74,95	**32,062**
2007	70,70	2,05	19,48	0,96	2,13	0,04	0,00	95,36	**41,183**
2008	29,43	1,72	21,27	0,83	1,78	0,00	0,00	55,03	**23,440**
2009	15,05	1,43	13,45	1,49	0,39	0,00	0,00	31,81	**13,193**

[a)] *Carbonates are included in the form of calcium carbonate (on the basis of stoichiometry).*

4.3.8.4 Uncertainties and time-series consistency

The amount of $NaCO_3$, K_2CO_3, $CaCO_3$, $BaCO_3$ and the amount of $MgCO_3$ (noted as carbonates), their emission factors and their uncertainty for both AD and EF (in formula represent by symbol Δ) were used for uncertainty estimation. The uncertainty of CO_2 emissions is in interval (-1.52%; +1.53%).Formula can be written in the following form:

$$\text{Emissions} = \sum_{I} \left[(\text{carbonate amount} \pm \Delta\text{carbonate}) * (\text{EFCarb} \pm \Delta\text{EFCarb})\right.$$

In the emission computation from glass production the four producers are contributed to the calculating procedure (in the previous formula subscript *I* represent number of processes). The accumulated uncertainty and statistical characteristics for glass production are presented in the following table and figure.

Figure 4.8: Probability density function for category 2A71 in tons of CO_2

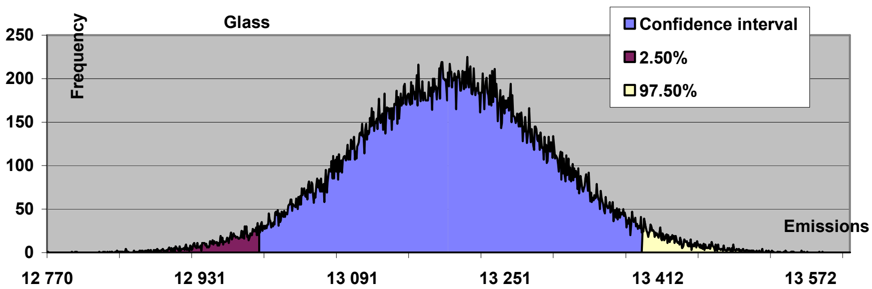


Table 4.13: Selected statistical characteristics for category 2A71, median, mean value, standard deviation, minimum, maximum of emissions and percentiles

Median	Average	Standard dev,	2,50%	97,50%
13 194,22	13 193,99	102,33	12 993,38	13 395,34
Min	**Max**		**Per_2,5**	**Per_97,5**
12 770,17	13 614,60		-1,52%	1,53%

4.3.8.5 Source specific QA/QC and verification

Information used for GHG emission inventories of IP sector are directly from the questionnaires sent to operators and lime producers in the Slovak Republic. First preliminary data related to the production and the quality of products in the Slovak Republic from the previous year is available at the beginning of October. This data are used for the estimation and verified by Mr. Vladimir Danielik – the sectoral expert for IP sector in the cooperation of the Slovak Technical University in Bratislava, the Faculty of Chemical and Food Technology. The data are compared with the information from the Statistical Office of the Slovak Republic (lime used) and available ETS reports.

4.3.8.6 Source specific recalculations

No recalculations in the submission 2011 focused on the base year 1990 or the other inventory years were provided. The corrections were provided in Table 4.12 in $BaCO_3$ consumption units (2004 – 2008) comparable to the previous submission 2010. These corrections have no implication on emissions.

4.3.8.7 Source specific planned improvements

No improvements are planned for this category for the next submission.

4.3.9 Source category description – Magnesite production (CRF 2.A.7.2)

Carbon dioxide is produced from thermal decomposition of magnesite. The principal chemical reaction scheme of the thermal decomposition is $MgCO_3 = MgO + CO_2$. Total CO_2 emissions from magnesite production decreased interannual (2008/2009) by 30% and were 265.6863 Gg in 2009. The decreasing was caused by decreasing of magnesite clink production.

Table 4.14: Total magnesite clinker production and CO_2 emissions in 2000 – 2009

Category 2A72 Magnesite Production			
Year	Magnesite Clinker Production (kt)	CO_2 emissions (Gg)	EF (t/t)
1990	460,05	431,94	0,939
1991	273,98	257,24	0,939
1992	233,79	219,50	0,939
1993	240,36	225,67	0,939
1994	217,61	204,31	0,939
1995	313,17	294,03	0,939
1996	320,72	301,12	0,939
1997	330,44	310,25	0,939
1998	401,01	376,51	0,939
1999	420,54	394,85	0,939
2000	436,49	409,82	0,939
2001	459,71	431,63	0,939
2002	467,06	438,52	0,939
2003	479,23	449,95	0,939
2004	524,93	499,67	0,952
2005	481,88	476,00	0,988
2006	346,49	340,62	0,983
2007	320,05	304,00	0,950
2008	404,18	377,22	0,933
2009	283,43	265,69	0,937

4.3.9.1 Methodological issues – methods

Magnesite clinker produced in the Slovak Republic contains a small amount of $CaCO_3$. Emissions are calculated on the basis of carbonates by using Tier 3 method according to the IPCC 2000 GPG and the plant specific emission factors since 2004. The amounts of magnesite clinker and emissions of CO_2 in the period of 1990 – 2009 are summarized in Table 4.14.

4.3.9.2 Methodological issues – emission factors and other parameters

Emission factor of CO_2 emissions for magnesite clinker was calculated as weighted average of EF for MgO (1.092 t per 1 ton of MgO) and EF for CaO (0.785 t per 1 ton of CaO). Average emission factor was 0.9374 t per 1 ton of magnesite clinker in 2009.

4.3.9.3 Activity data

Total amount of magnesite clinker produced in the Slovak Republic was 283.429 kt in 2009. The purity of magnesite in the Slovak Republic varies mainly from 86% to 91%. It should be noted that CaO content which can be presented in some magnesite clinkers was recalculated to the hypothetical "MgO content" on the basis of stoichiometry.

4.3.9.4 Uncertainties and time-series consistency

The uncertainties in mass of produced magnesite clink (2%) and the content of MgO and CaO (3%) were estimated according to the IPCC 2000 GPG for each plant. Their emission factors and uncertainty for both AD and EF (in formula represent by symbol Δ) were used for uncertainty estimation. The uncertainty of CO_2 emissions is in interval (-2.84%; +2.92%). Formula can be written in the following form:

$$\text{Emissions} = \sum_I \left[(\text{clinker} \pm \Delta\text{clinker}) * (\text{content of CaO} \pm \Delta\text{CaO}) * (\text{EFCaO} \pm \Delta\text{EFCaO}) + (\text{clinker} \pm \Delta\text{clinker}) * (\text{content of MgO} \pm \Delta\text{MgO}) * (EF_{Mg} \pm \Delta EF_{Mg})\right]$$

Three producers have contributed to the emissions computations from magnesite consumption. During the uncertainty computation the relation between the content of $CaCO_3$ and MgO is inspected. It means that the sum of $CaCO_3$ content and of MgO content could not exceed the value one in clinker (the recommended value is 0.95). This correlation is integrated to the computational procedure. The accumulated uncertainty and statistical characteristics for magnesite are presented in the following table and figure.

Figure 4.9: Probability density function for category 2A72 in tons of CO_2

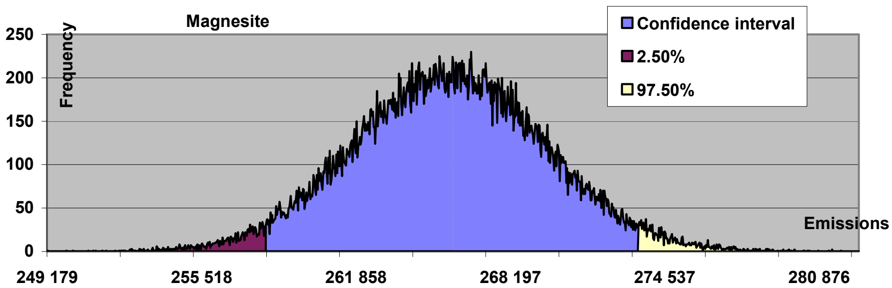


Table 4.15: Selected statistical characteristics for category 2A72, median, mean value, standard deviation, minimum, maximum of emissions and percentiles

Median	Average	Standard dev,	2,50%	97,50%
265 711,39	265 709,41	3 910,14	258 154,97	273 457,01
Min	**Max**		**Per_2,5**	**Per_97,5**
249 178,86	282 544,34		-2,84%	2,92%

4.3.9.5 Source specific QA/QC and verification

Information used for GHG emission inventories of IP sector are directly from the questionnaires sent to operators and lime producers in the Slovak Republic. First preliminary data related to the production and the quality of products in the Slovak Republic from the previous year is available at the beginning of October. This data are used for the estimation and verified by Mr. Vladimir Danielik – the sectoral expert for IP sector in the cooperation of the Slovak Technical University in Bratislava, the Faculty of Chemical and Food Technology. The data are compared with the information from the Statistical Office of the Slovak Republic (magnesite production) and available ETS reports.

4.3.9.6 Source specific recalculations

No recalculations in the submission 2011 focused on the base year 1990 or the other inventory years were provided.

4.3.9.7 Source specific planned improvements

No improvements are planned for this category for the next submission.

4.4 Chemical industry (CRF 2.B)

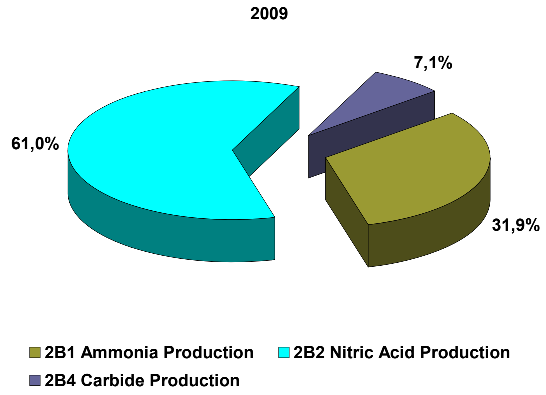
4.4.1 Source category description

The major share of emissions comes from N_2O pollution in nitric acid production Total emissions were 2 031.51 Gg of CO_2 equivalents in 2009, the decrease by more than 10% compared to the previous year is significant and the increasing trend of has been continual since base year was interrupted and reached 13%. The overall increasing trend is visible in nitric acid production and carbide production. The major share (61%) in emissions belongs to nitric acid production, 32% belongs to ammonia production and 7% to carbide production.

Table 4.16: GHG emissions in individual subcategories in the 2B category in 1990 – 2009

Category 2B - CO_2 emissions equivalents (Gg)				
Year	2B1 Ammonia Production	2B2 Nitric Acid Production	2B4 Carbide Production	2B Total
1990	648,79	1 148,71	NO	**1 797,51**
1991	639,52	796,52	NO	**1 436,04**
1992	623,19	711,14	21,90	**1 356,23**
1993	371,67	549,69	54,50	**975,86**
1994	626,44	980,65	84,19	**1 691,28**
1995	688,06	1 125,61	96,51	**1 910,19**
1996	737,22	1 314,71	103,60	**2 155,53**
1997	731,60	1 243,98	110,61	**2 086,19**
1998	648,58	1 057,64	101,52	**1 807,75**
1999	649,22	794,65	92,59	**1 536,47**
2000	719,47	1 032,26	101,79	**1 853,52**
2001	733,24	1 167,81	114,10	**2 015,16**
2002	712,77	1 044,45	114,65	**1 871,86**
2003	630,76	1 156,18	115,11	**1 902,04**
2004	726,79	1 321,63	157,40	**2 205,82**
2005	759,08	1 281,18	140,21	**2 180,47**
2006	634,00	1 687,51	149,61	**2 471,11**
2007	646,56	1 447,99	151,17	**2 245,72**
2008	585,57	1 523,14	154,04	**2 262,75**
2009	647,97	1 238,82	144,72	**2 031,51**

Figure 4.10: The share of individual categories on emissions in category 2B chemical industry in 2009



Category	CO_2 Eq. (Gg)	Share (%)
2B1 Ammonia Production	647,97	31,90%
2B2 Nitric Acid Production	1 238,82	60,98%
2B4 Carbide Production	144,72	7,12%

4.4.2 Source category description – Ammonia production (CRF 2.B.1)

Ammonia is basically made from nitrogen and hydrogen by fine-tuned versions of the process developed by Haber and Bosch $N_2 + 3H_2 = 2NH_3$. In principle, the reaction between hydrogen and nitrogen is easy. However, to get a respectable yield of ammonia in a chemical plant a catalyst and extreme pressures up to 600 atmospheres and temperature of 400°C are needed. The results are summarized in Table 4.17.

4.4.2.1 Methodological issues – methods

The Tier 2 methodology according to the IPCC 2000 GPG was applied to category 2B1 ammonia production and the plant specific emission factors were used. The information on ammonia production, provided directly by the company, was used based on ETS information in 2009. The measured values of CO_2 production from the plant were used for CO_2 emissions estimation and calculated according to the relationship:

$$E(CO_2) = FR \cdot CF \cdot CCF \cdot OF \cdot \frac{44}{12}$$

where: FR – fuel requirement (natural gas) in m^3; CF – conversion factor in TJ / m^3 (36.292 at 0°C); CCF – content of carbon in the fuel in t / TJ (15.066); OF – oxidation factor of the fuel (1).

Table 4.17: Ammonia production and GHG emissions in 1990 – 2009

Category 2B1 Ammonia Production						
Year	Ammonia Production (kt)	CO_2 emissions (Gg)	CH_4 emissions (t)	N_2O emissions (t)	NG Consump. (m^3)	EF CO_2 (t/t NH_3)
1990	360,00	616,97	1 170,00	23,40	322 544 714,00	1,7138
1991	351,60	608,44	1 142,70	22,85	315 018 671,00	1,7305
1992	344,20	592,76	1 118,65	22,37	308 388 585,00	1,7221
1993	206,90	353,38	672,42	13,45	185 373 615,00	1,7080
1994	353,90	595,16	1 150,17	23,00	317 079 373,00	1,6817
1995	383,80	654,14	1 247,35	24,95	343 868 503,00	1,7044
1996	411,70	700,83	1 338,02	26,76	368 865 719,00	1,7023
1997	409,90	695,36	1 332,17	26,64	367 252 995,00	1,6964
1998	364,30	616,38	1 183,97	23,68	326 397 331,00	1,6919
1999	364,00	617,04	1 183,00	23,66	326 128 544,00	1,6952
2000	403,00	683,85	1 309,75	26,19	361 070 888,00	1,6969
2001	411,80	696,84	1 338,36	26,77	368 958 002,00	1,6922
2002	400,00	677,41	1 300,00	26,00	358 383 015,00	1,6935
2003	353,68	599,49	1 149,46	22,99	316 882 262,00	1,6950
2004	407,90	690,73	1 325,68	26,51	365 461 976,00	1,6934
2005	426,35	721,40	1 385,63	27,71	381 988 809,00	1,6920
2006	354,56	602,65	1 152,31	23,05	317 668 913,00	1,6997
2007	362,44	614,52	1 177,93	23,56	324 730 850,00	1,6955
2008	328,20	556,57	1 066,23	21,32	293 937 581,00	1,6958
2009	344,40	618,40	1 086,93	21,74	308 455 000,00	1,7956

4.4.2.2 Methodological issues – emission factors and other parameters

The emission factor is 1.7956 t CO_2 per 1 t of ammonia produced and is based on plant specific data and calculated for ammonia produced by chemical reaction. The emission factor for CH_4 was 5 t of CH_4 per 1 t of NH_3 and 0.1 t of N_2O per 1 t of NH_3. The data on the consumption of natural gas are available from ETS reports.

4.4.2.3 Activity data

The produced amount of ammonia was 344.4 ktons in 2009. Based on data supplied by the plant 308 455 000 Nm^3 (217 386 ktons) of natural gas was consumed for ammonia production. The presented data are based on the measurements in the plants; therefore the emission factor of CO_2 has been changed in comparison with the previous emission inventory.

4.4.2.4 Uncertainties and time-series consistency

To compute the uncertainty for this subsector the input parameters were applied: natural gas consumption, gas caloric value, oxidation factor, their emission factors and their uncertainties for both AD and EF according to the IPCC 2000 GPG for each plant. The production process generates CO_2 emissions and CH_4 and N_2O emissions and PFCs emissions. Their emission factors and uncertainty for both AD and EF (in formula represent by symbol Δ) were used for uncertainty estimation. The uncertainty of CO_2 emissions (in equivalents) is in interval (-4.1%; +5.5%). Formula can be written in the following form:

$$\text{Emissions} = (\text{gas} \pm \Delta\text{gas}) * (\text{caloric} \pm \Delta\text{caloric}) * (\text{oxid.fact} \pm \Delta\text{oxid.fact}) * \frac{44}{12} / 1000 +$$
$$+ \sum_{I} (\text{gas} \pm \Delta\text{gas}) * (\text{g\_density} \pm \Delta\text{g\_density}) * (EF_i \pm \Delta EF_i) * CF_i$$

In the previous formula subscript *I* represent CH_4 and N_2O contribution to the total emission. The accumulated uncertainty and statistical characteristics for ammonia production are presented in the following figure.

Figure 4.11: Probability density function for category 2B1 in tons of CO_2

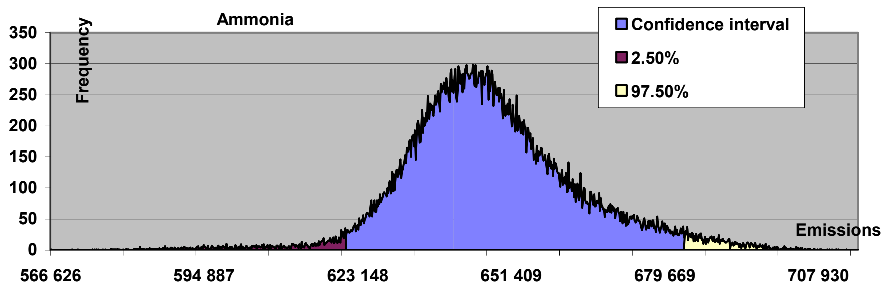


Table 4.18: Selected statistical characteristics for category 2B1, median, mean value, standard deviation, minimum, maximum of emissions and percentiles

Median	Average	Standard dev,	2,50%	97,50%
646 066,97	647 644,96	15 631,99	621 083,55	683 255,56
Min	**Max**		**Per_2,5**	**Per_97,5**
566 626,43	715 367,12		-4,10%	5,50%

4.4.2.5 Source specific QA/QC and verification

Information used for GHG emission inventories of IP sector are directly from the questionnaires sent to operators and lime producers in the Slovak Republic. First preliminary data related to the production and the quality of products in the Slovak Republic from the previous year is available at the beginning of October. This data are used for the estimation and verified by Mr. Vladimir Danielik – the sectoral expert for IP sector in the cooperation of the Slovak Technical University in Bratislava, the Faculty of

Chemical and Food Technology. The data are compared with the information from the Statistical Office of the Slovak Republic (ammonia and fertilisers production) and available ETS reports.

4.4.2.6 Source specific recalculations

No recalculations in the submission 2011 focused on the base year 1990 or the other inventory years were provided.

4.4.2.7 Source specific planned improvements

No improvements are planned for this category for the next submission.

4.4.3 Source category description – Nitric acid production (CRF 2.B.2)

Globally, nitric acid production consumes about 20% of all produced ammonia. Nitric acid production in the Slovak Republic is an important source of N_2O emissions and a key source category in level and trend assessment. Total nitric acid production significantly decreased interannual (2008/2009) followed by 18% decrease of N_2O emissions in 2009. This is in contrast with the increasing of NO_x emissions (25%) comparable 2008 due to the technological reasons (more efficient N_2O separators installed) as was explained by HNO_3 producer.

4.4.3.1 Methodological issues – methods

Since 2005, emissions of N_2O and NO_x have been monitoring in Duslo Šaľa (the nitric acid producer). The Tier 2 methodology according to the IPCC 2000 GPG was applied to this category in combination with plant specific emission factors.

4.4.3.2 Methodological issues – emission factors and other parameters

According to the directly measured information of emissions from the nitric acid production, the emission factors were estimated annually, based on certified measurements in the plant. It seems that the discrepancy between previously and recently used EFs is based on non-correct information about holding time of gasses at catalyst and temperature in reactor.

Table 4.19: Estimated N_2O emissions and weighted EFs in 1990 – 2009

Category 2B2 Nitric Acid Production						
Year	Nitric Acid Production (kt)	EF N_2O (t/t HNO_3)	N_2O atmospheric (t)	N_2O medium pressure (t)	N_2O high pressure (t)	Total N_2O emissions (t)
1990	400,54	0,00925	1 953,77	1 751,75	0,00	3 705,52
1991	301,83	0,00851	989,37	1 580,05	0,00	2 569,42
1992	278,44	0,00824	747,36	1 546,64	0,00	2 294,00
1993	233,62	0,00759	298,74	1 474,45	0,00	1 773,19
1994	360,82	0,00877	1 381,64	1 781,75	0,00	3 163,39
1995	398,80	0,00910	1 818,70	1 812,31	0,00	3 631,01
1996	446,78	0,00949	2 412,67	1 828,34	0,00	4 241,01
1997	421,33	0,00952	2 304,38	1 708,46	0,00	4 012,84
1998	377,35	0,00904	1 668,94	1 742,81	0,00	3 411,75
1999	306,51	0,00836	554,58	1 280,42	728,40	2 563,40
2000	407,22	0,00818	0,00	1 172,81	2 157,06	3 329,87
2001	464,35	0,00811	0,00	1 442,02	2 325,11	3 767,14
2002	403,84	0,00834	0,00	928,93	2 440,26	3 369,19
2003	454,64	0,00820	0,00	1 267,40	2 462,20	3 729,60
2004	524,82	0,00812	0,00	1 610,27	2 653,06	4 263,32
2005	497,68	0,00830	0,00	1 573,54	2 559,28	4 132,82
2006	564,00	0,00965	0,00	2 805,69	2 637,90	5 443,58
2007	489,22	0,00955	0,00	2 032,88	2 638,07	4 670,95
2008	509,26	0,00965	0,00	2 518,73	2 394,62	4 913,36
2009	418,62	0,00955	0,00	1 734,87	2 261,35	3 996,20

According to the measured data, the EFs are 10.332 kg N_2O per 1 t of HNO_3 for medium-pressure plant and 9.02 kg N_2O per 1 t of HNO_3 for high-pressure plant, respectively (reg. No.: SNAS 230/S-189). According to the ERT review team recommendation, the EF 10.332 kg N_2O per 1 t of HNO_3

should be used also for the other producers in the Slovak Republic. The used technologies are very similar. The weighted EF was 9.546 kg N_2O/t of HNO_3 and the N_2O emissions were 3 996.2 tons.

4.4.3.3 Activity data

Total production of nitric acid was 418.616 ktons and the emissions of NO_x were 287 tons in 2009. Activity data and emissions are presented in Table 4.19.

4.4.3.4 Uncertainties and time-series consistency

The uncertainties in mass of produced nitric acid (2%) and used EF (10%) were estimated according to the IPCC 2000 GPG for each plant. It follows that the uncertainty of EF is 5.9% and the uncertainty of N_2O emissions is 8.6% according to the IPCC 2000 GPG for each plant. The production process generates N_2O emissions. Their emission factors and uncertainty for both AD and EF (in formula represent by symbol Δ) were used for uncertainty estimation. The uncertainty of CO_2 emissions (in equivalents) is in interval (-2.12%; +2.14%). Formula can be written in the following form:

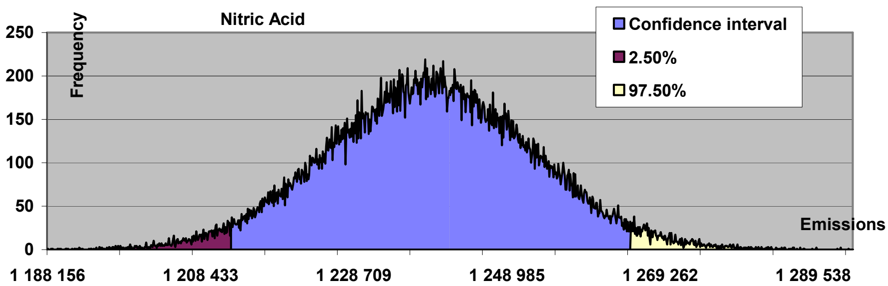
$$\text{Emissions} = \sum_{i} \left[(\text{HNO}_3 \text{ amount} \pm \Delta\text{amount}) * (\text{EF} \pm \Delta\text{EF}) * \text{CF}_i / 1000\right.$$

Three sources of two main producers entered the calculating procedure. The accumulated uncertainty and statistical characteristics for nitric acid are presented in the following figure.

Table 4.20: Selected statistical characteristics for category 2B2, median, mean value, standard deviation, minimum, maximum of emissions and percentiles

Median	Average	Standard dev,	2,50%	97,50%
1 238 777,60	1 238 825,68	13 498,09	1 212 587,14	1 265 361,87
Min	**Max**		**Per_2,5**	**Per_97,5**
1 188 156,42	1 294 873,76		-2,12%	2,14%

Figure 4.12: Probability density function for category 2B2 in tons of CO_2



4.4.3.5 Source specific QA/QC and verification

Information used for GHG emission inventories of IP sector are directly from the questionnaires sent to operators and lime producers in the Slovak Republic. First preliminary data related to the production and the quality of products in the Slovak Republic from the previous year is available at the beginning of October. This data are used for the estimation and verified by Mr. Vladimir Danielik – the sectoral expert for IP sector in the cooperation of the Slovak Technical University in Bratislava, the Faculty of Chemical and Food Technology. The data are compared with the information from the Statistical Office of the Slovak Republic (HNO_3 production) and available ETS reports.

4.4.3.6 Source specific recalculations

No recalculations in the submission 2011 focused on the base year 1990 or the other inventory years were provided.

4.4.3.7 Source specific planned improvements

No improvements are planned for this category for the next submission.

4.4.4 Source category description – Adipic acid production (CRF 2.B.3)

Adipic acid is not produced in the Slovak Republic.

4.4.5 Source category description – Carbide production (CRF 2.B.4)

4.4.5.1 Silicon Carbide (CRF 2.B.4.1)

Silicon carbide is not produced in the Slovak Republic.

4.4.5.2 Calcium Carbide (CRF 2.B.4.2)

Calcium carbide (the correct chemical name of this compound is calcium acetylide) is produced by the reaction of CaO and coke in submerged arc furnace. Recently this plant was modernized in order to decrease the emissions (in 1992).

4.4.5.3 Methodological issues – methods

The main component of released emissions is CO_2. However, emissions of CO_2 from the decomposition of limestone are included in the category 2A3 limestone and dolomite use. Because no national data are known only the IPCC default factors were used. The Tier 2 methodology according to the IPCC 2000 GPG was applied to this category in combination with plant specific emission factors. In the previous emission inventory, the CO_2 emissions from reduction step were included in the energy sector category 1A2c (chemicals, solid fuels). According to the ERT review team recommendation, the CO_2 emissions should be allocated into this category. Therefore CO_2 emissions have been recalculated since 1992 (beginning of the production) and they are summarized in Table 4.21. CO_2 emissions from using the products were calculated only from non-exported production.

Table 4.21: Estimated CO_2 emissions and carbide production and export in 1990 – 2009

Category 2B4.2 Calcium Carbide Production					
	Carbide Production	Carbide Export	CO_2 Emissions (reduction step)	CO_2 Emissions (using of the product)	CO_2 Emissions Total
Year	[kt]				[Gg]
1990	0,00	0,00	0,00	0,00	0,00
1991	0,00	0,00	0,00	0,00	0,00
1992	10,00	0,00	10,90	11,00	21,90
1993	50,00	50,00	54,50	0,00	54,50
1994	73,50	69,80	80,12	4,07	84,19
1995	84,30	80,10	91,89	4,62	96,51
1996	90,00	85,00	98,10	5,50	103,60
1997	96,60	91,77	105,29	5,31	110,61
1998	88,60	84,10	96,57	4,95	101,52
1999	80,87	76,82	88,14	4,45	92,59
2000	88,82	84,30	96,81	4,97	101,79
2001	99,65	94,67	108,62	5,48	114,10
2002	100,13	95,12	109,14	5,51	114,65
2003	100,44	95,32	109,48	5,63	115,11
2004	100,00	56,00	109,00	48,40	157,40
2005	97,03	65,71	105,76	34,45	140,21
2006	97,26	57,62	106,01	43,60	149,61
2007	101,22	64,08	110,32	40,85	151,17
2008	107,52	74,04	117,20	36,83	154,04
2009	97,50	62,56	106,28	38,44	144,72

4.4.5.4 Methodological issues – emission factors and other parameters

Emission factors for CO_2 (0.76 t CO_2/t of CaC_2 from the decomposition of limestone; 1.09 t CO_2 /t of carbide from the reduction and 1.1 t CO_2/t of carbide from using the product) were taken from the IPCC 2000 GPG. Weighted emission factor for the category 2B4.2 was 1.484 t CO_2 for 1 t of produced CaC_2. The CO_2 emissions at the decomposition of limestone are included in the category 1A3 Limestone and Dolomite Use.

4.4.5.5 Activity data

Total production of CaC_2 (calcium carbide) was 97 504.3 tons in 2009. According to the data supplied by the producer, 62 558 tons of produced calcium carbide was exported from the Slovak Republic. The rest was used for acetylene production.

4.4.5.6 Uncertainties and time-series consistency

The emissions related to limestone consumption were reallocated to the use of limestone and dolomite. This fact was applied to the computation of uncertainty for 2009. The emission factors and uncertainty for both AD and EF (in formula represent by symbol Δ) were used for uncertainty estimation. The uncertainty of CO_2 emissions (in equivalents) is in interval (-8.66%; +8.81%). Formula can be written in the following form:

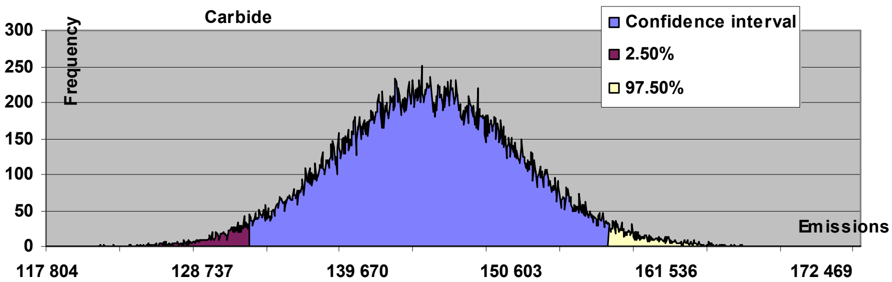
$$\text{Emission} = (\text{carbide production} \pm \Delta(\text{carbide production})))*(\text{EFcarb} \pm \Delta\text{EFcarb})+((\text{carbide production} \pm \Delta(\text{carbide production}))-(\text{exported carbide} \pm \Delta(\text{exported carbide}))*(\text{EFcarb} \pm \Delta\text{EFcarb})$$

The accumulated uncertainty and statistical characteristics for carbide production are presented in the following figure.

Table 4.22: Selected statistical characteristics for category 2B4, median, mean value, standard deviation, minimum, maximum of emissions and percentiles

Median	Average	Standard dev,	2,50%	97,50%
144 677,22	144 723,92	6 454,16	132 194,82	157 476,34
Min	**Max**		**Per_2,5**	**Per_97,5**
117 803,78	175 345,88		-8,66%	8,81%

Figure 4.13: Probability density function for category 2B4 in tons of CO_2



4.4.5.7 Source specific QA/QC and verification

Information used for GHG emission inventories of IP sector are directly from the questionnaires sent to operators and lime producers in the Slovak Republic. First preliminary data related to the production and the quality of products in the Slovak Republic from the previous year is available at the beginning of October. This data are used for the estimation and verified by Mr. Vladimir Danielik – the sectoral expert for IP sector in the cooperation of the Slovak Technical University in Bratislava, the Faculty of Chemical and Food Technology. The data are compared with the information from the Statistical Office of the Slovak Republic (carbide production) and available ETS reports.

4.4.5.8 Source specific recalculations

No recalculations in the submission 2011 focused on the base year 1990 or the other inventory years were provided.

4.4.5.9 Source specific planned improvements

No improvements are planned for this category for the next submission.

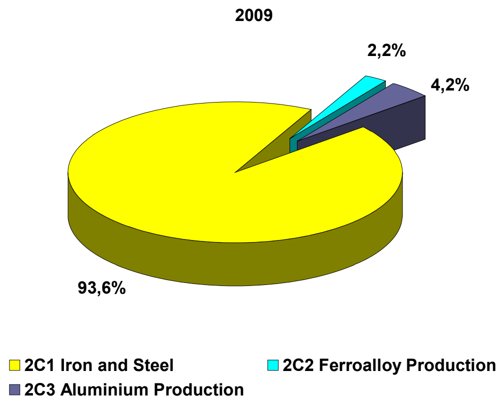
4.5 Metal production (CRF 2.C)

4.5.1 Source category description

Total emissions were 4 752.92 Gg of CO_2 equivalents in 2009, the decrease is 16% compared with the previous year. Comparing with the base year, the decrease is more than 21%. The decrease is caused by the decrease in emissions from iron and steel production and ferroalloy production due to the economical recession in 2009. Total NMVOC emissions from this category are 331 tons. The emissions of other basic pollutants are included in the energy sector, category iron and steel.

The major share (94%) in emissions belongs to the iron and steel production, 4% belongs to the ferroalloy production and 2% to the aluminum production.

Figure 4.14: The share of individual categories in emissions in category 2C metal production in 2009



Category	CO_2 Eq. (Gg)	Share (%)
2C1 Iron and Steel	4 447,08	93,57%
2C2 Ferroalloy Production	104,51	2,20%
2C3 Aluminium Production	201,33	4,24%

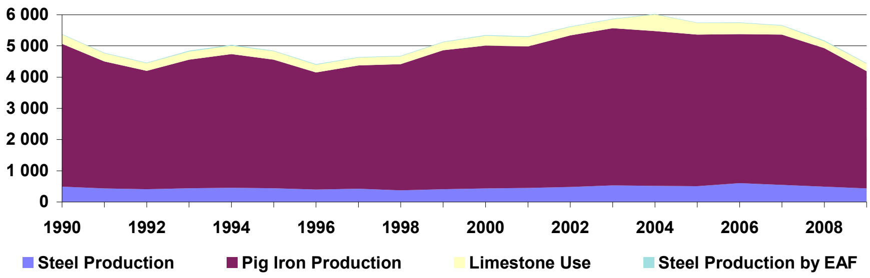
Table 4.23: GHG emissions in individual subcategories in the 2C category in 1990 – 2009

Category 2C - CO_2 emissions equivalents (Gg)				
Year	2C1 Iron and Steel	2C2 Ferroalloy Production	2C3 Aluminium Production	2B Total
1990	5 380,51	270,04	392,69	**6 043,24**
1991	4 781,62	263,54	386,28	**5 431,44**
1992	4 463,07	255,74	359,48	**5 078,29**
1993	4 843,89	239,70	224,90	**5 308,49**
1994	5 032,85	237,19	191,10	**5 461,14**
1995	4 847,42	214,21	173,00	**5 234,63**
1996	4 414,60	205,46	201,61	**4 821,67**
1997	4 644,07	189,85	198,71	**5 032,62**
1998	4 685,72	225,18	184,64	**5 095,53**
1999	5 131,92	200,27	175,14	**5 507,34**
2000	5 349,74	167,57	176,13	**5 693,44**
2001	5 306,38	152,60	176,53	**5 635,51**
2002	5 626,19	304,80	176,13	**6 107,12**
2003	5 870,76	301,88	188,30	**6 360,94**
2004	6 021,93	339,25	254,67	**6 615,85**
2005	5 750,65	207,09	250,75	**6 208,49**
2006	5 755,24	250,10	232,26	**6 237,61**
2007	5 667,85	271,86	217,10	**6 156,82**
2008	5 173,17	237,89	234,69	**5 645,75**
2009	4 447,08	104,51	201,33	**4 752,92**

4.5.2 Source category description – Iron and steel production (CRF 2.C.1)

Total emissions were 4 447.078 Gg of CO_2 in 2009, the decrease is by almost 14% compared with the previous year due to the production decrease. Comparing with the base year, the decrease is 17%. Pig iron is produced by the reduction of iron ore by coke in a blast furnace, the main emission is CO_2. Limestone is added as an agent for slag formation. Pig iron contains about 4% of carbon and a part of this carbon is oxidized in the next step. This process is accompanied by CO emissions, the most of which is burned to CO_2. Iron ore was processed to pig iron. Category iron and steel production includes emission from steel production (2C11), pig iron production (2C12), sinter production (2C13), coke production (2C14), limestone use (2C15-other) and steel production in electric arc furnaces (2C15-other). The emissions from coke and sinter are included in energy sector, category iron and steel production (1A2a) according to the methodology in the IPCC 2000 GPG. Major share of technological CO_2 emissions represents pig iron production with the 85% and decreasing trend. The emissions from other sources are almost stable (Figure 4.15).

Figure 4.15: The trend of individual categories in emissions in category 2C1 iron and steel production in 2009



4.5.2.1 Methodological issues – methods

Tier 2 methodology based on the plant specific information about activity data and emission factors was applied for the estimation of emissions from steel, pig iron production and Tier 1 approach for the estimation of emissions from limestone use. The technological emissions from iron (2C1.1) and steel (2C1.2) production, limestone use (2C1.5) and emissions from coke electrodes used by EAF steel production (2C1.5) are included in the category 2C1 iron and steel production. The CO_2 emissions originated from coke production in iron and steel industry and emissions originated from sinter production are still included in energy sector, category 1A2a in line with the IPCC2006 GL.

4.5.2.2 Methodological issues – emission factors and other parameters

It should be noted that the EFs differ and are estimated annually and are estimated on plant level. Differences between each-year emission factors are caused by the different amounts of iron scrap added to the charge in steel making process. Emission factor for limestone use in iron and steel production is 0.427 t per t of limestone used (default value constant). The content of carbon in iron ore was 0.216 kg/t, 40 kg/t in pig iron and 0.684 kg/t in steel (data supplied by the plants). Emission factors are summarized in Table 4.24 and in Table 4.25.

4.5.2.3 Activity data

Iron and steel in the Slovak Republic are produced by several plants (U.S.Steel Kosice, a.s., UNEX, Prakovce, Metalurg and by ironworks Železiarne Podbrezová, a.s.). The producers of iron and steel made 1 356 451 tons of coke, 3 019 093 tons of pig iron and 3 642 283 tons of steel from 1 931 845 tons of iron ore in 2009. Total production of steel produced by EAF was 348.065 kt in 2009. By the iron and steel production 543.564 kt of limestone were used in 2009.

According to the information provided in the ETS reports, several plants produced steel in electric arc furnaces. The emissions from these plants were not reported in previous submission (2010). According to the ERT recommendation during centralized review 2010, the thorough survey of the CO_2 emissions from these plants was done. The information are summarized in Table 4.26. The emission calculation was based on the available data and assumptions:

- Železiarne Podbrezová: EU ETS reports are available for the period 2005 – 2009. According to the questionnaires concerning the period 2000 – 2004; it was used approximately 13.4 kg of carbon (in all material inputs) for production of 1 tone of steel.

- Metalurg Steel: EU ETS reports are available for the period 2007 – 2009. According to the questionnaires concerning the period 2000 – 2006; the emission factor of CO_2 was 0.165 t per 1 tone of steel.
- UNEX Prakovce: The plant is not included in the EU ETS. The default emission factor of CO_2 was used (0.08 t CO_2 / 1 t of steel).
- The above data were used for the emission calculation in the period 1990 – 1999, as well.

Table 4.24: Activity data, emission factors and CO_2 emissions in individual subcategories in the 2C1 category in 1990 – 2009

Year	Steel Production	*EF per Steel*	CO_2 (Steel)	Pig Iron Production	*EF per Pig Iron*	CO_2 (Pig Iron)	Sinter Production	Coke Production	Limestone Use	CO_2 (Limestone)	Total CO_2 Emissions
	[kt]	*[t/t]*	[kt]	[kt]	*[t/t]*	[kt]	[kt]	[kt]	[kt]	[kt]	**[kt]**
1990	3 561,50	*0,1375*	489,64	3 561,00	*1,2857*	4 578,38	150,59	2 340,00	689,64	294,34	**5 362,35**
1991	3 163,40	*0,1375*	434,91	3 163,00	*1,2857*	4 066,61	150,59	2 137,00	612,55	261,44	**4 762,96**
1992	2 952,40	*0,1375*	405,90	2 952,00	*1,2857*	3 795,37	108,67	2 040,00	571,69	244,00	**4 445,26**
1993	3 205,40	*0,1375*	440,69	3 205,00	*1,2857*	4 120,60	108,67	1 876,00	620,68	264,91	**4 826,19**
1994	3 330,40	*0,1375*	457,88	3 330,00	*1,2857*	4 281,28	56,64	1 735,00	644,89	275,24	**5 014,40**
1995	3 207,40	*0,1375*	440,96	3 207,00	*1,2857*	4 123,17	88,10	1 854,00	621,07	265,07	**4 829,20**
1996	2 920,00	*0,1379*	402,60	2 928,00	*1,2816*	3 752,56	55,63	1 708,00	565,42	241,32	**4 396,48**
1997	3 072,30	*0,1375*	422,40	3 072,00	*1,2856*	3 949,48	75,12	1 730,00	594,91	253,91	**4 625,79**
1998	3 100,00	*0,1222*	378,95	2 756,00	*1,4631*	4 032,35	45,95	1 421,24	600,27	256,20	**4 667,50**
1999	3 420,00	*0,1201*	410,71	2 987,00	*1,4918*	4 455,95	45,02	1 512,26	578,39	246,86	**5 113,52**
2000	3 519,99	*0,1237*	435,38	3 166,38	*1,4444*	4 573,57	38,76	1 596,92	755,18	322,31	**5 331,26**
2001	3 751,85	*0,1193*	447,51	3 254,58	*1,3957*	4 542,46	37,33	1 597,79	697,98	297,90	**5 287,86**
2002	4 103,20	*0,1184*	485,81	3 533,15	*1,3722*	4 848,35	30,68	1 565,00	642,12	274,06	**5 608,22**
2003	4 382,92	*0,1221*	535,20	3 892,37	*1,2926*	5 031,11	39,89	1 624,36	669,71	285,83	**5 852,14**
2004	4 421,14	*0,1171*	517,75	3 765,48	*1,3178*	4 962,08	44,22	1 777,35	1 228,71	524,41	**6 004,25**
2005	4 238,12	*0,1194*	506,20	3 681,42	*1,3193*	4 856,75	46,44	1 740,00	876,85	374,24	**5 737,19**
2006	4 836,49	*0,1255*	607,11	4 415,32	*1,0816*	4 775,57	55,29	1 748,61	840,71	358,81	**5 741,49**
2007	4 784,81	*0,1153*	551,66	4 012,08	*1,1984*	4 807,94	57,19	1 740,00	674,12	287,71	**5 647,31**
2008	4 229,40	*0,1151*	486,65	3 539,27	*1,2553*	4 442,89	58,04	1 600,00	522,00	222,79	**5 152,33**
2009	3 642,28	*0,1195*	435,23	3 019,09	*1,2461*	3 762,20	35,16	1 356,45	543,56	231,99	**4 429,42**

Table 4.25: Activity data, emission factors and CO_2 emissions in individual plants for EAF steel production in the category 2C1.5 in 1990 – 2009

	Železiarne Podbrezová			Metalurg Steel		UNEX, Prakovce		Total		
Year	Steel Production by EAF	Carbon	Emissions CO_2	Steel Production	Emissions CO_2	Steel Production	Emissions CO_2	Steel Production	Emissions CO_2	*Average EF*
	[t]									*[t/t]*
1990	C	3 810	13 970	C	4 021	C	162	310 729	**18,153**	*0,0584*
1991	C	3 928	14 403	C	4 097	C	162	319 963	**18,662**	*0,0583*
1992	C	3 735	13 695	C	3 947	C	161	304 644	**17,803**	*0,0584*
1993	C	3 729	13 673	C	3 863	C	166	303 750	**17,702**	*0,0583*
1994	C	3 884	14 241	C	4 042	C	166	316 433	**18,449**	*0,0583*
1995	C	3 878	14 219	C	3 829	C	164	314 641	**18,212**	*0,0579*
1996	C	3 797	13 922	C	4 041	C	160	309 851	**18,123**	*0,0585*
1997	C	3 841	14 084	C	4 025	C	167	313 155	**18,276**	*0,0584*
1998	C	3 876	14 212	C	3 842	C	166	314 601	**18,220**	*0,0579*
1999	C	3 952	14 491	C	3 750	C	159	319 660	**18,400**	*0,0576*
2000	C	3 879	14 223	C	4 096	C	167	316 358	**18,486**	*0,0584*
2001	C	3 900	14 300	C	4 055	C	166	317 710	**18,521**	*0,0583*
2002	C	3 765	13 805	C	4 002	C	171	307 356	**17,978**	*0,0585*
2003	C	3 953	14 494	C	3 991	C	134	320 863	**18,619**	*0,0580*
2004	C	4 583	16 804	C	829	C	46	347 605	**17,679**	*0,0509*
2005	C	3 409	12 490	C	888	C	83	356 900	**13,461**	*0,0377*
2006	C	3 232	11 843	C	1 815	C	94	376 581	**13,752**	*0,0365*
2007	C	4 982	18 254	C	2 218	C	69	389 435	**20,541**	*0,0527*
2008	C	4 986	18 269	C	2 508	C	62	382 609	**20,839**	*0,0545*
2009	C	4 597	16 856	C	776	C	23	348 065	**17,655**	*0,0507*

Activity data for sinter production are based on written information supplied by the producers (VSS, a.s. Košice, Zlieváreň SEZ, a.s. Krompachy, Strojchem Chemosvit, SJT Moldava, UNEX, Prakovce, Zlievároň, s.r.o. Trnava, ZLH, a.s. Hronec, GML Casting, SMZ Kunová Teplica, s.r.o., Eurocast Košice and Compel Metal Martin). Total production of cast iron in the Slovak Republic was 35 162 tons in 2009.

4.5.2.4 Uncertainties and time-series consistency

The uncertainties in mass of used coke (2%), mass of used iron ore (2%), mass of produced pig iron (2%), mass of produced steel (2%), contents of carbon in iron ore (25%), in pig iron (25%), in steel (25%) and used default EF from coke (5%) were estimated according to IPCC 2000 GPG for each plant. It follows that the uncertainty of EF is 5.1% and the uncertainty of CO_2 emissions is 5.1%. The emission factors and uncertainty for both AD and EF (in formula represent by symbol Δ) were used for uncertainty estimation. The uncertainty of CO_2 emissions (in equivalents) is in interval (-5.25%; +5.31%). Formula can be written in the following form:

$$
\begin{aligned}
\text{Emissions} &= (\text{amount of Coke} \pm \Delta\text{Coke}) * (\text{EFCoke} \pm \Delta\text{EFCoke}) + \\
&+ ((\text{amount of Ore} \pm \Delta\text{Ore}) * (\text{content of C\_Ore} \pm \Delta\text{C\_Ore}) - \\
&- (\text{amount of Iron} \pm \Delta\text{Iron}) * (\text{content of C\_I} \pm \Delta\text{C\_I})) * \frac{44}{12} + \\
&+ (\text{Limest consump} \pm \Delta\text{Limest}) * (\text{Limest purity} \pm \Delta\text{Limest}) * (\text{EFLimest} \pm \Delta\text{EFLimest}) + \\
&+ (\text{amount of Iron} \pm \Delta\text{Iron}) * ((\text{content C\_I} \pm \Delta\text{C\_I}) - (\text{content C\_Steel} \pm \Delta\text{C\_Steel})) * \frac{44}{12}
\end{aligned}
$$

To compute the uncertainty for this subsector the following input parameters were applied: the amount of ore, the content of C in the ore, the amount of crude iron, the content of C in crude iron, the content of C in steel, the amount of coke, the consumption of limestone, the purity of limestone, their emission factors and their uncertainties for both AD and EF. The accumulated uncertainty and statistical characteristics for iron and steel production are presented in the following table.

Figure 4.16: Probability density function for category 2C1 in tons of CO_2

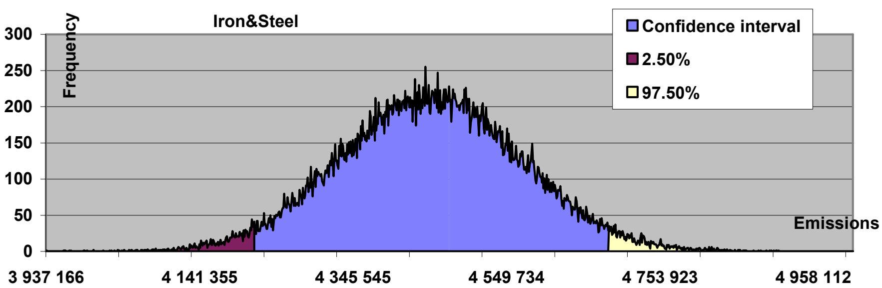


Table 4.26: Selected statistical characteristics for category 2C1, median, mean value, standard deviation, minimum, maximum of emissions and percentiles

Median	Average	Standard dev,	2,50%	97,50%
4 448 686,68	4 448 962,61	120 129,09	4 215 275,67	4 685 366,28
Min	**Max**		**Per_2,5**	**Per_97,5**
3 937 166,31	5 011 846,03		-5,25%	5,31%

4.5.2.5 Source specific QA/QC and verification

Information used for GHG emission inventories of IP sector are directly from the questionnaires sent to operators and lime producers in the Slovak Republic. First preliminary data related to the production and the quality of products in the Slovak Republic from the previous year is available at the beginning of October. This data are used for the estimation and verified by Mr. Vladimir Danielik – the sectoral expert for IP sector in the cooperation of the Slovak Technical University in Bratislava, the Faculty of Chemical and Food Technology. The data are compared with the information from the Statistical Office of the Slovak Republic (iron and steel production) and available ETS reports.

4.5.2.6 Source specific recalculations

No recalculations in the submission 2011 focused on the base year 1990 or the other inventory years were provided. The new estimation was completed in the category 2C1.5 steel production by EAF for time series 1990 – 2009.

4.5.2.7 Source specific planned improvements

No improvements are planned for this category for the next submission.

4.5.3 Source category description – Ferroalloys production (CRF 2.C.2)

Ferroalloys are produced in arc furnaces, submerged arc furnaces by the reduction of the mixture of iron ore, and added metal and/or metalloid (Si) oxides. Technological CO_2 and CH_4 (only from FeSi alloys) emissions from ferroalloys production were reallocated from energy sector in previous submission and according to the inventory in 2009 were 104.415 Gg of CO_2 and 4.637 t of CH_4.

4.5.3.1 Methodological issues – methods

Based on new input data the revaluation of methodological approaches was made by sectoral expert. The CO_2 emission estimation for the period 1990 – 2001 was based on tier 2 approach, the period 2002 – 2009 was estimated by tier 3 methodology based on plant specific activity data. Since 2002 more detailed information about ferroalloys production are known. The production of FeSi started in 1998. The estimation is provided in Table 4.28 and table 4.29.

4.5.3.2 Methodological issues – emission factors and other parameters

In the previous inventory submission (2010), the emission factors for CO_2 were taken from the IPCC 2000 GL recommendation (1.45 t/t of ferroalloys based on Mn, 1.3 t/t of ferroalloys based on Cr and 4 t/t of ferroalloys based on Si). However, according to the recommendations of the ERT during the centralised review 2010, the CO_2 emissions should be estimated on the basis of plant specific data. Therefore the thorough survey of CO_2 emissions was done in the cooperation with the producers. According to the survey directly with the operators, the plant specific emission factors were estimated (on the basis of carbon balance) and they are summarized in Table 4.27. Methane emission factor was not changed and the default value 1 kg CH_4/1 tone of FeSi ferroalloys was used

Table 4.27: Plant specific emission factors of CO_2 at ferroalloys production in tones of CO_2 per 1 tone of ferroalloy in 2009

Ferroalloy	$FeSi_{75}$	$FeSi_{65}$	$FeSi_{45}$	FeSiMn	FeMnC	FeCr	FeSiCa
EF (CO_2) t/t of ferroalloy	3,155	3,030	3,030	1,734	1,629	1,300	4,800

4.5.3.3 Activity data

Information about activity data were taken from the ETS reports and directly from the producers of ferroalloys in the Slovak Republic based on questionnaires and are summarized in Table 4.28 and Table 4.29.

Table 4.28: Activity data, emission factors and CO_2 for ferroalloys production in 2002 – 2009

Year	Ferroalloys [t]								Total CO_2 [t]	EF (CO_2) [t/t]	Total CH_4 [t]
	$FeSi_{75}$	$FeSi_{65}$	$FeSi_{45}$	FeSiMn	FeMnC	FeCr	FeSiCa	Total			
2002	31 208			62 084	56 297	3 521	364	153 474	304 147,20	1,982	31,21
2003	41 539			52 773	43 434	1 654	1 155	140 555	301 012,10	2,142	41,54
2004	34 684			64 842	66 959	1 634	1 137	169 256	338 522,10	2,000	34,68
2005	13 943	1 710	859	47 843	43 458	894	11	108 718	206 742,10	1,902	16,51
2006	12 319	2 473	1 363	59 128	59 391			134 674	249 765,40	1,855	16,16
2007	8 417	112		71 587	74 065			154 181	271 678,70	1,762	8,58
2008	9 510	941	393	59 940	61 194			131 978	237 667,10	1,801	10,84
2009	4 241	118	278	32 102	20 976			57 715	104 415,00	1,809	4,64

Table 4.29: Activity data, emission factors and CO_2 for ferroalloys production in 1990 – 2001

Year	Ferroalloys [t]				Total CO_2 [t]	EF (CO_2) [t/t]	Total CH_4 [t]
	Based on Cr	Based on Mn	Based on Si	Total			
1990	53 000	116 000	0	169 000	270 044,00	1,598	0,00
1991	52 000	113 000	0	165 000	263 542,00	1,597	0,00
1992	50 000	110 000	0	160 000	255 740,00	1,598	0,00
1993	47 000	103 000	0	150 000	239 702,00	1,598	0,00
1994	34 000	111 300	0	145 300	237 194,20	1,632	0,00
1995	45 000	89 800	0	134 800	214 213,20	1,589	0,00
1996	46 000	84 000	0	130 000	205 456,00	1,580	0,00
1997	42 000	78 000	0	120 000	189 852,00	1,582	0,00
1998	44 000	81 000	8 666	133 666	224 995,20	1,683	8,67
1999	46 700	56 300	13 205	116 205	199 996,00	1,721	13,21
2000	17 658	69 458	7 611	94 727	167 408,30	1,767	7,61
2001	12 140	69 380	5 200	86 720	152 492,90	1,758	5,20

4.5.3.4 Uncertainties and time-series consistency

To compute the uncertainties for this subsector, the following input parameters were applied: the production of FeSi, FeSiMn, FeMnC, their emission factors (for carbon dioxide) and their uncertainties for both AD and EF. Additionally, not only CO_2, but also CH_4 emissions from FeSi have to be included. The emission factors and uncertainty for both AD and EF (in formula represent by symbol Δ) were used for uncertainty estimation. The uncertainty of CO_2 emissions (in equivalents) is in interval (-6.56%; +6.56%). Formula can be written in the following form:

$$\text{Emission} = \sum_{i} (\text{ferroalloy} \pm \Delta\text{ferroalloy}) * (\text{EF\_Ferroall} \pm \Delta\text{EF\_Ferroalloy})$$

The accumulated uncertainty and statistical characteristics for subsector ferroalloys are presented in the following table and figure.

Figure 4.17: Probability density function for category 2C2 in tons of CO_2

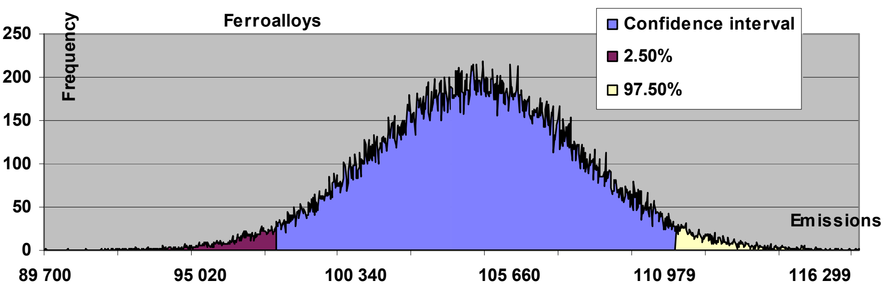


Table 4.30: Selected statistical characteristics for category 2C2, median, mean value, standard deviation, minimum, maximum of emissions and percentiles

Median	Average	Standard dev,	2,50%	97,50%
104 527,50	104 521,34	3 502,31	97 662,77	111 372,40
Min	**Max**		**Per_2,5**	**Per_97,5**
89 700,23	117 698,97		-6,56%	6,55%

4.5.3.5 Source specific QA/QC and verification

Information used for GHG emission inventories of IP sector are directly from the questionnaires sent to operators and lime producers in the Slovak Republic. First preliminary data related to the production and the quality of products in the Slovak Republic from the previous year is available at the beginning of October. This data are used for the estimation and verified by Mr. Vladimir Danielik – the sectoral expert for IP sector in the cooperation of the Slovak Technical University in Bratislava, the Faculty of Chemical and Food Technology. The data are compared with the information from the Statistical Office of the Slovak Republic (ferroalloy production) and available ETS reports.

4.5.3.6 Source specific recalculations

According to the recommendations of the ERT during the centralized review in 2010, the revision of emission factors for CO_2 emissions was made since 1990 in ferroalloys production according to the type of alloys. The production activity data were not changed, but the CO_2 emissions were recalculated (Table 4.31) using the country specific EFs. The methodological approach was change from tier 1 to tier 2 with CS EFs (1990 – 2001) and from tier 2 to tier 3 with PS EFs (2002 – 2009). The recalculated emissions are higher up to 14% in several years (mostly in 90-ties).

Table 4.31: The recalculations changes and comparison of the submissions 2010 and 2011

Year	Submission 2010		Submission 2011		2010/2011
	Total CO_2 [t]	EF (CO_2) [t/t]	Total CO_2 [t]	EF (CO_2) [t/t]	Changes
1990	237 100,00	1 ,403	270 044,00	1,598	113,89%
1991	231 450,00	1 ,403	263 542,00	1,597	113,87%
1992	224 500,00	1 ,403	255 740,00	1,598	113,92%
1993	210 450,00	1 ,403	239 702,00	1,598	113,90%
1994	205 585,00	1 ,415	237 194,20	1,632	115,38%
1995	188 710,00	1 ,400	214 213,20	1,589	113,51%
1996	181 600,00	1 ,397	205 456,00	1,580	113,14%
1997	167 700,00	1 ,398	189 852,00	1,582	113,21%
1998	209 314,00	1 ,566	224 995,20	1,683	107,49%
1999	195 165,00	1 ,679	199 996,00	1,721	102,48%
2000	154 114,00	1 ,627	167 408,30	1,767	108,63%
2001	137 183,00	1 ,582	152 492,90	1,758	111,16%
2002	302 520,00	1 ,971	304 147,20	1,982	100,54%
2003	312 883,00	2 ,226	301 012,10	2,142	96,21%
2004	337 535,00	1 ,994	338 522,10	2,000	100,29%
2005	199 430,00	1 ,834	206 742,10	1,902	103,67%
2006	236 486,00	1 ,756	249 765,40	1,855	105,62%
2007	245 651,00	1 ,593	271 678,70	1,762	110,60%
2008	219 083,00	1 ,660	237 667,10	1,801	108,48%

4.5.3.7 Source specific planned improvements

No improvements are planned for this category for the next submission.

4.5.4 Source category description – Aluminium production (CRF 2.C.3)

Aluminium is produced by the electrolysis of alumina dissolved in cryolite-based melt (t = 950°C). The main additives to cryolite (Na_3AlF_6) are aluminium fluoride (AlF_3) and CaF_2. From the point of emissions view, the content of AlF_3 is of great interest. The Slovak plants use a modern technology in which most of HF and other fluorides escaping from the electrolytic cells are absorbed and adsorbed on alumina, which is used subsequently in the electrolytic process. The anodes are made from graphite. So-called pre-baked anodes are made in separate plants. As a result of that the emissions are much lower than in the Soederberg process. It may happen that at a special technological disturbance (the anode effect), the release of CF_4 and C_2F_6 can occur. Because of the progress in process control, this irregularity occurs 1–2 times in a month only.

4.5.4.1 Methodological issues – methods

Tier 3 methodology based on plant specific emission factors and activity data has been applied since 2004 for CO_2 and PFCs emission estimation. 58 900 tons of graphite anodes was used in 2009 with the carbon content of 85%. The emissions of CO_2 were estimated based on the IPCC 2000 GPG methodology, the mass of used anodes was multiplied by carbon content and 44/12 (183 572 t in 2009). It means that the total PFC emission was 2.629 t in 2009. According to the questionnaire, the significant progress in control of the electrolysis was achieved in the plant in 2009. The progress results in decrease of PFC emissions.

4.5.4.2 Methodological issues – emission factors and other parameters

The EF of CO_2 is 3.1 t/t of coke according to the 2006 IPCC Guidelines. The emission factors are summarized in Table 4.32. The emission factors of PFCs (CF_4, C_2F_6) were calculated according to the Tabereaux's equation:

$$EF(PFC) = const \cdot \frac{x}{\eta} \cdot AE \cdot AED$$

Where *const* is a constant and it equals to:

- for emission factor of CF_4 = 1.698, for emission factor of C_2F_6 = 0.1698.
- *x* is the mole fraction of PFC. For the plants with pre-baked anodes it is 0.08;

  η is the current efficiency (fraction).
- *AE* is the number of anode effects per pot day.
- *AED* equals to the anode effect duration in minutes.

4.5.4.3 Activity data

According to the data from plant operator, the average current efficiency was 93.44% in 2009, the number of anode effects per pot day equals to 0.070 and their average duration was 1.57 min. It follows that the emission factors were 0.016 kg CF_4/t of aluminium and 0.0016 kg C_2F_6/t of aluminium, respectively. 149 604 t of aluminium were produced in 2009 and SF_6 was not used in castings in the Slovak Republic.

Table 4.33: The overview of emissions and EFs in aluminium production in 1990 – 2009

Year	Aluminium Production	*EF per Aluminium*	CO_2 (Aluminium)	CF_4	*EF per Aluminium*	C_2F_6	*EF per Aluminium*	Total CO_2 Emissions Equivalents
	[kt]	*[t/t]*	[kt]	[kt]	[kt]	[kt]	[kt]	**[kt]**
1990	67,40	*1,8000*	121,32	36,60	*0,5430*	3,64	*0,0540*	**161,56**
1991	66,30	*1,8000*	119,34	36,00	*0,5430*	3,58	*0,0540*	**158,92**
1992	61,70	*1,8000*	111,06	33,50	*0,5430*	3,33	*0,0540*	**147,89**
1993	38,60	*1,8000*	69,48	20,96	*0,5430*	2,08	*0,0540*	**92,52**
1994	32,80	*1,8000*	59,04	17,81	*0,5430*	1,77	*0,0540*	**78,62**
1995	32,60	*1,8000*	58,68	15,42	*0,4730*	1,53	*0,0470*	**75,63**
1996	111,40	*1,5000*	167,10	4,68	*0,0420*	0,45	*0,0040*	**172,22**
1997	110,19	*1,5000*	165,29	4,52	*0,0410*	0,44	*0,0040*	**170,24**
1998	108,00	*1,5000*	162,00	3,02	*0,0280*	0,32	*0,0030*	**165,35**
1999	109,20	*1,5000*	163,80	1,53	*0,0140*	0,15	*0,0014*	**165,48**
2000	109,81	*1,5000*	164,72	1,54	*0,0140*	0,15	*0,0014*	**166,41**
2001	110,06	*1,5000*	165,09	1,54	*0,0140*	0,15	*0,0014*	**166,79**
2002	109,81	*1,5000*	164,72	1,54	*0,0140*	0,15	*0,0014*	**166,41**
2003	111,62	*1,5000*	167,43	2,81	*0,0252*	0,28	*0,0025*	**170,52**
2004	156,89	*1,5000*	235,34	2,60	*0,0166*	0,26	*0,0017*	**238,21**
2005	159,20	*1,4490*	230,69	2,70	*0,0170*	0,27	*0,0017*	**233,66**
2006	158,29	*1,2410*	196,44	4,83	*0,0305*	0,48	*0,0031*	**201,75**
2007	160,46	*1,1979*	192,22	3,35	*0,0209*	0,34	*0,0021*	**195,91**
2008	163,00	*1,2180*	198,53	4,87	*0,0299*	0,49	*0,0030*	**203,89**
2009	149,60	*1,2271*	183,57	2,39	*0,0160*	0,24	*0,0016*	**186,21**

4.5.4.4 Uncertainties and time-series consistency

The uncertainties in the mass of produced aluminium (2%), the content of PFC in gas (3%), the measurement of CE (5%), AE (5%) and AED (5%) were estimated according to IPCC 2000 GPG for each plant. It follows that the uncertainty of EFs of PFCs is 9.2% and the uncertainty of PFC emissions is 9.4%. The uncertainty of CO_2 emissions (in equivalents) is in interval (-9.44%; +9.60%). To compute the uncertainties of CO_2 and PFC (CF_4 and C_2F_6) emissions for this subsector, the following input parameters were applied: the amount of anodes, the content of C in anodes and the mole fraction of PFC, current efficiency, the number of anode effects per pot day, the duration of anode effect and their uncertainties for both AD and EF.

Formula can be written in the following form:

$$Emission = (amount\ of\ Anodes \pm \Delta Anode) * (content\ of\ C \pm \Delta\_content\ of\ C) * \frac{44}{12} +$$

$$+ \sum_{I} (constant * (PFCcontent \pm \Delta PFCcontent) * (anode\ effects \pm \Delta anode\ effects)) *$$

$$* \frac{(duration\ of\ Anodes \pm \Delta duration\ of\ Anode)}{(current\ eff \pm \Delta\_current\ eff)} / 1000$$

The accumulated uncertainty and statistical characteristics for subsector aluminum are presented.

Figure 4.18: Probability density function for category 2C3 in tons of CO_2

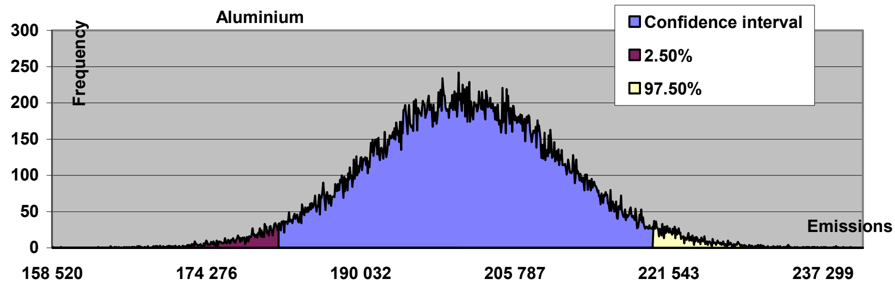


Table 4.34: Selected statistical characteristics for category 2C3, median, mean value, standard deviation, minimum, maximum of emissions and percentiles

Median	Average	Standard dev,	2,50%	97,50%
200 613,54	200 683,66	9 716,76	181 738,41	219 945,89
Min	**Max**		**Per_2,5**	**Per_97,5**
158 520,50	241 444,95		-9,44%	9,60%

4.5.4.5 Source specific QA/QC and verification

Information used for GHG emission inventories of IP sector are directly from the questionnaires sent to operators and lime producers in the Slovak Republic. First preliminary data related to the production and the quality of products in the Slovak Republic from the previous year is available at the beginning of October. This data are used for the estimation and verified by Mr. Vladimir Danielik – the sectoral expert for IP sector in the cooperation of the Slovak Technical University in Bratislava, the Faculty of Chemical and Food Technology. The data are compared with the information from the Statistical Office of the Slovak Republic (aluminium production) and available ETS reports.

4.5.4.6 Source specific recalculations

No recalculations in the submission 2011 focused on the base year 1990 or the other inventory years were provided. The revaluation of methodological approaches chosen for emission estimation of PFCs took place. Tier 3 methodology based on plant specific emission factors and other parameters was used since 2004 (instead tier 1 reported incorrectly in previous submission).

4.5.4.7 Source specific planned improvements

No improvements are planned for this category for the next submission.

4.5.5 Source category description – Aluminium Magnesium Foundries (CRF 2.C.4)

This production does not occur in the Slovak Republic.

4.6 Other production (CRF 2.D)

No GHGs emissions from the technology of paper and pulp and food industry were estimated. The emissions of SO_2 from paper and pulp production were not occurring in 2009 and NMVOC emissions from food industry were 324 tons.

4.7 Production of halocarbons and SF_6 (CRF 2.E)

No halocarbons or SF_6 were produced in the Slovak Republic in 1990 – 2009.

4.8 Consumption of halocarbons and SF_6 (CRF 2.F)

F-gases notion means the emissions of substances that, because of their effects, can be added to the greenhouse gases group. However, before COP3 in Kyoto they were not considered during the inventory and projection of GHGs. Following gases are considered to be new ones:

- HFCs – hydrofluorocarbons (23, 32, 41, 43, 125, 134, 134a, 152a, 143, 227ea, 236fa, 245ca).
- SF_6 – sulphur hexafluoride.
- PFCs – perfluorcarbons (CF_4, C_2F_6, C_3F_8, C_4F_{10}, C_4F_8, C_5F_{12}, C_6F_{14}, CF_3Br).

The aim is to evaluate the sources and emissions of selected substances since 1990. For given years the emissions are set based on the list of sources, production or usage of these substances in the Slovak Republic and the comments on accuracy of input and calculated data are given. The inventory of F-gases is complicated due to a high number of substances HFCs, PFCs a SF_6, 12 HFCs substances in total. They are components of different mixtures used in different more than 15 applications. Each application has its own development of consumption and trend of emission development. To ensure environmental integrity, the post-2012 agreement should include additional fluorinated gases (hydrofluoroethers and perfluoropolyethers) with lower GWPs.

Table 4.35: The overview of actual and potential HFCs and SF_6 emissions in 1990 – 2009

Category 2F Consumption of HFCs and SF_6						
Year	Actual HFCs (kt)	Potential HFCs (kt)	Ratio A/P	Actual SF_6 (kt)	Potential SF_6 (kt)	Ratio A/P
1990	NO	NO	NO	0,0013	NO	NO
1991	NO	NO	NO	0,0014	0,0100	7,26
1992	NO	NO	NO	0,0016	0,0220	13,76
1993	NO	NO	NO	0,0027	0,1130	41,57
1994	2,9091	NO	NO	0,3878	38,5060	99,30
1995	22,1532	119,8636	5,41	0,4146	3,0800	7,43
1996	37,5808	166,5176	4,43	0,4502	3,9800	8,84
1997	61,1335	208,5057	3,41	0,4745	2,8800	6,07
1998	40,9561	120,6116	2,94	0,5122	4,3400	8,47
1999	65,1244	151,0394	2,32	0,5309	2,5620	4,83
2000	75,5862	221,2709	2,93	0,5546	2,9130	5,25
2001	82,4298	236,7941	2,87	0,5792	3,0080	5,19
2002	102,3503	316,5629	3,09	0,6184	4,5899	7,42
2003	131,9550	319,7271	2,42	0,6439	3,1530	4,90
2004	152,8775	355,3012	2,32	0,6648	3,6090	5,43
2005	172,3377	360,6741	2,09	0,6951	3,8600	5,55
2006	198,8966	469,9987	2,36	0,7177	2,9390	4,10
2007	226,9872	537,5700	2,37	0,7296	3,3233	4,56
2008	264,4312	580,7426	2,20	0,7745	5,2570	6,79
2009	299,6059	685,3219	2,29	0,8112	4,4850	5,53

According to the latest inventory data, the actual HFCs emissions in category 2.F Consumption of halocarbons were 299.61 Gg of CO_2 equivalents in 2009 and have increased by 13% compared to the previous year and 13 times compared to the base year 1995. The potential emissions of HFCs represented 685.32 Gg of CO_2 equivalents in 2009. The emissions have increased by 18% compared to the previous year and 5.5 times compared to the base year 1995. The ratio of potential/actual HFCs emissions in 2009 was 2.29 and the trend of ratio is almost stable.

The emissions of PFCs in the category 2.F did not occur in 2009.

Actual emissions of SF_6 reached 0.81 tons in 2009 and increased by 5% compared to the previous inventory year. The potential emissions of SF_6 reached 4.49 tons and decreased by 15% compared to the previous year. The ratio of potential/actual emissions of SF_6 was 5.53 in 2009.

4.8.1 Methodological issues – methods

The actual estimation of emissions was performed by Tier 2 method accounts for the time lag between the consumption and the emissions. The method of potential emission estimation assumes that the emissions occur during the year in which the chemical is produced or sold to a particular end-use sector.

The following procedure was applied to reach the aim:

- Evaluation of the sources and emissions of selected substances since 1990 based on acquired data from importers and users in the last inventory year.
- Evaluation of the data storage in own tables and CRF tables according to IPCC 1996 methodology and IPCC 2000 GPG.

Substances in question alone are not registered under the item of the Custom Tariff in the Slovak Republic. The questions are addressed to the 250 potential supplier, users and consumers of the substances on the base of the description of the substances with GWP (global warming potential). These potential consumers of the substances are requested yearly by the letter authorized by the Ministry of Environment. Data in these tables enable to determine the rate of emissions and new filling by using the method of approximation. In case of doubt, received data are verified by a sender and they are summarized in the tables according to the way of use. Since the year 2009 the data are reported through the internet. Tables used since 1990 were used also in the last inventory for data storage in order to retain the continuity of observing the trends of sent data.

The EU policy targets are the further reduction of halocarbon refrigerant usage, the substantially decreased leakage percentage and energetically efficient operation of air conditioning systems, heat pumps and refrigeration installations. Success of EU Regulation No. 842/2006 depends on effective measures taken responsibly. Described solutions are based on data recorded in the log-book according to EN 378 Regulation (EC) No 1516/2007. Advantages of electronic data logging and reporting are shown on the possibilities of automatic analysis, fault detection and comparison, fast access to the full history of leak checks and various forms of output. Service engineers get quick survey of the customers, cooling circuits, details of all maintenance work and repairs, refrigerants in store, refrigerants added, recovered, reclaimed, and disposed of. Added value of electronic logbook is indirect detection of refrigerant leak. The fault detection classifier estimates the probability of refrigerant leak. Electronic way of the data records from refrigerants handling on stock enables summarizing, reporting and analyzing important data in a chosen period in connection with the internet. This system is based on the activities of Slovak Association for Cooling and Air-conditioning Technology started in the year 2003 and is available on web page http://www.szchkt.org/index.php?page=english/eng.htm. The electronically led documentation has developed from the previous paper form. Evaluated data were collected from the service organizations. Refrigerant movement reporting is required according legal status in EU and the Slovak Republic. Every certified company shall to restore its certificate yearly. Company has to enter the web site of notified body with its name and password. The company after entering its account the table will be shown and shall to be filled in. In this table the certified company has to declare the competencies of the employees, possession of technical equipment, regular checking of electronic detectors, and movement of refrigerant from the previous year. The confirmed data are saved and send to notified body till the end of January. After receiving the report, notified body will restore the certificate. Certified companies and competent persons are on the web site of notified body. The evaluation of sent and processed data on the sources and emissions of the substances in the Slovak Republic is realized on the base of recommended emission factors corrected according to the received data by IPCC methodology.

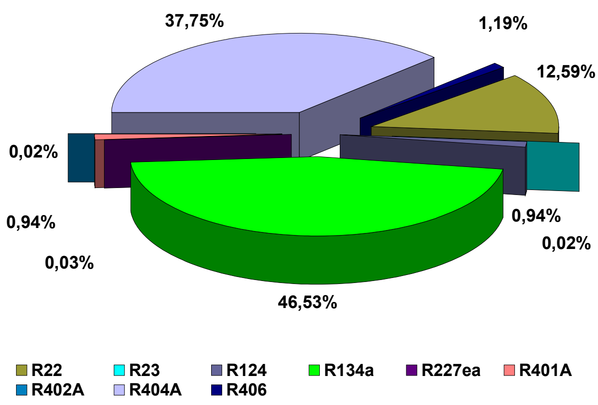
- Excel tables – evaluation according to sent data and IPCC methodology.
- CRF IPCC tables – evaluation according to sent data and IPCC methodology.

For given years the emissions are set based on the list of sources, production or usage of these substances in the Slovak Republic and comments on the accuracy of input and calculated data are given. The IPCC 2000 Good Practice Guidance are applied on the following sources:

- SF_6 emissions from electrical equipment and other sources.[11]
- Fluorinated carbon emissions[12] from semiconductor manufacturing.
- HFCs emissions from refrigeration and air conditioning.

The system is gathering data for the 2009 as a first year. Comparing to the data from previous years, it can be concluded, that data from importers of refrigerants are complete. If we subtract refrigerants on store 22 152 kg from imported amount 305 553 kg, we receive the amount 283 401 kg sold to the contractors. Contractors have reported that they have bought from importers 188 534 kg of refrigerants. It means that approximately 37% of contractors have not reported the data in the first year of the implementation of the new reporting system. From the reported data was clear, that reporting has to be divided to three types of tables: table for importers/producers, table for contractors and table for combination of importers and contractor. The last combination is common close to the borders, when contractors can buy refrigerant abroad and use in the country. The new internet reporting system needs time for running in. Problem was either to get data from importers of F-gases in products. These importers were used to get questionnaire. It was the first they should send data according the act no 286/2009 and its amendment no 314/2009 in paper form. Lot of the importers has not even known about it. Increased and emphasized promotion, publicity from the Ministry of Environment and increased number of inspections from the Slovak Inspection of Environment will be needed to increase the knowledge to get more precise data. It can be expected that next year the reported data will be more complex and precise. Situation in import of new F-gases in 2009 can be seen in the following Figure 4.19.

Figure 4.19: Results from data reported by importers of refrigerants in 2009



Refrigerant	kg of new (imported)	Share (%)
R22	32 173,90	12,59%
R23	54,60	0,02%
R124	2 398,00	0,94%
R134a	118 932,33	46,53%
R227ea	70,00	0,03%
R401A	2 404,00	0,94%
R402A	40,00	0,02%
R404A	96 499,20	37,75%
R406	3 044,00	1,19%

[11] *SF_6 from other uses like sound-proof windows, medical purposes, military application, equipment used in accelerators, lasers and night vision goggles, car tires, sport shoes, balls, etc. are delayed for some years.*

[12] *Including CF_4, C_2F_6, C_3F_8, C_4F_8, CHF_3, NF_3, SF_6*

4.8.2 Source category description – Refrigeration and Air Conditioning Equipment (CRF 2.F.1)

The emissions originated from refrigeration and AC equipments represent more than 90% of emissions from 2.F category. Total actual emissions of HFCs were 169.01 Gg of CO_2 equivalents and they increased from the previous year by 13%, the potential emissions of HFCs were 343.19 Gg of CO_2 equivalents in 2009, they increased by 2% compared to the previous inventory year. The emissions of PFCs and SF_6 are not occurring in this category. The HFC-32 emissions are included in category 2.IIA.F.1.2 Commercial refrigeration.

4.8.2.1 Methodological issues – methods

The Tier 2 methodology was used according to the IPCC 2000 GPG with the country specific emission factors and company specific activity data.

The assessment of direct and aggregated emissions of new gases is based on the approximation of the coolant consumption trend considering the up-to-date trend of CFCs and HCFCs decrease and start of HFCs coolants use. The approximation is based on the following analyses:

- The trend of decrease of CFCs and HCFCs coolants in appliance fillings, supplied with a certain rate of recycled of these coolants and taking into account operational emissions of coolants.
- The approximation of the trend of total consumption and emissions of halogenated coolants.
- The approximation of the trend of total consumption and emissions of particular halogenated coolants.

Conditions for the evaluation of retrospective and perspective of the trend of consumption of HFC were thus prepared using the total sums of purchased and cumulated CFC, HCFC and HFC coolants. Following areas of the use of these substances are considered in their assessment of the IPCC 2000 GPG practice recommendations on seven sources of emissions of:

- Aerosols and metered dose inhalers
- Solvent uses
- Foams
- Stationary refrigeration
- Mobile air conditioning
- Fire protection
- Other applications

The Revised 1996 IPCC Guidelines describe two tiers for the estimation of emissions from the use of OD substitutes:

- The advanced or actual method (Tier 2).
- The basic or potential method (Tier 1).[13]

4.8.2.2 Methodological issues – emission factors and other parameters

Summarized amounts of mixtures imported in bulks and products are followed by the conversion of mixtures to single substances and the results were evaluated since 1990 and summarized for the actual inventory year.

4.8.3 Activity data

The following substances belong to this group:

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[13] Decision 2/CP.3 affirms that actual emissions should be used for the reporting of emissions to the UNFCCC, and the Parties should make an effort to develop the necessary sources of data.

- HFC 23 (CHF_3 trifluormethane) – it is not used as extinguishing medium for fixed extinguishing devices in the Slovak Republic but there are some requests for its approval. It is used as a coolant for low temperatures cooling devices and as a component of coolant mixtures R503 and R508. Expected slight increase of R23 consumption has not been confirmed yet.
- HFC 152a ($C_2H_4F_2$ 1,1–difluormethane) – a component of coolant mixtures 401A, B, C. It is a substitute of coolant R12 in cars AC, aerosols and a swell up agent of PUR, polystyrene. Slight decrease in its consumption as a component in coolant mixtures is expected.
- HFC 32 (CH_2F_2 difluormethane) – a component of mixtures R407A, B, C, R504, R410A. The increase of its consumption is expected in the near future, especially regarding perspective mixtures as R407C and R410A. Its consumption should not increase after 2015 because of expected start of natural coolant usage.
- HFC 125 (C_2HF_5 pentafluorethane) – a component of coolant mixtures R407A, B, C, R504, R410A, R402A, B. The increase of its consumption is expected in the near future as an important component of coolant mixtures. Its consumption should not increase after 2015 because of expected start of natural coolant usage.
- HFC 143a ($C_2H_3F_3$ 1,1,1–trifluorethane) – a swell up agent for polystyrene, polyofeline, coolant, a component of coolant mixtures R507, R404A. The increase of its consumption as component of coolant mixtures is expected but it will be in gradually substituted by R410A coolant as well as natural coolants, especially carbon dioxide and ammonia.
- HFC 134a (CH_2FCF3 1,1,1,2-tetrafluorethane) – a coolant, extinguishing medium, aerosol, swell up agent for PUR foam, extruded polystyrene, adhesive films, sterilizers, an important component of mixtures R407A, B, C, R404A. The generally expected increase of its consumption, especially as a substitute of R12 coolant and also as a coolant in automobile air-conditioning, has already been reached. Its consumption should not increase in the next years. Slow decrease can be expected because of the use of R600a in domestic refrigerators, R404A (ammonia in the future) in commercial cooling and CO_2 in automobile air-conditioning. As an extinguishing medium it is designed for fixed extinguishing substances. It is not yet used as an extinguishing medium in the Slovak Republic, but it might be an effort to approve it in the line with expected increase in consumption.
- HFC 227ea (C_3HF_7 1,1,1,2,3,3,3–heptafluorpropane) – a coolant, extinguishing medium, aerosol, component of sterile mixtures. As an extinguishing medium it is designed for fixed extinguishing substances. It is approved in the Slovak Republic and nowadays it is the only alternative for H 1301 known under mark FM 100 imported until 1993. Extinguishing medium HFC 227ea is known under mark FM 200. It has been importing to the Slovak Republic since 1994. It is used as a coolant in AC of cabins in metal melting plants with high temperature. Slight increase of its consumption is expected in the future.
- HFC 236fa ($C_3H_2F_6$ 1,1,1,2,3,3,3–hexafluorpropane) – an extinguishing medium, swell up agent of PUR. As an extinguishing medium it is designed for portable extinguishing substances. It is approved in the Slovak Republic and nowadays it is the only alternative for CFC 1211 and HCFC 123. Extinguishing medium HFC 236fa is known under mark FE 36. It has been importing to the Slovak Republic since 2000, but is not used as coolant yet. Slight increase of its consumption is expected in the future.
- SF_6 – sulphurhexafluoride - its lifetime is up to 3 200 years and GWP (at lifetime of 100 years) is up to 23.9 $kgCO_2/kg$. It is used as an extinguishing medium in electronics, protection against explosion, isolation, sterilization, detection gas, alloying of Al and Mg, tobacco production. Beside that it is a substitute for halons, 90% of its use is devoted to the isolation in high and low voltage electric equipment because of a higher safety level and the size of reduction, 10% of its use is devoted to the surface treatment of metals and so on in the world. Up to thousands kg of

SF_6 can be in one interrupter of high voltage. Highly toxic products originate at temperatures over 400°C. Alternatives at low voltage are vacuum and air. For example, Novec™612 (fluorinated ketone) ($C_3F_7C(O)C_2F_5$) has been developed. In the past, it was used in older types of extinguishers and in aluminium production in the Slovak Republic. Today it is used especially as an isolating gas in high voltage switchgears, in high voltage switchers at Slovenské elektrárne - ENEL (electricity distribution plant) and the supposed release is 1% of filling per year. The filling lasts for 30 years without refilling. Nitrasklo Ltd. has been using the SF_6 since 1993 for anti noise and thermal isolation in windows. It is mixed with argon in the rate 30:70 thus its consumption has decreased and the production is more cost-effective. It is filled in close cycles practically without releases. The consumption of SF_6 in Nitrasklo Ltd. was decreasing and it was phased out in 2002. 10 kg is stored in windows in the Slovak Republic and 480 kg is filled into windows, annually.

- PFCs (perfluorcarbons) - they have been produced for 30 years. They are used in special heating and cooling systems. In electronics they are used in gaseous state as a protection against explosion, isolation and detection gases. Furthermore, they are used for cleansing, dissolving, fluorine etching of glass and as extinguishing media.
- PFC14 (perfluormethane) - it originates as a by-product during the aluminium production in Žiar nad Hronom. PFC 14 is used for fluorine etching of glass and printed circuit.
- PFC116 (C_2F_6 perfluorethane) - it originates as a by-product during the aluminium production in Žiar nad Hronom.
- PFC218 (C_2F_6 perfluorethane) - there is an effort to use PFC218 in research as a component in coolant mixture.
- PFC410 (C_4F_{10} perfluorbuthane) - in electronics it is used as protection against explosion, isolation and detection gas. It has not been used yet as an extinguishing medium designed for fixed extinguishing devices in the Slovak Republic, but an effort is expected to approve it.
- PFC318 (c-C_4F_8 perfluorcyclobuthane) – it is expected an effort to approve the PFC318 for cleaning and dissolving as a substitute for 1,1,1–trichlorethane.

4.8.4 Source category description – Foam blowing (CRF 2.F.2)

No emissions of F gases were included in this category.

4.8.5 Source category description – Fire extinguishers (CRF 2.F.3)

The emissions originated from fire extinguishers represent less than 10% of emissions from 2.F category. In 2009, total actual emissions of HFCs were 5.33 Gg of CO_2 equivalents and they decreased by 20% compared to the previous year. The potential emissions of HFCs were 32.43 Gg of CO_2 equivalents and they increased by 15% compared to the previous inventory year. The emissions of PFCs and SF_6 are not occurring in this category.

4.8.6 Source category description – Aerosols/metered dose inhalers (CRF 2.F.4)

No emissions of F gases were included in this category.

4.8.7 Source category description – Solvents (CRF 2.F.5)

No emissions of F gases were included in this category.

4.8.8 Source category description – Other applications using ODS substitutes (CRF 2.F.6)

No emissions of F gases were included in this category.

4.8.9 Source category description – Semiconductor manufacture (CRF 2.F.7)

No emissions of F gases were included in this category.

4.8.10 Source category description – Electrical equipment (CRF 2.F.8)

The emissions originated from electrical equipment represent less than 10% of SF_6 emissions from 2.F category. In 2009, total actual emissions of SF_6 were 0.81 Gg of CO_2 equivalents and they increased by 5% compared to the previous year. The potential emissions of SF_6 were 0.0045 Gg of CO_2 equivalents and they decreased by 13% compared to the previous inventory year. The emissions of HFCs and PFCs are not occurring in this category.

4.8.11 Source category description – Other (CRF 2.F.9)

No emissions of F gases were included in this category.

4.9 Consumption of halocarbons and SF_6 potential emissions (CRF 2.F.P)

The method of estimation of potential emissions assumes that the emissions occur during the year in which the chemical is produced or sold into a particular end-use sector. Conditions for the evaluation of retrospective and perspective of the trend of consumption of HFC were thus prepared using the total sums of purchased and cumulated CFC, HCFC and HFC coolants.

Total potential emissions of F gases from industry sector are from the import in bulk. In 2009, the emissions of HFCs from the consumption were 685.32 Gg of CO_2 equivalents. Total potential emissions of SF_6 were 4.49 Gg of CO_2 equivalents. No PFCs emissions are occurring in 2009.

4.9.1 Methodological issues – methods

The Revised 1996 IPCC Guidelines describe two tiers for estimating emissions, which occur during the year in which the chemical is produced or sold into a particular end-use sector. The bottom-up approach takes into account the time lag between consumption and emissions explicitly through emission factors. The top-down approach takes the time lag into account implicitly, by tracking the amount of virgin chemical consumed in a year that replaces emissions from the previous year. The top-down approach is used as the basic one but the cumulative amount of substances is observed and the emissions are calculated by using emissions factors. The substances used to substitute emissions are calculated from:

- Top down approach.
- Cumulative amount of substances and emissions factors.

4.9.2 Methodological issues – emission factors and other parameters

Summarized amounts of mixtures imported in bulks and products are followed by the conversion of mixtures to the single substances. The results have been evaluated since 1990 and summarized for the actual inventory year.

4.9.3 Activity data

Because of expected prohibition of coolant R12 import, 700 tones of it were purchased in years 1993 and 1995. This amount had been consumed gradually and coolant R12 is still available. In the Slovak Republic the consumption of coolants has decreased by 60% comparing to 1990.

Up to 1998 the products designed for coolants R22, R134a and R404A were usually imported. Only in 1999 the indications of import of products containing coolants R407C and R410A were emerging. Because of the entry into force of Act 76/1998 on the Protection of the Ozone Layer of the Earth on

April 1, 1998, the year 1998 was the year of making the supplies of coolant R22. The consumption of alternative coolants R401A and R409A for R12 started to decrease in 2002. Coolants R407C and R410A show the growth tendency since 1999. Coolant R134a shows continuing growth tendency mainly because of rising import of cars with AC. A slight decrease of R134a consumption is expected after 2011.

Table 4.36: Import of coolants in equipments and bulks to the Slovak Republic according to the usage

Type of equipment	R22 (t)											
	1998	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**
Industrial coolants, AC	7,00	8,45	7,06	6,32	-2,30	-2,75	-3,36	-3,40	-0,69	-1,80	-2,52	0,00
Commercial coolants	0,49	0,61	0,24	0,17	0,01	0,19	0,00	0,00	0,00	0,00	0,00	0,00
Domestic coolants	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Car AC	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Total in import equipments	7,49	9,06	7,30	6,49	-2,29	-2,56	-3,36	-3,40	-0,69	-1,80	-2,52	-2,52
Import in bulks	129,00	28,60	41,38	50,00	70,36	44,60	32,65	33,20	39,76	42,80	30,30	32,20
Import in mixtures	0,00	0,00	10,84	10,50	10,07	9,95	5,80	4,70	2,20	6,15	1,94	3,04
Total	**136,50**	**37,66**	**59,52**	**66,99**	**78,14**	**51,99**	**35,09**	**36,60**	**41,26**	**47,20**	**29,72**	**35,24**

Type of equipment	R407C (t)											
	1998	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**
Industrial coolants, AC	0,10	1,91	3,18	1,93	6,88	5,00	-2,84	0,68	1,73	2,66	2,39	0,98
Commercial coolants	0,00	0,01	0,00	0,00	0,04	0,04	0,15	1,13	0,34	1,36	1,17	1,59
Domestic coolants	0,00	0,00	0,00	0,14	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Car AC	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Total in import equipments	0,10	2,05	3,18	2,07	6,92	5,04	-2,99	1,81	2,10	4,96	3,56	3,56
Import in bulks	0,50	0,40	6,55	11,56	18,80	25,30	27,06	32,89	43,58	40,60	30,26	39,57
Total	**0,60**	**1,05**	**9,73**	**13,63**	**25,70**	**30,34**	**24,07**	**34,70**	**45,68**	**45,50**	**33,82**	**43,13**
% in bulks									95,00	89,00	89,00	

Type of equipment	R134a (t)											
	1998	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**
Industrial coolants, AC	0,91	0,67	1,15	0,76	2,27	1,58	0,44	2,90	1,06	1,77	2,85	1,25
Commercial coolants	0,23	1,28	0,80	-1,11	-0,99	-1,60	1,57	1,30	1,50	0,76	2,20	0,00
Domestic coolants	16,50	17,35	10,10	9,06	3,11	2,85	1,29	1,20	1,27	0,70	0,55	0,00
Car AC	0,00	0,00	0,00	19,30	19,05	20,80	29,12	32,30	45,60	49,10	52,80	53,13
Total in import equipments	17,80	19,30	12,05	28,01	23,44	23,63	32,42	37,70	49,44	54,26	58,40	58,41
Import in bulks	52,10	50,00	82,00	32,49	50,36	51,70	47,81	54,00	83,00	89,50	73,30	119,00
Import in mixtures	0,00	0,00	0,00	6,67	12,90	15,00	14,24	20,00	26,50	26,40	21,50	25,60
Total	**69,80**	**66,60**	**94,00**	**67,16**	**86,70**	**90,33**	**94,46**	**111,70**	**158,50**	**170,10**	**153,20**	**203,00**

Type of equipment	R404A (t)											
	1998	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**
Industrial coolants, AC	0,23	0,10	0,21	1,71	0,35	0,34	0,16	0,40	0,00	0,00	0,00	0,00
Commercial coolants	0,17	0,22	0,60	0,80	0,98	-0,60	-0,49	0,49	1,68	2,06	1,55	1,01
Domestic coolants	0,00	0,00	0,00	0,00	0,44	0,00	0,00	0,00	0,00	0,00	0,18	0,00
Car AC	0,00	0,00	0,00	0,00	0,00	0,00	0,00	1,90	2,10	1,87	2,14	2,10
Total in import equipments	0,40	0,32	0,81	2,51	1,77	-0,26	-0,33	2,79	3,78	3,94	3,87	3,01
Import in bulks	2,70	2,60	23,29	28,39	45,82	45,80	42,81	42,40	59,92	61,20	77,73	92,66
Total	**3,10**	**4,60**	**24,10**	**30,90**	**47,60**	**45,54**	**42,48**	**45,20**	**63,70**	**65,12**	**81,60**	**95,70**

Type of equipment	R410A (t)											
	1998	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**
Industrial coolants, AC	0,00	0,03	0,40	0,47	1,66	2,20	3,25	7,24	6,69	18,08	24,83	17,80
Commercial coolants	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,56	0,04	0,93	0,05	2,44
Domestic coolants	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,63
Car AC	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Mixures	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Total in import equipments	0,00	0,03	0,40	0,47	1,66	2,20	3,25	7,80	9,74	18,86	24,86	20,80
Import in bulks	0,00	0,03	0,03	0,73	1,55	4,63	1,74	4,54	6,14	9,30	11,68	21,79
Total	**0,00**	**0,06**	**0,43**	**1,20**	**3,02**	**6,83**	**4,99**	**12,33**	**15,88**	**28,14**	**36,54**	**42,59**
% in bulks									38,00	33,00	31,20	

Type of equipment	HCFC and HFC mix refrigerants total (t)											
	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Industrial coolants, AC	8,24	11,20	12,00	11,20	7,70	6,40	-2,35	7,82	11,79	20,70	27,55	20,30
Commercial coolants	0,89	2,11	2,33	-0,14	-0,01	-0,40	1,23	3,48	7,52	5,11	4,97	5,04
Domestic coolants	16,50	17,35	10,10	9,06	3,11	2,85	1,29	1,20	1,27	0,70	0,73	0,63
Car AC	0,00	0,00	0,00	19,30	19,05	20,80	29,12	34,20	45,60	56,10	60,56	60,51
HCFC Mixures	0,00	0,00	0,00	24,30	19,36	18,30	9,60	10,44	8,24	4,30	3,59	5,63
Total in import equipments	26,00	30,50	24,20	39,50	31,20	28,00	29,30	50,28	64,37	82,00	93,81	86,20
Import in bulks	184,50	80,80	152,80	147,50	214,80	190,00	152,10	167,10	232,40	243,40	223,30	305,20
Total	**210,50**	**111,30**	**177,00**	**187,00**	**246,00**	**218,00**	**191,00**	**224,00**	**305,00**	**330,00**	**321,00**	**397,00**
% in bulks	87,60	72,60	86,00	78,90	87,00	87,00	79,60	73,00	76,00	74,00	69,00	77,00

Refrigerant/import 2009	AC	CC	DC	CAR AC	Bulks	Store	Total
R22	0,00	0,00	0,00	0,00	35,20	0,00	**35,20**
R134a	1,25	0,00	0,00	58,41	144,60	22,20	**182,00**
R404A	0,00	1,01	0,00	2,10	92,66	4,54	**91,20**
R407C	0,98	1,59	0,00	0,00	39,57	0,00	**43,13**
R410A	17,80	2,44	0,63	0,00	21,79	2,37	**40,29**
HCFC, HFC mixtures	0,00	0,00	0,00	0,00	5,63	0,23	**5,40**
Total	**20,03**	**5,04**	**0,63**	**60,51**	**339,45**	**29,34**	**397,00**
TOTAL	**397 tons**						

The following figure shows the consumption of refrigerants in the Slovak Republic. The higher consumption in the years 1998 and 2002 was caused by higher purchase of refrigerant R22 because of expected legislation, fees and limited possibility of purchase. The consumption of refrigerants is still rising in accordance with the growing economy.

The ratio of import of refrigerants in bulks and products is described in the next figure (increase of import). The level of import of products in 2009 is higher although the increasing export of products is included too. Rising import of cars with air conditioning with refrigerant R134a has the main influence.

Figure 4.20: Development of refrigerant import in products and bulks in the Slovak Republic

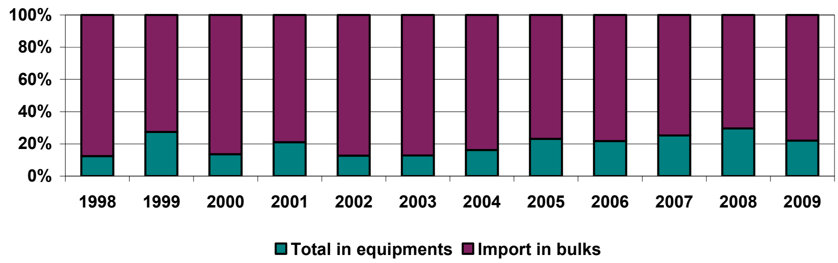
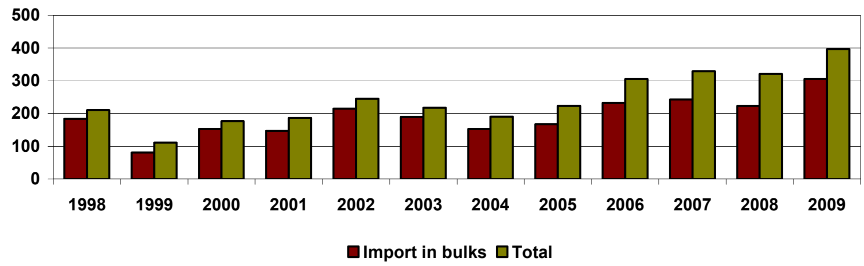
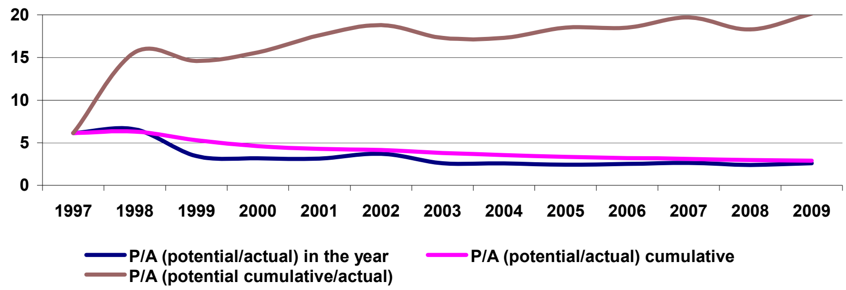


Figure 4.21: Development of refrigerant consumption in the Slovak Republic



The potential and real emissions from aluminium production decreased in 1997, 1998 and mainly in 1999 compared to 1995 due to the new technologies of aluminium production. It can be significantly seen on the decreased P/A ratio in 1999. A consumption of coolants and extinguishing media in 1998 decreased because of the decrease of investments in construction works in the Slovak Republic. But in the future mainly potential emissions will increase due to gradual substitution of CFC and HCFC coolants by HFC coolants, especially coolant R134a or coolants R125 and R143a as components in mixtures of coolants R 404A, R407C and R410. On the other hand, there is the decrease from the production of aluminium and extinguishing media. The increase of extinguishing media HFC 227ea and HFC 236fa started in 2000. Only 1% of emissions from new extinguishing media were calculated. Emissions from foams, solvents and aerosols are not occurring because these substances are not used for these purposes in the Slovak Republic except of R134a substance that was used in isolation foam in IDAF Šurany. This production was finished in 2001. The use of PFC solvents and extinguishing media will probably show its effect on emissions in the future.

Figure 4.22: The development of ratio of potential and actual emissions

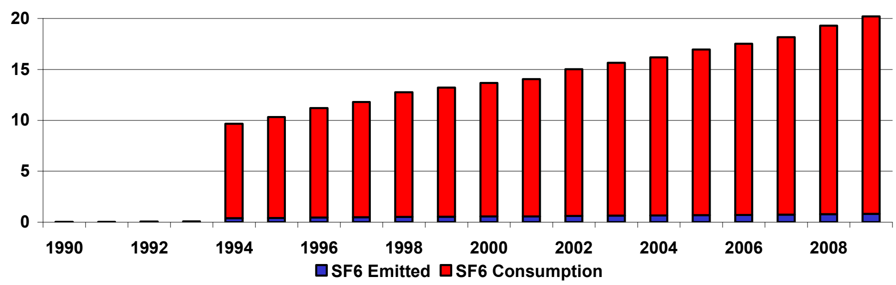


- Potential and actual emissions of PFC14 and PFC116 - C_2F_6 perfluorethane originates as a by-product during the aluminium production in Žiar nad Hronom. Since 2000 PFC 14 and PFC116 have been originated as a by-product during the aluminium production and they have not been included in this part of inventory.
- Less then 1 % of emissions from new extinguishing media has been calculated (without consumption for extinguishing - no consumption was recorded in the last years).

In relation with the high reliability of the new cooling equipments with the content of HFCs, PFCs and SF_6 and progressive implementation of preventive service, the ratio of cumulative potential and actual emissions is still rising although in the years 2003/2004 and 2005/2009 was nearly on the same level. The ratio of potential and actual emissions and as well of the cumulative potential and cumulative actual emissions is declining. It is because the actual emissions are rising adequately to the cumulative amount of these HFCs substances – substitutes of ODS.

The above analysis shows that in the year 2009 was reached faster application of HFCs because the HCFCs applications have been completely abandoned in new installations by Act 76/1998 Z.z. in version 408/2000 Z.z. in the year 2004. Decline of extinguishing media consumption is because they are very expensive and the investment to them is planned for a longer time. Consumption of SF_6 is approximately at the same level. Technical solutions, which could substitute this gas, are still very expensive. Consumption of PFCs during etching is practically without emissions and this technology is still less used.

Figure 4.23: The development of SF_6 consumption and emissions



4.9.4 Uncertainties and time-series consistency

The inventory of F-gases is complicated due to a high number HFCs, PFCs and SF_6 substances. They are components of different mixtures used in different more then 15 applications. Each application has its own development of consumption and trend of emission development. According to the IPCC GPG it is no sense to deal with uncertainties, which do not have fundamental influence on the total emissions. This should be taken into account in all numerous applications of different F-gases. That is why, in the coincidence with IPCC GPG, the quantification of uncertainties is the first step and it is done by expert judgment due to the large extent of different applications and gases for potential and actual emissions.

Given substances are not solo (independently) documented under any of items in custom scale of rates (tariff). On the base of description of the F-gases with GWP in questionnaires, they are sent to potential importers, producers, users and consumers of given substances in the Slovak Republic. It means that a lot of different data sources on the base of questionnaires were requested.

Similarly, the uncertainness come out from the assessment of emission factor, which was gradually decreasing during 1994 – 2009 in the range from 17 to 8% according to the application. The lowest emission factors are on the products completed in the factories mainly in domestic refrigerators, chillers and so on. Higher emission factors are in cooling circuits assembled at the place of application for example commercial, agricultural, industrial, transport refrigeration and so on. The given range of emission factors is overcome only in car air conditioning, where emission factor is expected over 20%. From this assessment it comes out that emission factor is in the range from 8 to 25% in all applications. The assessment of uncertainties by expert judgment is considered for the development of potential and actual emissions. The potential emissions, which depend on the preciseness and completeness of reported data, are evaluated in the range from 5 to 15% and the actual emissions are in the range from 8 to 17%. Both distributions are nonsymmetrical. In the case of potential emissions, it is supposed that the data are rather underestimated. In the case of emission factor, the trend to the lower emission factor is supposed in more applications. Potential emissions correlate to the economic development in the Slovak Republic. The uncertainties in to the relation to the potential emissions depend on time (years). The trend of development of potential emissions can fluctuate, predominantly increase. In the future, it will decrease due to the introduction of alternative natural refrigerants. Nowadays, the development is given mainly by the fact that HFCs substances are substituting CFCs and HCFCs substances that are excluded from usage by the Montreal Protocol. Emission factors depend on time (years) and correlate with technical and technological development and the implementation of legal acts, technical standards and so on. The trend of the development of emission factor should decrease.

In order to analyze these assessments statistically and exactly, software for statistical analysis by the method of Monte Carlo should be bought to analyze the probability of distribution of inputs. It means the emission factors and the movement of substances in every application. Such work would be quite extensive and it would require higher financial costs. Therefore, it is necessary to consider whether such a work in comparison with the expert judgment, which is acceptable by GPG, will be adequate to the significance and the ratio of emissions in all applications or only in the chosen ones. Monte Carlo method requires the sequence of steps during several years. It is a method, which improves the quality of inventory only on the base of gradually acquired experiences by gradual decrease of uncertainties.

4.9.5 Source specific QA/QC and verification

Due to the links, the relations in the questionnaire to other potential importers, producers, and the most of companies are presented in the Catalogue of RAC companies that are the members or are trained by the Slovak Association of Cooling and Air Conditioning Technique (SZ CHKT). The SZ CHKT is authorized by the Ministry of Environment for training and certification of personnel, or they are at the internet, participating in the exhibitions and so on. It is assumed, that more than 90% of potential companies have been addressed. The addressed companies filled the questionnaires on the base of their documentation and so the reported data should correspond to the reality. With the reported data, these companies are confronted during the next two years. It should be enough for checking and correcting the wrong data. The data processed this way are considered to be representative. During the inventory, we can assume nonsymmetrical error distribution in reported data in the range from -5% to + 15%.

4.9.6 Source specific recalculations

Minor corrections were reported in HFCs consumptions in refrigeration category 2F1 and potential emissions of HFC-227ea in category 2FP2.1. The changes are described in the following table.

Table 4.37: The recalculations changes and comparison of the submissions 2010 and 2011

Year	Submission 2010			Submission 2011			2010/2011
	Actual HFCs (kt)	Potential HFCs (kt)	Ratio A/P	Actual HFCs (kt)	Potential HFCs (kt)	Ratio A/P	Changes
2008	264,43	582,77	2,21	263,24	580,74	2,29	99,55%

The ERT during the centralised review to the submission 2010 identified in the CRF tables that actual emissions from consumption of halocarbons and SF_6 are reported as NO and that potential emissions are reported. Mr. Peter Tomlein, a sectoral expert for F-gases inventory, verified and checked the CRF reporting tables and the reporting of SF_6 emissions in the categories 2.F.8 and 2.F.9. According with the recommendations of the ERT it was found out, that the potential emissions of SF_6 were allocated in the category 2.F.9 – other and the actual emissions of SF_6 were allocated in the category 2.F.8 – electrical equipment. Sectoral expert verified that the potential and actual SF_6 emissions occur only from electrical equipment in the Slovak Republic and therefore is not reason for reporting of SF_6 emissions in the category 2.F.9. The notation key “NO” shall be use in the category 2.F.9. The potential SF_6 emissions from category 2.F.9 – Other were reallocated to the category 2.F.8 – Electrical Equipment. Total SF_6 potential emissions were not change.

4.9.7 Source specific planned improvements

The improvements regarding the detailed information fill into the sectoral tables are planed for the next submission.

4.10 Other (CRF 2.G)

No emissions are included in the category 2.G Other in the Slovak Republic in 2009.

CHAPTER 5: SOLVENT AND OTHER PRODUCTS USE (CRF 3)

5.1 Overview of sector (CRF 3)

This category includes the emissions of CO_2, N_2O and NM VOC (photochemical smog) from solvent and other product use according to the IPCC 2000 GPG. The lack of relevant input sources and emission factors for CO_2 has the significance for the omission of this source from the inventory. In other way, the CO_2 emissions might be ballast with the high uncertainty.

In 2011 submission, the primary attention regarding the solvent use sector inventory was put on N_2O emissions and CO_2 emission recalculation of categories 3A and 3B. The most important issue was collection all available input data about solvents used in industry in a consistency manner. The statistical information is insufficient, so it was decided to request directly the producers, importers, distributors and users.

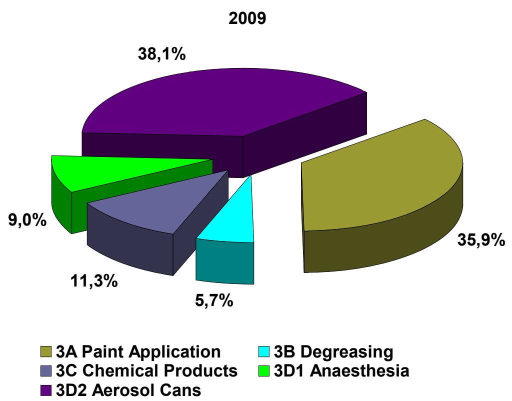
In the frame of the National Program for Emission Reduction of Non-Methane Volatile Organic Compounds, total NM VOC emissions from solvent and other products use were estimated in the cooperation with the Ministry of Environment, the team of experts established in compliance with Directive 1999/13/EC and upon a close cooperation with producers in the Slovak Republic.

Table 5.1: GHG emissions in individual categories in the solvent use sector in 1990 – 2009

Year	Total CO_2	Total N_2O	Total NMVOC	Total CO_2			Total N_2O	
				3A Paint Application	3B Degreasing	3C Chemical Products	3D1 Anaesthesia	3D2 Aerosol Cans
	[Gg]	[Gg]	[Gg]	[Gg]			[Gg]	
1990	130,1047	0,0550	52,8746	94,4398	17,5544	18,1105	0,0550	NO
1991	109,5933	0,0550	36,0000	77,7141	13,7382	18,1410	0,0550	NO
1992	92,9463	0,0550	29,5000	63,3225	11,4485	18,1753	0,0550	NO
1993	84,5963	0,0550	34,9653	55,6922	10,7083	18,1958	0,0550	NO
1994	86,1464	0,0542	27,7000	58,1415	9,7614	18,2435	0,0542	NO
1995	90,5394	0,1000	37,0661	59,5433	12,6912	18,3049	0,1000	NO
1996	82,2803	0,1072	33,7997	55,0388	8,8991	18,3424	0,1072	NO
1997	70,7026	0,0868	29,2943	45,0553	7,2742	18,3731	0,0868	NO
1998	73,2692	0,0683	30,1764	46,1538	8,7253	18,3901	0,0683	NO
1999	68,6309	0,0706	28,4143	41,3469	8,8746	18,4094	0,0706	NO
2000	64,9067	0,0650	26,9782	38,0339	8,4501	18,4227	0,0650	NO
2001	69,7733	0,0967	28,7247	40,3683	11,0628	18,3422	0,0810	0,0157
2002	74,6601	0,1847	31,0199	43,4912	12,8260	18,3429	0,0762	0,1085
2003	78,0961	0,1911	32,2721	47,1150	12,6351	18,3460	0,0733	0,1178
2004	83,2017	0,2590	32,7597	53,1247	11,7148	18,3622	0,0706	0,1884
2005	85,1935	0,2785	33,5612	54,4514	12,3650	18,3771	0,0656	0,2129
2006	88,1603	0,2659	34,6342	56,1531	13,6149	18,3923	0,0598	0,2061
2007	86,2972	0,2579	33,5792	57,7098	10,1701	18,4173	0,0609	0,1970
2008	87,6672	0,2546	33,7841	58,5344	10,6761	18,4567	0,0522	0,2024
2009	86,9883	0,2497	33,3316	59,0474	9,4419	18,4990	0,0476	0,2020

The major share (38%) in sector solvent use is represented by N_2O emissions from aerosol cans used in food industry. The second large share (36%) belongs to medicinal use of N_2O in anesthesia. The CO_2 emissions from 3A and 3B were recalculated based on national methodology used NMVOC emission inventory of different type of solvents. Their shares are presented on the Figure 5.1.

Figure 5.1: The share of individual categories in emissions in sector solvent use in 2009



Category	CO_2 Eq. (Gg)	Share (%)
3A Paint Application	59,05	35,92%
3B Degreasing	9,44	5,74%
3C Chemical Products	18,50	11,25%
3D1 Anaesthesia	14,77	8,98%
3D2 Aerosol Cans	62,63	38,10%

5.2 Uncertainties and time-series consistency

To compute uncertainty of CO_2 (for 3ABC category) and N_2O (for 3D category) emissions for this subsector the following input parameters were applied: NMVOC emissions, the content of C in the NMVOC and their uncertainties for both AD and EF. For 3D category, CO_2 equivalent was estimated from N_2O emissions and its uncertainty. The accumulated uncertainty and statistical characteristics for subsector solvent are presented.

Formula can be written in the form:

$$\text{Emission} = \sum_{I}(\text{NMVOC} \pm \Delta\text{NMVOC}) * (\text{content of C} \pm \Delta\_\text{content of C}) * \frac{44}{12} +$$

$$+ \sum_{I}(\text{constant} * (\text{N2O} \pm \Delta\text{N2O}))$$

First row of formula is related to CO_2 emissions, last row is related to CO_2 emissions equivalent. The accumulated uncertainty and statistical characteristics for solvent are presented in the following figure. From the presented results of CO_2 emissions (in equivalents) obtained by Monte Carlo simulation it seems that mean value is 164 349 ton per year. Confidence interval (95%) is represented by the relative values to the mean: (-19.56%, 19.56%). The normal distribution for every subcategories have influence to the total uncertainties. The symmetry of aggregate uncertainty is not surprised in this case.

Figure 5.2: Probability density function for sector Solvent use in tons of CO_2

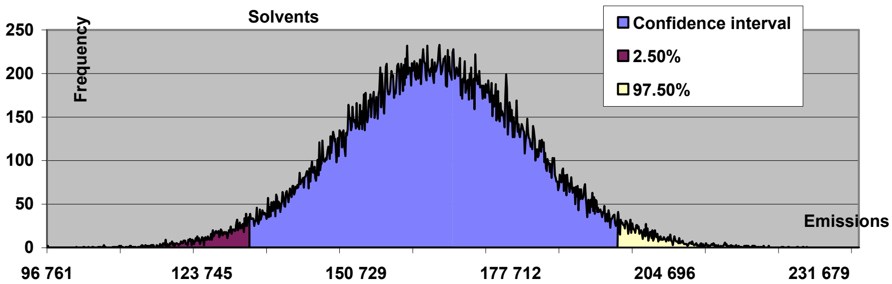


Table 5.2: Selected statistical characteristics for sector Solvent use, median, mean value, standard deviation, minimum, maximum of emissions and percentiles

Median	Average	Standard dev,	2,50%	97,50%
164 348,67	164 344,22	16 319,40	132 206,53	196 482,00
Min	**Max**		**Per_2,5**	**Per_97,5**
96 761,37	238 780,37		-19,56%	19,56%

5.3 Source specific QA/QC and verification

Information used for GHG emission inventories of Solvent use sector are directly from questionnaires sent to operators and producers of solvents in the Slovak Republic. The first preliminary data related to the production and the quality of products for the previous year in the Slovak Republic will be available at the beginning of October. These data are used for the estimation of emissions and are verified by Mr. Vladimir Danielik – the sectoral expert for Solvent use sector in the cooperation with the Slovak Technical University in Bratislava, the Faculty of Chemical and Food Technology and the Slovak Union of Paint producers. The data will be compared with the information from the Statistical Office of the Slovak Republic and available industrial sources.

5.4 Source specific recalculations

In the frame of the QA/QC plan implemented in the previous year, the improvement of methodology for CO_2 emissions according NMVOC emissions was developed and the emissions in categories 3A and 3B were recalculated. The methodology is described in sections 2.6 – 2.8 and the emissions are complete in term of time series consistency.

5.5 Source specific planned improvements

No improvements are planned for this category for the next submission.

Table 5.3: The recalculations changes and comparison of the submissions 2010 and 2011

Year	Submission 2010		Submission 2011		2010/2011
	3A Paint Application	3B Degreasing	3A Paint Application	3B Degreasing	Changes total 3A&3B
	Total CO_2 (Gg)				
1990	72,18	25,30	94,44	17,55	88,85%
1991	59,40	19,80	77,71	13,74	88,82%
1992	48,40	16,50	63,32	11,45	89,38%
1993	42,57	15,48	55,69	10,71	90,13%
1994	44,44	16,50	58,14	9,76	91,92%
1995	45,51	16,93	59,54	12,69	89,18%
1996	42,07	13,35	55,04	8,90	89,64%
1997	34,44	10,91	45,06	7,27	90,12%
1998	35,28	11,96	46,15	8,73	89,57%
1999	31,60	11,83	41,35	8,87	90,11%
2000	29,07	11,20	38,03	8,45	90,43%
2001	30,86	13,58	40,37	11,06	89,97%
2002	33,24	16,13	43,49	12,83	90,70%
2003	36,01	16,30	47,12	12,64	90,47%
2004	40,61	12,81	53,12	11,71	86,27%
2005	41,62	13,42	54,45	12,37	86,18%
2006	42,95	14,52	56,15	13,61	86,05%
2007	44,01	11,12	57,71	10,17	85,23%
2008	44,85	11,11	58,53	10,68	84,89%

5.6 Paint application (CRF 3.A)

The calculation of the CO_2 emissions is based on the NMVOC emissions. Last year the thorough survey of the used solvents was done. According to the survey the solvents were divided into several classes in which the content of carbon was calculated. The indirect CO_2 emissions from paint application have been recalculated since the base year 1990 (Table 5.1). In this category the solvents are divided into 8 classes in the time period 1990 – 2005. The contents of carbon are summarized in Table 5.4. In the later period (2006 – 2009) more detailed information are available and the appropriate carbon contents are listed in Table 5.5. The NMVOC and CO_2 emissions are summarized in Table 5.6 and Table 5.7. CO_2 emissions from paint application were 58.53 Gg and NMVOC emissions from paint application were 20.37 ktons. The increasing trend is continuing also in 2009 due to the increase of used painting and glues.

Table 5.4: The carbon contents in solvent classes for 3A category ("Paint") in 1990 – 2005

Solvent	Solvent naphta	Aromates	Ester	Alcohols	Acetone	Dichlormethane	Cyklohexane	Others
Carbon Content	0,86	0,91	0,59	0,59	0,62	0,14	0,28	0,6

Table 5.5: The carbon contents in solvent classes for 3A category ("Paint") in 2006 – 2009

Solvent	Solvent Naphta	Xylene	Toluene	Styrene	Ethylacetate	Buthylacetate	Methylacetate	Metoxypropylacetate
Carbon Content	0,86	0,905	0,913	0,923	0,545	0,62	0,486	0,545
Solvent	Ethylalcohol	Buthylalcohol	Isopropanol	Isobuthanol	Acetone	Dichlormethane	Cyklohexane	Others
Carbon Content	0,521	0,648	0,6	0,648	0,62	0,141	0,273	0,6

Table 5.6: The NMVOC and CO_2 emissions in solvent classes for 3A category in 1990 – 2005

Year	Activity Data [t]	NMVOC emissions [t]									CO_2 Emissions [t]
		Total	Solvent naphta	Aromates	Ester	Alcohols	Acetone	Dichlor-methane	Cyklo-hexane	Others	
1990	56 907	**32 811**	11 910,40	10 171,40	6 234,10	2 788,90	1 214,00	65,60	262,50	164,10	**94 439,8**
1991	56 907	**27 000**	9 801,00	8 370,00	5 130,00	2 295,00	999,00	54,00	216,00	135,00	**77 714,1**
1992	56 907	**22 000**	7 986,00	6 820,00	4 180,00	1 870,00	814,00	44,00	176,00	110,00	**63 322,5**
1993	35 306	**19 349**	7 023,70	5 998,20	3 676,30	1 644,70	715,90	38,70	154,80	96,70	**55 692,2**
1994	36 306	**20 200**	7 332,60	6 262,00	3 838,00	1 717,00	747,40	40,40	161,60	101,00	**58 141,5**
1995	38 462	**20 687**	7 509,40	6 413,00	3 930,50	1 758,40	765,40	41,40	165,50	103,40	**59 543,3**
1996	35 406	**19 122**	6 941,30	5 927,80	3 633,20	1 625,40	707,50	38,20	153,00	95,60	**55 038,8**
1997	31 122	**15 653**	5 682,20	4 852,60	2 974,10	1 330,50	579,20	31,30	125,20	78,30	**45 055,3**
1998	28 951	**16 035**	5 820,70	4 970,90	3 046,70	1 363,00	593,30	32,10	128,30	80,20	**46 153,8**
1999	24 937	**14 365**	5 214,50	4 453,20	2 729,40	1 221,00	531,50	28,70	114,90	71,80	**41 346,9**
2000	24 642	**13 214**	4 796,70	4 096,30	2 510,70	1 123,20	488,90	26,40	105,70	66,10	**38 033,9**
2001	25 356	**14 025**	5 091,10	4 347,80	2 664,80	1 192,10	518,90	28,10	112,20	70,10	**40 368,3**
2002	26 971	**15 110**	5 484,90	4 684,10	2 870,90	1 284,40	559,10	30,20	120,90	75,60	**43 491,2**
2003	29 533	**16 369**	5 941,90	5 074,40	3 110,10	1 391,40	605,70	32,70	131,00	81,80	**47 115,0**
2004	32 612	**18 457**	6 699,90	5 721,70	3 506,80	1 568,80	682,90	36,90	147,70	92,30	**53 124,7**
2005	34 064	**18 918**	6 867,20	5 864,60	3 594,40	1 608,00	700,00	37,80	151,30	94,60	**54 451,4**

Table 5.7: The NMVOC and CO_2 emissions in solvent classes for 3A category in 2005 – 2009

Year		2006	2007	2008	2009
Activity data [t]		35 562	36 405	36 690	36 805
NMVOC emissions [t]	**Total**	**19 522**	**20 003**	**20 205**	**20 367**
	Solvent Naphta	7 223	7 232	7 183	7 386
	Xylene	2 310	2 774	2 889	2 817
	Toluene	2 789	2 725	2 987	3 035
	Styrene	872	849	825	816
	Ethylacetate	1 110	1 131	1 122	1 144
	Buthylacetate	2 135	2 155	2 185	2 110
	Methylacetate	262	243	230	236
	Metoxypropylacetate	192	201	168	121
	Ethylalcohol	696	917	919	929
	Buthylalcohol	310	232	250	307
	Isopropanol	193	185	148	154
	Isobuthanol	426	410	388	394
	Acetone	702	741	760	763
	Dichlormethane	39	39	31	34
	Cyklohexane	164	42	45	46
	Others	99	127	75	75
CO_2 emissions [t]		**56 153,1**	**57 709,8**	**58 534,4**	**59 047,4**

5.6.1 Uncertainties and time-series consistency

The accumulated uncertainty and statistical characteristics for subsector solvent are presented. Confidence interval (95%) is represented by the relative values to the mean: (-50.26%, 50.17%).

Median	Average	Standard dev,	2,50%	97,50%
58 975,04	58 987,93	15 078,06	29 339,10	88 582,92
Min	**Max**		**Per_2,5**	**Per_97,5**
1 503,08	125 201,95		-50,26%	50,17%

5.7 Degreasing and Dry Cleaning (CRF 3.B)

The indirect CO_2 emissions from degreasing and dry cleaning have been estimated since the base year 1990 (Table 5.1). The calculation of the CO_2 emissions is based on the NMVOC emissions. In this category the solvents are divided into 4 classes. The contents of carbon are summarized in Table 5.8. NMVOC and CO_2 emissions are listed in Table 5.9. NMVOC emissions from degreasing and dry cleaning use in industry and services were 4.41 ktons and CO_2 emissions were estimated to 9.44 Gg in 2009. The decreasing trend in emissions is visible since 2006.

Table 5.8: Carbon contents in solvent classes for 3B category ("Degreasing") since 1990

Solvent	Trichlorethylne	Tetrachlorethylne	Acetone	Isopropanol
Carbon Content	0,183	0,145	0,620	0,600

Table 5.9: NMVOC and CO_2 emissions in solvent classes for 3B category since 1990

Year	NMVOC emissions [t]					CO_2 emissions [t]
	Trichlor-ethylene	Tetrachlor-ethylene	Acetone	Isopropanol	Total	
1990	3 105,00	2 070,00	6 210,00	115,00	**11 500,00**	**17 554,40**
1991	2 430,00	1 620,00	4 860,00	90,00	**9 000,00**	**13 738,20**
1992	2 025,00	1 350,00	4 050,00	75,00	**7 500,00**	**11 448,50**
1993	1 910,80	1 275,70	3 766,90	83,90	**7 037,20**	**10 708,30**
1994	3 339,10	1 098,30	2 717,80	344,70	**7 500,00**	**9 761,40**
1995	1 689,30	1 195,00	4 606,60	204,60	**7 695,50**	**12 691,20**
1996	1 804,00	1 113,30	2 261,40	889,00	**6 067,70**	**8 899,10**
1997	1 499,10	889,70	1 966,30	602,30	**4 957,50**	**7 274,20**
1998	1 481,40	694,30	2 543,60	718,00	**5 437,40**	**8 725,30**
1999	1 302,60	697,90	2 703,10	674,70	**5 378,40**	**8 874,60**
2000	1 318,60	551,60	2 524,30	697,10	**5 091,50**	**8 450,10**
2001	1 287,70	481,50	3 526,10	875,70	**6 171,10**	**11 062,80**
2002	1 833,10	484,00	4 172,50	842,30	**7 332,00**	**12 826,00**
2003	2 142,90	404,50	3 933,20	927,60	**7 408,20**	**12 635,10**
2004	563,50	315,00	4 004,10	939,30	**5 822,00**	**11 714,80**
2005	461,40	394,90	4 175,60	1 069,50	**6 101,40**	**12 365,00**
2006	529,80	258,60	4 578,60	1 233,20	**6 600,30**	**13 614,90**
2007	409,20	340,30	3 254,40	1 052,80	**5 056,80**	**10 170,10**
2008	225,50	211,00	3 519,80	1 095,90	**5 052,10**	**10 676,10**
2009	179,80	132,30	3 164,70	934,80	**4 411,60**	**9 441,90**

5.7.1 Uncertainties and time-series consistency

The accumulated uncertainty and statistical characteristics for subsector solvent are presented. Confidence interval (95%) is represented by the relative values to the mean: (-50.26%, 50.17%).

Median	Average	Standard dev,	2,50%	97,50%
9 418,77	9 420,83	2 408,08	4 685,68	14 147,38
Min	**Max**		**Per_2,5**	**Per_97,5**
240,05	19 995,72		-50,26%	50,17%

5.8 Chemical Products, Manufactured and Processing (CRF 3.C)

The indirect CO_2 emissions from chemical products, manufactured and processing have been estimated since the base year 1990 (Table 5.1). The calculation of the CO_2 emissions is based on the NMVOC emissions. In this category, methodology of emission estimation was not changed. The NMVOC emissions from chemical products, manufactured and processing were 8.41 ktons and CO_2 emissions were estimated to 18.5 Gg in 2009. The EF for NMVOC is based on number of inhabitants in accordance with the applied methodology (EMEP/CORINAIR) and slightly increased compared to the previous year.

5.8.1 Uncertainties and time-series consistency

The accumulated uncertainty and statistical characteristics for subsector solvent are presented. Confidence interval (95%) is represented by the relative values to the mean: (-50.556%, 52.1%).

Median	Average	Standard dev,	2,50%	97,50%
18 435,86	18 477,98	4 821,53	9 136,28	28 105,82
Min	**Max**		**Per_2,5**	**Per_97,5**
460,16	40 255,99		-50,56%	52,10%

5.9 Other (CRF 3.D) (3.D.1 Use of N_2O for Anesthesia, 3.D.3 N_2O from Aerosol Cans)

The aim of N_2O emission inventory from solvent and other product use sector is in the medicine (anesthesia) and food use (aerosol cans). There is also the consumption of N_2O for analytical purposes, but the gas is burned after the use, so this source is not included into the total inventory. Total N_2O emissions from aerosol cans were 0.202 Gg and total N_2O emissions from anesthesia were 0.048 Gg in 2009.

5.9.1 Methodological issues – methods

The methodology is based on Tier 1 approach, solvent use is not key source. The final emissions from these sources are equal to the consumed gas. The time series was reconstructed based on statistical data about production. The N_2O emissions are summarized in Table 5.1.

The estimation of NM VOC emissions was processed based on IPCC methodology (IPCC, 1996) uses CORINAIR Methodology (CORINAIR, 2003) and SNAP classification. The inventory was carried out upon the base of data about production, import, export and selling of individual types of solvents. The activity data according to the CORINAIR methodology have been consistent since 1990. The emissions of NMVOC from processing of vegetable fat and oil were estimated to be 144 tons and they slightly increased compared to the previous inventory due to the increase in production.

5.9.2 Methodological issues – emission factors and other parameters

Emission factors for the consumption of N_2O for the medicine and food purposes are equal to activity data if all gas is evaporated into the atmosphere.

5.9.3 Activity data

The activity data come from the three major distributors of N_2O liquid gas – Messer-Tatragas, Linde and SIAD companies.

5.9.4 Uncertainties and time-series consistency

The accumulated uncertainty and statistical characteristics for subsector solvent are presented. Confidence interval (95%) is represented by the relative values to the mean: (-8.28%, 8.33%).

Median	Average	Standard dev,	2,50%	97,50%
77 411,36	77 403,32	3 295,86	70 992,31	83 852,55
Min	**Max**		**Per_2,5**	**Per_97,5**
63 374,67	90 580,57		-8,28%	8,33%

CHAPTER 6: AGRICULTURE (CRF 4)

6.1 Overview of sector (CRF 4)

In comparison with other sectors, the generation of emissions and sinks of greenhouse gases in agriculture have not been investigated thoroughly. Some sources are difficult to quantify, the others are hidden. Besides significant climate differences, there are also different types of soil due to indented ground of the Slovak Republic. This fact affects sowing procedures, manure applications and the management in agriculture.

The humankind activities in agriculture sector significantly contribute to the changes of concentration of some gases in atmosphere what consequently increase their greenhouse effect as well as the acidity of environment. Despite of the fact that water vapour and CO_2 are the gases of the highest importance sharing greenhouse effect of the atmosphere, N_2O and CH_4 emitted from agriculture are considered as the most important gases from the point of view of planning adaptive measures to reduce their influence on environment. Sources of N_2O and CH_4 emissions are analyzed according to revised IPCC 1996 GL and IPCC 2006 GL methodologies when principles of good practice in GHGs inventory in agriculture were taking into account. Some national data from research projects were utilized too. The emissions of N_2O, CH_4 and NH_3 can be reduced if effective adaptation measures are accepted in agricultural practice. Effective measures have been proposed for the conditions of the Slovak Republic. The shortage of data in relation to storage and application of manures has resulted in the fact that the emissions are evaluated at the level of business as usual. The methodology also makes use of results of research institutions sharing nitrogen fluxes in the conditions of the Slovak Republic. Emissions from burning of field residuals have not been evaluated because these forms of soil cultivation are prohibited by low in the Slovak Republic. The area of histosols is only 4 893 ha in the Slovak Republic and those soils have not been cultivated due to the landscape protection during recent years. This source is not evaluated in the GHG inventory. Methane and nitrous oxide are the most important gases emitted from agriculture. Agriculture produces about 23% of total methane and more than 56% of total nitrous oxide emissions in the Slovak Republic.

By the end of 2009, the primary soil fund of the Slovak Republic was 1 930 348 ha. The importance of agriculture in economy shows a long-lasting decrease, as regards either the share in GDP or employment. In 2009, the area of seeded soil slightly decreased (0.02%), but the areas of following plants increased: sugar-beet (43.3%), annual forage (7.3%), oilseed rape (8.4%) and sunflower (11.7%). This was reaction on the negative price situation on EU agricultural commodity market. The decreasing of seeded soil with potatoes (17.6%), crops (3.7%) and multi-year forage (4.9%) was reaction on situation low prices and demand on the market. However, Act 77/2009 Coll. changing and amending Act 139/1998 Coll. on narcotics and psychotropic substances, which has been effective since March 2009, allows growing of technical cannabis. In case of sugar-beet, the reform of sugar regime goes on and its growing is has been reduced. Potatoes growing have been influenced in the long term by several factors, like climate change, the decrease in human and animal consumption and the absence of companies processing potatoes. Increased interest of producers in oilseed rape was caused by increasing demands on the production of methyl ester and a higher average price.

Table 6.1: GHG emissions in individual categories in the agriculture sector in 1990 – 2009

	Sector 4 Agriculture		Categories (t)			
	CH_4 emissions (Gg)	N_2O emissions (Gg)	4A Enteric Fermentation CH_4	4B Manure Management CH_4	4B Manure Management N_2O	4D Agricultural Soil N_2O
1990	112,32	15,18	94 769,60	17 555,08	3 465,54	11 712,93
1991	103,22	12,29	86 891,50	16 324,44	3 144,52	9 148,70
1992	91,23	9,87	76 414,50	14 816,71	2 704,39	7 170,19
1993	79,71	8,37	66 093,90	13 617,34	2 343,28	6 026,20
1994	75,30	8,16	62 391,80	12 905,62	2 188,72	5 973,58
1995	80,15	8,37	66 901,61	13 253,17	2 306,57	6 063,45
1996	75,27	8,21	62 674,38	12 597,28	2 127,34	6 082,35
1997	67,66	8,22	56 096,08	11 559,48	1 948,65	6 273,85
1998	63,12	7,54	52 914,12	10 210,04	1 717,66	5 826,99
1999	60,65	6,88	50 778,96	9 869,61	1 636,33	5 244,04
2000	59,68	7,06	50 163,11	9 519,76	1 601,25	5 456,97
2001	61,08	6,99	51 442,58	9 634,41	1 548,33	5 445,63
2002	59,52	7,34	49 782,31	9 742,34	1 531,67	5 813,31
2003	56,91	7,06	47 645,46	9 262,14	1 487,71	5 576,90
2004	52,69	6,82	44 846,22	7 842,90	1 386,13	5 431,35
2005	53,19	6,76	45 530,58	7 660,82	1 339,54	5 422,21
2006	52,28	6,66	44 793,29	7 489,05	1 309,46	5 350,22
2007	51,36	7,06	44 514,04	6 844,36	1 284,46	5 777,32
2008	48,98	6,85	43 131,54	5 853,10	1 239,11	5 612,12
2009	47,15	6,54	41 202,94	5 943,25	1 216,14	5 327,54

In animal production, the problems persist with the nutrition, feeding techniques and care of animals that result in ineffective production. A long-lasting decrease in the number of cattle is accompanied with changes in breed structure. This brings a higher share of milk production with a lower number of dairy cows. Free stabling of animals is the most important technological change in animal production. Production of pigs is stagnant; however, it does not cover domestic consumption. Trend in poultry breeding is positive.

Sector agriculture with its share of 7.6% with 3 018.59 Gg of CO_2 equivalents is the main source of methane and N_2O emissions in the GHG emissions balance in the Slovak Republic. The emission balance is compiled annually on the basis of sectoral statistics and in recent years on the basis of a new regionalisation of agricultural areas of the Slovak Republic. The Ministry of Agriculture of the Slovak Republic issued annual statistics "Green Report", part agriculture and food industry on a yearly basis.

The trend in GHG emissions has been mildly decreasing since the base year. It is related mainly to the reduction of livestock number, in particular cattle, and the restricted use of fertilizers. In recent years, the good emission balances have been achieved also owing to the introduction of new procedures in cattle stabling and animal waste management (waste recovery by incineration and bio-gas utilisation).

The largest share of methane emissions was generated by enteric fermentation, which produced 41.2 Gg (29%) of methane in 2009, in particular in category of cattle. Regarding N_2O emissions, direct emissions from fertilization of agricultural soils were the most important sources, and they produced 5.3 Gg N_2O (55%) in 2009.

Figure 6.1: Trend in aggregated emissions (Gg) by categories within agriculture sector in 1990 – 2009

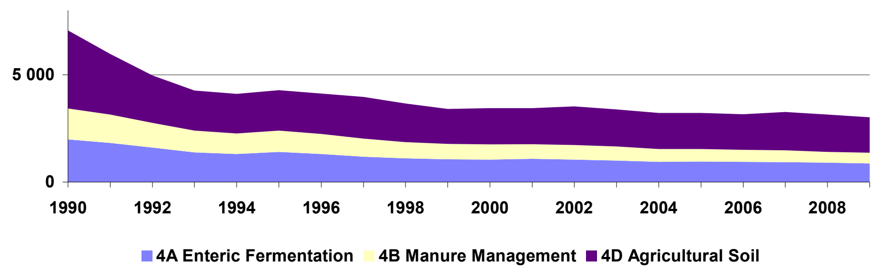
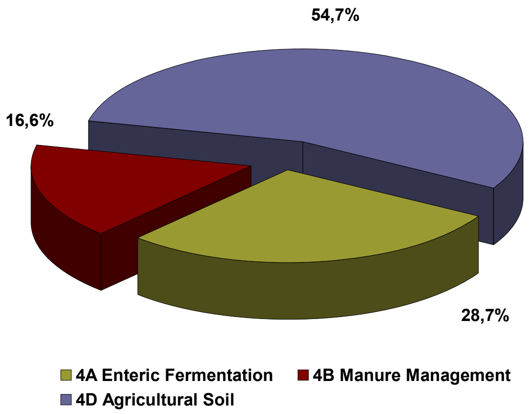


Figure 6.2: The share of aggregated emissions by categories within agriculture sector in 2009



Category	CO_2 Eq. (Gg)	Share (%)
4A Enteric Fermentation	865 261,71	28,66%
4B Manure Management	501 813,17	16,62%
4D Agricultural Soil	1 651 537,60	54,71%

6.2 Enteric fermentation (CRF 4.A)

6.2.1 Source category description

Among all domestic livestock the cattle is the most important producer of methane due to its digestive tract, weight and a relatively high number compared with other population of livestock in the Slovak

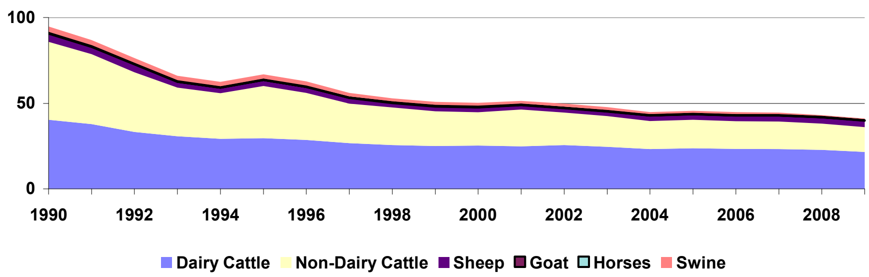
Republic. Therefore, the trends in total CH_4 emissions reflect a number of animals in this category. The number of dairy cows as well as other cattle has decreased by more than a half during the evaluated period. Except for domestic livestock category the amount of emitted methane is influenced by some parameters within the category such as the age or the weight of animals, the amount of food and its quality and the consumption of energy for basal metabolisms.

Methane emissions from enteric fermentation are dominant emissions from animal husbandry and from agriculture at all. The cattle produce more than 90% of these emissions and dairy cattle give nearly half of emissions in the category. Less than 10% of emissions are produced by other categories of domestic livestock. An intensification of animal husbandry increased also methane emissions to the level of 100 kg CH_4 per head and per year. On the other hand, a higher efficiency leads to the decrease in the number of dairy cattle and consequently to the decrease in total methane emissions from this category. Methane emissions from enteric fermentation of dairy and non-dairy cattle are key source categories according to level and trend assessment for the base year and for 2009. Total methane emissions from enteric fermentation decreased from 94.77 Gg in 1990 to 41.20 Gg in 2009, what is the decrease by more than 56% and by 4% compared to the previous year. According to the projections, in 2015, a decreasing number of dairy cattle (calculated according to milk productivity and limits of milk production for the Slovak Republic) and a number of sheep and goats will reduce the emissions from this source to 39.7 Gg per year what is less than one third of emissions of 1990. From the following Figures is visible that the diary and non-dairy cattle are the key categories within the enteric fermentation.

Table 6.2: Methane emissions from enteric fermentation according to the livestock in 1990 – 2009

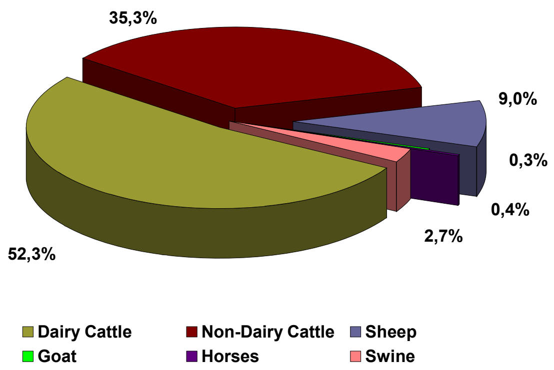
Category 4A Enteric Fermentation - CH_4 (Gg)						
	Dairy Cattle	Non-Dairy Cattle	Sheep	Goat	Horses	Swine
1990	40,368	45,443	4,800	0,1250	0,2520	3,7815
1991	37,832	40,811	4,248	0,1250	0,2340	3,6420
1992	33,245	34,849	4,576	0,1250	0,2160	3,4035
1993	30,678	28,537	3,288	0,1250	0,1980	3,2685
1994	29,243	26,594	3,176	0,1250	0,1980	3,0555
1995	29,638	30,420	3,423	0,1250	0,1820	3,1146
1996	28,650	27,390	3,351	0,1305	0,1750	2,9778
1997	26,746	22,991	3,339	0,1339	0,1716	2,7148
1998	25,648	21,842	2,610	0,2545	0,1719	2,3889
1999	25,041	20,248	2,723	0,2554	0,1682	2,3432
2000	25,343	19,375	2,784	0,2571	0,1713	2,2327
2001	24,883	21,409	2,530	0,2019	0,1419	2,2759
2002	25,613	18,963	2,528	0,2010	0,1462	2,3308
2003	24,529	18,005	2,604	0,1961	0,1461	2,1645
2004	23,216	16,368	3,196	0,1951	0,1478	1,7239
2005	23,642	16,690	3,188	0,1978	0,1499	1,6624
2006	23,328	16,221	3,247	0,1918	0,1480	1,6572
2007	23,236	16,144	3,373	0,1894	0,1443	1,4280
2008	22,861	15,274	3,537	0,1854	0,1516	1,1228
2009	21,550	14,536	3,697	0,1793	0,1296	1,1113

Figure 6.3: Trend in methane emissions (Gg) by categories within enteric fermentation in 1990 – 2009



Dairy and non-dairy cattle methane emissions represent the major share of enteric fermentation emissions (52% and 35%). Almost 9% belongs to sheep methane emissions. These sources are significant and key sources in enteric fermentation category and are estimated by tier 2 methodology. Other not so significant animal categories are estimated with tier 1 methodology.

Figure 6.4: The share of aggregated emissions by categories within enteric fermentation in 2009



Category	CO_2 eq. (Gg)	Share (%)
Dairy Cattle	452,55	52,30%
Non-Dairy Cattle	305,25	35,28%
Sheep	77,63	8,97%
Goat	3,77	0,44%
Horses	2,72	0,31%
Swine	23,34	2,70%

6.2.2 Methodological issues – methods

The Slovak Republic used a methodology based on national data about animal number in detailed categories (for other non-dairy cattle) and more advanced characteristic about feed and milk conditions for category dairy cattle and sheep. Detailed input data are available from 1997 up to the present. The datasets are published in the Green Reports of the Slovak Republic (www.land.gov.sk) and verified by district offices of statistical farm information (bottom-up approach). Methane emissions from enteric fermentation for dairy cattle, non-dairy cattle and sheep are based on tier 2 approach (sheep since 2004). The bottom-up regional input data about the number of animals, feeding situation, weight, milk production, average gross energy intake and other information are available since 1997. The time series 1990 – 1996 was evaluated with the extrapolation methodology for dairy and non-dairy cattle. The complete time series is consistent with the recommendations of the IPCC 2000 GPG. Tier 1 methodology is used for goat, horses and swine because these categories are not key sources.

6.2.3 Methodological issues – emission factors and other parameters

Emission factors for dairy cattle, non-dairy cattle and sheep were estimated on the bases of milk production, average gross energy intake and they are specific for the Slovak Republic. Methane emissions from enteric fermentation of dairy cattle reflect milk production from 1997. For the estimation of emission factor for methane emissions from enteric fermentation of dairy and non-dairy cattle, the extrapolation, linear function was used back to the base year 1990. The time series of EFs is based on average gross energy intake (AGEI) and detailed analysis of cattle categories. Direct activity data are available from the national statistics since 1990. Other input parameters such as milk production, fat of milk (3.77%) average gross energy intake and detailed population statistics according to the age of cattle are available since 1997 in regional disaggregation form (from eight districts). The time series back to the base year was completed by extrapolation method from 1997 back to 1990. The average methane conversion rate was 6% for cattle (dairy and non-dairy) and 7% for sheep for the time series 1990 – 2009. Average weight was 550 kg for cattle (dairy and non-dairy) and 54.2 kg for sheep in 2009. The average digestibility of feed was 60% for cattle and sheep and constant in time series. The average pregnancy for dairy cattle was 90% and constant in time series. AGEI for sheep is constant value (23.14 kg/head/day) and constant value for milk yield is 0.12 kg per head per day for sheep category (Table 6.3). Emission factor for dairy cattle was decreased reflecting the decrease in milk yield in 2009 (Table 6.4).

Table 6.3: Activity data and methane emissions for dairy cattle in 1990 – 2009

Activity Data for Dairy Cattle in Enteric Fermentation					
	Population in 1 000 head	Milk in kg/day	AGEI in MJ/head/day	EF in kg/head/year	CH_4 Emissions in Gg
1990	549,000	6,340	211,117	73,530	40,3681
1991	501,000	6,860	216,771	75,512	37,8315
1992	429,000	7,380	222,424	77,494	33,2448
1993	386,000	7,910	228,078	79,476	30,6776
1994	359,000	8,430	233,732	81,457	29,2432
1995	355,200	8,950	239,386	83,439	29,6376
1996	335,400	9,480	245,040	85,421	28,6502
1997	309,742	9,650	246,935	86,350	26,7461
1998	284,165	10,650	258,983	90,256	25,6475
1999	274,065	10,940	262,219	91,370	25,0414
2000	271,184	11,990	266,456	93,453	25,3430
2001	259,269	12,430	274,997	95,975	24,8834
2002	259,873	13,070	282,506	98,559	25,6129
2003	245,802	13,320	286,210	99,793	24,5294
2004	231,874	13,450	286,093	100,122	23,2157
2005	229,607	14,240	295,402	102,969	23,6424
2006	218,653	15,604	306,598	106,691	23,3284
2007	215,659	16,300	304,373	107,742	23,2355
2008	211,185	16,500	304,373	108,250	22,8609
2009	204,133	15,800	303,777	105,569	21,5501

Table 6.4: The overview of used country specific parameters for dairy cattle in 2009

Activity Data	Population in head	Milk in litre/day	Milk in kg/day	Energy MJ/head/day	EF in kg/head/year	CH_4 in tons
District						
Bratislava	6 464	20,094	19,70	341,28	134,30	781,32
Trnava	30 425	19,584	19,20	336,26	132,33	3 623,49
Trencin	18 973	17,646	17,30	317,20	124,83	2 131,50
Nitra	27 016	19,074	18,70	331,24	130,35	3 169,49
Zilina	30 930	13,566	13,30	277,06	109,03	3 035,15
Banska Bystrica	32 108	13,260	13,00	274,05	107,85	3 116,51
Presov	38 291	13,362	13,10	275,06	108,24	3 730,26
Kosice	19 926	13,668	13,40	278,07	109,43	1 962,41
Total SR	**204 133**	**16,830**	**15,80**	**303,78**	**105,57**	**21 550,13**

Total methane emissions from enteric fermentation of non-dairy cattle were estimated based on detailed classification of animals to the following categories: young males, young females (0-8 M, 8M-1yr), males, females (1-2 yr), fattening cattle and bulls. The country specific EFs are estimated annually as an average based on AGEI and other parameters specific for each category (Table 6.5).

Total methane emissions from enteric fermentation of sheep were estimated on the basis of detailed classification of animals to three categories: ewes, lambs and other sheep. The country specific data are available since 2004. The emission factors are calculated as weight average from these three categories based on gross energy intake, milk productivity, average methane conversion rate and other country specific information (Table 6.5).

Emission factors for goats, horses and swine in enteric fermentation are constant default parameters based on IPCC 2000 GPG. EF for goats is 5 kg/head/year (default value), emission factor for horses is 18 kg/head/year (default value) and emission factor for category swine is 1.5 kg/head/year (Table 6.6).

Table 6.5: Activity data and methane emissions for non-dairy cattle and sheep in 1990 – 2009

	Activity Data for Non-Dairy Cattle in Enteric Fermentation				Activity Data for Sheep in Enteric Fermentation		
	Population in 1 000 head	AGEI in MJ/head/day	EF in kg/head/year	CH_4 Emissions in Gg	Population in 1 000 head	EF in kg/head/year	CH_4 Emissions in Gg
1990	1 014,000	122,035	44,816	45,443	600,000	8,000	4,800
1991	896,000	123,049	45,548	40,811	531,000	8,000	4,248
1992	753,000	124,063	46,280	34,849	572,000	8,000	4,576
1993	607,000	125,077	47,013	28,537	411,000	8,000	3,288
1994	557,000	126,092	47,745	26,594	397,000	8,000	3,176
1995	627,500	127,106	48,478	30,420	427,844	8,000	3,423
1996	556,600	128,120	49,210	27,390	418,823	8,000	3,351
1997	493,656	131,395	46,573	22,991	417,337	8,000	3,339
1998	420,627	130,198	51,927	21,842	326,199	8,000	2,610
1999	390,990	130,198	51,787	20,248	340,346	8,000	2,723
2000	374,964	131,387	51,672	19,375	347,983	8,000	2,784
2001	365,921	133,647	58,507	21,409	316,302	8,000	2,530
2002	347,944	130,906	54,501	18,963	316,028	8,000	2,528
2003	347,380	135,861	51,831	18,005	325,521	8,000	2,604
2004	308,272	134,317	53,095	16,368	321,227	9,950	3,196
2005	298,282	140,808	55,953	16,690	320,487	9,948	3,188
2006	289,167	140,808	56,095	16,221	332,571	9,764	3,247
2007	286,158	141,266	56,416	16,144	347,179	9,716	3,373
2008	277,252	139,326	55,091	15,274	361,634	9,780	3,537
2009	267,834	139,143	54,272	14,536	376,978	9,807	3,697

Table 6.6: Activity data and methane emissions for other animal in 1990 – 2009

	Goat		Horses		Swine		
	Population in head	CH_4 in Gg	Population in head	CH_4 in Gg	Population in head	CH_4 in Gg	EF in kg/head/year
1990	25,000	0,125	14,000	0,252	2 035	3,782	1,858
1991	25,000	0,125	13,000	0,234	1 942	3,642	1,875
1992	25,000	0,125	12,000	0,216	1 799	3,404	1,892
1993	25,000	0,125	11,000	0,198	1 731	3,269	1,888
1994	25,000	0,125	11,000	0,198	1 613	3,056	1,894
1995	25,000	0,125	10,109	0,182	1 644	3,115	1,894
1996	26,100	0,131	9,722	0,175	1 575	2,978	1,891
1997	26,778	0,134	9,533	0,172	1 435	2,715	1,892
1998	50,905	0,255	9,550	0,172	1 220	2,389	1,958
1999	51,075	0,255	9,342	0,168	1 192	2,343	1,966
2000	51,419	0,257	9,516	0,171	1 099	2,233	2,031
2001	40,386	0,202	7,883	0,142	1 116	2,276	2,040
2002	40,194	0,201	8,122	0,146	1 237	2,331	1,884
2003	39,225	0,196	8,114	0,146	1 184	2,165	1,828
2004	39,012	0,195	8,209	0,148	1 149	1,724	1,500
2005	39,566	0,198	8,328	0,150	1 045	1,662	1,591
2006	38,352	0,192	8,222	0,148	1 105	1,657	1,500
2007	37,873	0,189	8,017	0,144	952	1,428	1,500
2008	37,088	0,185	8,421	0,152	749	1,123	1,500
2009	35,866	0,179	7,199	0,130	741	1,111	1,500

6.2.4 Activity data

The Slovak Agricultural University in Nitra, namely Dr. B. Šiška has taken responsibility for inventory of emissions from agriculture sector. Methodology used also the results of research institutions sharing nitrogen fluxes in the conditions of the Slovak Republic. Basic sources of data used for the evaluations of emissions were published in:

- Census of sowing areas of field crops in the Slovak Republic.
- Annual census of domestic livestock in the Slovak Republic.
- Green report of the Slovak Republic 1998 – 2010, the Ministry of Agriculture of the Slovak Republic.
- Statistical Yearbook 1990 – 2010, the Statistical Office of the Slovak Republic.

Activity data for dairy, non-dairy cattle and sheep used for tier 2 methodology are based on bottom-up statistical information at district level. The aggregation of input parameters is performed as weighted average. Detailed information on cattle has been available since 1997 and on sheep since 2004. The time series have been reconstructed by the extrapolation since 1990. Activity data used for methane emission estimation of dairy cattle are summarized in Table 6.4. Detailed statistical information is available at the district level and emissions are estimated by bottom-up tier 2 methodology.

Activity data for non-dairy cattle are available for detailed animal categories (Table 6.7) such as young male (below 6 months, 6 m – 1 year), young female (below 6 months, 6 m – 1 year), males (1-2 years), females (1-2 years), fattening cattle (males, females) and bulls.

Table 6.7: The overview of used country specific parameters for non-dairy cattle in 2009

Activity Data	Population in head	*from total Bulls*	*from total Fattening*	*from total Young*	Energy MJ/head/day	EF in kg/head/year	CH_4 in tons
District					*average*	*average*	
Bratislava	6 949	18	559	6 372	136,20	53,60	386,69
Trnava	48 954	29	4 318	44 607	166,76	65,62	3 282,30
Trencin	25 847	59	2 717	23 071	152,96	60,19	1 538,62
Nitra	40 975	65	3 625	37 285	136,70	53,80	2 109,48
Zilina	35 037	102	6 046	28 889	121,18	47,69	1 598,26
Banska Bystrica	43 335	195	7 573	35 567	135,83	53,45	2 278,62
Presov	41 634	235	6 510	34 889	134,07	52,76	2 110,19
Kosice	25 103	153	4 343	20 607	129,45	50,94	1 231,60
Total SR	**267 834**	***856***	***35 691***	***231 287***	**139,14**	**54,27**	**14 535,76**

Activity data for sheep are available for detailed categories (Table 6.8) such as ram, lambs and ewes.

Table 6.8: The overview of used country specific parameters for sheep in 2009

Activity Data	Population in head	Milk in litre/day	Milk in kg/day	Energy MJ/head/day	EF in kg/head/year	CH_4 in tons
District				*average*	*average*	
Bratislava	438	0,122	0,120	23,14	10,23	4,48
Trnava	2 341	0,122	0,120	23,14	9,60	22,47
Trencin	31 871	0,122	0,120	23,14	9,79	312,13
Nitra	10 077	0,122	0,120	23,14	9,27	93,45
Zilina	81 900	0,122	0,120	23,14	9,86	807,87
Banska Bystrica	126 315	0,122	0,120	23,14	9,83	1 241,46
Presov	80 479	0,122	0,120	23,14	9,85	792,41
Kosice	43 557	0,122	0,120	23,14	9,70	422,56
Total SR	**376 978**	**0,122**	**0,120**	**23,14**	**9,81**	**3 696,84**

6.2.5 Uncertainties and time-series consistency

Data on number of domestic livestock according to categories and amount of applied fertilizers are required either for the calculation of GHG or ammonia emissions. Basic sources of the data used for the evaluations of emissions in this study were published in:

- Green Report of the Slovak Republic.
- Statistical Yearbook of the Slovak Republic.

Data published in the Green Report of the Slovak Republic, as well as in the Statistical Yearbook can differ slightly, especially if the number of animals in some category is very low. Round up or down if the numbers of domestic livestock are given in thousands of head can cause differences up to 3%. However, the differences are not of high importance. Subcategories of domestic livestock can be estimated according to Annual census of domestic livestock in the Slovak Republic. Data from this publication are issued relatively soon after the end of previous year but many times they are different in comparison with data from Green Report or Statistical Yearbook. The productivity of different categories of domestic livestock varies in conditions of the Slovak Republic significantly depending upon the scale and production level of a farm. Tier 1 uncertainty was included in total assessment. Time series consistency is ensured.

6.2.6 Source specific QA/QC and verification

Prof. Bernard Šiška (Agricultural university Nitra) as the sectoral expert for agriculture assigned by the Emissions Department SHMÚ as SNE and the Ministry of Environment of the Slovak Republic as NFP by the letter under the National Inventory System, has signed the agreement with the Slovak Hydrometeorological Institute on January 2009 on preparing report evaluating GHG emissions from agriculture sector in 2009.

The principal source of all agricultural sector data used for GHG emission estimations is based on official numbers published by the Statistical Office of the Slovak Republic and official information from the Ministry of Agriculture of the Slovak Republic (Green Reports).

The information used for the preparation of this report is archived by the author and by SNE.

6.2.7 Source specific recalculations

No recalculations in the submission 2011 focused on the base year 1990 or the other inventory years were provided.

6.2.8 Source specific planned improvements

Several important methodological changes were occurred during last inventory submission in enteric fermentation. The recalculation was based by using tier 2 methodology for the estimation of methane emissions. The data provided by regional statistics are more precise and detailed. The estimations were recalculated since 1997. The time series were calculated back to the base year using linear regression and expert judgment for cattle. Productivity of different categories of domestic livestock varies in the conditions of the Slovak Republic significantly depending upon the scale and production level of farm. The recalculation of the sheep time series before 2004 is planned for the next submission based on existing regional data for recent years.

6.3 Manure management (CRF 4.B(a)) – CH_4 emissions

6.3.1 Source category description

Methane can be emitted also in anaerobic conditions due to the decomposition of manure. These conditions can be found especially in large-scale farms (farms for dairy cattle, fattening pigs, poultry).

Methane emissions from manure management are the emissions depending on animal husbandry and the number of animals. In future a higher part of total methane emission will create emissions from animal excreta that are much easier to manage, e.g. by proper storage, than the emission from enteric fermentation. Methane emissions from manure management of dairy and non-dairy cattle are not key source categories according level or trend assessment for the base year and for 2009.

Methane emissions from this source decreased from 17.56 Gg in 1990 to 5.94 Gg in 2009. CH_4 emissions from manure management in category manure management decreased due to decrease in livestock number of all categories except for poultry. Extreme decrease of animals was recorded in swine due to economical reason (low prices of meat on the market) during recent years what consequently influenced methane emissions from manure management. Emissions decreased by more than 66% in this category, however swine stay key source. Next decrease is supposed also for the future. Methane emissions can drop by about 10% up to year 2015 because of continuing decrease in cattle population.

Table 6.9: Methane emissions from manure management according to the animals in 1990 – 2009

	Category 4B Manure Management - CH_4 (Gg)						
	Dairy Cattle	Non-Dairy Cattle	Sheep	Goat	Horses	Swine	Poultry
1990	2,196	3,853	0,114	0,0030	0,0196	10,0840	1,2853
1991	2,004	3,405	0,101	0,0030	0,0182	9,7120	1,0815
1992	1,716	2,861	0,109	0,0030	0,0168	9,0760	1,0348
1993	1,544	2,307	0,078	0,0030	0,0154	8,7160	0,9543
1994	1,436	2,117	0,075	0,0030	0,0154	8,1480	1,1112
1995	1,421	2,385	0,081	0,0030	0,0142	8,3056	1,0438
1996	1,342	2,115	0,080	0,0031	0,0136	7,9408	1,1035
1997	1,239	1,876	0,079	0,0032	0,0133	7,2395	1,1093
1998	1,137	1,598	0,062	0,0061	0,0134	6,3704	1,0231
1999	1,096	1,486	0,065	0,0061	0,0131	6,2484	0,9553
2000	1,085	1,425	0,066	0,0062	0,0133	5,9538	0,9708
2001	1,037	1,390	0,060	0,0048	0,0110	6,0691	1,0617
2002	1,039	1,322	0,060	0,0048	0,0114	6,2155	1,0888
2003	0,983	1,320	0,062	0,0047	0,0114	5,7721	1,1089
2004	0,927	1,171	0,061	0,0047	0,0115	4,5971	1,0696
2005	0,918	1,133	0,061	0,0047	0,0117	4,4331	1,0986
2006	0,875	1,099	0,063	0,0046	0,0115	4,4193	1,0170
2007	0,863	1,087	0,066	0,0045	0,0112	3,8080	1,0050
2008	0,845	1,054	0,069	0,0045	0,0118	2,9941	0,8758
2009	0,817	1,018	0,072	0,0043	0,0101	2,9634	1,0595

Figure 6.5 shows the decrease in swine and non-dairy cattle methane emissions from manure management category.

Figure 6.5: Trend in CH_4 emissions (in Gg) by categories within manure management in 1990 – 2009

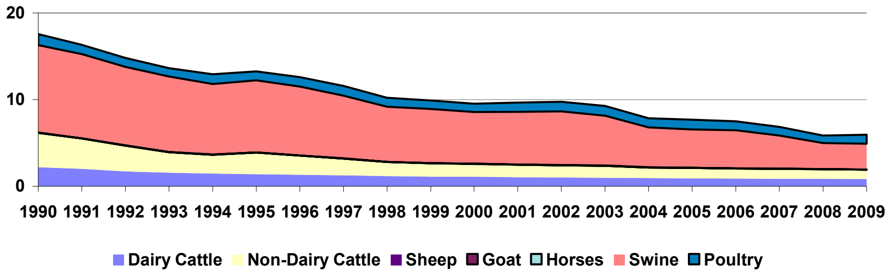
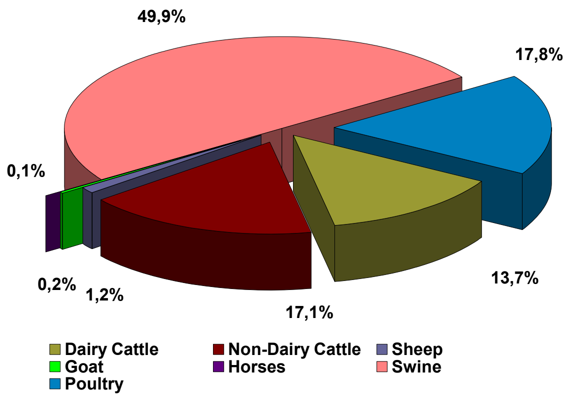


Figure 6.6 shows the share of individual categories in the production of manure methane emissions. The share of swine category is 50% which is in compliance with the methodology.

Figure 6.6: The share of aggregated emissions by categories within manure management in 2009



Category	CH_4 (Gg)	Share (%)
Dairy Cattle	0,8165	13,74%
Non-Dairy Cattle	1,0178	17,12%
Sheep	0,0716	1,21%
Goat	0,0043	0,07%
Horses	0,0101	0,17%
Swine	2,9634	49,86%
Poultry	1,0595	17,83%

6.3.2 Methodological issues – methods

The methodology based on the national data was evaluated for the estimation of methane emission in manure management. The national approach is based on the number of animals per regions, the calculation of volatile solid excretion (VS) and methane conversion factor (MCF) as inputs to the formula for the estimation of national EFs. This approach will be used in the next submission. The methodology used for the estimation in manure management is based on tier 1 IPCC methodology using the country specific parameters and activity data.

6.3.3 Methodological issues – emission factors and other parameters

Methane emissions from manure management are base on country specific emission factors used constantly during time series. Table 6.10 shows emission factors for different animal categories.

Table 6.10: EF for methane emissions in manure management in 2009

Category	EF CH_4 (Gg)
Dairy Cattle	4,000
Non-Dairy Cattle	3,800
Sheep	0,190
Goat	0,120
Horses	1,400
Swine	4,000
Poultry	0,078

6.3.4 Activity data

Decreasing number of domestic livestock, especially in categories pigs (as mentioned above) and dairy cows, produce lower amount of nitrogen. The number of animals in category dairy cows starts to be limited by milk quotation. The input of nitrogen from manure management was 0.87 Gg in 2009. The number of animals was consistent with the number of animals from enteric fermentation and the figures were provided by regional statistics at district level. Swine category is divided into four subcategories (sows, sows up to 50 kg, young sows over 50 kg and fattening pigs), poultry category is divided into ducks & turkey, laying hens and broilers categories.

6.3.5 Uncertainties and time-series consistency

Tier 1 uncertainty was included in total assessment. Time series consistency is ensured.

6.3.6 Source specific QA/QC and verification

See section 6.2.6 for source specific verification and QA/QC.

6.3.7 Source specific recalculations

No recalculations in the submission 2011 focused on the base year 1990 or the other inventory years were provided.

6.3.8 Source specific planned improvements

Methane emissions from manure management are not key source by level or trend assessment, the improvements in emission factors are planned, but it is not a high priority.

6.4 Manure management (CRF 4.B(b)) – N_2O emissions

6.4.1 Source category description

Because domestic livestock produce different kinds of nitrogen inputs (liquid or dry) into the ecosystem also the structure of domestic livestock is important (the ratio of different categories of domestic livestock) from the point of view of direct emissions as well as the emissions from AWMS. Except for it, the production of nitrogen per head per year also plays certain role. The production of nitrogen in category cattle is 90 kg per head per year and for dairy cows with milk productivity higher than 4 500 l is 100 kg N per head per year (CORINAIR, 2003). Some differences are also in category other cattle, where for intensive animal husbandry the higher production of nitrogen (60 kg N pre head per year instead of 56 kg N per head per year) was used. Direct measurements of nitrogen produced by domestic livestock in the Czech Republic showed that real amounts could be much higher than the values of produced nitrogen recommended in methodologies what influenced directly also N_2O emissions. The applied animal fertilizers lost the definite amount of nitrogen by volatilization and N-NO_x conversion. This amount is 20% for animal fertilizers, what means that only 80% of total amount applied synthetic fertilizers remains for the conversion of N to N_2O. Solid and liquid systems are the most often form for the storage of excreta in manure management (especially sows and pigs) in the Slovak Republic. The pasture range in some periods of year (200 days per year on average) is a characteristic management system for sheep, horses and goats. Input of nitrogen oxide from manure management was 1.216 Gg of N_2O in 2009 and total decrease was about 65% compared to the base year.

Table 6.11: N_2O and N emissions in manure management according to the animal categories and AWMS in 1990 – 2009

Category 4B Manure Management										
	N_2O (Gg)			N - Excretion (kt)						
	Liquid System	Solid Storage and Dry Lot	Total	Dairy Cattle	Non-Dairy Cattle	Sheep	Goat	Horses	Swine	Poultry
1990	0,063	3,402	**3,4655**	54,900	60,840	9,600	0,400	0,350	33,055	12,229
1991	0,058	3,087	**3,1445**	50,100	53,760	8,496	0,400	0,325	31,747	10,641
1992	0,054	2,650	**2,7044**	42,900	45,180	9,152	0,400	0,300	29,591	9,966
1993	0,050	2,293	**2,3433**	38,600	36,420	6,576	0,400	0,275	28,432	9,447
1994	0,049	2,140	**2,1887**	35,900	33,420	6,352	0,400	0,275	26,555	10,685
1995	0,049	2,258	**2,3066**	35,520	37,650	6,846	0,400	0,253	27,069	10,286
1996	0,048	2,079	**2,1273**	33,540	33,396	6,701	0,418	0,243	25,893	10,561
1997	0,045	1,904	**1,9486**	30,974	29,619	6,677	0,428	0,238	23,602	10,662
1998	0,040	1,678	**1,7177**	28,417	25,238	5,219	0,814	0,239	20,558	9,831
1999	0,038	1,598	**1,6363**	27,407	23,459	5,446	0,817	0,234	20,139	9,217
2000	0,037	1,565	**1,6012**	27,118	22,498	5,568	0,823	0,238	18,725	9,365
2001	0,038	1,510	**1,5483**	25,927	21,955	5,061	0,646	0,197	18,918	10,062
2002	0,040	1,492	**1,5317**	25,987	20,878	5,056	0,643	0,203	20,291	10,346
2003	0,039	1,449	**1,4877**	24,580	20,843	5,208	0,628	0,203	19,265	10,484
2004	0,037	1,349	**1,3861**	23,187	18,496	5,140	0,624	0,205	18,594	10,160
2005	0,036	1,304	**1,3395**	22,961	17,897	5,128	0,633	0,208	16,863	10,296
2006	0,036	1,273	**1,3095**	21,865	17,350	5,321	0,614	0,206	17,777	9,793
2007	0,032	1,252	**1,2845**	21,566	17,169	5,555	0,606	0,200	15,196	9,721
2008	0,026	1,213	**1,2391**	21,119	16,635	5,786	0,593	0,211	11,725	8,367
2009	0,028	1,188	**1,2161**	20,413	16,070	6,032	0,574	0,180	11,722	9,868

Figure 6.7: Trend in nitrogen excretion (kt) by categories within manure management in 1990 – 2009

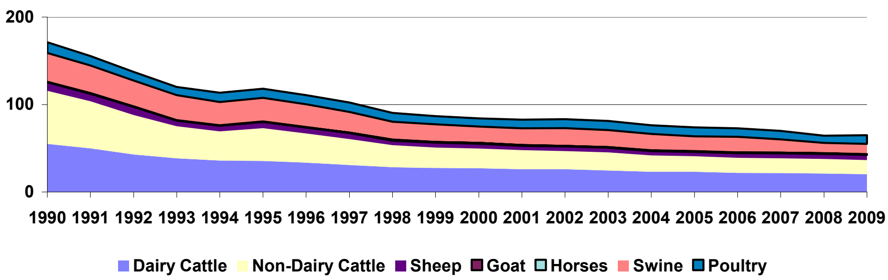
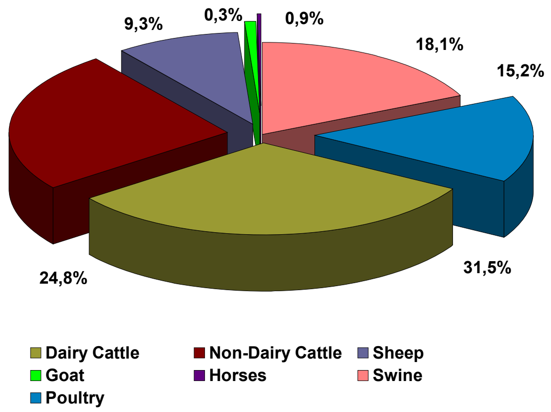


Figure 6.8: The share of aggregated emissions by categories within manure management in 2009



Category	N (kt per year)	Share (%)
Dairy Cattle	20,413	31,47%
Non-Dairy Cattle	16,070	24,78%
Sheep	6,032	9,30%
Goat	0,574	0,88%
Horses	0,180	0,28%
Swine	11,722	18,07%
Poultry	9,868	15,21%

6.4.2 Methodological issues – methods

Information on animal housing, pasture and production of manures and slurries was collected on the base of questioners published in national papers. Some additional information was based on expert estimation. Duration of pasture is limited by climatic conditions. According to the IPCC methodology the Animal Waste Management Systems (AWMS) were recognized for evaluation in the Slovak Republic as follows:

- Liquid system,
- Solid storage and dry lot,
- Pasture range and paddock.

Solid storage of manure was found as the most frequent AMWS in the conditions of the Slovak Republic. Liquid storage of slurries is also frequently used especially in category pigs. Housing on grasslands since April to October is frequent for sheep, goats and horses. The methodology used for the estimation of manure management is based on tier 2 IPCC methodology using country specific parameters and activity data.

6.4.3 Methodological issues – emission factors and other parameters

N_2O emissions from AWMS were based on the analysis of housing systems at the territory of the Slovak Republic that was made the Research Institute of Animal Production in Nitra. It is supposed that sheep, goats and horses can stay on pasture 200 days a year, 40% of dairy cattle only 150 days especially in mountainous regions. During winter period sheep and goats produce 9% of waste as slurry and 91% as manure (Brestenský et al., 1998).

Table 6.12: N production (kg/head/year) for different domestic livestock and share in AWMS in 2009

Category	N	Liquid System	Solid System	Pasture
	kg/head/year		*Share (%)*	
Dairy Cattle	100	5,00%	0,75%	0,20%
Non-Dairy Cattle	60	0,05%	0,85%	0,10%
Sheep	16	0,04%	0,41%	0,55%
Horses	25	0,00%	0,45%	0,55%
Sows	36	41,60%	58,40%	0,00%
Sows up to 50 kg	15	91,00%	9,00%	0,00%
Young Sows over 50 kg	16	41,60%	58,40%	0,00%
Fattening pigs	14	91,00%	9,00%	0,00%
Laying hens	1	2,20%	97,80%	0,00%
Broilers	1	98,20%	1,80%	0,00%
Turkeys and Ducks	2	100,00%	0,00%	0,00%
Goats	16	4,00%	41,00%	55,00%

Allocation according to the climate condition is 100% for cool climate for all animals based on IPCC methodology. Methane conversion factor is 1.

6.4.4 Activity data

Some trends in the use of animal housing and consequently animal waste management system can be seen. The Ministry of Agriculture of the Slovak Republic is the second source of data on animal housing, pasture and production of manures and slurries. Figures are given in the table below as the alternative source of data for the calculation of emissions. Therefore the calculations were done in two variants.

6.4.5 Uncertainties and time-series consistency

Trends of total N_2O emissions from agriculture sector reflect the trends of direct emissions from cultivated soils, emissions from AWMS and indirect emission from leaching and deposition of ammonia and NO_x. Tier 1 uncertainty was included in total assessment. Time series consistency is ensured. The productivity of different categories of domestic livestock varies significantly in the conditions of the Slovak Republic depending on the scale and the production level of farms.

In the Slovak Republic, both the extensive and intensive farming system in animal husbandry can be found. Nitrogen production from dairy cows is in the range of 60 – 140 kg per head per year. Nitrogen inputs from animal excreta differ depending on used methodology and therefore two variants of calculation were applied in this study:

- Nitrogen input was calculated for animal categories of domestic livestock according to the IPCC methodology: cattle (dairy cattle – 90 kg of N per head and others with the production of 56 N per head), pigs, sheep, goats, horses and poultry.
- More detailed figures for the calculation of NH_3 emissions were used, when the categories of domestic livestock were separated according to the weight to subcategories and the production of 100 kg N per year for dairy cattle and 60 kg N for other cattle was supposed.

Nitrogen inputs can differ from the calculations in range ±10%. Towards the future, this mistake should be lower because the level of animal husbandry can be concentrated to a relatively smaller number of producers and so it can be much easier to define production level of farms. Dry storage of animal excreta is the most frequent way of AWMS, especially in category cattle.

6.4.6 Source specific QA/QC and verification

See section 6.2.6 for the source specific verification and QA/QC.

6.4.7 Source specific recalculations

Harmonisation of the N_2O emissions within the liquid and solid animal waste systems was provided based on total nitrogen excreted by animals. The total nitrogen excreted by animal categories didn’t change. The recalculation led to increasing of emissions and corrections of emission factors.

6.4.8 Source specific planned improvements

Tier 2 methodology and national N-excretion values are planned to be improve in the next submission.

Table 6.13: Recalculations of N_2O emissions in solid and liquid AWMS in 1990 – 2008

	Submission 2010			Submission 2011			2011/2010		
	Liquid System	Solid Storage and Dry Lot	Total N_2O (Gg)	Liquid System	Solid Storage and Dry Lot	Total N_2O (Gg)	Difference 2011/2010		
1990	0,063	3,402	**3,4655**	0,060	3,471	**3,5308**	94,58%	102,02%	**101,88%**
1991	0,058	3,087	**3,1445**	0,055	3,149	**3,2036**	94,62%	102,01%	**101,88%**
1992	0,054	2,650	**2,7044**	0,051	2,712	**2,7631**	94,33%	102,33%	**102,17%**
1993	0,050	2,293	**2,3433**	0,047	2,349	**2,3963**	94,43%	102,43%	**102,26%**
1994	0,049	2,140	**2,1887**	0,046	2,198	**2,2441**	94,04%	102,72%	**102,53%**
1995	0,049	2,258	**2,3066**	0,046	2,312	**2,3587**	94,40%	102,43%	**102,26%**
1996	0,048	2,079	**2,1273**	0,045	2,137	**2,1818**	94,02%	102,76%	**102,56%**
1997	0,045	1,904	**1,9486**	0,042	1,956	**1,9985**	94,13%	102,75%	**102,56%**
1998	0,040	1,678	**1,7177**	0,037	1,727	**1,7646**	93,78%	102,94%	**102,73%**
1999	0,038	1,598	**1,6363**	0,036	1,646	**1,6817**	93,79%	102,99%	**102,77%**
2000	0,037	1,565	**1,6012**	0,034	1,611	**1,6447**	93,48%	102,93%	**102,71%**
2001	0,038	1,510	**1,5483**	0,035	1,559	**1,5942**	93,61%	103,20%	**102,97%**
2002	0,040	1,492	**1,5317**	0,038	1,538	**1,5754**	94,23%	103,09%	**102,86%**
2003	0,039	1,449	**1,4877**	0,037	1,492	**1,5287**	94,46%	102,98%	**102,76%**
2004	0,037	1,349	**1,3861**	0,035	1,391	**1,4261**	94,36%	103,12%	**102,88%**
2005	0,036	1,304	**1,3395**	0,036	1,341	**1,3765**	98,96%	102,86%	**102,76%**
2006	0,036	1,273	**1,3095**	0,035	1,303	**1,3372**	95,94%	102,30%	**102,12%**
2007	0,032	1,252	**1,2845**	0,031	1,276	**1,3071**	96,34%	101,90%	**101,76%**
2008	0,026	1,213	**1,2391**	0,024	1,237	**1,2614**	95,43%	101,93%	**101,80%**

6.5 Rice Cultivation (CRF 4.C)

No emissions from rise cultivation were estimated in this category because of no rice had been cultivated in the Slovak Republic in 1990 – 2009.

6.6 Agricultural Soils (CRF 4.D)

6.6.1 Source category description

The applied amounts of synthetic fertilizers into cultivated soils have been very low for last 15 years. The potential for the volatilization of ammonia and N_2O emissions can vary in a very large range. The best information on NH_3 emissions from cultivated soils in the Slovak Republic is available on the base of applied nitrogen fertilizers. Emissions also depend on the type of fertilizers, soil parameters (pH), meteorological conditions, time of application in relation to crop development. Applied nitrogen fertilizers were calculated on the base of FAO materials for the Slovak Republic (Bielek, 1998). The selection of emission coefficients reflect climatic and soil condition of the Slovak Republic, when the climate in Central Europe was defined as cool (ECOTEC, 1994) with prevailing acidic soils. ECOTEC coefficients are lower than those published by Assman in 1992 or the coefficients for non-defined climatic conditions (simple methodology). Emissions of ammonia from cultivated soil can be higher by 6–20% depending on used methodology.

N-inputs from symbiotic fixation of leguminous crops in the conditions of the Slovak Republic vary in the range of 20-30 $kg.ha^{-1}$ (Bielek, 1998). 26 $kg\ N.ha^{-1}$ can be accepted as an average value (Vostál at all., cit. in Bielek, 1998). This value varies in the range ±20% from the mean value. The data on the production of nitrogen from the excreta of domestic livestock are influenced by N production of domestic livestock and the number of domestic livestock according to the categories.

The content of nitrogen in crop residuals as well as their decomposition in soil significantly influences the formation of yield in the following years. National methodology for the calculation of nitrogen inputs from crop residuals was used when the nitrogen amount was calculated according to the acreage of field crops and the nitrogen content in different crops (Jurčová, 1998). The yield of field crops can vary in range ±20% from year to year.

Total N_2O emissions from agricultural soils were 5.33 Gg of N_2O. The emissions have been decreasing by 1.5% in comparison with 2008 and by 65% in comparison with the base year. The major reason for the decreasing trend is a sharp decrease in the use of synthetic fertilizers in early 90-ties and the continual decrease in the use of animal manure and the manure from pasture, the range and paddocks which corresponds with the decrease in the number of animals.

Figure 6.9: Trend in nitrogen excretion (kt) by categories within agricultural soils in 1990 – 2009

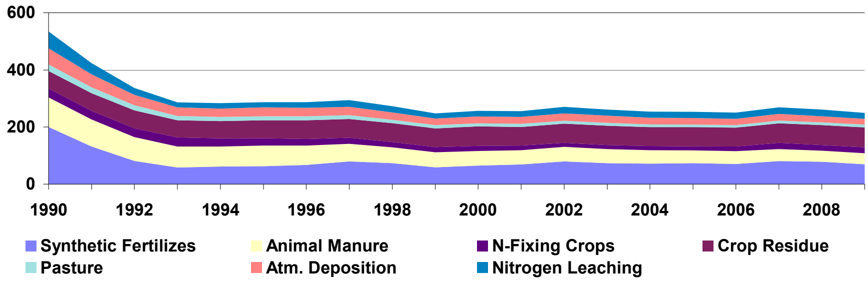
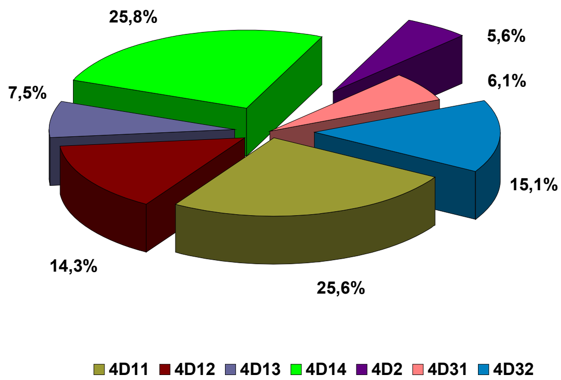


Table 6.14: N_2O emissions from agricultural soils according to the subcategories in 1990 – 2009

Category 4D N_2O (Gg) from Agricultural Soils								
	4D1 Direct Emissions					4D2	4D3 Indirect Emissions	
	4D11 Synthetic Fertilizes	4D12 Animal Manure	4D13 N-Fixing Crops	4D14 Crop Residue	4D15 Cultivation of Histosols	Pasture, Range & Paddocks	4D31 Atmospheric Deposition	4D32 Nitrogen Leaching & Run-off
1990	3,929	2,044	0,620	1,195	NO	0,715	0,888	2,323
1991	2,587	1,856	0,606	1,208	NO	0,643	0,719	1,529
1992	1,594	1,636	0,612	1,230	NO	0,582	0,574	0,942
1993	1,146	1,441	0,634	1,165	NO	0,482	0,480	0,678
1994	1,214	1,364	0,574	1,187	NO	0,452	0,465	0,718
1995	1,230	1,417	0,507	1,231	NO	0,471	0,480	0,727
1996	1,316	1,329	0,464	1,286	NO	0,443	0,465	0,778
1997	1,556	1,224	0,418	1,282	NO	0,415	0,460	0,920
1998	1,447	1,082	0,370	1,294	NO	0,366	0,412	0,855
1999	1,156	1,036	0,353	1,283	NO	0,358	0,375	0,683
2000	1,284	1,004	0,345	1,330	NO	0,356	0,379	0,759
2001	1,344	0,992	0,309	1,292	NO	0,334	0,380	0,795
2002	1,560	1,002	0,287	1,310	NO	0,331	0,401	0,922
2003	1,437	0,975	0,278	1,330	NO	0,324	0,383	0,850
2004	1,413	0,916	0,281	1,314	NO	0,307	0,366	0,835
2005	1,438	0,884	0,278	1,308	NO	0,304	0,360	0,850
2006	1,391	0,872	0,312	1,302	NO	0,298	0,353	0,822
2007	1,572	0,832	0,446	1,339	NO	0,299	0,360	0,929
2008	1,551	0,755	0,379	1,370	NO	0,299	0,340	0,917
2009	1,362	0,762	0,400	1,377	NO	0,296	0,325	0,805

Figure 6.10: The share of aggregated emissions by categories within agricultural soils in 2009



Category	N_2O (Gg)	Share (%)
Synthetic Fertilizes	1,362	25,57%
Animal Manure	0,762	14,31%
N-Fixing Crops	0,400	7,50%
Crop Residue	1,377	25,85%
Pasture	0,296	5,56%
At.Deposition	0,325	6,10%
N Leaching & Run-off	0,805	15,12%

The major share belongs to synthetic fertilizers use (26%) and crop residue (26%). Animal manure use (14%) and nitrogen leaching and run-off (15%) are influenced by manure management and the number of animals.

6.6.2 Source category description – Synthetic fertilizers (CRF 4.D.1.1)

The consumption of synthetic fertilizers decreased during last decade of 20^{th} century, from 222 kt in 1990 to 69 kt in 2009. The synthetic fertilizers were applied on 60.7% of area of arable soils and only on 62.3% of sowing area of cereals in 2009. Especially sugar beet and fodder crops were short of nutrient during the last decade in the conditions of the Slovak agriculture. Despite these facts the consumption of synthetic fertilizers increased slightly in 2006 – 2009 by about 5% compared with 2000. Because of decreasing numbers of domestic livestock in some categories (producing still less nitrogen in wastes), this trend in higher consumption of synthetic fertilizers should continue if the present level of yields of field crops is accepted (Green Report, 2009).

6.6.2.1 Methodological issues – methods

Applied synthetic fertilizers lose the definite amount of nitrogen by volatilization and N–NO_x conversion. This is 10% for synthetic fertilizers, what means that only 90% of total applied synthetic fertilizers remain for the conversion of N to N_2O (69 kt in 2009). Having used the IPCC default emission factor 0.0125 kg N_2O–N / kg N, total emissions of N_2O from using the synthetic fertilizers were 1.36 Gg in 2009. Tier 2 methodology was applied in combination with IPCC default EF and other parameters.

6.6.2.2 Methodological issues – emission factors and other parameters

Nitrogen inputs from applied fertilizers are published annually in the Green Report. The loss by volatilization is 10% and default emission factor 0.0125 kg N_2O-N/kg N was used for the calculation.

Table 6.15: Input parameters and EF in category 4D11 Synthetic fertilizers in 1990 – 2009

Category 4D11 Synthetic Fertilisers				
	N-input in fertilisers (kg/year)	N-input to the soil (kg/year)	EF (kg N_2O-N/kg N)	N_2O Emissions (Gg)
1990	222 255 000	200 029 500	0,0125	3,929
1991	146 341 000	131 706 900	0,0125	2,587
1992	90 186 000	81 167 400	0,0125	1,594
1993	64 852 000	58 366 800	0,0125	1,146
1994	68 669 000	61 802 100	0,0125	1,214
1995	69 587 000	62 628 300	0,0125	1,230
1996	74 464 000	67 017 600	0,0125	1,316
1997	88 016 680	79 215 012	0,0125	1,556
1998	81 842 520	73 658 268	0,0125	1,447
1999	65 392 620	58 853 358	0,0125	1,156
2000	72 653 460	65 388 114	0,0125	1,284
2001	76 031 820	68 428 638	0,0125	1,344
2002	88 259 680	79 433 712	0,0125	1,560
2003	81 299 580	73 169 622	0,0125	1,437
2004	79 910 810	71 919 729	0,0125	1,413
2005	81 316 560	73 184 904	0,0125	1,438
2006	78 681 120	70 813 008	0,0125	1,391
2007	88 935 400	80 041 860	0,0125	1,572
2008	87 736 950	78 963 255	0,0125	1,551
2009	77 058 450	69 352 605	0,0125	1,362

6.6.2.3 Activity data

Activity data are summarized in Table 6.15.

6.6.2.4 Uncertainties and time-series consistency

Tier 1 uncertainty was included in total uncertainty assessment. Time series consistency is ensured.

Uncertainties are defined by emission coefficients. The values can differ from reality within the range from 20 to 200% for direct soil N_2O emissions, from 25 to 150% for N_2O from animal waste management system, from 20 to 200% for indirect N_2O emissions from NH_3 volatilization and from 10 to 500% for indirect N_2O emissions from leaching. Great uncertainties are defined for N_2O and NH_3 emissions (especially from agricultural soils, foliar emissions and decomposition) and therefore presented results should be considered as preliminary. Direct measurements show that ammonia can volatilize in a large range. The values were found within the range of 2 – 20 $kg.ha^{-1}$ in winter wheat crop (Bielek, 1998). Volatilization is influenced by soil parameters, where e.g. haplic fluvisols emit less ammonia in the same climatic conditions than other soils. The highest uncertainties are observed in the case of cultivated soils (soils with fertilizers). More exact data on NH_3 and N_2O emissions from cultivated soils can be reached by modeling e.g. by DNDC model. This kind of model is used at the Department of Biometeorology and Hydrology at the Slovak Agricultural University in Nitra.

6.6.2.5 Source specific QA/QC and verification

See section 6.2.6 for source specific verification and QA/QC.

6.6.2.6 Source specific recalculations

No recalculations in the submission 2011 focused on the base year 1990 or the other inventory years were provided.

6.6.2.7 Source specific planned improvements

The planned improvements for the next submission are in the direct soil emissions of N_2O and the N_2O emissions from manure management. The share of animal waste management system according to animal categories will be updated with using the information from regional statistics. The direct N_2O emissions from soils will be recalculated according to new research knowledge in agro-climatic regionalisation in the Slovak Republic. Based on this approach, the first outputs from the model DNDC are known. The direct measurements of N_2O soil's emissions to adjust model are planned for the international project of the Agricultural University in Nitra (Slovak Republic).

6.6.3 Source category description – Animal manure applied to soil (CRF 4.D.1.2)

As domestic livestock produce different kind of nitrogen inputs (liquid or dry) into the ecosystem also the structure of domestic livestock is important (the ratio of different categories of domestic livestock) from the point of view of direct emissions as well as the emissions from AWMS. Except for it the production of nitrogen per head per year plays also certain role.

6.6.3.1 Methodological issues – methods

The direct inputs of nitrogen slightly vary according to the applied methodology. Based on the IPCC GL 1996 (Method A)[14] higher inputs of nitrogen from animal excreta can be estimated (in average higher by about 5%) as compared with detailed method based on the IPCC GPG 2000 (Method B).[15]

Total nitrogen excretion per liquid (17 623 t/N/year) and solid system (37 814 t/N/year) in manure management in 2009 were used for the estimation of total nitrogen input of manure applied to soils.

6.6.3.2 Methodological issues – emission factors and other parameters

Calculated amount of nitrogen from animal waste applied to soils was 38 806.02 t/N/year (liquid and solid systems; ($1\text{-}Frac_{Fuel}+Frac_{Graz}+Frac_{Gasm}$ = 1-0-0.057-0.24 = 0.703) and default EF was 0.0125 kg N_2O-N/kgN. Total amount of N_2O emissions from animal excreta applied to soils was 0.762 Gg in 2009.

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[14] Method A: nitrogen input was calculated for animal categories of domestic livestock according to IPCC Methodology[12] cattle (dairy and others), pigs, sheep, goats, horses, and poultry, 1996.

[15] Method B: the more detailed values for calculation of N_2O emissions were used, when categories of domestic livestock per year for other cattle were supposed.

Table 6.16: Input parameters and EF in category 4D12 Animal manure applied to soils in 1990 – 2009

Category 4D12 Animal Manure Applied to Soils					
	N-input from Liquid System (kg/year)	N-input from Solid System (kg/year)	N-input from Manure to Soils (kg/year)	EF (kg N_2O-N/kg N)	N_2O Emissions (Gg)
1990	40 369 536	108 248 711	104 032 773	0,0125	2,044
1991	36 787 859	98 213 383	94 500 869	0,0125	1,856
1992	34 656 493	84 315 964	83 280 720	0,0125	1,636
1993	31 832 436	72 967 375	73 359 868	0,0125	1,441
1994	31 114 025	68 085 495	69 439 664	0,0125	1,364
1995	31 198 641	71 831 044	72 120 779	0,0125	1,417
1996	30 491 919	66 163 432	67 658 746	0,0125	1,329
1997	28 425 135	60 581 119	62 304 378	0,0125	1,224
1998	25 268 331	53 389 543	55 060 512	0,0125	1,082
1999	24 477 446	50 841 019	52 722 925	0,0125	1,036
2000	23 227 965	49 787 460	51 110 798	0,0125	1,004
2001	24 077 041	48 061 160	50 496 741	0,0125	0,992
2002	25 408 785	47 464 553	51 011 337	0,0125	1,002
2003	24 792 408	46 096 457	49 622 205	0,0125	0,975
2004	23 717 970	42 918 379	46 645 444	0,0125	0,916
2005	22 841 385	41 479 728	45 024 779	0,0125	0,884
2006	22 920 857	40 518 595	44 407 616	0,0125	0,872
2007	20 648 769	39 836 819	42 339 911	0,0125	0,832
2008	16 313 083	38 610 705	38 446 652	0,0125	0,755
2009	17 622 793	37 814 372	38 806 016	0,0125	0,762

6.6.3.3 Activity data

Activity data are summarized in Table 6.16.

6.6.3.4 Uncertainties and time-series consistency

Tier 1 uncertainty was included in total uncertainty assessment. Time series consistency is ensured.

6.6.3.5 Source specific QA/QC and verification

See section 6.2.6 for source specific verification and QA/QC.

6.6.3.6 Source specific recalculations

In the view of harmonisation of the N inputs within the liquid and solid animal waste systems (manure management), the total nitrogen input into soils from manure management was recalculated in several years. However the changes are negligible.

Table 6.17: Recalculations of N-inputs and N_2O emissions in category 4.D.1.2 in 1990 – 2008

	Submission 2010		Submission 2011		2011/2010	
	N-input from Manure Applied to Soil (kgN)	Total N_2O (Gg)	N-input from Manure Applied to Soil (kgN)	Total N_2O (Gg)	Difference 2011/2010	
1990	96 251 012,667	**1,8906**	104 032 772,67	**2,0435**	108,0849%	**108,0849%**
1991	94 500 869,167	**1,8563**	94 500 869,17	**1,8563**	100,0000%	**100,00%**
1992	83 280 719,667	**1,6359**	83 280 719,67	**1,6359**	100,0000%	**100,00%**
1993	73 359 868,167	**1,4410**	73 359 868,17	**1,4410**	100,0000%	**100,00%**
1994	69 439 664,000	**1,3640**	69 439 664,00	**1,3640**	100,0000%	**100,00%**
1995	72 120 779,022	**1,4167**	72 120 779,02	**1,4167**	100,0000%	**100,00%**
1996	67 658 745,677	**1,3290**	67 658 745,68	**1,3290**	100,0000%	**100,00%**
1997	62 304 378,440	**1,2238**	62 304 378,44	**1,2238**	100,0000%	**99,9997%**
1998	55 060 511,540	**1,0816**	55 060 511,54	**1,0815**	100,0000%	**99,9996%**
1999	52 722 925,290	**1,0356**	52 722 925,29	**1,0356**	100,0000%	**99,9999%**
2000	51 110 797,780	**1,0040**	51 110 797,78	**1,0040**	100,0000%	**100,00%**
2001	50 496 740,950	**0,9919**	50 496 740,95	**0,9919**	100,0000%	**100,00%**
2002	51 011 336,670	**1,0020**	51 011 336,67	**1,0020**	100,0000%	**99,9998%**
2003	49 622 205,430	**0,9747**	49 622 205,43	**0,9747**	100,0000%	**100,00%**
2004	46 645 648,035	**0,9163**	46 645 444,19	**0,9162**	99,9996%	**99,9996%**
2005	45 689 231,700	**0,8975**	45 024 778,79	**0,8844**	98,5457%	**98,5454%**
2006	44 407 616,330	**0,8723**	44 407 616,33	**0,8723**	100,0000%	**100,00%**
2007	42 339 911,100	**0,8317**	42 339 911,08	**0,8317**	100,0000%	**99,9972%**
2008	38 446 651,775	**0,7552**	38 446 651,78	**0,7552**	100,0000%	**100,00%**

6.6.3.7 Source specific planned improvements

Further research and development of national emission factors are included the list of the improvements for the next submissions.

6.6.4 Source category description – N-Fixing crops (CRF 4.D.1.3)

Nitrogen inputs from symbiotic fixation are of local importance and depend on the acreage of leguminous plants. Total input of nitrogen into cultivated soils drastically decreased in the first half of the nineties (from 620.0 Gg in 1990 to 500.0 Gg in 1995). During recent years the inputs of nitrogen into soils were stabilized on the level of 350.0 Gg per year.

6.6.4.1 Methodological issues – methods

Nitrogen inputs from symbiotic fixation are within the range of 20 – 30 kg/ha (Bielek 1998), but there are enough reasons to accept an experimental value 26 kg N/ha. Details for the estimation of total input of nitrogen from N-fixing residuals were recalculated according to the data obtained from direct measurement (Jurcova, 2000) at national conditions and recalculated for the growing areas of N-fixing crops and average harvest.

6.6.4.2 Methodological issues – emission factors and other parameters

Total growing areas of N-fixing crops (peas, lens, beans, mix of fodder beans and cereals, soybeans, alfalfa and clover) were 88 717 ha in 2008 and the direct inputs of nitrogen from N-fixing crops were 26 344.76 t N in 2009. The crop residuals from the previous year were the base for the calculation of N_2O emissions from N-fixing crops (according to the used methodology) in recent inventory year. The used default emission factor was 0.0125 kg N_2O-N / kg N and total N_2O emissions from N-fixing crops were 0.40 Gg including biologic fixation in 2009.

6.6.4.3 Activity data

Total N_2O emissions from N–fixing crops (residuals + biologic fixation) were 0.40 Gg in 2009. Except for total nitrogen inputs into soils certain changes of the importance of nitrogen sources were identified. While the consumption of synthetic fertilizers as well as the input of nitrogen from animal husbandry decreased N-fixing crops created a relatively stable input of nitrogen (approximately 0.350 Gg). This fact documents an abnormal intake of nutrients from soils what can influence their fertility during next years. 1.25% of nitrogen from inputs defined above in sense of applied methodology creates direct N_2O emissions and so the trends reflect their sources.

Table 6.18: Crops characteristics in category 4D13 N-Fixing crops in 2009

Crop	Area of N-Fixing Crops (ha)	Harvested Residuals (t/ha)	Content of N in Dry Matter (%)	Nitrogen in Soil (kg/ha)	Nitrogen Fixed Total (kg)
Peas	3 243,37	6,51	1,66	0,11	350,50
Lens	342,88	7,00	2,42	0,17	58,08
Beans	236,35	7,00	2,96	0,21	48,97
Mix of fodder beans and cereals	16 068,74	10,94	2,96	0,32	5 203,44
Soybeans	9 286,44	3,44	4,19	0,14	1 338,51
Alfalfa	51 568,01	7,00	2,42	0,17	8 735,62
Clover	7 971,51	6,00	1,97	0,12	942,23
Other Fodder Crops*	31 027,08	6,00	1,97	0,12	3 667,40
Total	**88 717,30**				**20 344,76**
* permanent (not including in total harvested area)					

Table 6.19: Input parameters and EF in category 4D13 N-Fixing crops in 1990 – 2009

Category 4D13 N-Fixing Crops				
	Area of N-Fixing Crops (ha)	Nitrogen Fixed by N-Fixing Crops (kg/year)	EF (kg N_2O-N/kg N)	N_2O Emissions (Gg)
1990	193 412	31 551 835	0,0125	0,620
1991	200 889	30 843 953	0,0125	0,606
1992	215 542	31 138 436	0,0125	0,612
1993	198 563	32 272 384	0,0125	0,634
1994	172 386	29 211 274	0,0125	0,574
1995	156 809	25 815 160	0,0125	0,507
1996	140 056	23 645 793	0,0125	0,464
1997	124 154	21 255 833	0,0125	0,418
1998	112 960	18 837 557	0,0125	0,370
1999	112 793	17 952 705	0,0125	0,353
2000	100 886	17 542 586	0,0125	0,345
2001	94 616	15 732 782	0,0125	0,309
2002	92 572	14 511 772	0,0125	0,287
2003	92 028	14 169 250	0,0125	0,278
2004	88 371	14 285 517	0,0125	0,281
2005	90 577	14 163 138	0,0125	0,278
2006	81 036	15 884 972	0,0125	0,312
2007	99 136	22 711 071	0,0125	0,446
2008	82 893	19 305 014	0,0125	0,379
2009	88 717	20 344 762	0,0125	0,400

6.6.4.4 Uncertainties and time-series consistency

Tier 1 uncertainty was included in total uncertainty assessment. Time series consistency is ensured.

6.6.4.5 Source specific QA/QC and verification

See section 6.2.6 for source specific verification and QA/QC.

6.6.4.6 Source specific recalculations

Recalculation of the total area of N-fixing crops was increased emissions in 2008. The information is summarized in the following table.

Table 6.20: Recalculations of area and N_2O emissions in category 4.D.1.3 in 2008

	Submission 2010			Submission 2011			2011/2010	
Crop	Area of N-Fixing Crops (ha)	Nitrogen Fixed Total (kg)	Total N_2O (Gg)	Area of N-Fixing Crops (ha)	Nitrogen Fixed Total (kg)	Total N_2O (Gg)	Difference 2011/2010	
Peas	4 887,39	528,16		4 310,78	465,85		88,20%	
Lens	468,39	79,35		284,12	48,13		60,66%	
Beans	179,93	37,28		178,60	37,01		99,26%	
Mix of fodder beans and cereals	6 974,97	2 258,66		15 229,43	4 931,65		218,34%	
Soybeans	5 481,76	790,12		5 408,12	779,50		98,66%	
Alfalfa	51 310,79	8 692,05		50 411,39	8 539,69		98,25%	
Clover	7 745,41	915,51		7 070,89	835,78		91,29%	
Other Fodder Crops*	31 027,08	3 667,40		31 027,08	3 667,40		100,00%	
Total	**77 048,64**	**16 968,53**	**0,333**	**82 893,33**	**19 305,01**	**0,379**	**107,59%**	**113,77%**
* permanent (not including in total harvested area)								

6.6.4.7 Source specific planned improvements

Further research and development of national emission factors are included in improvement list for the next submissions.

6.6.5 Source category description – Crop residue (CRF 4.D.1.4)

Directly after incorporation of the crop residuals into the soil, the multilateral interactions between organic compounds and nutrients presented in the residuals with the mineral and organic components of soil take place. The knowledge of nutrient potential in crop residuals by crop rotation are mostly actual in the in the present requirements of biologicalisation in plant production.

6.6.5.1 *Methodological issues – methods*

During the period of 1986 – 1997, the crop and root residuals from 29 crop species were observed at three to seven different soil-climate sites in the Slovak Republic (partly at small production parcels and partly at large scale production). The sampling was provided according to the plant specification (a number of plants per hectare). The crop residuals were abstracted from the same field as root residuals directly after root take off. According to the applied methodology, crop residuals as well as symbiotic fixation depend on the acreage of field crops and leguminous. Nitrogen input from crop residuals varies round about the value of 70 kt per year. Nitrogen in crop residuals of different categories was determined from the results of field trial of the Research Institute of Plant Production (Jurcova, 2000). The estimation of nitrogen from residual crops was calculated according to the growing areas of crops and vegetable.

The content of mineral component in crop residuals fluctuates mostly upon the dependence of genetic plant attributes and the level of agro technique in primary fertilization. The content of nitrogen can differ in the residuals of the same crop and is higher in roots. The content of nitrogen fluctuates and is the highest in the N-fixing crops. Besides the nutrient content in a plant, the second factor is the weight of crop residuals and root residuals and its influence on the nitrogen content in soils. This depends on the crop specification and harvesting practice. Potential content of nitrogen in kg per hectare in residuals can be specified. Within the national research activities, the observation of 29 crops potential in relation to the content of nitrogen in kg per hectare and the most common harvesting practices were studied. Tables 6.18 and 6.20 describe the results of statistical average of potential values of nitrogen inputs for the observed crops. The average nitrogen potential ranges between 10 – 100 kg N per hectare.

The decision regarding the calculation of nitrogen inputs from crop residuals according to the acreage of field crops and the average N potential of crop has been taken for the reasons as follows:

- Preferable use of national data from direct measurements instead of default values.
- According to the IPCC GPG 2000, the basic information on nitrogen input into soil from crop residuals comes from the yields of field crops. Some crops suffer from winter frosts (oil seed rape, winter wheat, winter barley) and summer drought (sunflower and other) and they are not harvested. So they are not included into official statistics on crop yields. Anyway, they are the source of nitrogen in soils. If there is only crop yield taking into account they are not included into the calculation of N_2O emissions. Therefore, the acreage of field crops and the national data on nitrogen content in crop residuals look as more representative. The importance of crops is changing. More and more agricultural lands cease from utilizing. The acreage of oil seed rape and sunflower increases, while the acreage of sugar beet, potato and fodder crops (alfalfa, clover, leguminous plants) decreases.
- Regional differences.

6.6.5.2 *Methodological issues – emission factors and other parameters*

Total growing area of crops (wheat, ray, barley, oat, maize, potato, sugar beet, oil plants, tobacco, vegetable, fodder crops, grassland and other) was 1 135 231 ha in 2008 and the direct inputs of nitrogen from crop residuals were 70 105 t in 2009. The crops residuals from previous year (2008) were the base for the calculation of N_2O emissions in current inventory year (according to the country specific methodology). The used default emission factor was 0.0125 kg N_2O-N / kg N and total N_2O emissions from crops residuals were 1.377 Gg in 2009.

Table 6.21: Growing areas and total nitrogen amount of crops and leguminous in 2009

Crop		Average nitrient potential of crop residuals (kg N/ha)	Area of Crops (ha)	Nitrogen Fixed Total (kg)
Cereals	Wheat	52,50	379 195,12	19 907 743,80
	Ray	45,00	33 554,56	1 509 955,20
	Barley	44,00	195 826,26	8 616 355,44
	Oat	55,00	15 929,03	876 096,65
	Maize	39,00	144 234,85	5 625 159,15
Potato		59,00	11 620,12	685 587,08
Sugar beet		20,00	15 952,31	319 046,20
Oil plants		107,00	267 712,81	28 645 270,67
Tobacco		45,00	19,19	863,55
Fodder crops		59,00	916,71	54 085,89
Maize for silage		55,00	70 269,71	3 864 834,05
Total			1 135 230,67	70 104 997,68

Table 6.22: Input parameters and EF in category 4D14 Crop residue in 1990 – 2009

Category 4D14 Crop Residue				
	Cropland Acreage (ha)	Nitrogen in Crop Residues Returned to Soils (kg/year)	EF (kg N_2O-N/kg N)	N_2O Emissions (Gg)
1990	1 184 531	60 830 021	0,0125	1,195
1991	1 188 937	61 516 525	0,0125	1,208
1992	1 183 686	62 622 894	0,0125	1,230
1993	1 153 657	59 315 948	0,0125	1,165
1994	1 159 134	60 438 162	0,0125	1,187
1995	1 184 530	62 660 737	0,0125	1,231
1996	1 196 868	65 478 104	0,0125	1,286
1997	1 185 919	65 288 400	0,0125	1,282
1998	1 202 413	65 901 472	0,0125	1,294
1999	1 179 262	65 304 595	0,0125	1,283
2000	1 139 329	67 699 850	0,0125	1,330
2001	1 149 184	65 794 680	0,0125	1,292
2002	1 152 764	66 682 980	0,0125	1,310
2003	1 156 021	67 689 915	0,0125	1,330
2004	1 144 607	66 891 845	0,0125	1,314
2005	1 149 857	66 599 880	0,0125	1,308
2006	1 116 456	66 271 980	0,0125	1,302
2007	1 139 880	68 148 673	0,0125	1,339
2008	1 150 765	69 769 371	0,0125	1,370
2009	1 135 231	70 104 998	0,0125	1,377

6.6.5.3 Activity data

Stems and leaves are usually utilized as a fodder for domestic livestock. Data on export of straw abroad are missing. Except for it, the data on grasslands, alfalfa, horse been, maize for silage and clover includes also a green part of crops (leaves and stems) utilized for animal feeding. Therefore the crop residuals are defined only as a part of plants – short stems and roots staying on the field. According to the Statistical Yearbook and the Green Report of the Slovak Republic it is not possible to split fodder crops and grasslands into subcategories.

The activity data on crop residuals started in 1989 because of mineralization rate. It is supposed that crop residuals from one year are mostly the source of N_2O emissions in the following year. Scientists from the Department of Plant Nutrition and Agro Chemistry at the Agriculture University in Nitra recommended this approach.

The acreage instead of the yield was used for several reasons, such as:

- Missing statistics on yield of some fodder crops at the beginning of evaluated period.

- Some crops suffer from winter frosts (oil seed rape, winter wheat, winter barley) and summer drought (sunflower and other) and they are not harvested. So they are not included into the official statistics on crop yields. Anyway, they are the source of nitrogen in soils. If there is only crop yield taking into account they are not included into the calculation of N_2O emissions. Therefore the acreage of field crops and national data about nitrogen content in crop residuals look as more representative data for calculation procedure,
- The differences between these approaches were caused by excluding the permanent grasslands as well as the soil from statistics. These soils are not cultivated and fertilized and sufficient data on nitrogen inputs and acreage are not available.

Table 6.23: Nutrition potential in crop residuals in kg of nitrogen per hectare according to the study of the Research Institute of Plant Production (Jurcova, 2000)

Crop	Average nitrient potential of crop residuals (kg N/ha)	Crop	Average nitrient potential of crop residuals (kg N/ha)	Crop	Average nitrient potential of crop residuals (kg N/ha)	Crop	Average nitrient potential of crop residuals (kg N/ha)
Horse Been	298	Beans as fodder	46	Tobacco	45	Oat	89
Checken Pea	201	Oil Seedrape - spring form	166	Sugar Beet	20	Spring Wheat	84
Beans	192	Sunflow er	108	Clover in mix in 2nd year	153	Triticale	80
Lens	163	Oil Seedrape - w inter form	107	Alfalfa+Grass in 3rd year	127	Winter Wheat	79
Soybeen	132	Mustard	91	Clover in 3rd year	127	Winter Ray	77
Corn	127	Potato	59	Grasslands in 3rd year	123	Winter Balrey	66
Popper	115	Maize for Silage	55	Grassland in 2nd year	113	Spring Barley	60
Peas	112						

6.6.5.4 Uncertainties and time-series consistency

Tier 1 uncertainty was included in total uncertainty assessment. Time series consistency is ensured.

6.6.5.5 Source specific QA/QC and verification

See section 6.2.6 for source specific verification and QA/QC.

6.6.5.6 Source specific recalculations

The recalculations of the harvested area were provided for 2008. The changes are summarized in the following table.

Table 6.24: Recalculations of area and N_2O emissions in category 4.D.1.4 in 2008

Crop		Submission 2010			Submission 2011			2011/2010	
Cereals		**Area of Crops (ha)**	**Nitrogen Fixed Total (kg)**	**Total N_2O (Gg)**	**Area of Crops (ha)**	**Nitrogen Fixed Total (kg)**	**Total N_2O (Gg)**	**Difference 2011/2010**	
	Wheat	374 402,25	19 656 118,13		373 662,09	19 617 259,73		99,80%	99,80%
	Ray	39 988,57	1 799 485,65		41 387,96	1 862 458,20		103,50%	103,50%
	Barley	213 851,80	9 409 479,20		213 049,95	9 374 197,80		99,63%	99,63%
	Oat	18 173,34	999 533,70		17 036,57	937 011,35		93,74%	93,74%
	Maize	148 789,21	5 802 779,19		154 237,56	6 015 264,84		103,66%	103,66%
Potato		14 198,73	837 725,07		14 270,32	841 948,88		100,50%	100,50%
Sugar beet		10 898,47	217 969,40		11 117,78	222 355,60		102,01%	102,01%
Oil plants		250 551,92	26 809 055,44		249 327,02	26 677 991,14		99,51%	99,51%
Tobacco		20,43	919,35		9,81	441,45		48,02%	48,02%
Fodder crops		960,20	56 651,80		957,05	56 465,95		99,67%	99,67%
Maize for silage		81 794,65	4 498 705,75		75 708,66	4 163 976,30		92,56%	92,56%
Total		**1 153 629,57**	**70 088 422,68**	**1,377**	**1 150 764,77**	**69 769 371,24**	**1,370**	**99,75%**	**99,54%**

6.6.5.7 Source specific planned improvements

Further research and development of national emission factors are included in the list of improvements for the next submissions.

6.6.6 Source category description – Cultivation of histosols (CRF 4.D.1.5)

No emissions from the category 4.D.1.5 Cultivation of histosols were occurred in the Slovak Republic in 2009. The total area of protected histosols is 4 893 ha.

6.6.7 Source category description – Pasture, range and paddock manure (CRF 4.D.2)

Production of slurries is typical for domestic livestock in category pig. Pasture is typical for sheep, goats, horses and part of cattle during spring, summer and autumn. N_2O emissions from AWMS were based on the analysis of housing systems at the territory of the Slovak Republic that was made by the Research Institute of Animal Production in Nitra (Brestenský, 1998).

6.6.7.1 Methodological issues – methods

It is supposed that sheep, goats and horses can stay at pasture 200 days a year, 40% of dairy cattle stay only 150 days. Results of the analysis on animal waste management system were used for the calculation of nitrogen input from animal husbandry into N-cycle. This analysis was based on the questionnaires from 222 agricultural subjects (21.3% of total amount of subjects in the Slovak Republic). These subjects cultivated 14.7% of total agricultural land and 15.2% of arable land. The storage of dry manures is probably more frequent than the questionnaires showed and the emissions from AWMS will be higher. Housing at grasslands since April to October is frequent for sheep, goats and horses. The duration of grazing period can vary significantly depending on weather conditions in different part of the Slovak Republic. Reliable data for statistical evaluation is not available, but significant differences can be found in this regard.

6.6.7.2 Methodological issues – emission factors and other parameters

The estimation of N_2O from pasture of animals is based on default emission factor 0.02 kg N_2O-N / kg N and N_{ex} per AWMS estimated by manure management category. Total nitrogen from animals in AWMS was 9 422 t in 2009. Total emissions of N_2O from pasture of animals were 0.296 Gg of N_2O in 2009. The trend of pasture, range and paddocks is almost stable from 1998.

6.6.7.3 Activity data

Activity data in this category are in consistency with the activity data in category 4B(b) Manure management (Table 6.11). Table 6.25 shows time series of parameters and emissions.

6.6.7.4 Uncertainties and time-series consistency

Tier 1 uncertainty was included in total uncertainty assessment. Time series consistency is ensured.

6.6.7.5 Source specific QA/QC and verification

See section 6.2.6 for source specific verification and QA/QC.

6.6.7.6 Source specific recalculations

No recalculations in the submission 2011 focused on the base year 1990 or the other inventory years were provided.

6.6.7.7 Source specific planned improvements

Further research and development of national emission factors are included in the list of improvements for the next submissions.

Table 6.25: Input parameters and EF in category 4D2 Pasture, range and paddock in 1990 – 2009

Category 4D2 Pasture, Range and Paddock Manure			
	N Excretion on Pasture (kg)	EF (kg N_2O-N/kg N)	N_2O Emissions (Gg)
1990	22 756 500	0,020	0,715
1991	20 467 550	0,020	0,643
1992	18 516 600	0,020	0,582
1993	15 350 050	0,020	0,482
1994	14 386 850	0,020	0,452
1995	14 993 026	0,020	0,471
1996	14 096 600	0,020	0,443
1997	13 196 067	0,020	0,415
1998	11 656 914	0,020	0,366
1999	11 400 197	0,020	0,358
2000	11 319 047	0,020	0,356
2001	10 628 152	0,020	0,334
2002	10 531 663	0,020	0,331
2003	10 321 652	0,020	0,324
2004	9 770 089	0,020	0,307
2005	9 664 808	0,020	0,304
2006	9 485 237	0,020	0,298
2007	9 528 819	0,020	0,299
2008	9 511 754	0,020	0,299
2009	9 421 677	0,020	0,296

6.6.8 Source category description – Atmospheric deposition (CRF 4.D.3.1)

This part of N_2O emissions resulted from the processes of atmospheric deposition of ammonia and NO_x, as well as due to the transformation of nitrogen from leaching and runoff losses. The indirect emissions decreased during the evaluated period due to their dependence on direct inputs of nitrogen that decreased too. Total indirect emissions from atmospheric deposition were 0.325 Gg in 2009 which is more than 60% below 1990.

6.6.8.1 Methodological issues – methods

IPCC default methodology tier 1 and default emissions factors were used for estimation indirect N_2O emissions from atmospheric deposition.

6.6.8.2 Methodological issues – emission factors and other parameters

Mean value for leaching of nitrogen varies in the range of 7–10 kg per 1 ha per year (7% of N-inputs) in national conditions. The IPCC default emission factor (0.01 kg N_2O-N / kg N) was used during the time series. It was assumed, that 10% of nitrogen input from synthetic fertilizers is applied to volatilize (NH_3 and NO_x) in soil and 20% of nitrogen from manure is volatilized in soils.

6.6.8.3 Activity data

Volatized nitrogen (NH_3 and NO_X) from synthetic fertilizers and animal wastes was 20 6778 t N in 2009. Activity data in this category are in consistency with the activity data in categories synthetic fertilizers and animal manure applied to soil 4D11 and 4D12. Table 6.26 shows the time series of parameters and emissions.

6.6.8.4 Uncertainties and time-series consistency

Tier 1 uncertainty was included in total uncertainty assessment. Time series consistency is ensured.

6.6.8.5 Source specific QA/QC and verification

See section 6.2.6 for source specific verification and QA/QC.

Table 6.26: Input parameters and EF in category 4D31 Atmospheric deposition in 1990 – 2009

Category 4D31 Atmospheric Deposition					
	Volatilized N from Synthetic Fertilizers (kg)	Volatilized N from Animal Manure (kg)	Total Volatilized N (kg)	EF (kg N_2O-N/kg N)	N_2O Emissions (Gg)
1990	22 225 500	34 274 949	56 500 449	0,010	0,888
1991	14 634 100	31 093 758	45 727 858	0,010	0,719
1992	9 018 600	27 497 811	36 516 411	0,010	0,574
1993	6 485 200	24 029 972	30 515 172	0,010	0,480
1994	6 866 900	22 717 274	29 584 174	0,010	0,465
1995	6 958 700	23 604 542	30 563 242	0,010	0,480
1996	7 446 400	22 150 390	29 596 790	0,010	0,465
1997	8 801 668	20 440 464	29 242 132	0,010	0,460
1998	8 184 252	18 062 957	26 247 209	0,010	0,412
1999	6 539 262	17 343 732	23 882 994	0,010	0,375
2000	7 265 346	16 866 894	24 132 240	0,010	0,379
2001	7 603 182	16 553 271	24 156 453	0,010	0,380
2002	8 825 968	16 681 000	25 506 968	0,010	0,401
2003	8 129 958	16 242 103	24 372 061	0,010	0,383
2004	7 991 081	15 281 288	23 272 369	0,010	0,366
2005	8 131 656	14 797 184	22 928 840	0,010	0,360
2006	7 868 112	14 584 938	22 453 050	0,010	0,353
2007	8 893 540	14 002 881	22 896 421	0,010	0,360
2008	8 773 695	12 887 109	21 660 804	0,010	0,340
2009	7 705 845	12 971 769	20 677 614	0,010	0,325

6.6.8.6 *Source specific recalculations*

According to the changes in N-inputs in direct soil emissions, the changes and recalculation in indirect soil emissions occurred. The results of recalculations are summarized in the following table.

Table 6.27: Recalculations of N-inputs and N_2O emissions in category 4.D.3.1 in 1990 – 2008

	Submission 2010		Submission 2011		2011/2010	
	Volatilized N from Synthetic Fertilizers (kg)	Volatilized N from Animal Manure (kg)	Volatilized N from Synthetic Fertilizers (kg)	Volatilized N from Animal Manure (kg)	Difference 2011/2010	
1990	22 225 500,00	32 051 589,33	22 225 500,00	34 274 949,33	**100,00%**	**106,94%**
1991	14 634 100,00	31 093 758,33	14 634 100,00	31 093 758,33	**100,00%**	**100,00%**
1992	9 018 600,00	27 497 811,33	9 018 600,00	27 497 811,33	**100,00%**	**100,00%**
1993	6 485 200,00	24 029 972,33	6 485 200,00	24 029 972,33	**100,00%**	**100,00%**
1994	6 866 900,00	22 717 274,00	6 866 900,00	22 717 274,00	**100,00%**	**100,00%**
1995	6 958 700,00	23 604 542,05	6 958 700,00	23 604 542,05	**100,00%**	**100,00%**
1996	7 446 400,00	22 150 390,17	7 446 400,00	22 150 390,17	**100,00%**	**100,00%**
1997	8 801 700,00	20 449 912,68	8 801 668,00	20 440 464,33	**100,00%**	**99,95%**
1998	8 184 300,00	18 016 736,91	8 184 252,00	18 062 957,47	**100,00%**	**100,26%**
1999	6 539 300,00	17 224 718,16	6 539 262,00	17 343 732,40	**100,00%**	**100,69%**
2000	7 265 300,00	16 717 292,82	7 265 346,00	16 866 894,40	**100,00%**	**100,89%**
2001	8 134 500,00	16 769 515,83	7 603 182,00	16 553 270,60	**93,47%**	**98,71%**
2002	8 826 000,00	16 526 700,64	8 825 968,00	16 681 000,24	**100,00%**	**100,93%**
2003	8 130 000,00	16 076 460,00	8 129 958,00	16 242 103,44	**100,00%**	**101,03%**
2004	7 991 100,00	15 281 345,80	7 991 081,00	15 281 287,56	**100,00%**	**100,00%**
2005	8 131 700,00	14 797 184,19	8 131 656,00	14 797 184,19	**100,00%**	**100,00%**
2006	7 868 112,00	14 584 937,76	7 868 112,00	14 584 937,76	**100,00%**	**100,00%**
2007	8 893 540,00	14 002 881,32	8 893 540,00	14 002 881,32	**100,00%**	**100,00%**
2008	8 773 695,00	12 887 108,52	8 773 695,00	12 887 108,52	**100,00%**	**100,00%**

6.6.8.7 *Source specific planned improvements*

Further research and development of national emission factors are included in the list of improvements for the next submissions.

6.6.9 Source category description – Nitrogen leaching and Run-off (CRF 4.D.3.2)

The following nitrogen losses 5–10 (7% of N-inputs) kg per ha per year are caused by soil erosion and runoff (Bielek, 1998). Total losses in soils were about 14% of nitrogen input due to leaching, runoff and erosion in climatic condition of the Slovak Republic. Total indirect emissions from nitrogen leaching and run-off were 0.805 Gg in 2009 which is more than 50% below 1990.

6.6.9.1 Methodological issues – methods

IPCC default methodology tier 1 and default emissions factors were used for the estimation of indirect N_2O emissions from nitrogen leaching and run-off

6.6.9.2 Methodological issues – emission factors and other parameters

The IPCC default emission factor (0.025 kg N_2O-N / kg N) was used during the time series. It was assumed, that 14% of nitrogen input from synthetic fertilizers and manure applied to soil is lost through leaching and run off.

6.6.9.3 Activity data

Lost nitrogen (NH_3 and NO_x) from synthetic fertilizers and animal wastes through leaching and run-off was 20 498 t N in 2009. Activity data in this category are in consistency with the activity data in categories synthetic fertilizers and animal manure applied to soil 4D11 and 4D12. Table 6.28 shows time series of parameters and emissions.

Table 6.28: Input parameters and EF in category 4D32 Nitrogen leaching and Run-off in 1990 – 2009

Category 4D32 Nitrogen Leaching and Run-off					
	Lost N from Synthetic Fertilizers (kg)	Lost N from Animal Manure (kg)	Total Lost N (kg)	EF (kg N_2O-N/kg N)	N_2O Emissions (Gg)
1990	31 115 700	28 004 130	59 119 830	0,025	2,323
1991	20 487 740	18 438 966	38 926 706	0,025	1,529
1992	12 626 040	11 363 436	23 989 476	0,025	0,942
1993	9 079 280	8 171 352	17 250 632	0,025	0,678
1994	9 613 660	8 652 294	18 265 954	0,025	0,718
1995	9 742 180	8 767 962	18 510 142	0,025	0,727
1996	10 424 960	9 382 464	19 807 424	0,025	0,778
1997	12 322 335	11 090 102	23 412 437	0,025	0,920
1998	11 457 953	10 312 158	21 770 110	0,025	0,855
1999	9 154 967	8 239 470	17 394 437	0,025	0,683
2000	10 171 484	9 154 336	19 325 820	0,025	0,759
2001	10 644 455	9 580 009	20 224 464	0,025	0,795
2002	12 356 355	11 120 720	23 477 075	0,025	0,922
2003	11 381 941	10 243 747	21 625 688	0,025	0,850
2004	11 187 513	10 068 762	21 256 275	0,025	0,835
2005	11 384 318	10 245 887	21 630 205	0,025	0,850
2006	11 015 357	9 913 821	20 929 178	0,025	0,822
2007	12 450 956	11 205 860	23 656 816	0,025	0,929
2008	12 283 173	11 054 856	23 338 029	0,025	0,917
2009	10 788 183	9 709 365	20 497 548	0,025	0,805

6.6.9.4 Uncertainties and time-series consistency

Tier 1 uncertainty was included in total uncertainty assessment. Time series consistency is ensured.

6.6.9.5 Source specific QA/QC and verification

See section 6.2.6 for source specific verification and QA/QC.

6.6.9.6 Source specific recalculations

According to the changes in N-inputs in direct soil emissions, the changes and recalculation in indirect soil emissions occurred. The corrections in formula for the calculation of total nitrogen were provided. The results of recalculations are summarized in the following Table 6.29.

6.6.9.7 Source specific planned improvements

Further research and development of national emission factors are included in the list of improvements for the next submissions.

Table 6.29: Recalculations of N-inputs and N_2O emissions in category 4.D.3.2 in 1990 – 2008

	Submission 2010		Submission 2011		2011/2010	
	Total lost N (kg)	Total N_2O (Gg)	Total lost N (kg)	Total N_2O (Gg)	Difference 2011/2010	
1990	53 551 812,53	**2,104**	59 119 830,00	**2,323**	110,40%	**110,40%**
1991	42 253 370,83	**1,660**	38 926 706,00	**1,529**	92,13%	**92,13%**
1992	31 874 507,93	**1,252**	23 989 476,00	**0,942**	75,26%	**75,26%**
1993	25 900 260,63	**1,018**	17 250 632,00	**0,678**	66,60%	**66,60%**
1994	25 515 751,80	**1,002**	18 265 954,00	**0,718**	71,59%	**71,59%**
1995	26 265 359,44	**1,032**	18 510 142,00	**0,727**	70,47%	**70,47%**
1996	25 930 233,12	**1,019**	19 807 424,00	**0,778**	76,39%	**76,39%**
1997	26 637 318,88	**1,048**	23 412 436,88	**0,920**	87,89%	**87,80%**
1998	24 069 735,83	**0,946**	21 770 110,32	**0,855**	90,45%	**90,44%**
1999	21 212 322,71	**0,833**	17 394 436,92	**0,683**	82,00%	**82,00%**
2000	21 873 524,97	**0,859**	19 325 820,36	**0,759**	88,35%	**88,35%**
2001	23 126 961,08	**0,909**	20 224 464,12	**0,795**	87,45%	**87,45%**
2002	23 925 090,45	**0,940**	23 477 074,88	**0,922**	98,13%	**98,13%**
2003	22 635 522,00	**0,889**	21 625 688,28	**0,850**	95,54%	**95,54%**
2004	21 884 482,06	**0,860**	21 256 275,46	**0,835**	97,13%	**97,13%**
2005	21 742 408,93	**0,854**	21 630 204,96	**0,850**	99,48%	**99,48%**
2006	21 224 813,23	**0,834**	20 929 177,92	**0,822**	98,61%	**98,61%**
2007	22 252 972,92	**0,874**	23 656 816,40	**0,929**	106,31%	**106,31%**
2008	21 304 148,96	**0,837**	23 338 028,70	**0,917**	109,55%	**109,55%**

6.7 Prescribed Burning of Savannas (CRF 4.E)

The category Prescribed burning of savannas 4.E is not occurring in the Slovak Republic.

6.8 Field Burning of Agricultural Residues (CRF 4.F)

This form of cultivation is strictly prohibited by law in the Slovak Republic. No emissions from this category were estimated.

CHAPTER 7: LULUCF (CRF 5)

7.1 Overview of sector (CRF 5)

Forestry and Land use sector covers the wide range of biological and technical processes within the landscape, which influence the GHG inventory. This sector includes all GHGs (CO_2, N_2O a CH_4) and basic pollutants from forest fires (NO_x and CO). Individual inventory categories are linked with all relevant processes related to all five carbon pools (living biomass – above and below ground, dead organic matter - dead wood and litter, soil carbon), as have been defined in the Marrakech Accords. The inventory in LULUCF sector is based on the definition of representative types of land use – forest land, cropland, grassland, wetlands, settlements and other land and their temporal changes. The first three types of land use have the most importance due to their coverage of the Slovak territory which represents more than 90% of the whole territory. These processes connected with the land use and land use change are mostly related to CO_2 balance.

Biomass burning, which represents managed processes (i. e. burning of harvesting residues) and unmanaged processes (i. e. forest fires), is a special category in landscape. This category covers all three main GHGs and basic pollutants. Beside this the inventory covers the estimation of CO_2 emissions from the agricultural lime application.

Total net emissions/removals of CO_2 represent -3 476.81 Gg due to the following categories Forest land (-2 834.15 Gg), Cropland (-695.61Gg) Grassland (-425.52 Gg), Settlements (216.66 Gg) and

Other land (261.80 Gg). Total amount of methane emissions from LULUCF sector represented 0.989 Gg of CH_4 and total amount of N_2O was 0.0227 Gg in 2009. The emissions of other pollutant originated from forest fires and controlled burning of forest. The estimated amount of NOx emissions was 0.50 Gg and the estimated amount of CO emissions was 8.73 Gg in 2009. Total removals from the LULUCF sector fluctuated between 1990 and 2009.

Table 7.1: Summary of GHG emissions and removals (Gg) according to the categories in 1990 – 2009

	Emissions of CO_2						CH_4 Emissions	N_2O Emissions
Year	Forest land	Cropland	Grassland	Settlements	Other land	LULUCF	LULUCF	LULUCF
1990	-3 035,43	-148,33	-346,84	123,34	426,45	**-2 980,81**	**0,6710**	**0,0390**
1991	-3 825,08	-107,13	-270,86	124,21	254,46	**-3 824,41**	**0,4270**	**0,0194**
1992	-4 540,35	-130,39	-1 409,65	132,58	230,87	**-5 716,94**	**0,3820**	**0,0844**
1993	-4 512,35	-67,97	-601,94	145,67	213,34	**-4 823,26**	**0,3860**	**0,1004**
1994	-3 573,68	-143,47	-377,01	99,16	191,04	**-3 803,97**	**0,4060**	**0,0103**
1995	-2 739,71	-238,48	-619,07	97,27	141,21	**-3 358,78**	**0,4550**	**0,0113**
1996	-2 704,70	-317,14	-393,35	105,23	172,42	**-3 137,54**	**0,4870**	**0,0303**
1997	-1 934,96	-372,90	-437,62	117,71	172,98	**-2 454,79**	**0,5370**	**0,0103**
1998	-2 379,86	-351,40	-400,23	76,42	159,28	**-2 895,79**	**0,5370**	**0,0033**
1999	-1 978,03	-336,19	-735,13	134,31	218,29	**-2 696,75**	**0,6097**	**0,0103**
2000	-1 978,94	-459,07	-946,80	92,94	171,46	**-3 120,40**	**0,5597**	**0,1203**
2001	-5 448,84	-294,20	-857,06	106,61	181,70	**-6 311,79**	**0,6797**	**0,0103**
2002	-5 461,44	-543,17	-754,22	90,32	147,71	**-6 520,80**	**0,6687**	**0,0043**
2003	-4 935,71	-624,86	-511,52	105,15	135,55	**-5 831,40**	**0,7197**	**0,0203**
2004	-4 184,57	-612,72	-501,60	81,58	93,71	**-5 123,60**	**0,8190**	**0,0142**
2005	-826,95	-629,74	-352,55	91,97	259,91	**-1 457,37**	**1,0685**	**0,0172**
2006	-3 278,86	-718,62	-402,56	82,07	164,85	**-4 153,11**	**0,9000**	**0,0102**
2007	-3 266,59	-641,80	-365,55	92,61	195,03	**-3 986,30**	**0,8922**	**0,0264**
2008	-2 454,08	-696,94	-375,88	103,53	224,30	**-3 199,06**	**1,0025**	**0,0059**
2009	-2 834,15	-695,61	-425,52	216,66	261,80	**-3 476,81**	**0,9888**	**0,0227**

Table 7.2: Summary of total emissions and removals according to the categories in 2009

	Net CO_2		CH_4	N_2O	NO_x	CO
	Emissions/Removals		Emissions			
	(Gg)					
5. LULUCF		**-3 476,81**	**0,99**	**0,02**	**0,50**	**8,73**
A. Forest Land		-2 834,15	0,99	0,02	0,50	8,73
B. Cropland		-695,61	0,00	0,00	0,00	0,00
C. Grassland		-425,52	0,00	0,00	0,00	0,00
D. Wetlands		NO	0,00	0,00	0,00	0,00
E. Settlements	216,66		0,00	0,00	0,00	0,00
F. Other Land	261,80		0,00	0,00	0,00	0,00
G. Other		NO	0,00	0,00	0,00	0,00

Figure 7.1: CO_2 emissions and removals balance (Gg) according to the categories in 1990 – 2009

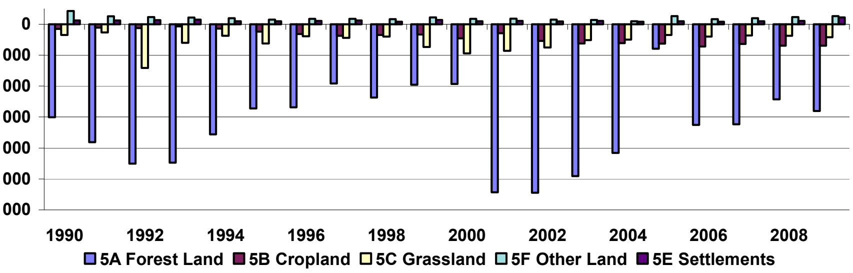
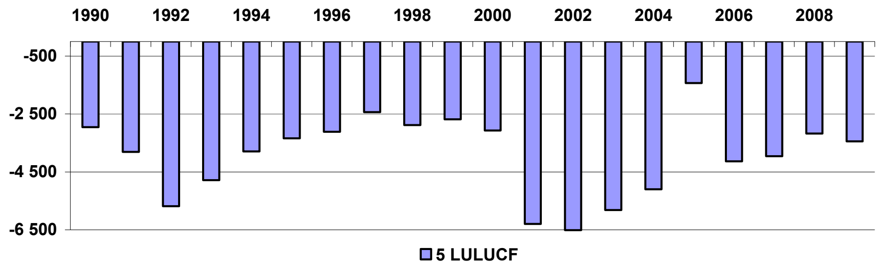


Figure 7.2: Total GHG trend in LULUCF sector (Gg of CO_2 eq.) in 1990 – 2009



7.2 Activity data

The area of forest land in the Slovak Republic covers 40% of the territory and wood harvesting is historically an important economic activity. Since 1990, sinks from sector LULUCF have remained at the level of 8-10% of total GHG emissions. Historically stable trend was disrupted in 1996 and 2004 by the wind calamity in the High Tatras, which resulted in increased harvest of wood damaged by the calamity and pests and consequently in the decrease in total sinks to the half of earlier volumes. The complete recalculation of LULUCF sector based on new estimation of land-use categories took place in this submission. The identification of land–use categories is based on key data source represented by areas data from Geodesy, Cartography and Cadastre Authority of the Slovak Republic (GCCA). This institute issued annually the Statistical Yearbook of the Soil Resources in the Slovak Republic. It provides updated cadastral information of land use areas. Since 2007 this book is available on the website of GCCA (www.geodesy.gov.sk). The GCCA database distinguishes ten land categories, six of them belonging to land utilized by agriculture (arable land, hop-fields, vineyards, gardens, orchards, grassland) and the rest of them under other use (forest land, water surfaces, built-up areas and courtyards, and other land). Integrating mentioned categories have been selected six land-use categories – forest land, cropland, grassland, wetland, settlements and other land as given in the GPG for LULUCF (IPCC, 2003) and in the GPG for AFOLU (IPCC, 2006). The Slovak Republic used for the reporting of GHG emissions and removals in the LULUCF sector following land use definitions:

- Forest land

This category includes the land covered by all tree species serving for the fulfillment 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. In the Permanent Forest Inventory and the Statistical Office databases is referred to as timber land.

- Cropland

This category includes lands for growing cereals, root-crops, industrial crops, vegetables and other kinds of agricultural crops. Perennial woody crops are included into this category too. There are included lands temporary overgrown with grass or used for growing of folder lasting more years, as well as hotbeds and greenhouses if the are built up on arable land. This category includes also fallow land which is arable land left for regeneration on one growing season. During this time there were not seed another crops or just crops for green manure, eventually it is covered by spontaneous vegetation, which would be used as a mess or plough under.

- Grassland

This category includes the permanent grassland and meadows used for the pasture or hay production, which is not considered as cropland.

- Wetlands

The wetlands include artificial reservoirs and dam lakes, natural lakes, rivers and swamps.

- Settlements

The settlements include all developed land, including transportation infrastructure and human settlements of any size.

- Other land

This category represents the last of land use categories in the Slovak Republic. Other land is represented by bare soil, rock and all unmanaged land areas that do not fall into any of the other categories.

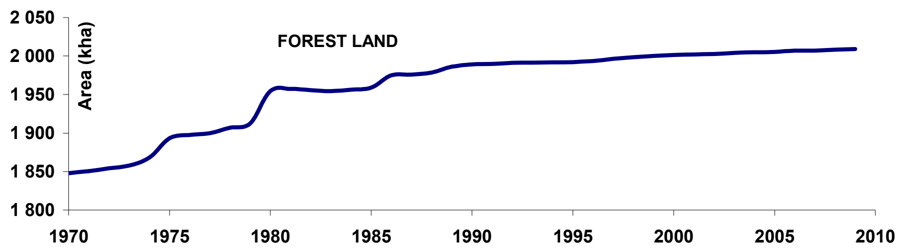
Each of these categories is divided into lands remaining in the given category during the inventory year, and land there are newly converted into the category from different one. The areas of six land use categories remaining in each category are in Table 7.3.

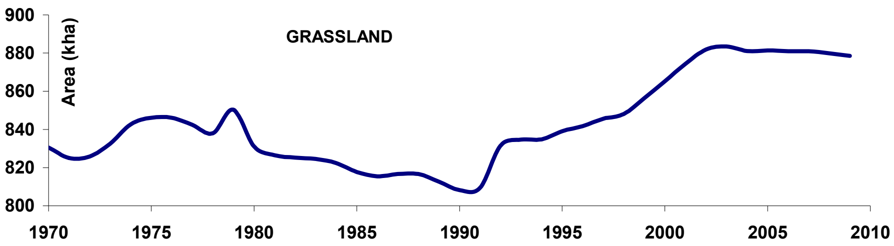
Table 7.3: The areas (kha) of land-use categories remaining into category have been used since 1990

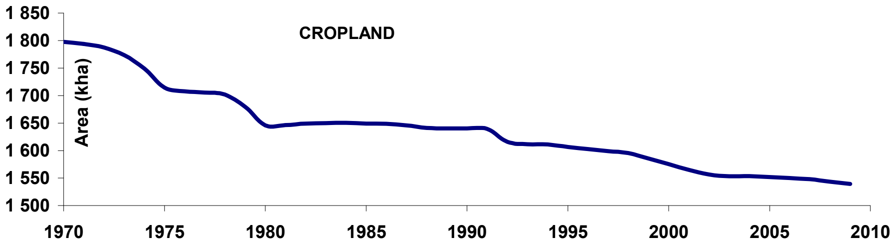
	Area [kha]				
	5A1 Forest Land Rem. Forest Land	5B1 Cropland Rem. Cropland	5C1 Grassland Rem. Grassland	5E1 Settlements Rem. Settlements	5F1 Other Land Rem. Other Land
1990	1 805,46	1 487,20	680,17	95,44	190,71
1991	1 810,89	1 490,15	683,78	96,71	197,30
1992	1 817,08	1 476,45	687,07	98,39	199,21
1993	1 821,00	1 476,29	695,50	99,14	208,26
1994	1 832,33	1 479,76	712,07	100,99	213,87
1995	1 858,39	1 481,32	717,39	102,96	227,55
1996	1 865,61	1 497,92	739,30	104,51	143,78
1997	1 870,46	1 501,30	744,74	105,77	119,76
1998	1 880,09	1 507,39	748,55	106,05	121,87
1999	1 886,38	1 507,44	752,61	107,87	131,38
2000	1 925,15	1 494,91	747,09	112,77	137,58
2001	1 932,41	1 504,65	759,54	112,07	127,56
2002	1 933,97	1 503,97	762,72	113,18	128,98
2003	1 936,59	1 503,54	761,37	114,19	128,54
2004	1 941,26	1 507,01	758,91	115,40	129,15
2005	1 944,21	1 508,86	756,98	116,64	130,69
2006	1 960,80	1 512,20	758,93	120,02	130,31
2007	1 962,62	1 515,16	763,02	121,51	133,24
2008	1 966,33	1 513,32	763,54	123,07	135,09
2009	1 975,50	1 512,50	761,04	124,48	133,87

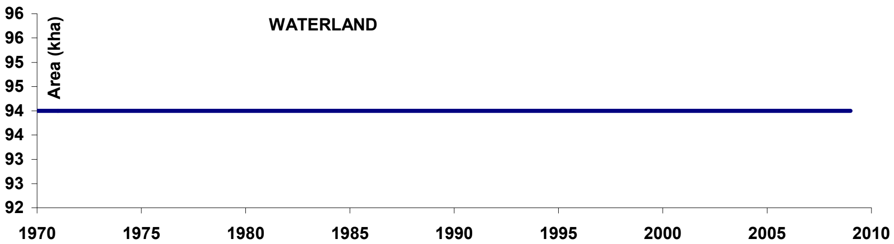
The increasing trend of forest land-use category is evident in the Slovak Republic since 1970. The opposite, decreasing trend of cropland land-use category was recorded at the same time. Grassland areas decreased from 1980 to beginning of 1990 and since this year increasing trend was recorded up to 2005. Since 2005 moderately downward trend is taking place. Continual increasing trend assigned settlement land-use category during whole time period. This situation is mostly caused by development of transport infrastructure, industrial areas, municipal development and raising the standards and infrastructure in country and is very often connected with decreasing of the cropland and other land categories. Wetland represents 1.9% (94 kha) of the Slovak territory and it is considered to be constant, not involving any land use conversions.

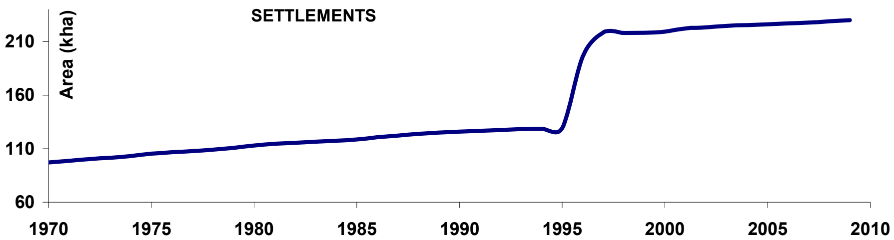
Figure 7.3: Overall trends in the areas of the major land-use categories in 1970 – 2009 (based on information from the Geodesy, Cartography and Cadastre Authority of the Slovak Republic).

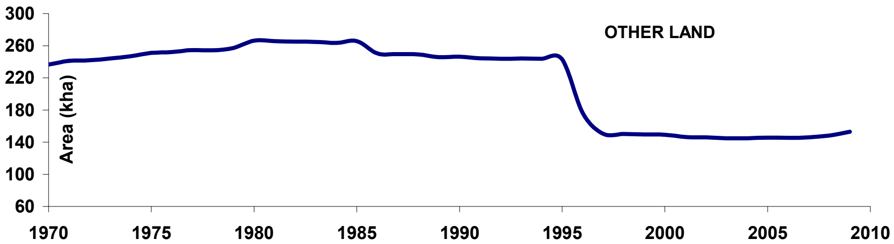












The areas of land-use change among the major land use categories from 1990 to 2009 for individual years shows the land-use change matrices in Table 7.4. The annual totals for individual years in the matrices do not correspond to the areas referred in the CRF Tables. These areas account for the progressing 20 years transition period beginning in 1970. This approach represents the tier 1 assumption of GPG for LULUCF (2003) for calculation of soil carbon stocks changes. The areas of biomass carbon pools are not the same as for the soil carbon one.

Table 7.4: Land-use matrixes identified annual land-use conversions among the categories in 1990 and 2000 – 2009 and describing initial and final areas of particular land-use categories

Year 1990		**Initial (1989)**						**Area**
	Category	Forest Land	Grassland	Cropland	Wetland	Settlements	Other Land	**(kha)**
Final (1990)	Forest Land	**1 985,22**	2,27	0,09	0,00	0,00	1,42	1 988,99
	Grassland	0,35	**807,18**	0,75	0,00	0,00	0,00	808,29
	Cropland	0,01	1,06	**1 639,28**	0,00	0,00	0,00	1 640,34
	Wetland	0,00	0,00	0,00	**94,00**	0,00	0,00	94,00
	Settlements	0,03	0,90	0,00	0,00	**125,11**	0,00	126,03
	Other Land	0,42	1,29	0,00	0,00	0,00	**244,53**	246,24
	Area (kha)	1 986,03	812,70	1 640,12	94,00	125,11	245,73	**4 903,68**

Year 2000		**Initial (1999)**						**Area**
	Category	Forest Land	Grassland	Cropland	Wetland	Settlements	Other Land	**(kha)**
Final (2000)	Forest Land	**1 999,96**	0,69	0,10	0,00	0,00	0,50	2 001,25
	Grassland	0,02	**852,98**	12,21	0,00	0,00	0,00	865,22
	Cropland	0,01	2,47	**1 572,97**	0,00	0,00	0,00	1 575,45
	Wetland	0,00	0,00	0,00	**94,00**	0,00	0,00	94,00
	Settlements	0,01	0,28	0,24	0,00	**218,43**	0,38	219,34
	Other Land	0,09	0,00	0,28	0,00	0,00	**148,74**	149,11
	Area (kha)	2 000,09	856,43	1 585,81	94,00	218,43	149,63	**4 904,40**

Year 2001		**Initial (2000)**						**Area**
	Category	Forest Land	Grassland	Cropland	Wetland	Settlements	Other Land	**(kha)**
Final (2001)	Forest Land	**2 000,95**	0,42	0,01	0,00	0,00	0,74	2 002,13
	Grassland	0,10	**862,20**	12,11	0,00	0,00	0,00	874,42
	Cropland	0,04	2,60	**1 562,35**	0,00	0,00	0,00	1 564,99
	Wetland	0,00	0,00	0,00	**94,00**	0,00	0,00	94,00
	Settlements	0,04	0,00	0,60	0,00	**219,34**	2,50	222,48
	Other Land	0,12	0,00	0,36	0,00	0,00	**145,92**	146,40
	Area (kha)	2 001,25	865,22	1 575,45	94,00	219,34	149,11	**4 904,40**

Year 2002		**Initial (2001)**						**Area**
	Category	Forest Land	Grassland	Cropland	Wetland	Settlements	Other Land	**(kha)**
Final (2002)	Forest Land	**2 001,98**	0,51	0,01	0,00	0,00	0,28	2 002,77
	Grassland	0,06	**872,81**	8,98	0,00	0,00	0,00	881,86
	Cropland	0,01	1,09	**1 555,39**	0,00	0,00	0,00	1 556,49
	Wetland	0,00	0,00	0,00	**94,00**	0,00	0,00	94,00
	Settlements	0,02	0,00	0,14	0,00	**222,48**	0,72	223,36
	Other Land	0,06	0,00	0,46	0,00	0,00	**145,57**	146,10
	Area (kha)	2 002,13	874,42	1 564,99	94,00	222,48	146,40	**4 904,60**

Year 2003		**Initial (2002)**						**Area**
	Category	Forest Land	Grassland	Cropland	Wetland	Settlements	Other Land	**(kha)**
Final (2003)	Forest Land	**2 002,45**	1,11	0,05	0,00	0,00	0,49	2 004,10
	Grassland	0,19	**878,76**	4,56	0,00	0,00	0,00	883,51
	Cropland	0,01	1,99	**1 551,37**	0,00	0,00	0,00	1 553,37
	Wetland	0,00	0,00	0,00	**94,00**	0,00	0,00	94,00
	Settlements	0,07	0,00	0,38	0,00	**223,36**	0,87	224,67
	Other Land	0,06	0,00	0,13	0,00	0,00	**144,65**	144,84
	Area (kha)	2 002,77	881,86	1 556,49	94,00	223,36	146,10	**4 904,50**

Year 2004		**Initial (2003)**						**Area**
	Category	Forest Land	Grassland	Cropland	Wetland	Settlements	Other Land	**(kha)**
Final (2004)	Forest Land	**2 004,08**	0,77	0,09	0,00	0,00	0,00	2 004,93
	Grassland	0,02	**878,88**	2,16	0,00	0,00	0,00	881,05
	Cropland	0,01	2,98	**1 551,13**	0,00	0,00	0,00	1 553,70
	Wetland	0,00	0,00	0,00	**94,00**	0,00	0,00	94,00
	Settlements	0,00	0,89	0,00	0,00	**224,67**	0,00	225,56
	Other Land	0,00	0,00	0,00	0,00	0,00	**144,82**	144,82
	Area (kha)	2 004,10	883,51	1 553,37	94,00	224,67	144,84	**4 904,50**

Year 2005		**Initial (2004)**						**Area**
	Category	Forest Land	Grassland	Cropland	Wetland	Settlements	Other Land	**(kha)**
Final (2005)	Forest Land	**2 004,39**	0,46	0,02	0,00	0,00	0,36	2 005,23
	Grassland	0,22	**879,92**	1,15	0,00	0,00	0,00	881,28
	Cropland	0,02	0,68	**1 551,00**	0,00	0,00	0,00	1 551,70
	Wetland	0,00	0,00	0,00	**94,00**	0,00	0,00	94,00
	Settlements	0,04	0,00	0,60	0,00	**225,56**	0,06	226,26
	Other Land	0,26	0,00	0,93	0,00	0,00	**144,43**	145,62
	Area (kha)	2 004,93	881,05	1 553,70	94,00	225,56	144,82	**4 904,10**

Year 2006		Initial (2005)						Area
	Category	Forest Land	Grassland	Cropland	Wetland	Settlements	Other Land	(kha)
Final (2006)	Forest Land	**2 005,00**	0,50	0,04	0,00	0,00	1,40	2 006,94
	Grassland	0,11	**879,78**	0,98	0,00	0,00	0,00	880,87
	Cropland	0,00	0,45	**1 549,36**	0,00	0,00	0,00	1 549,81
	Wetland	0,00	0,00	0,00	**94,00**	0,00	0,00	94,00
	Settlements	0,02	0,06	0,83	0,00	**226,18**	0,00	227,09
	Other Land	0,11	0,49	0,49	0,00	0,08	**144,20**	145,36
	Area (kha)	2 005,23	881,28	1 551,70	94,00	226,26	145,62	**4 904,10**

Year 2007		Initial (2006)						Area
	Category	Forest Land	Grassland	Cropland	Wetland	Settlements	Other Land	(kha)
Final (2007)	Forest Land	**2 006,49**	0,37	0,07	0,00	0,00	0,23	2 007,14
	Grassland	0,14	**879,69**	1,09	0,00	0,00	0,00	880,92
	Cropland	0,07	0,82	**1 547,09**	0,00	0,00	0,00	1 547,98
	Wetland	0,00	0,00	0,00	**94,00**	0,00	0,00	94,00
	Settlements	0,05	0,00	0,79	0,00	**227,09**	0,00	227,93
	Other Land	0,20	0,00	0,77	0,00	0,00	**144,98**	145,94
	Area (kha)	2 006,94	880,87	1 549,81	94,00	227,09	145,36	**4 904,00**

Year 2008		Initial (2007)						Area
	Category	Forest Land	Grassland	Cropland	Wetland	Settlements	Other Land	(kha)
Final (2008)	Forest Land	**2 006,82**	0,85	0,08	0,00	0,00	0,51	2 008,26
	Grassland	0,12	**878,49**	1,25	0,00	0,00	0,00	879,85
	Cropland	0,01	0,77	**1 542,84**	0,00	0,00	0,00	1 543,63
	Wetland	0,00	0,00	0,00	**94,00**	0,00	0,00	94,00
	Settlements	0,06	0,00	1,07	0,00	**227,93**	0,00	229,06
	Other Land	0,14	0,82	2,73	0,00	0,00	**144,65**	148,33
	Area (kha)	2 007,14	880,92	1 547,98	94,00	227,93	145,94	**4 903,80**

Year 2009		Initial (2008)						Area
	Category	Forest Land	Grassland	Cropland	Wetland	Settlements	Other Land	(kha)
Final (2009)	Forest Land	**2 007,80**	0,47	0,04	0,00	0,00	0,53	2 008,84
	Grassland	0,05	**877,16**	1,26	0,00	0,00	0,00	878,47
	Cropland	0,01	1,24	**1 538,21**	0,00	0,00	0,00	1 539,47
	Wetland	0,00	0,00	0,00	**94,00**	0,00	0,00	94,00
	Settlements	0,26	0,00	0,52	0,00	**229,06**	0,10	229,94
	Other Land	0,14	0,98	3,59	0,00	0,00	**148,25**	152,96
	Area (kha)	2 008,26	879,85	1 543,63	94,00	229,06	148,33	**4 903,10**

7.3 Methodological issues – methods

The methodology of GHG inventory is built up on the principles from the Revised IPCC 1996 Guidelines (GL 1996), Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories 2000 (GPG 2000), Good Practice Guidance for Land Use, Land-Use Change and Forestry 2003 (GPG LULUCF 2003) and partially IPCC Guidelines for National greenhouse gas inventories – Volume IV Agriculture, Forestry and Other Land Use 2006 (GL 2006). Based on the previous results there are two main sources/sinks in this sector:

- Changes in living biomass – Forest lands
- Land use conversion – Changes in soil organic carbon

The completeness of inventory is determined by several factors, especially by importance of the processes and data availability. The summary of all categories and subcategories in the Slovak National Inventory for LULUCF is described in the Table 7.5.

Table 7.5: The IPCC categories according to the GPG LULUCF 2003 in the Slovak Republic

5	**LULUCF**	**Inventory**				**Note**
5A1	***Forest Land***					
5A1 a	Forest Land Remaining Forest Land	Y	Living biomass	DOM	Soil C	
5A1 b	Land Converted to Forest Land	Y	Living biomass		Soil C	
5A1 b i	Cropland Converted to Forest Land	Y	Living biomass		Soil C	
5A1 b ii	Grassland Converted to Forest Land	Y	Living biomass		Soil C	
5A1 b iii	Wetlands Converted to Forest Land	NO				
5A1 b iv	Settlements Converted to Forest Land	NO				
5A1 b v	Other Land Converted to Forest Land	Y	Living biomass		Soil C	
5A2	***Cropland***					
5A2 a	Cropland remaining Cropland	Y	Living biomass			
5A2 b	Land Converted to Cropland	Y			Soil C	
5A2 b i	Forestland Converted to Cropland	Y	Living biomass	DOM	Soil C	
5A2 b ii	Grassland Converted to Cropland	Y			Soil C	
5A2 b iii	Wetlands Converted to Cropland	NO				
5A2 b iv	Settlements Converted to Cropland	NO				
5A2 b v	Other Land Converted to Cropland	Y			Soil C	
5A3	***Grassland***					
5A3 a	Grassland Remaining Grassland	NO				2
5A3 b	Land Converted to Grassland	Y			Soil C	
5A3 b i	Forestland Converted to Grassland	Y	Living biomass	DOM	Soil C	
5A3 b ii	Cropland Converted to Grassland	Y			Soil C	
53A3 b iii	Wetlands Converted to Grassland	NO				
5A3 b iv	Settlements Converted to Grassland	NO				
5A3 b v	Other Land Converted to Grassland	Y			Soil C	
5A4	***Wetlands***					
5A4 a	Wetlands Remaining Wetlands	Y				1
5A4 a i	CO_2 emissions from peat lands remaining pea lands	NO				1
5A4 a ii	CO_2 emissions from flooded land remaining flooded land	NO				1
5A4 b	Land Converted to Wetlands	NO				1
5A4 b i	CO_2 emissions from land being converted for peat extraction	NO				1
5A4 b ii	CO_2 emissions from land converted to flooded land	NO				1
5A5	***Settlements***					
5A5 a	Settlements Remaining Settlements	Y				
5A5 b	Land Converted to Settlements	Y			Soil C	
5A5 b i	Forest Land Converted to Settlements	Y	Living biomass	DOM	Soil C	
5A5 b ii	Cropland Converted to Settlements	Y			Soil C	
5A5 b iii	Grassland Converted to Settlements	Y			Soil C	
5A5 b iv	Wetlands Converted to Settlements	Y				
5A5 b v	Other Land Converted to Settlements	Y			Soil C	
5A6	***Other Land***					
5A6 a	Other Land Remaining Other Land	Y				
5A6 b	Land Converted to Other Land	Y			Soil C	
5A6 b i	Forest Land Converted to Other Land	Y	Living biomass	DOM	Soil C	
5A6 b ii	Cropland Converted to Other Land	Y			Soil C	
5A6 b iii	Grassland Converted to Other Land	Y			Soil C	
5A6 b iv	Wetlands Converted to Other Land	Y				
5A6 b v	Settlements Converted to Other Land	Y			Soil C	
5C1	*N fertilization of Forest land and Other*		*NO*			1
5C2	*Drainage of soil and wetland*		*NO*			1
5C3	*cropland*		*NO*			1
5C4	*Liming of Agricultural soils*		*Y*			
5C5	*GHG emission from biomass burning*		*Y*			
5C5 a i	*Emissions from biomass burning in forest lands*		*Y*			
5C5 a ii	*Emissions from biomass burning in croplands*		*NO*			1
5C5 a iii	*Emissions from biomass burning in grasslands*		*NO*			1
5C5 a iv	*Emissions from biomass burning in other lands*		*NO*			1
3C6	*Other(Please specify)*		*NO*			1

Notes: 1 –Source under estimation threshold, 2 – lack of activity data

7.4 Forest land (CRF 5.A)

7.4.1 Source category description

Forest currently covers 41% of the Slovak Republic area. All forests can be considered as temperate-zone managed forests. Slovak forests are known for their richly diverse species composition with European beech being the dominant forest cover (31.2%) followed by Norway spruce (25.9%) and oaks (13.4%). At present, forest management is focused more on close-to-nature silvicultural procedures and establishment of forest stands with better structural and species diversity and higher ecological stability. Split by main species groups is as follows: coniferous forests 31%, broadleaved forests 50%, and mixed forests 19%. The growing stock has shown a continual increase in the volume of timber available in forests. In 2008, the growing stock was estimated at 456.4 million m^3 (merchantable volume, define as tree stem and branch volume under bark with minimum diameter threshold of 7 cm). Average hectare growing stock was put at 237 m^3. Volume of harvest timber increased inter annually to 9 248 million m^3 – the second largest volume ever recorded in the Slovak Republic (Green Report 2009).

All actually available information of forests is based on the Forest Management Plans (FMP), which are usually updated on a cyclical basis. Investigation is carried out in a 10-years period – i.e. one tenth of the territory is surveyed each year using growth tables and ocular estimate methods. Gathered data are stored in databases and further processed into aggregated files used for reporting and compilation of various documents including the Compendium of Forestry Statistics, Aggregated Forest Management Plan (AFMP) and the Permanent Forest Inventory (PFI). Aggregated data refer to the various time levels and have different time relevance (1–10 years). Their accuracy and reliability is to a large extent unknown and it is impossible to secondarily calculate. The second source of information consists of the data from first cycle of the statistical (sample based, tree level) forest inventory performed during 2005 – 2006 by the National Forest Centre. The National Forest Inventory and Monitoring (NFIM) is a selective statistical method of forest condition inventory. It has two levels – national and regional, and provides data for all forests regardless of land category (forest, non-forest). NFIM provided a comprehensive set of data on forests correct to 31st December 2005. Accuracy and reliability of provided outcomes meets the quality expected at the beginning of investigation (standard error 2.1% for total standing volume). The NFIM data for forest land area match those from AFMP based on different investigation methods, but the volume of growing stock obtained from NFIM is 23% higher than that entered in FMP (Green Report 2009). This source of data is not usable for detection of carbon stock changes in forests, because only one inventory cycle was performed. But it is usable for estimation of carbon pools for example dead organic matter – dead wood.

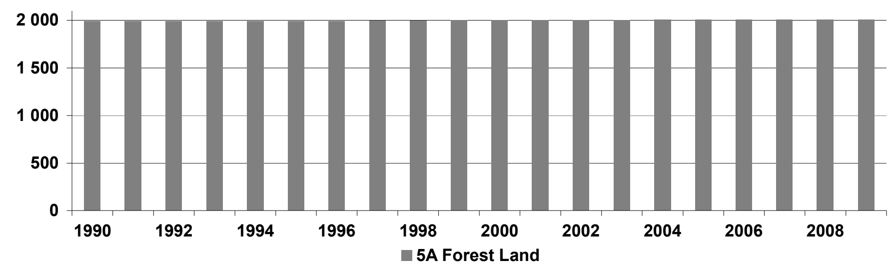
7.4.2 Methodological issues – methods

This category (5A) includes emissions and removals of CO_2 associated with forests. Category consists from two parts 5.A.1 Forest land remaining Forest land and 5.A.2 Land converted to Forest land.

7.4.2.1 Forest land remaining Forest land (CRF 5.A.1)

Calculations are based on the principles defined in IPCC GPG LULUCF (2003), IPCC GL for AFOLU (2006) and data from the „Permanent Forest Inventory“ processed in the Slovak Republic continuously each year. Results of calculations were obtained by using the new LULUCF methodology (IPCC GPG LULUCF 2003) and national data on area of forested land and land converted to the forest during the inventory year 2008. This category should include the stock carbon changes in five carbon pools: living biomass – above and below ground, dead organic matter - coarse woody debris and litterfall, and soil organic carbon. Carbon stocks changes in this category are given by the sum of changes in living biomass, dead organic matter and soils.

Figure 7.4: Development of activity data (kha) for category 5A Forest land in the period 1990 – 2009



The total area of Forest land remaining Forest land category represents 1 975.50 kha, the changes in the Forest land were following: Grassland converted to FL 17.57 kha, Cropland converted to FL 1.94 kha and Other land converted to FL 13.84 kha per 2009. Total forest area in 2009 was 2 008.84 kha.

The carbon stock change in living biomass was estimated by using a default method according to equation 3.2.2 of the IPCC GPG LULUCF (2003). This method is based on separate estimation of increments and removals, and their difference. Calculations of stock carbon changes in living biomass as a result of annual biomass increment and annual biomass loss were carried out by using the equations 3.2.4 - 3.2.6 (IPCC GPG LULUCF 2003).

According to the present knowledge, about 55–90% (depending on tree species) of total tree's biomass can be assumed to be stored in stems. The density of wood (at dry weight) varies from 350 to 800 kg/m^3. The biomass conversion/expansion factors, showed in Table 7.6 were educed using experimental data source for main forest tree species. Together with the carbon content of 50% for coniferous resp. 49.9% for broadleaved wood were used for calculation of carbon gains and losses in living biomass. The total carbon stored in biomass of forest trees was 157.4 Tg C in 1990. The average stock of carbon varies from 47.9 (Poplars) to 108.8 (Beech) tons of carbon per hectare.

Table 7.6: Total carbon uptake increment for individual forest tree species in the Slovak Republic

Tree Species		Area of Forest/Biomass Stocks	Annual Growth Rate	Annual Biomass Increment	Biomass Conversion/ Expansion	Carbon Fraction of dm	Total Carbon Uptake Increment
		kha	t dm/ha	kt dm	t dm/m^3		kt C
Picea abies	Spruce	503,75	3,50	1 762,66	0,60	0,50	**881,33**
Abies alba	Fir	79,41	3,60	285,73	0,60	0,50	**142,87**
Pinus sp.	Pine	139,07	3,52	489,50	0,80	0,50	**244,75**
Larix decidua	Larch	47,02	3,71	174,40	0,80	0,50	**87,20**
Other coniferous		22,13	4,58	101,36	0,60	0,50	**50,68**
Quecus robur, petr.	Oak	212,37	4,29	910,26	1,30	0,49	**446,03**
Fagus sylvatica	Beech	623,86	5,89	3 671,66	1,20	0,49	**1 799,11**
Carpinus betulus	Hornbeam	113,99	5,51	627,87	1,10	0,49	**307,65**
Acer sp.	Maple	41,88	5,05	211,70	1,10	0,49	**103,73**
Fraxinus excelsior	Ash	29,63	4,99	147,77	1,00	0,49	**72,41**
Ulmus sp.	Elm	0,79	4,82	3,81	1,00	0,49	**1,87**
Quercus cerris	Pubescent oak	49,58	4,71	233,79	1,30	0,49	**114,56**
Robinia pseudoac.	Robinia	34,18	2,99	102,26	1,20	0,49	**50,11**
Betulus sp.	Birch	28,64	1,54	44,15	0,80	0,49	**21,64**
Alnus sp.	Alder	15,01	2,53	38,01	0,90	0,49	**18,62**
Tilia sp.	Linden	7,70	4,01	30,86	0,80	0,49	**15,12**
Breeding poplars		7,51	2,59	19,45	0,60	0,49	**9,53**
Populus sp.	Poplar	9,48	1,43	13,54	0,60	0,49	**6,64**
Salix sp.	Willow	1,98	2,23	4,40	1,00	0,49	**2,15**
Other broadleaves		7,51	1,32	9,91	1,10	0,49	**4,86**
Total		**1 975,50**	**3,64**	**8 883,08**			**4 380,85**

The equation for estimating the annual carbon loss due to commercial felling is provided in equation 3.2.7 (IPCC GPG LULUCF 2003). The annual amount of total harvest removals and fuel wood removals are published in the Green Reports annually. The current age structure of Slovak forests and its foreseen development suggest a gradual increase in the volume of mature felling. The predictions are based on the currently abnormal per cent of premature forests (both in terms of area and growing stock volume) coming to rotation in next few decades. In the next 30 to 40 years, the volume of total felling is projected to grow; in the same period, the volume of intermediate felling is expected to fall. Annual allowable cut represents one of the main indicators of management planning and is obligatorily entered in the Forest Management Plans. The carbon loss due to fuelwood gathering is estimated using equation 3.2.8. GPG LULUCF 2003.

The area of category Forest land remaining the Forest land was1 975.5 kha in 2009, the changes in forest land were following: 1.94 kha of Cropland were converted to Forest land, 17.57 kha of Grassland were converted to Forest land and 13.84 kha of Other land were converted to Forest land in 2009. Total estimated forest area was 2 008.84 kha in 2009. The annual tree biomass increment per hectare (resulting from the application of annual wood volume increment data and biomass conversion/expansion factor) varies from 1.3 to 5.9 t dm/ha. The total annual carbon increment in tree biomass is 4 382.45 kt C. The total annual carbon consumption from forest harvest in the Slovak forests is -3 694.60 kt C.

Table 7.7: Total biomass consumption from stocks for individual forest tree species in the Slovak Republic

Tree Species		Commercial Harvest	Total Biomass Removed in Harvest	Total Fuelwood Consumed	Other Wood Use	Total Biomass Consumption from Stocks
		1 000 m³	kt dm	kt dm	kt dm	kt dm
Picea abies	Spruce	2 398,34	1 439,01	74,67	874,11	2 387,78
Abies alba	Fir	675,54	353,62	6,64	197,62	557,88
Pinus sp.	Pine	586,18	409,12	44,61	297,28	751,01
Larix decidua	Larch	81,02	56,55	8,77	65,87	131,19
Other coniferous		0,00	0,00	0,00	0,00	0,00
Quecus robur, petr.	Oak	228,57	299,47	26,67	136,13	462,27
Fagus sylvatica	Beech	1 252,52	1 514,75	140,60	818,68	2 474,03
Carpinus betulus	Hornbeam	55,47	61,50	15,00	130,54	207,04
Acer sp.	Maple	36,98	41,00	3,22	23,21	67,43
Fraxinus excelsior	Ash	21,40	21,56	14,65	14,07	50,28
Ulmus sp.	Elm	15,28	15,40	0,00	0,00	15,40
Quercus cerris	Pubescent oak	59,60	78,09	8,95	44,48	131,51
Robinia pseudoac.	Robinia	47,68	57,66	8,93	55,12	121,72
Betulus sp.	Birch	13,45	10,84	1,61	14,55	27,00
Alnus sp.	Alder	5,50	4,99	1,12	3,45	9,55
Tilia sp.	Linden	0,37	0,30	0,00	0,00	0,30
Breeding poplars		43,10	26,06	0,74	12,63	39,44
Populus sp.	Poplar	9,17	5,55	0,19	3,45	9,18
Salix sp.	Willow	4,58	4,62	0,46	2,87	7,96
Other broadleaves		5,04	5,59	0,40	4,91	10,90
Total		**5 539,80**	**4 405,67**	**357,24**	**2 698,97**	**7 461,87**

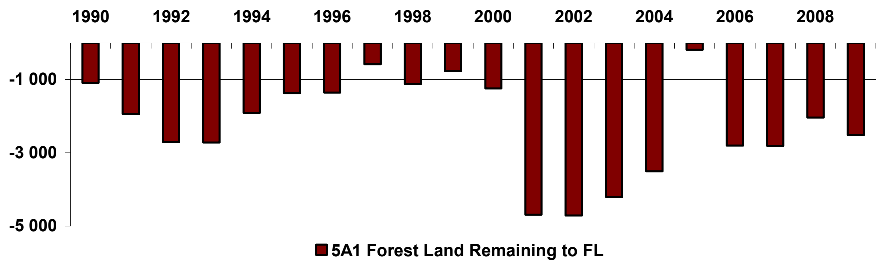
The assessment of the net carbon stock change in DOM (dead wood and litter) followed the tier 1 approach (GPG LULUCF 2003) assumption of zero change in these carbon pools. This is a conservative assumption, if the country did not experience significant changes in forest types, disturbance or management regimes within the reporting year. The total carbon stocks located in soil organic matter of mineral forest soils to 100 cm depth (without surface organic layer) were estimated for 270 Mt of C. The carbon stock in soil to 20 cm depth represents about 50% of it, resp. in soil to 50 cm about 83% of it. Information on soil carbon stocks in forest soils is based on databases from soil survey on permanent monitoring plots (16x16 km grid of large-scale forest monitoring), soil survey on NFI (National Forest Inventory) plots and set of research plots. The most detailed information source with respect to soil depth (L, F, H layers, 0-10 cm, 10-20 cm, 20-40 cm, 40-80 cm) and sampling design is the set of 112 plots (large-scale forest monitoring) and 9 intensive monitoring plots. The largest and most representative information source is the set of plots of the National Forest Inventory – almost 1 500 plots but with sampling depth limited to 20 cm. Carbon stocks per hectare (in both data sources) are calculated using information on C concentration in fine earth, bulk density and coarse fragment content. Supplementary information about carbon content and carbon stock in forest soils comes also from other research plots with detailed soil profile description and classification. It is used mainly for derivation of indices for recalculation of carbon stocks for different depths and respective soil types or site units. Evaluation of changes from re-sampling after 13 years in 16x16 km grid of plots as well as the validation and final data management from NFI plots has not been finished yet and for this reason the results are not yet used for improvement of calculation of carbon stocks and changes based on measured data. For estimation of carbon stock change for mineral soils carbon pool tier 1 approach was followed and soil carbon stocks change in 5.A.1 (Forests remain Forests) was considered to equal zero and mean the facts that it did not change.

Table 7.8: Carbon fraction and net annual carbon uptake or release for individual forest tree species

Tree Species		Total Biomass Consumption from Stocks	Carbon Fraction	Annual Carbon Release	Net Annual Carbon Uptake (+) or Release (-)	Convert to CO_2
		kt dm		kt C	kt C	Gg CO_2
Picea abies	Spruce	2 387,78	0,50	1 193,89	-312,56	**-1 146,05**
Abies alba	Fir	557,88	0,50	278,94	-136,07	**-498,93**
Pinus sp.	Pine	751,01	0,50	375,51	-130,76	**-479,44**
Larix decidua	Larch	131,19	0,50	65,60	21,60	**79,21**
Other coniferous		0,00	0,50	0,00	50,68	**185,82**
Quecus robur, petr.	Oak	462,27	0,49	226,51	219,51	**804,89**
Fagus sylvatica	Beech	2 474,03	0,49	1 212,27	586,84	**2 151,74**
Carpinus betulus	Hornbeam	207,04	0,49	101,45	206,20	**756,08**
Acer sp.	Maple	67,43	0,49	33,04	70,69	**259,21**
Fraxinus excelsior	Ash	50,28	0,49	24,64	47,77	**175,17**
Ulmus sp.	Elm	15,40	0,49	7,55	-5,68	**-20,83**
Quercus cerris	Pubescent oak	131,51	0,49	64,44	50,11	**183,75**
Robinia pseudoac.	Robinia	121,72	0,49	59,64	-9,53	**-34,96**
Betulus sp.	Birch	27,00	0,49	13,23	8,40	**30,82**
Alnus sp.	Alder	9,55	0,49	4,68	13,94	**51,13**
Tilia sp.	Linden	0,30	0,49	0,15	14,98	**54,91**
Breeding poplars		39,44	0,49	19,32	-9,80	**-35,92**
Populus sp.	Poplar	9,18	0,49	4,50	2,14	**7,84**
Salix sp.	Willow	7,96	0,49	3,90	-1,74	**-6,40**
Other broadleaves		10,90	0,49	5,34	-0,49	**-1,79**
Total		**7 461,87**		**3 694,60**	**687,85**	**2 516,26**

Net CO_2 removal from the forest land was -2 516.26 Gg of CO_2 in 2009. It is necessary to mention that almost total forest area of the Slovak Republic is managed; it means that total annually uptake on woody areas for last 100 years and the harvest from deforestation are included in this category. The uptake of carbon into the biomass of forest trees has been slightly increased since 1990 despite a high fluctuation of carbon release in this category and it is a determining factor of the final balance difference. The category of fuel wood is connected to the energy sector (fuel combustion) where other gases are balanced. Total decrease in removals from the managed forest land in the Slovak Republic is more than 10% compared to 1990

Figure 7.5: Summary results of CO_2 removals (Gg) from 5A1 in 1990 – 2009



7.4.2.2 Land converted to Forest land (CRF 5.A.2)

This activity is closely connected with artificial or natural regeneration. The Green Report (GR 2009) confirmed the decreasing trend in the total volume of artificial regeneration. Improvements in the implementation of shelterwood system and soil disturbance increased the rate of natural regeneration to 41% in 2009. The calculation net carbon stock change in living biomass, DOM and in the mineral soil is included in this category. Tier 1 method (IPCC 2003) was used for calculation of carbon stocks change in first two carbon pools. Changes in carbon stocks in living biomass on land converted to forest land through the forest regeneration were estimated with the use of equation 3.2.22 (GPG LULUCF 2003).

The carbon increment is proportional to the extent of afforested areas and the yearly growing biomass. The new afforested areas were determined from cadastral database. The annual increment of the total tree biomass for four main tree species including Norway spruce, Scotch pine, European beech and Sessile oak were selected from experimental database of the National Forest Centre. The annual increment of the total tree biomass for the four main tree species included in the inventory are following: spruce 3.30 t dm/ha/y, pine 3.57 t dm/ha/y, beech 3.21 t dm/ha/y, oak 1.80 t dm/ha/y. The ratio of main tree species from total natural regeneration areas for different years was selected from database of the Slovak Statistical Office and represented 34% of spruce, 12% of pine, 47% of beech and 7% of oak. The carbon loss connected with living biomass due to by silvicultural cuttings in the category of land converted to forest land was assumed to be insignificant (zero). The reason is that the first significant thinning occurs in older age forest stands. The net carbon stock change in dead organic matter was assumed to be insignificant (zero), in accordance with the assumptions of tier 1 method (GPG LULUCF 2003). Methods to quantify emissions and removals of carbon in dead organic matter pools following conversion of land to forest land require estimates of the carbon stocks just prior to and just following conversion, and the estimates of the areas of lands converted during the period. Most of the land uses categories (CL, GL, OL) does not produce dead wood or litter (GL is producing litter, but this data does not exist in Slovakia), so that corresponding carbon pools prior to conversion can be taken as zero amount. The net carbon stock change in mineral soils was estimated using the country specific tier 2 method. It was based on existing data sets from soil inventories and published information with the default assumption of 20 years period for carbon stock equilibrium in „new land use“ conditions. The mean soil organic carbon stocks for main soil units and land use categories in Slovakia calculated from above mentioned data vary between 16 and 200 Mg C ha^{-1}. For respective land use categories following values (calculated as weighted average) were used for calculations of stock carbon changes in mineral soils as a result of land use change:

- Forest land 166.1 Mg C ha^{-1}
- Grassland 129.7 Mg C ha^{-1}
- Cropland 108.6 Mg C ha^{-1}
- Other land 97.3 Mg C ha^{-1}

The same values was used as in previous reports as validation and final data management from the NFI plots has not been finished yet and for this reason the results are not yet used for improvement of calculation of carbon stocks and changes.

Table 7.9: The land use matrix since 1989 to 2009

Year 2009		Initial (1989)						Area
	Category	Forest Land	Grassland	Cropland	Wetland	Settlements	Other Land	**(kha)**
Final (2009)	Forest Land	**1 975,50**	17,57	1,94	0,00	0,00	13,84	2 008,84
	Grassland	5,45	**761,04**	107,09	0,00	0,00	4,89	878,47
	Cropland	0,51	25,89	**1 512,50**	0,00	0,00	0,57	1 539,47
	Wetland	0,00	0,00	0,00	**94,00**	0,00	0,00	94,00
	Settlements	1,29	3,21	8,39	0,00	**124,48**	92,57	229,94
	Other Land	3,28	4,99	10,20	0,00	0,62	**133,87**	152,96
	Area (kha)	1 986,03	812,70	1 640,12	94,00	125,11	245,73	**4 903,68**

Removals from this category were estimated to be -317.87 Gg CO_2 in 2009. The net carbon stock change in soil from Land converted to Cropland represented gains of 85.10 Gg C in the reporting year.

Table 7.10: The results of the category 5A2 Land converted to Forest land in 2009

Land Use Category	Carbon stock change in living biomass (Gg C)			Net carbon stock change in DOM (Gg C)	Net carbon stock change in soil (Gg C)	Net CO_2 emission/removals (Gg CO2)
	gains	losses	net change			
Land converted to FL	**1,60**	**NA,NO**	**1,60**	**NA,NO**	**85,10**	**-317,89**
GF	0,72	NO	0,72	NO	31,96	-119,85
CF	0,07	NO	0,07	NO	5,55	-20,58
WF	NA	NA	NA	NA	NA	NA
SF	NO	NO	NO	NO	NO	NO
OF	0,81	NO	0,81	NO	47,59	-177,46

7.4.3 Methodological issues – emission factors and parameters

Information about emission factors and other parameters are described in the sections 7.4.2.1 and 7.4.2.2.

7.4.4 Activity data

Information about activity data are described in the sections 7.4.2.1 and 7.4.2.2.

7.4.5 Uncertainties and time consistency

According to the expert estimation and based on statistical approach for the estimation of wood stocks in the Slovak forest; 20% is in the category 5.A. The time series is consistent with the consistent methodology, activity data collection and using emission factors and other parameters.

7.4.6 Source specific QA/QC and verification

The completeness of the inventory is determined by several factors, especially by the importance of processes and data availability. Dr. T. Priwitzer (external expert of LULUCF KP for SHMÚ) took responsibility for the inventory emission balance from LULUCF. The completeness of inventory is determined by several factors, especially by importance of the processes and data availability. All calculation has been based on the activity data taken from official national sources, such as the National Forest Centre (NFC), the Ministry of Agriculture, the Office of Geodesy, Cartography and Cadastre Authority of the Slovak Republic (GCCA), the Slovak Statistical Office (SSO). The input information, data and calculations are archived by the national experts and coordinator of NIS. Therefore, all background data and calculation are verifiable and data are updated annually.

Table 7.11: The sources of activity data, methodology, uncertainty, references and planned improvements

Input Activity Data	Area of forest land remaining forest land by tree species.	The Statistical Yearbook of the Soil Resources in the SR
	Average annual increment rate in total biomass by forest tree	The Permanent Forest Inventory (National Forest Centre)
	Carbon fraction of dry matter.	Pozgaj et al. 1993
	Biomass conversion/expansion factors for conversion of annual net increment (including bark) to aboveground tree	Pozgaj et al. 1993, Sebik, L. 1989
	Annual loss due to commercial fellings, fuelw ood and other losses of biomass.	The Permanent Forest Inventory (National Forest Centre)
Uncertainty	20%	Based on the statistical approach for estimation w oodstocks in Slovak forest
Changes in methods	2003	IPCC GPG LULUCF time series w ere recalculated

7.4.7 Source specific recalculations

The category Forest land was recalculated for whole time period since 1990. The main reason was using new areas and their changes obtained from the Office of Geodesy, Cartography and Cadastre Authority of the Slovak Republic (GCCA). It affected the estimation of emissions /removals of GHGs for the categories 5.A.1 Forest land remaining Forest land, as well as for 5.A.2 Land converted to Forest land.

7.4.8 Source specific planned improvements

Following improvements are planned for this category for the next submission:

- Determination new annual biomass increments for all tree species.
- Estimation more accurate soil carbon stocks data for forest soils.
- Improve the estimation of DOM carbon pools.

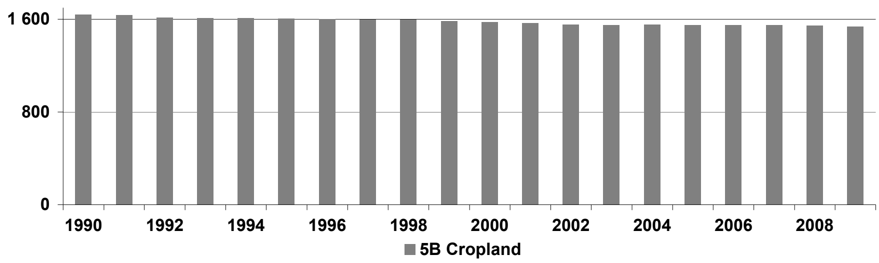
NFC has applied for the research project: Research on the characteristics of dead wood as an important part of forest ecosystems in Slovakia. The project application is currently under consideration.

7.5 Cropland (CRF 5.B)

7.5.1 Source category description

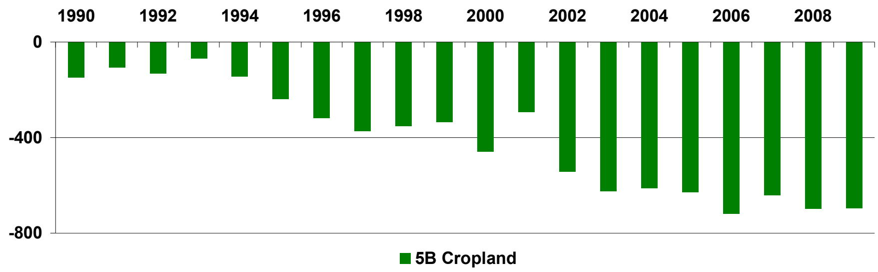
The emission and removals of GHGs in this category were obtained by using the methodology described in the GPG LULUCF (IPCC 2003) and national data on area of cropland and land converted to the cropland during the inventory year 2009. The total area of cropland represented 1 539.47 kha in 2009, this is approximately 31% of the total area of the country. This land use category has constantly decreased during whole reporting period, even since 1970.

Figure 7.6: Development of activity data (kha) for category 5B Cropland in the period 1990 – 2009



The total area of Cropland remaining Cropland represents 1 512.50 kha, the changes in the Cropland were following: Cropland converted to FL 0.51 kha, Cropland converted to the GL 25.89 kha and Other land converted to Cropland 0.57 kha per 2009. Total cropland area in 2009 represents 1 539.47 kha.

Figure 7.7: CO_2 balance (Gg) for category 5B Cropland in 1990 – 2009



7.5.2 Cropland remaining Cropland (CRF 5.B.1)

The emission inventory in this category included only net carbon stock change in living biomass, especially in perennial woody crops. In Slovak condition perennial woody crops includes vineyards, orchards and gardens and represented 120.96 kha in 2009. For calculation the change in biomass carbon stocks of Cropland remaining Cropland were used tier 1 method of GPG LULUCF (IPCC 2003). The annual change of carbon stocks in biomass was calculated using Equation 2.7 from GPG AFOLU (IPCC 2006). The immature perennial woody cropland area accumulates carbon at a rate of approximately 2.1 t of above ground C ha^{-1} yr^{-1}. Default above ground biomass carbon stock at harvest for a temperate perennial woody cropland are 63 t C/ha (Table 5.1 IPCC 2006).

In general, croplands will have little or no dead wood, crop residues or litter, with the exception of agroforestry systems which may be accounted under either cropland or forest land, depending upon definitions adopted by countries for reporting. Tier 1 method assumes that the dead wood and litter stocks are not present in cropland or are at equilibrium as in agroforestry systems and orchards. Thus, there is no need to estimate the carbon stock changes for these pools GPG AFOLU (IPCC 2006).

7.5.3 Land converted to Cropland (CRF 5.B.2)

This category includes all processes connected with the conversion of lands into croplands. Land conversion to cropland from forest land and grassland usually results in a net loss carbon from biomass and soils to the atmosphere (IPCC 2003). With regard to changes in carbon stocks in living biomass, we have only calculated losses for conversion from forest and grassland.

7.5.3.1 Methodological issues – methods

For calculation of carbon stock changes in biomass was used tier 1 method GPG AFOLU (IPCC 2006). Tier 1 method follows the approach in used by forest land where the amount of biomass that is cleared for cropland is estimated by multiplying the area converted in one year by the average carbon stock in biomass in the forest land or grassland prior to conversion. For calculation of biomass carbon stocks on forest land prior conversion, the annually updated average growing stock volumes, BCEFs (0.7 for conifers and 1.2 for broadleaf) and default carbon content (0.5) were used. For biomass carbon stock on grassland prior the conversion a default values of 6.5 t/ha for above ground and below ground biomass were used (Table 6.4, IPCC 2006). Amount of biomass of 0 t/ha was assumed after land conversion to cropland. Methods to quantify emissions and removals of carbon in dead organic matter pools following conversion of land to forest land require estimates of the carbon stocks just prior to and just following conversion. For the estimation of deadwood prior the conversion in forest land was used the data obtained from the first National Forest Inventory realised in 2005/2006.

7.5.3.2 Methodological issues – emission factors and parameters

It provides data, published on the mean deadwood biomass stocks (m^3/ha) separately for coniferous and broadleaves in the following categories: standing dead trees, stumps, coarse laying deadwood and small-sized laying deadwood. Each of mentioned categories was classified in four categories according to decomposition degree as a fresh, hard, soft and decomposed deadwood. The deadwood carbon stock was estimated from mean deadwood biomass stocks (m^3/ha), dry wood density weighted by mean growing stock volume of coniferous (0.425 t/m^3) and broadleaves (0.675 t/m^3) tree species, reduction coefficient 0.8, 0.5, 0.5 and 0.2 and applicable to above described decomposition degrees and default carbon content (0.5 t C/t biomass). Because the cropland does not produce deadwood this carbon pools after conversion can be taken as zero as a default assumption.

7.5.3.3 Activity data

The calculation of stock carbon changes in mineral soils was based on the data from the soil inventory with the default assumption of 20 years period for carbon stock equilibrium in „new land use“ conditions. Calculations of stock carbon changes in mineral soils as a result of Forest land and

Grassland conversion to Cropland carried out as follows GPG LULUCF (IPCC 2003). The net carbon stock change in mineral soils was estimated using the country specific tier 2 method described in detail in section 7.2. For estimation of net carbon stock change in mineral soil were used the average carbon stock per hectare noted above (category 5.A.2. Land converted to Forest land).

Table 7.12: Land use matrix since 1989 to 2009

Year 2009		Initial (1989)						Area
	Category	Forest Land	Grassland	Cropland	Wetland	Settlements	Other Land	**(kha)**
Final (2009)	Forest Land	**1 975,50**	17,57	1,94	0,00	0,00	13,84	2 008,84
	Grassland	5,45	**761,04**	107,09	0,00	0,00	4,89	878,47
	Cropland	0,51	25,89	**1 512,50**	0,00	0,00	0,57	1 539,47
	Wetland	0,00	0,00	0,00	**94,00**	0,00	0,00	94,00
	Settlements	1,29	3,21	8,39	0,00	**124,48**	92,57	229,94
	Other Land	3,28	4,99	10,20	0,00	0,62	**133,87**	152,96
	Area (kha)	1 986,03	812,70	1 640,12	94,00	125,11	245,73	**4 903,68**

Table 7.13: Results from the category 5.B.2 Land converted to Cropland

Land Use Category	Carbon stock change in living biomass (Gg C)			Net carbon stock change in DOM (Gg C)	Net carbon stock change in soil (Gg C)	Net CO2 emission/removals (Gg CO_2)
	gains	losses	net change			
Land converted to CL	NO	16,48	-16,48	-0,07	-28,10	163,71
FC	NO	2,18	-2,18	-0,07	-1,46	13,60
GC	NO	14,31	-14,31	NA	-26,96	151,31
WC	NA	NA	NA	NA	NA	NA
SC	NA	NA	NA	NA	NA	NA
OC	NO	NO	NO	NO	0,33	-1,20

7.5.4 Uncertainties and time consistency

According to the expert estimation and based on statistical approach for the estimation of wood stocks in the Slovak forest, 50% is in the category 5.B. The time series is consistent with the consistent methodology, activity data collection and using emission factors and other parameters.

7.5.5 Source specific QA/QC and verification

The completeness of the inventory is determined by several factors, especially by the importance of processes and data availability. All calculation has been based on the activity data taken from the official national sources, such as the National Forest Centre (NFC), the Ministry of Agriculture, the Office of Geodesy, Cartography and Cadastre Authority of the Slovak Republic (GCCA) and the Slovak Statistical Office (SSO). The input information, data and calculations are archived by the national experts and the NIS coordinator. Therefore, all background data and calculation are verifiable. Besides this all data are updated annually. Dr. T. Priwitzer (external expert of LULUCF KP for SHMÚ) took responsibility for the inventory emission balance from LULUCF.

Table 7.14: The sources of activity data, methodology, uncertainty, references and planned improvements

Input Activity Data	Soil organic carbon stocks for individual land categories.	Partial monitoring system "Soil" (Soil science and Conservation Research Institute Bratislava).
	Time period for conversion.	T=20 years (default value)
	Land area of each soil types per land categories.	Soil map of Slovakia, Land Corine map of Slovakia.
Uncertainty	50%	Based on the expert judgment.
Changes in methods	2003	IPCC GPG LULUCF time series w ere recalculated

7.5.6 Source specific recalculations

The category Cropland was recalculated for whole time period since 1990. The main reason was using new areas and their changes obtained from the Office of Geodesy, Cartography and Cadastre Authority of the Slovak Republic (GCCA). It affected the estimation of emissions/removals of GHGs for the categories 5.B.1 Cropland remaining Cropland as well as for 5.B.2 Land converted to Cropland.

7.5.7 Source specific planned improvements

Following improvements are planned for this category for the next submission:

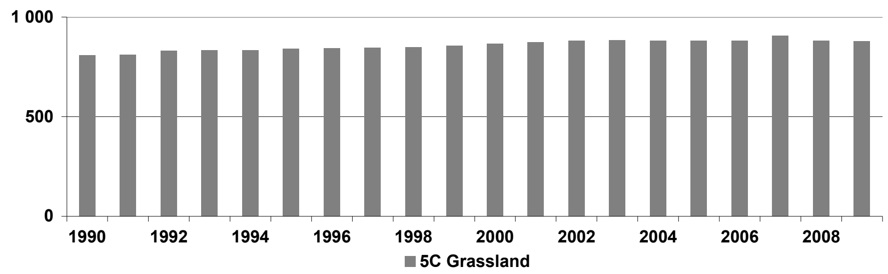
- Estimation more accurate soil carbon stocks data for agricultural soils.
- Improving the estimation of DOM carbon pools.

7.6 Grassland (CRF 5.C)

7.6.1 Source category description

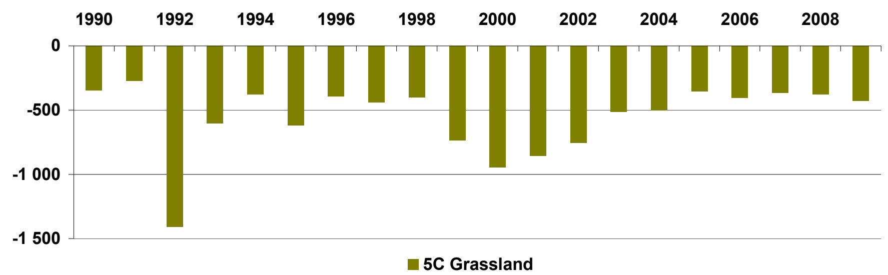
The emission and removals of GHGs in this category were obtained by using the GPG LULUCF methodology (IPCC 2003) and national data on area of grassland and land converted to the grassland during the inventory year 2009. The total area of grassland represented 878.47 kha in 2009, this is approximately 18% of the total area of country. Grassland areas decreased from 1980 to beginning of 1990 and since this year started increasing to 2005. Since 2005 shows moderately downward trend.

Figure 7.8: Development of activity data (kha) for category 5.C Grassland in 1990 – 2009



The total area of Grassland remaining Grassland in 2009 was 761.04 kha, the changes in the grassland were following: Forest land converted to Grassland 5.45 kha, Cropland converted to the Grassland 107.09 kha, Other land converted to Grassland 4.89 kha per 2009.

Figure 7.9: CO_2 balance (Gg) for category 5.C Grassland in 1990 – 2009



7.6.2 Grassland remaining Grassland (CRF 5.C.1)

Tier 1 approach assumes no change in living biomass in grassland remaining grassland. This approach was used in the Slovak GHG emissions/removals inventory for this category. This is a conservative assumption for the conditions in country where any application of higher tier approaches would not be justified with respect to data requirements and the expected insignificant stock changes. In grassland where there is no change in either type or intensity of management, biomass will be in an approximate steady-state (carbon accumulation through plant growth is roughly balanced by losses through grazing, decomposition and fire).

7.6.3 Land converted to Grassland (CRF 5.C.2)

7.6.3.1 Methodological issues – methods

This category includes all process connecting with conversion of lands into grassland. For calculation of carbon stock changes in biomass was used tier 1 method GPG AFOLU (IPCC 2006). Tier 1 methods require estimates of the biomass of the land use before conversion and after conversion. It is assumed that all biomass is cleared when preparing a site for grassland use, thus, the default for biomass immediately after conversion is 0 t/ha. Tier 1 method follows the approach in chapter Forest land where the amount of biomass that is cleared for grassland is estimated by multiplying the area converted in one year by the average carbon stock in biomass in the forest land or cropland prior to conversion.

7.6.3.2 Methodological issues – emission factors and parameters

For calculation of biomass carbon stocks on forest land prior conversion, the annually updated average growing stock volumes, BCEFs (0.7 for conifers and 1.2 for broadleaf) and default carbon content (0.5) were used. For biomass carbon stock on grassland prior the conversion a default values of 5.0 t C/ha for above ground and below ground biomass were used (Table 5.9, IPCC 2006). Carbon stock from one-year growth grassland vegetation following the conversion was assumed to be 6.5 t C/ha (Table 3.4.9, IPCC 2003). Estimation of DOM emission included the emission due to changes in deadwood included in forest land. The calculation procedure is identical as described in detail in land converted to cropland above.

7.6.3.3 Activity data

The calculation of stock carbon changes in mineral soils was based on the data from the soil inventory with the default assumption of 20 years period for carbon stock equilibrium in „new land use" conditions. Calculations of stock carbon changes in mineral soils as a result of Forest land, Cropland conversion to Grassland carried out as follows GPG LULUCF (IPCC 2003). The net carbon stock change in mineral soils was estimated using the country specific tier 2 method. For estimation of net carbon stock change in mineral soil were used the average carbon stock per hectare noted above category 5.A.2. Land converted to Forest land). Removals from this category were estimated at -426 Gg CO_2 in 2009. The net carbon stock change in soil from Land converted to Grassland represented gains of 109.53 Gg C in the reporting year.

Table 7.15: Land use matrix since 1989 to 2009

Year 2009		Initial (1989)						Area
	Category	Forest Land	Grassland	Cropland	Wetland	Settlements	Other Land	**(kha)**
Final (2009)	Forest Land	**1 975,50**	17,57	1,94	0,00	0,00	13,84	2 008,84
	Grassland	5,45	**761,04**	107,09	0,00	0,00	4,89	878,47
	Cropland	0,51	25,89	**1 512,50**	0,00	0,00	0,57	1 539,47
	Wetland	0,00	0,00	0,00	**94,00**	0,00	0,00	94,00
	Settlements	1,29	3,21	8,39	0,00	**124,48**	92,57	229,94
	Other Land	3,28	4,99	10,20	0,00	0,62	**133,87**	152,96
	Area (kha)	1 986,03	812,70	1 640,12	94,00	125,11	245,73	**4 903,68**

Table 7.16: Results from the category 5.C.2 Land converted to Grassland

Land Use Category	Carbon stock change in living biomass (Gg C)			Net carbon stock change in DOM (Gg C)	Net carbon stock change in soil (Gg C)	Net CO2 emission/removals (Gg CO_2)
	gains	losses	net change			
Land converted to GL	14,54	7,77	6,76	-0,24	109,53	-425,52
FG	0,00	7,77	-7,77	-0,24	-9,92	65,77
CG	14,54	NO	14,54	NO	111,53	-462,23
WG	NA	NA	NA	NA	NA	NA
SG	NA	NA	NA	NA	NA	NA
OG	NO	NO	NO	NO	7,92	-29,06

7.6.4 Uncertainties and time consistency

According to the expert estimation and based on statistical approach for the estimation of wood stocks in the Slovak forest, 50% is in the category 5.C. The time series is consistent with the consistent methodology, activity data collection and using emission factors and other parameters.

7.6.5 Source specific QA/QC and verification

The completeness of inventory is determined by several factors, especially by importance of the processes and data availability. All calculation has been based on the activity data taken from the official national sources, such as the National Forest Centre (NFC), the Ministry of Agriculture, the Office of Geodesy, Cartography and Cadastre Authority of the Slovak Republic (GCCA) and the Slovak Statistical Office (SSO). The input information, data and calculations are archived by the national experts and the NIS coordinator. Therefore, all background data and calculation are verifiable. Besides this all data are updated annually. Dr. T. Priwitzer (external expert of LULUCF KP for SHMÚ) took responsibility for the inventory emission balance from LULUCF.

Table 7.17: The sources of activity data, methodology, uncertainty, references and planned improvements

Input Activity Data	Soil organic carbon stocks for individual land categories.	Partial monitoring system "Soil" (Soil science and Conservation Research Institute Bratislava).
	Time period for conversion.	T=20 years (default value)
	Land area of each soil types per land categories.	Soil map of Slovakia, Land Corine map of Slovakia.
Uncertainty	50%	Based on the expert judgment.
Changes in methods	2003	IPCC GPG LULUCF time series w ere recalculated
Problems	All five carbon pools are not included due to the lack of the input data. Current process of the "new national forest inventory" w ill improve the availability of the input data.	

7.6.6 Source specific recalculations

The category Grassland was recalculated for whole time period since 1990. The main reason was using new areas and their changes obtained from the Office of Geodesy, Cartography and Cadastre Authority of the Slovak Republic (GCCA). It affected the estimation of emissions/removals of GHGs for the categories 5.C.1 Grassland remaining Grassland and for 5.C.2 Land converted to Grassland.

7.6.7 Source specific planned improvements

Following improvements are planned for this category for the next submission:

- Estimation more accurate soil carbon stocks data for soils representing grassland.

7.7 Wetlands (CRF 5.D)

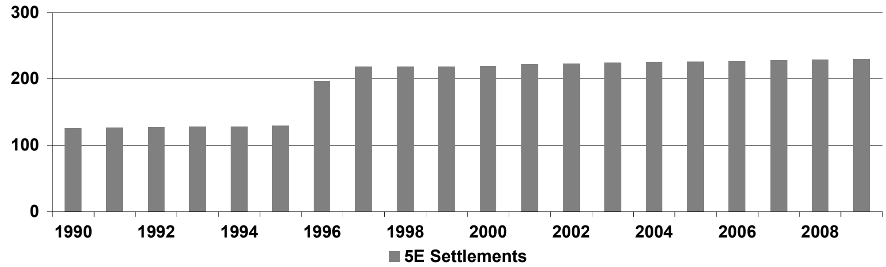
Basic on cadastral data this category of land use represents 1.9% of the whole Slovak territory. The area of this land use category is practically unchanged since 1990.

7.8 Settlements (CRF 5.E)

7.8.1 Source category description

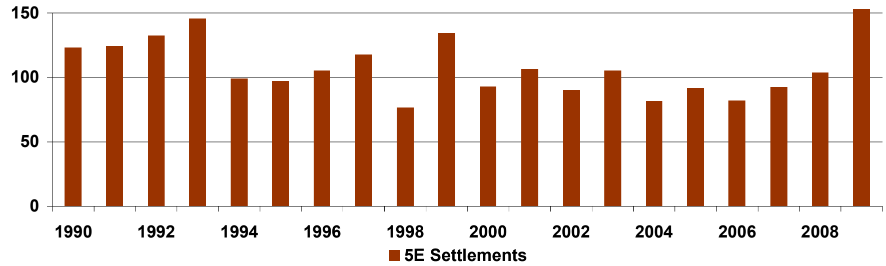
The category Settlements was reported as a separate category, at first time this reporting year (2009). This category represents about 5% of the Slovak area. Total settlements area represented 229.94 kha in 2009. Continual increasing trend assigned settlements during whole time of reporting period, especially during the most recent years. This situation is mostly caused by development of transport infrastructure, industrial areas, municipal development and raising the standards and infrastructure and is very often connected with decreasing of cropland and other land-use categories.

Figure 7.10: Development of activity data (kha) for category 5.E Settlements in 1990 – 2009



The total area of settlements remaining settlements represents 124.48 kha, the changes in the settlements were following: Forest land converted to Settlements 1.29 kha, Cropland converted to Settlements 3.21, Grassland converted to Settlements 8.39 kha, Other land converted to Settlements 92.57 kha per 2009.

Figure 7.11: CO_2 balance (Gg) for category 5.E Settlements in 1990 – 2009



7.8.2 Settlements remaining Settlements (CRF 5.E.1)

For this category the emissions of CO_2 can be considered insignificant as no change in living biomass, DOM (dead wood and litter) and soil carbon pools is assumed (Tier 1, IPCC 2006). This is a conservative assumption, if the country did not experience significant changes in land use types, disturbance or management regimes within the reporting year.

7.8.3 Land converted to Settlements (CRF 5.E.2)

This category includes all process connecting with conversion of lands into settlements.

7.8.3.1 Methodological issues – methods

For calculation of carbon stock changes in biomass was used tier 1 method GPG AFOLU (IPCC 2006). Tier 1 method requires estimate of the biomass of the land use before conversion and after conversion. It is assumed that all biomass is cleared when preparing a site for settlements, thus, the default for biomass immediately after conversion is 0 t/ha.

Tier 1 method follows the approach in chapter forest land where the amount of biomass that is cleared for settlements is estimated by multiplying the area converted in one year by the average carbon stock in biomass in the forest land, cropland or grassland prior to conversion. The calculation procedure is identical as described in detail in sections above.

7.8.3.2 Methodological issues – emission factors and parameters

Estimation of DOM emission included the emission due to changes in deadwood included in forest land. The calculation procedure is identical as described in detail in section land converted to cropland above.

7.8.3.3 *Activity data*

The calculation of stock carbon changes in mineral soils was based on the data from the soil inventory with the default assumption of 20 years period for carbon stock equilibrium in „new land use" conditions. Calculations of stock carbon changes in mineral soils as a result of forest land, cropland grassland and other land conversion to settlements carried out as follows GPG LULUCF (IPCC 2003). The net carbon stock change in mineral soils was estimated using the country specific tier 2 method. For estimation of net carbon stock change in mineral soil were used the average carbon stock per hectare noted above (category Land converted to Forest land).

Annual emissions from this category have been quite stable between 1990 and 2009 (between 326 and 352 ktonnes of CO_2). Emissions from this category were estimated at 217 Gg CO_2 in 2009. The net carbon stock change in soil from land converted to settlements represented losses of -14.48 Gg C in the reporting year.

Table 7.18: Land use matrix since 1989 to 2009

Year 2009		Initial (1989)						Area
	Category	Forest Land	Grassland	Cropland	Wetland	Settlements	Other Land	**(kha)**
Final (2009)	Forest Land	**1 975,50**	17,57	1,94	0,00	0,00	13,84	2 008,84
	Grassland	5,45	**761,04**	107,09	0,00	0,00	4,89	878,47
	Cropland	0,51	25,89	**1 512,50**	0,00	0,00	0,57	1 539,47
	Wetland	0,00	0,00	0,00	**94,00**	0,00	0,00	94,00
	Settlements	1,29	3,21	8,39	0,00	**124,48**	92,57	229,94
	Other Land	3,28	4,99	10,20	0,00	0,62	**133,87**	152,96
	Area (kha)	1 986,03	812,70	1 640,12	94,00	125,11	245,73	**4 903,68**

Table 7.19: Results from the category 5.E.2 Land converted to Settlements

Land Use Category	Carbon stock change in living biomass (Gg C)			Net carbon stock change in DOM (Gg C)	Net carbon stock change in soil (Gg C)	Net CO_2 emission/removals (Gg CO_2)
	gains	losses	net change			
Land converted to S	NO	43,33	-43,33	-1,28	-14,48	216,66
FS	NA,NO	40,74	-40,74	-1,28	-4,43	170,30
GS	NA	NA	NA	NA	-5,20	19,07
CS	NA	2,59	-2,59	NA	-4,85	27,30
WS	NA	NA	NA	NA	NA	NA
OS	NO	NO	NO	NO	NO	NO

7.8.4 Uncertainties and time consistency

According to the expert estimation and based on statistical approach for the estimation of wood stocks in the Slovak forest, 50% is in the category 5.C. The time series is consistent with the consistent methodology, activity data collection and using emission factors and other parameters.

7.8.5 Source specific QA/QC and verification

The completeness of inventory is determined by several factors, especially by importance of the processes and data availability. All calculation has been based on the activity data taken from the official national sources, such as the National Forest Centre (NFC), the Ministry of Agriculture, the Office of Geodesy, Cartography and Cadastre Authority of the Slovak Republic (GCCA) and the Slovak Statistical Office (SSO). The input information, data and calculations are archived by the national experts and the NIS coordinator. Therefore, all background data and calculation are verifiable. Besides this all data are updated annually. Dr. T. Priwitzer (external expert of LULUCF KP for SHMÚ) took responsibility for the inventory emission balance from LULUCF.

7.8.6 Source specific recalculations

The category Settlements was recalculated for whole time period since 1990. The main reason was using new areas and their changes obtained from the Office of Geodesy, Cartography and Cadastre Authority of the Slovak Republic (GCCA). It affected the estimation of emissions/removals of GHGs for the categories 5.E.1 Settlements remaining Settlements as well as for 5.E.2 Land converted to Settlements.

7.8.7 Source specific planned improvements

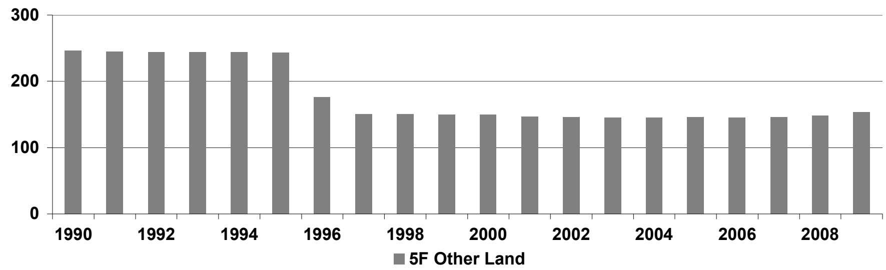
There are no short terms plans concerning improvements in this land use category.

7.9 Other land (CRF 5.F)

7.9.1 Source category description

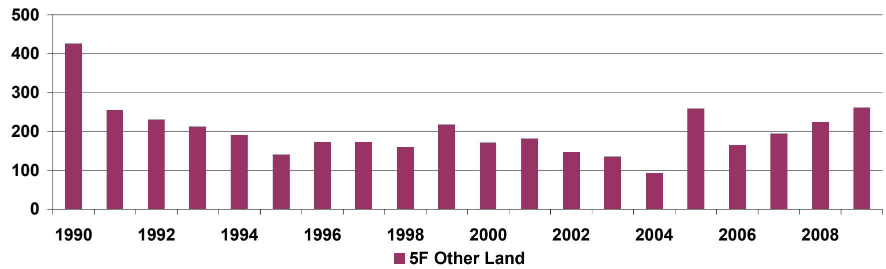
The emission and removals of GHGs in this category were obtained by using the GPG LULUCF methodology (IPCC 2003) and national data on area of Other land and Land converted to the Other land during the inventory year 2009. The total area of other land represented 152.96 kha in 2009, this is approximately 18% of the total area of the country. Other land areas decreased sharply between 1995 and 1997. Since this year shows well balanced trend.

Figure 7.12: Development of activity data (kha) for category 5.F Other land in 1990 – 2009



The total area of Other land remaining Other land was 124.48 kha, the changes in other land were following: Forest land converted to OL 3.28 kha, Cropland converted to OL 10.20 kha, Grassland converted to OL 4.99 kha, Settlements converted to OL 0.62 kha per 2009.

Figure 7.13: CO_2 balance (Gg) for category 5.F Other land in 1990 – 2009



7.9.2 Other land remaining Other land (CRF 5.F.1)

The emissions of CO_2 can be considered insignificant as no change in living biomass, DOM (dead wood and litter) and soil carbon pools is assumed (Tier 1, IPCC 2006) in this category. This is a conservative assumption, if the country did not has experience significant changes in land-use types, disturbance or management regimes within the reporting year.

7.9.3 Land converted to Other land (CRF 5.F.2)

This category includes all process connecting with conversion of lands into other lands. For calculation of carbon stock changes in biomass was used tier 1 method GPG AFOLU (IPCC 2006). Tier 1 method requires estimates of the biomass of the land use before conversion and after conversion. It is assumed that all biomass is cleared when preparing a site for other land, thus the default for biomass immediately after conversion is 0 t/ha.

7.9.3.1 Methodological issues – methods

Tier 1 method follows the approach in chapter forest land where the amount of biomass that is cleared for other land is estimated by multiplying the area converted in one year by the average carbon stock in biomass in the forest land, cropland or grassland prior to conversion. The calculation procedure is identical as described in detail in sections above.

7.9.3.2 Methodological issues – emission factors and parameters

Estimation of DOM emissions included the emissions due to changes in deadwood included in forest land. The calculation procedure is identical as described in detail in section Land converted to Cropland.

7.9.3.3 Activity data

The calculation of stock carbon changes in mineral soils was based on the data from the soil inventory with the default assumption of 20 years period for carbon stock equilibrium in „new land use“ conditions. Calculations of stock carbon changes in mineral soils as a result of forest land, cropland grassland conversion to other land carried out following GPG LULUCF (IPCC 2003). The net carbon stock change in mineral soils was estimated using the country specific tier 2 method described in detail in previous sections. For estimation of net carbon stock change in mineral soil were used the average carbon stock per hectare noted above.

Table 7.20: Land use matrix since 1989 to 2009

Year 2009		Initial (1989)						Area
	Category	Forest Land	Grassland	Cropland	Wetland	Settlements	Other Land	**(kha)**
Final (2009)	Forest Land	**1 975,50**	17,57	1,94	0,00	0,00	13,84	2 008,84
	Grassland	5,45	**761,04**	107,09	0,00	0,00	4,89	878,47
	Cropland	0,51	25,89	**1 512,50**	0,00	0,00	0,57	1 539,47
	Wetland	0,00	0,00	0,00	**94,00**	0,00	0,00	94,00
	Settlements	1,29	3,21	8,39	0,00	**124,48**	92,57	229,94
	Other Land	3,28	4,99	10,20	0,00	0,62	**133,87**	152,96
	Area (kha)	1 986,03	812,70	1 640,12	94,00	125,11	245,73	**4 903,68**

Table 7.21: Results from the category 5.F.2 Land converted to Other land

Land Use Category	**Carbon stock change in living biomass (Gg C)**			**Net carbon stock change in DOM (Gg C)**	**Net carbon stock change in soil (Gg C)**	**Net CO_2 emission/removals (Gg CO_2)**
	gains	**losses**	**net change**			
Land converted to OL	0,00	45,48	-45,48	-0,66	-25,26	261,80
FO	NA,NO	21,15	-21,15	-0,66	-11,28	121,33
GO	NA	6,37	-6,37	NA	-8,08	52,98
CO	NA	17,96	-17,96	NA	-5,90	87,49
WO	NA	NA	NA	NA	NA	NA
SO	NO	NO	NO	NO	NO	NO

Emissions from this category were estimated at 261.8 Gg CO_2 in 2009. The net carbon stock change in soil from Land converted to Other land represented losses of -25.26 Gg C in the reporting year.

7.9.4 Uncertainties and time consistency

According to the expert estimation and based on statistical approach for the estimation of wood stocks in the Slovak forest, 50% is in the category 5.F. The time series is consistent with the consistent methodology, activity data collection and using emission factors and other parameters.

7.9.5 Source specific QA/QC and verification

The completeness of inventory is determined by several factors, especially by importance of the processes and data availability. All calculation has been based on the activity data taken from the official national sources, such as the National Forest Centre (NFC), the Ministry of Agriculture, the

Office of Geodesy, Cartography and Cadastre Authority of the Slovak Republic (GCCA) and the Slovak Statistical Office (SSO). The input information, data and calculations are archived by the national experts and the NIS coordinator. Therefore, all background data and calculation are verifiable. Besides this all data are updated annually. Dr. T. Priwitzer (external expert of LULUCF KP for SHMÚ) took responsibility for the inventory emission balance from LULUCF.

7.9.6 Source specific recalculations

The category Other land was recalculated for whole time period since 1990. The main reason was using new areas and their changes obtained from the Office of Geodesy, Cartography and Cadastre Authority of the Slovak Republic (GCCA). It affected the estimation of emissions/removals of GHGs for the categories 5.F.1 Other land remaining Other land and for 5.F.2 Land converted to Other land.

7.9.7 Source specific planned improvements

The following improvement is planned for this category for the next submission:

- Re-evaluate the soil carbon stocks for OL category which is overestimated.

7.10 Direct N_2O emissions from N fertilization of Forest land and other (CRF 5(I))

Not estimated. Not important source in the Slovak Republic.

7.11 Non CO_2 emissions from drainage of soils and Wetlands (CRF 5(II))

Not estimated. Not important source in the Slovak Republic.

7.12 N_2O emissions from disturbance associated with land use conversion to Cropland (CRF 5(III))

Not estimated. Not important source in the Slovak Republic.

7.13 CO_2 emissions from agricultural lime application (CRF 5(IV))

The limestone (or dolomite) fertilizers are applied on the most acidic agricultural soils in the Slovak Republic. The CO_2 emissions from liming can be calculated according to the equation (IPCC 1996).

$$CO_2 \text{ emissions from liming} = \text{Total amount of limestone (dolomite)} \times EF$$

Data on liming of agricultural soils (cropland) come from summary of the Central Controlling and Testing Institute in Agriculture (ÚKSÚP). For years 1998 – 2009 the data are based on summarization of recordings that have to be submitted by land owners/users to ÚKSÚP in accordance with the national legislation. For years 1992 and 1994 – 1997 the data are based on statistics of ÚKSÚP according to the former legislation, for years 1990, 1991 and 1993 only estimated values are used.

The amount of applied limestone has been registered since 1998. For previous years only information on total application of CaO as component of various materials (besides limestone also burnt lime and other materials) is available. So the quotient derived from years with detailed information on applied materials (limestone, burnt lime, lime sludge and other calcareous materials) is used for calculation of limestone application in this case. The conversion factor used for limestone ($CaCO_3$) is 0.12 Mg CO_2-C/Mg.

Table 7.22: The results in emission inventory for fertilizers in LULUCF in 1990 – 2009

Year	Total amount of $CaCO_3$ (t)	Carbon Conversion Factor	CO_2 Emissions (Gg)
1990	101 400,00	0,12	**12,17**
1991	81 900,00	0,12	**9,83**
1992	62 400,00	0,12	**7,49**
1993	42 900,00	0,12	**5,15**
1994	23 400,00	0,12	**2,81**
1995	143 520,00	0,12	**17,22**
1996	109 200,00	0,12	**13,10**
1997	236 700,00	0,12	**28,40**
1998	319 279,80	0,12	**38,31**
1999	162 104,70	0,12	**19,45**
2000	99 248,70	0,12	**11,91**
2001	149 170,20	0,12	**17,90**
2002	63 675,60	0,12	**7,64**
2003	57 352,90	0,12	**6,88**
2004	25 379,80	0,12	**3,05**
2005	19 772,00	0,12	**2,37**
2006	20 982,70	0,12	**2,52**
2007	25 375,80	0,12	**3,05**
2008	45 737,70	0,12	**5,49**
2009	40 528,10	0,12	**4,86**

7.13.1 Source specific recalculations

This category was recalculated for whole time period since 1990. The main reason was using updated data obtained from liming of agricultural soils (cropland) come from database of the Central Controlling and Testing Institute in Agriculture (ÚKSÚP). The previous data of limestone application were based on expert judgment and were deeply underestimated.

7.14 Biomass Burning (CRF 5(V))

7.14.1 Source category description

This activity 5(V) includes emissions of CH_4, and N_2O associated with forest fires and biomass burning on forest areas. Activity data from controlled burning and forest fires has been summarized by the National Forest Centre since 1999. Total of 347 forest fires were reported in the Slovak Republic in 2009. This number increased twice in comparison to 2008. The total burnt area was 509.66 ha. The average burnt forest area per fire was 0.68 ha. The largest forest area damaged by fire was 150 ha. The forest fires were occurred mostly in spring and early summer.

Emissions from biomass burning from Cropland and Grassland were not estimated because biomass burning of these two categories is prohibited in the Slovak Republic. The emissions from biomass burning from Other land were not estimated. There are not important sources in the Slovak Republic.

Table 7.23: Activity data from forest fires and controlled burning of the forest in 1990 – 2009

Harvesting residues	Annual Loss of Biomass	Fraction of Biomass Burned on Site	Quantity of Biomass Burned on Site	Fraction of Biomass Oxidised on Site	Quantity of Biomass Oxidised on Site	Carbon Fraction of Abovegr. Biomass (on site)	Quantity of Carbon Released (burning on)
	kt dm		*kt dm*		*kt dm*		*kt C*
Coniferous	2 093,53	0,03	62,81	0,90	56,53	0,50	28,26
Broadleaves	1 453,23	0,05	72,66	0,90	65,40	0,50	32,70
Forest Fires	3,12	1,00	3,12	0,90	2,80	0,50	1,40

Quantity of C Released	N/C Ratio	Total N Released		Trace Gas Emissions Ratio	Trace Gas Emissions	Conversion Ratio	Emissions from Burning
kt C		*kt N*			*kt C*		*Gg*
Controlled Burning							
60,96	0,02	1,22	**CH_4**	0,012	0,732	16/12	0,975
			CO	0,060	3,658	28/12	8,534
					kt N		
			N_2O	0,007	0,009	44/28	0,013
			NOx	0,121	0,148	46/14	0,485
Wildfires							
1,40	0,02	0,03	**CH_4**	0,012	0,017	16/12	0,022
			CO	0,060	0,084	28/12	0,196
					kt N		
			N_2O	0,007	0,000	44/28	0,000
			NOx	0,121	0,003	46/14	0,011

Table 7.24: Biomass burned in forests, CH_4 and N_2O emissions from wildfires and controlled burning of the Slovak forests in 1990 – 2009

	Biomass Burned [kg dm]		CO_2 emissions (Gg)		CH_4 emissions (t)		N_2O emissions (t)	
	Controlled Burning	Wildfires	Controlled Burning	Wildfires	Controlled Burning	Wildfires	Controlled Burning	Wildfires
1990	91 778,28	5 320,00	IE	IE	661,00	10,00	38,00	1,00
1991	58 294,92	2 150,00	IE	IE	420,00	7,00	19,00	0,40
1992	52 180,61	11 733,00	IE	IE	376,00	6,00	84,00	0,40
1993	53 130,27	12 860,00	IE	IE	380,00	6,00	100,00	0,40
1994	55 527,56	1 570,00	IE	IE	400,00	6,00	10,00	0,30
1995	62 261,55	1 542,90	IE	IE	448,00	7,00	11,00	0,30
1996	66 932,59	3 886,00	IE	IE	480,00	7,00	30,00	0,30
1997	73 143,47	2 090,00	IE	IE	530,00	7,00	10,00	0,30
1998	73 096,00	552,00	IE	IE	530,00	7,00	3,00	0,30
1999	84 577,70	498,00	IE	IE	600,00	9,70	10,00	0,30
2000	76 952,10	15 690,00	IE	IE	550,00	9,70	120,00	0,30
2001	92 862,80	540,00	IE	IE	670,00	9,70	10,00	0,30
2002	91 587,00	550,00	IE	IE	659,00	9,70	4,00	0,30
2003	99 109,00	2 730,00	IE	IE	710,00	9,70	20,00	0,30
2004	110 172,00	2 070,00	IE	IE	808,00	11,00	14,00	0,20
2005	146 053,00	2 360,00	IE	IE	1 051,50	16,99	16,99	0,23
2006	123 469,90	1 920,00	IE	IE	890,00	10,00	10,00	0,23
2007	122 296,00	3 620,00	IE	IE	880,00	12,17	26,00	0,36
2008	137 348,30	814,85	IE	IE	988,90	13,60	5,87	0,08
2009	135 467,42	3 115,05	IE	IE	975,40	13,40	22,40	0,30

7.14.2 Controlled burning

Total methane emissions from controlled burning were 975.4 tons in 2009 and total emissions of N_2O were 13.40 tons in 2009. CO_2 emissions are included in category 5A changes in living biomass.

7.14.3 Forest fires

Total methane emissions from forest fires were 2.24 tons in 2009 and total emissions of N_2O were 0.31 tons in 2009. CO_2 emissions are included in category 5A Changes in living biomass.

7.14.4 Source specific QA/QC and verification

Table 7.25: The sources of activity data, methodology, uncertainty, references and planned improvements

Input Activity Data	Area burnt in ha	Forest Protection Service – Forest Fire Statistics (NFC Zvolen)
	"Mass of available fuel"	Forest Protection Service – Forest Fire Statistics (NFC Zvolen)
	Emission factor	IPCC default value
	Combustion efficiency	IPCC default value
Uncertainty	100%	Based on the expert judgment.
Changes in methods	No	IPCC GPG LULUCF time series w ere recalculated
Problems	No exact data about "mass of available fuel".	

CHAPTER 8: WASTE (CRF 6)

8.1 Overview of sector (CRF 6)

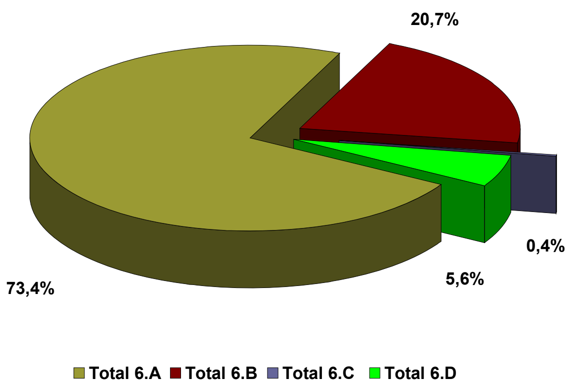
Inventory of emissions from waste management includes direct (CO_2, CH_4, N_2O) and indirect (NMVOCs) greenhouse gas emissions. The production of emission of CH_4 and N_2O are important for waste disposal and wastewater treatment. Disposal of wastes and handling of wastewater results in production of greenhouse gases emissions. An estimation of the following emissions in 2009 is presented:

- 6.A Solid waste disposal sites.
- 6.B Wastewater handling.
- 6.C Waste incineration.
- 6.D Other (Biological treatment of solid waste).

In 2009, total aggregated GHG emissions from waste were 2 159.46 Gg of CO_2 equivalents and they decreased compared to the previous year by almost 9% mostly caused by decrease in wastewater treatment (industrial). Compared to the reference year 1990 the emissions increased 98%. To the total emissions from waste sector belongs also the emissions from waste incineration with energy use allocated in energy sector (category 1A1a other fuels). Total emissions expressed in CO_2 equivalents in category were 74.55 Gg in 2009. These emissions are accounting in energy sector.

The most important gas is CH_4, with the almost 92.9% share, N_2O emissions with 6.7% and CO_2 emissions with 0.2% (without waste incineration with energy use). The most important source of GHG emissions are solid waste disposal on land (73%), wastewaters (21%), composting (5.6%) and waste incineration without energy use (0.4%).

Figure 8.1: The share of individual categories in emissions in sector waste in 2009



Category	GHG (Gg CO_2 eq.)	Share (%)
Solid Waste Disposals	1 584,45	73,37%
Wastewater	446,74	20,69%
Waste Incineration	7,67	0,35%
Composting	120,60	5,58%

Waste sector contributed by more than 5% to total GHG emissions. Introduction of more exact methodology for the evaluation of methane emissions from solid waste disposal on sites resulted in continual increase of emissions compared to the base year 1990. Similar trend is expected to remain in the future, although only with slight increase in emissions. The amount of emissions from landfills depends, to a large extent, on the methodology adopted to evaluate landfills and on the implementation of energy recovery of landfill gases by landfill operators.

Table 8.1: GHG emissions in individual categories in waste sector in 1990 – 2009

	Sector Waste (CRF 6)							
	Total CO_2 (Gg)	Total CH_4 (Gg)	Total N_2O (Gg)	Total GHG (Gg CO_2 eq.)	Total 6.A (Gg CO_2 eq.)	Total 6.B (Gg CO_2 eq.)	Total 6.C (Gg CO_2 eq.)	Total 6.D (Gg CO_2 eq.)
1990	62,700	42,156	0,462	1 091,330	469,770	552,592	65,428	3,540
1991	62,700	43,145	0,442	1 105,901	492,450	544,483	65,428	3,540
1992	62,700	43,924	0,403	1 109,975	507,360	533,647	65,428	3,540
1993	62,700	44,499	0,393	1 119,032	522,690	527,124	65,428	3,790
1994	62,700	47,158	0,394	1 175,029	582,750	523,488	65,428	3,363
1995	62,700	49,662	0,410	1 232,707	647,850	513,161	65,428	6,268
1996	62,700	52,527	0,412	1 293,615	710,010	512,586	65,428	5,591
1997	45,300	62,756	0,411	1 490,689	926,038	509,957	47,842	6,851
1998	91,100	76,781	0,405	1 828,935	1 218,169	509,498	94,541	6,726
1999	63,200	91,013	0,383	2 093,317	1 516,958	503,631	65,773	6,955
2000	62,800	76,381	0,349	1 774,994	1 206,802	496,116	65,652	6,424
2001	52,200	78,675	0,338	1 809,181	1 258,740	488,325	54,401	7,715
2002	24,700	111,160	0,720	2 582,247	1 845,900	499,180	29,567	207,600
2003	26,400	107,903	0,667	2 499,147	1 776,390	480,282	30,554	211,921
2004	28,000	109,464	0,443	2 464,023	1 875,720	474,863	33,332	80,108
2005	21,900	103,147	0,498	2 342,363	1 736,070	472,820	27,325	106,148
2006	48,500	109,709	0,568	2 528,530	1 853,460	470,661	53,553	150,856
2007	7,500	104,832	0,482	2 358,424	1 773,450	466,412	11,654	106,908
2008	5,700	105,297	0,480	2 365,620	1 780,800	457,873	9,544	117,403
2009	5,000	95,538	0,478	2 159,457	1 584,450	446,737	7,666	120,604

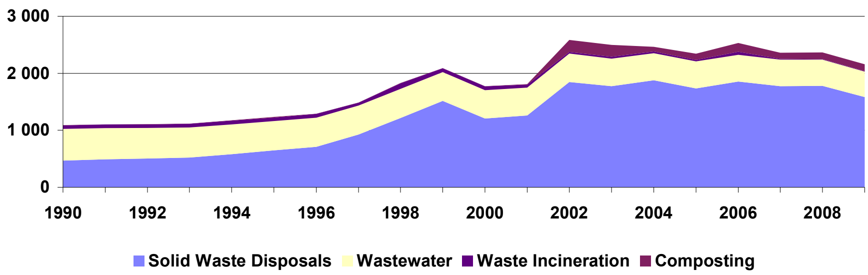
Methane emissions from municipal waste disposal sites (SWDS) have the largest share in total emissions from the sector. Waste balance methodology has been revised and tier 2 approach FOD (First Order Decay) methodology has been used for the recalculations of the time series since 1960. The trend of methane emissions has been increasing depending on the adopted values for parameters of municipal waste landfills. A more detailed description of the methodology as well as with the Monte Carlo uncertainty analysis are described in the references.[12]

The disaggregation of emissions from waste incineration into two groups, i.e. waste incineration for and without energy utilisation, was another important change with respect to the quality improvement of the emission inventory. The emissions from waste incineration with energy utilisation were reported under energy sector, sub-category 1A1a (other fuels). The emissions from waste incineration without energy utilisation are reported under sector waste.

Emissions from waste composting are a new category in sector waste, the share of which is supposed to increase due to adopted policies and measures.

Less important changes of parameters and methodology have occurred in categories domestic wastewater treatment and industrial wastewater treatment.

Figure 8.2: Emission trends of individual categories in sector waste in 2009



8.2 Solid waste disposal on land (CRF 6.A)

8.2.1 Source category description

The emissions from Solid waste disposal sites (SWDS) are the major source of waste sector. The methane emissions are estimated separately for subcategories:

- 6A1 Managed waste disposal on land in 2001 – 2009.
- 6A3 Other:
  - Uncategorised municipal solid waste in 1990 – 2000.
  - Agricultural and industrial solid waste in 1997 – 2009.

Total methane emissions in category 6A were 75.45 Gg (1 584 Gg of CO_2 eq.) in 2009 and they decreased by 12% compared to the previous year. This decrease was caused by reduction of industrial waste disposal. The emissions of NMVOC were estimated to be 5.04 tons in 2009.Emissions of CO_2 influencing national total were not occurring in this category.

The agricultural and industrial waste before 1997 was not estimated due to the lack of activity data about the waste stream. The emissions from unmanaged waste disposal sites in the subcategory 6A2 were not occurring from the base year 1990.

The emissions from solid waste disposal on land increased in comparison with the base year by almost 3.4 times due to the improvements of disposal practice, resulting in the increase in MSW emissions together with the cumulative effect of FOD methodology.

Table 8.2: GHG emissions in individual categories in solid waste disposal on land in 1990 – 2009

Solid Waste Disposal on Land (CRF 6A)				
	Total 6A	Managed MSW	Uncategorised MSW	Agricultural & Industrial SW
	CH_4 in Gg			
1990	22,370	IE	22,370	NE
1991	23,450	IE	23,450	NE
1992	24,160	IE	24,160	NE
1993	24,890	IE	24,890	NE
1994	27,750	IE	27,750	NE
1995	30,850	IE	30,850	NE
1996	33,810	IE	33,810	NE
1997	44,097	IE	36,700	7,397
1998	58,008	IE	39,400	18,608
1999	72,236	IE	42,180	30,056
2000	57,467	IE	42,510	14,957
2001	59,940	44,940	NO	15,000
2002	87,900	45,540	NO	42,360
2003	84,590	46,270	NO	38,320
2004	89,320	46,630	NO	42,690
2005	82,670	47,040	NO	35,630
2006	88,260	47,650	NO	40,610
2007	84,450	48,220	NO	36,230
2008	84,800	47,960	NO	36,840
2009	75,450	48,890	NO	26,560

8.2.2 Source category description – Managed waste disposal on land (CRF 6.A.1)

A new legislative regulation about SWDS entered into force on 1st July 2001 in accordance with the EU legislative harmonisation. The relevant Act 223/2001 and Decree of the Ministry of Environment 283/2001 contain new tools for waste disposal restrictions and monitoring of waste sites and waste gases generation. The gases produced by waste disposal, particularly CH_4, can be a local environmental hazard if precautions are not taken to prevent uncontrolled emissions or migration into surrounding land. Landfill gas is known to be produced both in managed “landfill” and “open dump” sites. Landfill gas can migrate from SWDSs laterally or by venting to atmosphere, causing vegetation damage and unpleasant odors at low concentrations, while at concentrations of 5–15% in air, the gas may form explosive mixtures. Development of engineered, controlled landfills, including gas collection systems, started in 1991 and old dumps as a disposal destination were gradually replaced over the following decade. It takes some time till a landfill cell is filled, closed and gas generation starts in the landfill body. Thus, the first attempts to flare landfill gas were introduced in 2004.

8.2.2.1 Methodological issues – methods

The estimation of methane emissions from SWDSs by FOD method were calculated using a spreadsheet model. Results are presented as cumulative diagram, which shows the contribution of emissions from MSW disposed each year and covers the entire period 1960 – 2009 and as a bar chart showing total emissions for the period 1990 – 2009.

The methane emissions for MSW are included into category Managed waste disposal on land (6A1) since 2001, before this year the waste disposal sites were uncategorized and emissions were included in category Other municipal waste uncategorized (6A3). According to the used model for estimation of methane emissions from MSW disposed to SWDSs the total emissions reached 48.89 Gg in 2009, but this number was reduced with the methane recovery value (1.68 Gg of CH_4 according to the information from the Terrasystem company).

When comparing the results obtained by the Tier 1 and Tier 2 method, the basic difference between these methods must be kept in mind:

- Tier 1 method assumes that all methane is emitted "at once" and not only activity data but also parameters reflect the situation in the year of MSW disposal.
- Tier 2 method assumes, that methane is emitted "continuously" and current emissions are influenced by the past emissions.

This difference in approaches can be negligible in countries with long history in controlled MSW disposal, but in countries which recently significantly changed their waste management practices (like the Slovak Republic) this creates additional uncertainties.

The IPCC 2006 Guidelines presents a decision tree for CH_4 emissions from waste disposal. Tier 2 estimated emissions using the IPCC FOD method with default parameters and good quality country-specific activity data were selected as appropriate method. Comparing the situation abroad with the situation in the Slovak Republic, several differences can be identified:

- Most countries are using the site-specific data. The methane emissions are calculated for each SWDS (or group of SWDS) separately and then the results are summed to obtain national methane emission estimations. This approach is not yet possible, because collected data on MSW do not include the needed characterisation of SWDS.
- Historical data on MSW management and disposal are more detailed than data available in the Slovak Republic.
- Data on MSW fractions are collected in more systematic and regular way than is the practice in the Slovak Republic.

The second version of FOD method, as it is defined in the IPCC 2000 GPG was selected as the most appropriate approach. This decision is supported by following reasons:

- Parameters used are better defined and allow direct comparison with the Tier 1 method.
- Some of the parameters used are defined as time-variables. This allows modeling of the waste sector transformation in the period 1992 – 2000.
- Structure of required input data corresponds better with MSW data available (data for the use of multiphase method are not available).

8.2.2.2 Methodological issues – emission factors and parameters

The IPPC methodologies encourage the use of locally based parameters, which reflect local level and conditions of MSW disposal. FOD method parameters (this includes Tier 1 parameters, because they are used in FOD method) were reviewed with the aim to identify parameters specific to MSW management in the Slovak Republic. Parameters currently used for methane emission estimation were critically reviewed and additional data were collected to support proposed changes in these parameters.

MCF

A small, but important change is done to better reflect the significant improvement of SWDSs practice in the period 1992 – 2000. The MCF is not depending on the year when MSW was disposed, but on the year when the estimation of methane emission was done. The MCF is depending on the year when MSW was disposed follows the idea that landfill operation practice does not changes with time. This is in contradiction to the situation in the Slovak Republic, where within a relatively short time disposal practices changed toward controlled landfilling. Compacting and covering of waste was introduced and this caused increased generation of methane. However, this period of modernizing of disposal practice requires further investigation.

Recently seven landfills have installed landfill gas recovery systems, in four cases the landfill gas collection and flaring system were installed by company Terrasystems within a carbon trading scheme. The trend is toward utilisation of landfill gas for energy generation.

Although landfill gas flaring is required by the EC Landfill Directive (Annex I, item 4.2.) at all landfills receiving biodegradable waste and Slovak legislation (regulation 283/2001) was in accordance with this directive, a later amendment (509/2002) requires flaring only if landfill gas is generated in sufficient amounts. This condition has reflected the situation in the landfill sector.

The company wants to include other four landfills, resulting in expected savings of ca. 550 kilotons of CO_2 in the period 2008 – 2012. The annual saving can be estimated to 110 Gg CO_2 or 5 Gg CH_4 or nearly 10% decrease of methane emissions from MSW landfills in the Slovak Republic. The value of methane recovery was 1.68 Gg in 2009.

The methane correction factor (MCF) describes the way how MSW is managed on site; this factor is individual for each landfill. The currently available data do not allow a site-by-site approach. But, with the adoption of the first Waste Act a period of re-direction of MSW stream from old non-complying SWDSs to controlled EU-standard landfills was enforced by the Slovak Ministry of Environment. Thus, the following hypothesis is proposed:

- Before 1992 all MSW was disposed of in SWDSs on which very little or no data exist = IPCC category uncategorized sites (6A3).
- Since 2000 all MSW has been disposed of in managed landfills = IPCC category managed sites (6A1).
- Period 1993 – 1999 is a period of transition when managed sites were gradually developed = linear growth of MCF (6A3).

Of course, there is a risk that managed sites existed before 1992 or uncategorized sites were still in (illegal) operation after 2000, but there is no available evidence to reject the hypothesis above. MCF(x) was 1 fraction from 2001 – 2009 (Table 8.3).

DOC

An analysis of existing data on MSW fractions in the Slovak Republic was done to verify the value of DOC. The MSW composition data cover different target areas (national, regional, municipal, suburban) and are from various years (in general 1997 – 2009) but the following calculations are aimed more at presenting a DOC calculation method to be used in future when better data are available. The data used can not be fully verified, and the methodology of MSW composition analysis is not known for some data, but they are quoted in official documents of the Slovak Ministry of Environment.

Table 8.3: Activity data and input parameters for municipal solid waste disposal in 1990 – 2009

Municipal Solid Waste Disposal on Land (CRF 6A1)								
	Annual MSW at the SWD (kt)	MCF	DOC_F (%)	EF CH_4 (t/t)	Fraction of DOC in MSW	Fraction of MSW to SWDS	Methane Recovery (Gg)	Oxidation Factor
1990	1 162,000	0,600	60,000	0,019	0,120	0,900	0,000	0,000
1991	1 182,000	0,600	60,000	0,020	0,120	0,900	0,000	0,000
1992	1 210,000	0,600	60,000	0,020	0,120	0,900	0,000	0,000
1993	1 238,000	0,600	60,000	0,020	0,120	0,900	0,000	0,000
1994	1 266,000	0,650	60,000	0,022	0,120	0,900	0,000	0,000
1995	1 347,000	0,700	60,000	0,023	0,120	0,860	0,000	0,000
1996	1 249,000	0,750	60,000	0,027	0,120	0,860	0,000	0,000
1997	1 206,000	0,800	60,000	0,030	0,120	0,830	0,000	0,000
1998	1 113,000	0,850	60,000	0,035	0,120	0,810	0,000	0,000
1999	1 134,000	0,900	60,000	0,037	0,120	0,820	0,000	0,000
2000	1 056,000	0,950	60,000	0,040	0,120	0,790	0,000	0,050
2001	1 049,000	1,000	60,000	0,043	0,120	0,830	0,000	0,050
2002	1 192,000	1,000	60,000	0,038	0,120	0,780	0,000	0,050
2003	1 256,000	1,000	60,000	0,037	0,120	0,790	0,000	0,050
2004	1 195,000	1,000	60,000	0,039	0,120	0,810	0,170	0,050
2005	1 227,000	1,000	60,000	0,038	0,120	0,780	0,340	0,050
2006	1 260,000	1,000	60,000	0,038	0,120	0,790	0,370	0,050
2007	1 295,000	1,000	60,000	0,037	0,120	0,776	0,500	0,050
2008	1 369,000	1,000	60,000	0,035	0,120	0,760	1,680	0,050
2009	1 411,000	1,000	60,000	0,036	0,120	0,770	1,680	0,050

The average DOC value is 0.12 Gg C/Gg MSW. This is very close to the DOC value used in the Slovak Republic for the estimation of methane emissions from SWDSs. Also, MSW composition data by type of dwellings and by type of heating published in Czech Republic in 2003 were processed to verify the DOC values with the following results.

Table 8.4: Historical DOC data derived from statistical data

DOC values for FOD model		
Year	Central heating	DOC
1961	7,40%	0,06
1970	23,60%	0,08
1980	46,20%	0,10
1991	74,70%	0,12
2001	76,30%	0,12

Well-managed SWDS use 0.1 for oxidation factor. The current situation of MSW disposal in the Slovak Republic has been improved significantly, according to the waste legislation only well-managed landfills can be operated. This provides the argument that the Slovak Republic should not used the IPCC default zero for this parameter. On the other hand, there are still old SWDS which were not properly built nor operated. The oxidation factor is considered a time-variable, although this is not stated in the IPCC documents. Currently we are using 0.05 fraction from 2000.

The methane generation potential is also a time-variable, as it value depends on time-variable parameters.

The methane generation constant depends mainly on moisture, for areas with rainfall over 500 mm/yr the recommended value is 0.065. The rainfall was over 500 mm/yr in the last 10 years.

Table 8.5: Parameters proposed as constant for estimation of methane emissions from SWDS

Parameter	Value	Note
Fraction dissimilated DOC (DOC_F)	0,6	IPCC default value, no national data available
Fraction of methane in landfill gas (F)	0,5	IPCC default value, no national data available
Methane recovery (R)	1,68	
Methane generation rate constant (k)	0,065	Not sufficient data for use of multiphase model

Table 8.6: Parameters proposed as time-variable for estimation of methane emissions from SWDS

Parameter	Range	Note
Methane correction factor (MCF)	0,6-1	Constant in 1960-1992, linear increase 1993-2000, constant from 2001.
Degradable organic carbon (DOC)	0,06-0,12	Linear increase in 1960-1991, constant after 1991.
Oxidation factor (OX)	0-0,05	zero untill 2000, 0,05 from 2001
Methane generation potential (L_0)	0,014-0,048	Calculated as function of DOC

8.2.2.3 Activity data

Total MSW disposed to landfills annually is used as activity data for estimation of methane emissions from SWDS. Additionally, the overall MSW balance is used for verification of these activity data.

The Statistical Office of the Slovak Republic publishes data on MSW generation and disposal since 1993. Although this creates a timeline of 15 years, this is not sufficient for the use of FOD method. There are several possibilities how to estimate the needed length of data timeline:

The latest available estimation on MSW in the Slovak Republic dates back to 1960 and data on housing (needed for estimation of DOC(x)) are available from 1961. Therefore it was decided to generate a MSW data from 1960, i.e. for 48 years. Analysis of MSW generation data shows a huge difference in MSW generation in years 1992 – 1994, compared to data 1995 – 2009. This can be explained by a “learning period” when waste generators were getting familiar with the new system of data recording. Therefore these “inflated” data were excluded from estimation of methane emissions and replace them by interpolated data, as explained in the following. It may be interesting that similar, but smaller “inflation” of data appears also in the period 2002 – 2005, when EU waste classification system was introduced.

Latest indication on MSW generation in the Slovak Republic was found for 1960 and 1970. Since 1992, data from annual monitoring are available. Annual MSW generation was interpolated. It is hard to expect that further research will result in more exact data on MSW generation in past (before 1989) as the practise of MSW generation estimation in that time was based on number of kilometres driven by a collection vehicle. These data were often considerably exaggerated.

When assessing the amount of MSW disposed to SWDSs, the key factor to the MSW management practice in the Slovak Republic is operation of two MSW incinerators in Bratislava and Kosice.

These two incinerators burned in average 150 Gg MSW per year in the period 1993 – 2004 (BA 100 Gg/yr, KE 50Gg/yr). It is assumed that this amount of MSW was burned since they were put in operation. Thus, the input values for fraction of MSW landfills can be divided into three periods:

- 1960 – 1976: 1 – all waste disposed to SWDS.
- 1977 – 1994: 0.9 – MSW Incinerators in operation.
- 1995 – 2005: Real data on MSW disposed were used.

Activity data used for the estimation of methane emissions from SWDS are the following:

- Length of data timeline.
- Total MSW generated.
- Fraction of MSW landfilled.

8.2.2.4 Uncertainties and time consistency

More complex method for estimating methane emissions from municipal solid waste disposal sites (SWDSs) acknowledges the fact that methane is emitted over a long period of time rather than instantaneously. A kinetic approach therefore needs to take into account the various factors, which influence the rate and extent of methane generation and release from SWDSs. The equations for first order decay (FOD) method are from the IPCC 1996 GL. The IPCC 2000 GPG provides further details on the FOD method, mainly in defining FOD model parameters. This approach can be used to model landfill gas generation rate curves for an individual landfill. It can also be used to model gas generation for a set of SWDSs to develop country emissions estimates or can be applied in a more general way to entire regions.

The IPCC methodology and Good Practice Guidelines were used to estimate methane emissions from landfills. A database of the Centre of Waste Service and Environmental Management in Bratislava has been used as a source of input data. GHG emissions from waste sector are the key source and concerning to the actual emission factors (EF) there are estimated with the high uncertainty level.

The uncertainty of estimation of CH_4 emissions is mainly caused by the uncertainty of statistical data on consumption. Another source of uncertainty is the applied default EFs. An additional error in calculation of the other greenhouse gas emissions may occur as a result of less exact methods and it cannot be estimated. The calculation of emission uncertainty of landfill by using more sophisticated Tier 2 - Monte Carlo method has been evaluated for these reasons. In some cases the pure analytic solution of investigated problem is difficult to find. For events where significant inaccuracy of mentioned data is presented, the statistical approach is accepted and it helps us to include uncertainty to the final assumption. To know the final margin of uncertainty of observed processes, it is necessary to estimate the eventual fluctuation of analyzed variable which entered to the examined processes interdependency. By using a classical statistical approach it can be difficult to obtain in some cases reasonable final information about consequential uncertainty of investigated processes.

A method, which allows implementing all uncertainty to the final analyses, is Monte Carlo method. In many applications of Monte Carlo method, the investigated process is simulated directly. There is no need to describe the behavior of the investigated system. It can be advantageous in some complicated systems. The only important requirement is that this system could be described by probability density functions (PDF). We will assume that the properties of a system can be described by PDF’s. Once the PDF’s are known, the Monte Carlo simulation can proceed by random sampling technique from the PDF’s. This approach works with random number generator of random numbers, which have properties of desirable PDF. Many trials are then performed and the expected result is obtained as an average over the number of values. In this case, it can be predicted the statistical structure as are variance, kurtosis and some other higher statistical moments of this simulated result. From these characteristics the estimation of the number of Monte Carlo trials can be achieved to obtain a result with an expected error. The Monte Carlo method is based on the generation of multiple trials to determine the expected value of a random value. In our case it can be said that this method is uncertainties combination of probability distribution functions for activity data (AD) and EFs. Total emissions are then computed as combination of random numbers for appropriate distribution function for assigned greenhouses gases. The advantage of this method is asymmetry allowance to the statistical distribution (Tier 1 method does not allow asymmetry). This advanced method is useful for data manipulation in the case, when proper input data quality is provided. Usually it can be assumed that higher tier methods should be associated with lower uncertainties of input data.

In practice, uncertainties of processes vary from a few percent to orders of magnitude, and may be correlated. This is not consistent with the simplified assumptions which are applied in the Tier 1 method (the variables are uncorrelated with a standard deviation of less than about 30% of the mean). Tier 1 method supposes the following assumptions: the number of emission and uptake terms is large no single term dominates the sum and the emissions and uptakes are independent. If this is the case then the sum of the variances of all the terms equals the variance of the total inventory, and the distribution of total emissions is normal. Thus the interval defined by approximately two standard deviations either side of the mean is the 95% confidence interval of the inventory.

In Tier 1, the uncertain quantities are usually combined by addition. In this case, with respect to the limitation it can be supposed that the standard deviation of the sum is the square root of the sum of the squares of the standard deviations of the quantities that are added with the standard deviations all expressed in absolute terms (this rule is exact for uncorrelated variables). On the next, in Tier 1 the uncertain quantities are combined by multiplication, the same rule applies as in previous case; except that the standard deviations must all be expressed as fractions of the appropriate mean values (this rule is approximate for all random variables). In spite of these simplified limitation an approximate results with Tier 1 method could be obtained in the cases, which exceed mentioned circumstances. Unlike to previous difficulties the Monte Carlo method can combine uncertainties with any probability distribution (non-Gaussian), range (large variances), and correlation structure. In these cases Monte Carlo method could be preferable method. The practice shows that in some cases Tier 1 method could yield results with lower uncertainty then higher tier methods. In this situation one should know limitation and statistic simplification of Tier 1 method. It is important to know that Tier 1 method offers only rough and approximate results. It gives informative data, which serve the background for more sophisticate analyses. On the other hand, Tier 1 method could be an unique starting point to obtain solid results in the absence of quality input data (high variance of examined processes, etc.). The ideal information of estimated uncertainties includes:

- The arithmetic mean (mean) of the data set.
- The standard deviation of the data set (the square root of the variance).
- The standard deviation of the mean (the standard error of the mean).
- The probability distribution of the data.
- Covariance's of the input quantity with other input quantities used in the inventory calculations.

This information, which have the base in measurement or in empirical source of data or in data which are assessed by expert, are sufficient to define the probability distribution for statistical analysis and for specification of 95% confidence interval. During the inventory the uncertainty source can be identified from next different processes:

- Uncertainties from definitions (e.g. meaning incomplete, unclear, or faulty definition of an emission or uptake).
- Uncertainties from natural variability of the process that produces an emission or uptake.
- Uncertainties resulting from the assessment of the process or quantity, including, depending on the method.

In inventory for simulation of CH_4 emissions from landfill the second variant of FOD method was chosen and additionally Tier 2 approach was used (Tier 1 approach was calculated too). Solid waste disposal site's emissions of CH_4 are mainly dependent on the factors and other parameters from emission inventory changed from year to year (amount of waste disposed of in landfill, meteorological conditions, population growth, composition of waste...) and from previous years (managing style of sites...), which yield methane contribution from deeper layers to the emissions in the inventory year. It is evident that total emissions depend on many factors, which vary from year to year.

Probability distribution functions and their basic characteristics, mean value and 95% confidence interval expressed with two percentage values relative to the mean value. In Table 8.7 some parameters should be explained. The parameter F is split to the variables with different confidence interval in the years before 1994 and after 1994. Parameters MCF are defined analogically. The difference from the previous case is that the mean value is changed too. For this reason, the data until 1993 and between 1994 and 2001 should be recalculated. In the interval from 1994 to 2001 the mean value is linearly interpolated between the values of data before 1994 and data after 2001. The variability is modified adequately.

Table 8.7: The uncertainty and mean value estimations, IPCC default values for parameters used in FOD model

Parameter	IPCC Mean Value	IPCC Confidence Interval Value
k	0,05	(-40 %; +300 %)
MSWT(x)		±10%
MSWF(x)		±10%
MCF(x)	1	(-10 %; 0 %)
	0,4	(-30 %; +30 %)
	0,6	(-50 %; +60 %)
DOC(x)	0,21	(-50 %; +20 %)
DOCF(x)	0,77	(-30 %; 0 %)
F(x)	0,5	(0 %; +20 %)
R(x)	variable	
OX(x)	0	

Special explanation is required in relation to parameter MSWL, which is a product of multiplication of MSWT and MSWF. In this case we exploit the possibility to transform easily the standard distribution to the normal distribution. Parameter MSWL is varied during the analyzed period 1960 – 2009 significantly, the mean value and 95% confidence interval is varied during this period, but PDF has feature of the normal distribution. The uncertainty of MSWL until 1995 was taken to 50% of the mean value. After 1995 the uncertainty of MSWL was taken to 10% of the mean value. DOC(x) value was changed linearly from value 0.06 in 1960 to value 0.12 in 1990. After 1990 this parameter has constant value. For the parameter OX, the values from Table 8.7 are valid only in the period from 1994 to 2009. Before this period the zero value is assumed. The country specific value for mean values and confidence interval in Table 8.8 were estimated by sector expert for waste.

Table 8.8: Uncertainty and mean value estimation, which are used in the Slovak Republic

Category	Mean Value	Confidence Interval	Distribution Function
k	0,065	(-45 %; +230 %)	empirical
F(x) until 1994	0,5	(-20 %; +20 %)	normal
F(x) after 1994	0,5	(-2 %; +20 %)	empirical
MSWL			standard normal
DOCF(x)	0,6	(-30 %; +28 %)	triangular
DOC(x)	0,12	(-50 %; +20 %)	empirical
MCF(x) until 1994	1	(-30 %; +4 %)	empirical
MCF(x) after 2001	0,6	(-50 %; +60 %)	triangular
OX(x)	0,05	(-95 %; +100 %)	triangular

Tier 1 approach is below method limits and its results should be interpreted carefully. The formulas are not simple, they contain time dependence and nonlinear feature are important. Standard deviations of some input parameters are higher than 30% of mean value. In this case the rules of uncertainty computation by Tier 1 can serve only informative results.

If obtained data are used for developing distributions, it is important to determine whether it is a random, representative sample. To obtain the 95% confidence limits, some additional information about the data set is needed. The use of properties of PDF or cumulative distribution function (CDF) allows obtaining additional information about percentiles and data properties. Based on this knowledge, the propagation of uncertainties can be analyzed and the values for confidence interval can be determined.

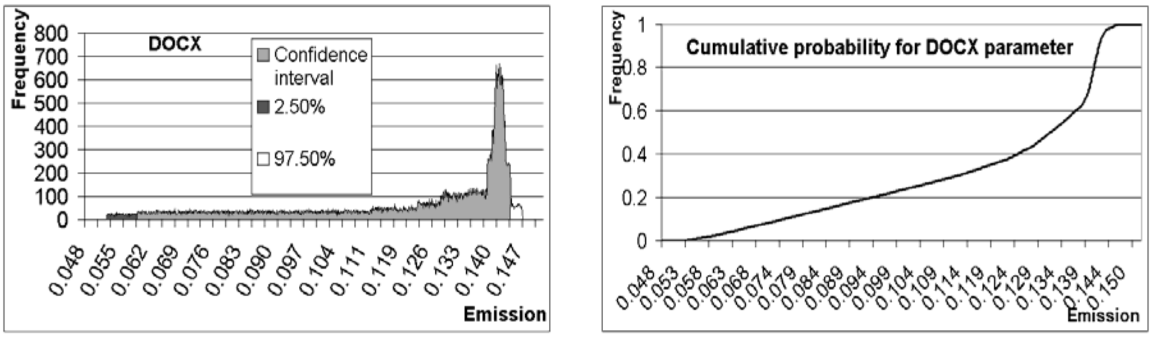
In some cases an empirical distribution is constructed, which supplies analytical properties of PDF or CDF. There are many references, which prefer to use analytical distribution instead of empirical distribution. They say that empirical probability distributions are unwieldy and they offer the replacement of the empirical distribution by an analytical function, either CDF or PDF. In the text below it can be seen that in some cases keeping the empirical distribution has more advantages than forcing to find analytical function. For example in many cases, several functions can fit the empirical data satisfactorily within a given probability criteria. These different functions can have different distributions at the extremes where there are few or no data to constrain them, and the choice of one function over another can systematically change the outcome of an uncertainty analysis.

Some recommendations how to construct PDF or CDF can be found in papers. These recommendations start to be important especially when there are some degrees of freedom for the construction of PDF, usually when expert recommendations are important and no sufficient data are available.

When empirical data are available, the first choice should be to assume a normal distribution of the data (either in complete or truncated form to avoid negative values, if these would be unrealistic), unless the scatter plot of the data suggests a better fit to another distribution. When expert judgment is used, the distribution function adopted should be normal or lognormal as in previous case, supplemented by uniform or triangular distributions. Other distributions are used only where there are compelling reasons, either from empirical observations or from expert judgment backed up by theoretical argument.

The analytical PDF and their statistical properties are well known, except empirical distribution. In some special cases, for example when strong skewness of PDF is desired, empirical distribution has to be constructed. For this reason we develop methodology. To know all the recommendations above, how to construct the PDF, the empirical distribution is constructed in the following way. There are requirements which should be strictly observed. On the first, monotonous property before and after one global maximum on the examined interval is demanded. Probability decomposition is assigned by confidence interval (in our case represents 95%) values, which are known from expert entry. Mean value for data set is assigned too. These requirements create relations which allow us to construct system of equations, which describe these objectives. In the system one can have few free parameters which allow us to modify the shape of probability function. The number of tuned parameters depends on the number of subintervals (relating to points density where function values are computed).

Figures 8.3: Empirical behavior of DOC(x) parameter



On the left, probability density function is generated by empirical function, on the right cumulative probability function for DOC(x) parameter is presented. Mean value is 0.120, confidence interval 50%:20% relative to the mean value (0.060:0.144). In this case, with respect to the previous recommendations how to construct the PDF, it should be effective to take this data sample and construct it by some methods, for example by statistical parameters estimation methods, Method of Matching Moment (MoMM) and Maximum Likelihood Estimation (MLE) desired analytical distributions. Our experience suggests keeping empirical form of data in special cases (high skewness), because continuous analytical form which approximate our empirical distribution can change the desired statistical criteria significantly (confidence interval or average is differ from initial conditions).

If the expert determines the confidence interval, the PDF procedure creation could force us to play with these input statistical characteristics. Uncertainty changes are not linear and before the value changes for fitting PDF function it should be investigates influence to the total uncertainty. To prevent manipulation with input values, which represent confidence interval or mean value, it could be preferable as it was explained above to use empirical PDF. This approach will absolutely satisfy expert requirements.

Figure 8.4: Frequency distribution function for waste for year 2009

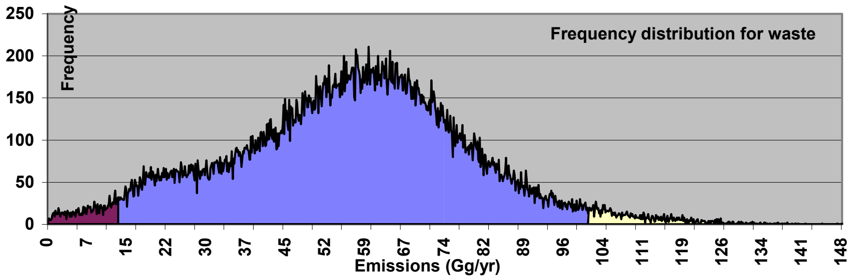


Table 8.9: Uncertainty and mean value estimation

Median	Average	Standard dev,	2,50%	97,50%
57,60	56,61	21,94	13,28	100,90
Min	**Max**		**Per_2,5**	**Per_97,5**
0,00	148,34		-76,54%	78,24%

Figure 8.5: Variation of the median, the average, the standard deviation and 95% confidence interval are expressed by the values during the period 1960 – 2009

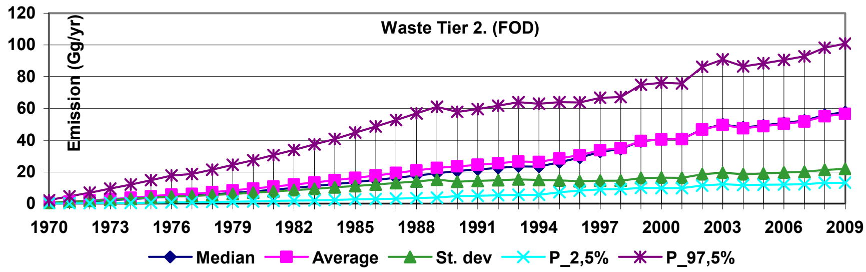
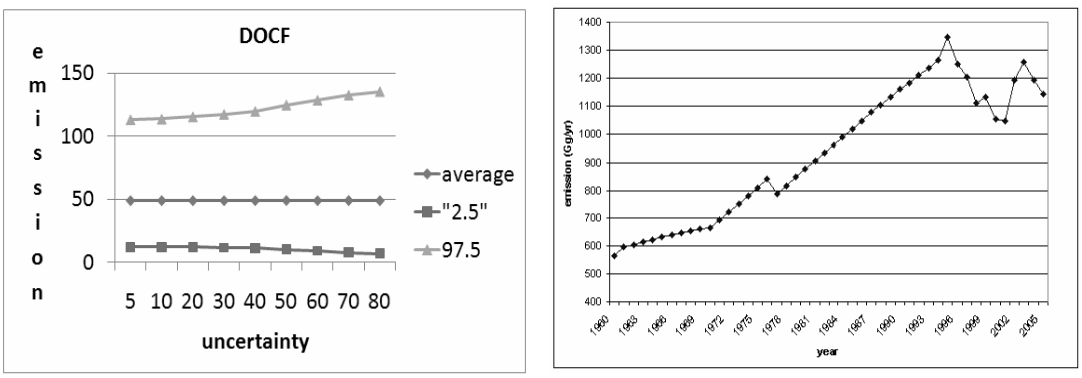


Figure 8.6: On the left, DOCF parameter sensitivity to the normal PDF uncertainty variation, on the right, municipal solid waste landfill (MSWL) mean value variation during the period 1960 – 2005



With this knowledge, the PDF from entered parameters were constructed and consecutively they were applied to the FOD. After application of Monte Carlo method to the FOD model, the final probability distributions are obtained for every inventory year. This approach allows us to see detailed variation and combination of input parameters and their distribution functions. As shown above, the interactions of PDF's are not simple. The final statistic is available for total methane emissions for chosen year's period (1960 – 2009). The result is from 60 000 trials. A number of trials have the influence on the result precision.

The uncertainty of emissions seems to be strongly dependent on the PDF's setting. These features were identified by FOD model investigation by simple linear analyses of uncertainty of total emissions and in the second case by changing PDF's setting. The data accuracy plays an important role in the computation of total uncertainty. PDFs selection in the case of symmetry uncertainty can only increase the total uncertainty. Increasing of partial uncertainties for input factors, they nonlinearly increase the total uncertainties. In the case of allowing asymmetry, total uncertainty could be smaller than single input parameters uncertainties. It can be seen that variation of parameter K has less significant influence on total emissions than other parameters. This result was obtained with normal PDF setting for all parameters and by changing the uncertainty level from ±50% to ±10% for a given parameter. Other parameters show similar dependence on the uncertainty of total emission. This approach shows that more important feature which has the strongest influence on the total uncertainty is asymmetry allowance. The result is the fact that total uncertainty increased compared to IPCC default recommended value in the interval -76.54%; +78.24% in 2009. Default value is 50% for total methane emissions from SWDS. This uncertainty increase is not the failure of Tier 2 against Tier 1. On the text above the applicability of Tier 1 method was discussed. On the contrary, Tier 2 provides deeper analyze and describes reality more precisely. It means that actual uncertainty is close to the Tier 2 result and improvement could be achieved by decreasing of input parameters uncertainty. This default uncertainty value is applicable to the Tier 1 default method. From this value in the Tier 1, the key sources are identified by categories magnitude, which adds up to over 95% of the total emissions or emission trend. In Tier 2 FOD method the 90% of the level or trend uncertainties are also taken for the key sources specification. The results of our analysis show that methane emissions from MSWDs are important key category. Specification and identification of the key sources are important for private companies and governmental institutions to obtain overview of important emissions. During the uncertainty computation, emitting CH_4 from underlayer and many other factors such as meteorological conditions, managing sites and policies and measures are included. These dependences are expressed in FOD model, which has been solved by Monte Carlo simulation. Spreading of emission uncertainty during the analyzed period was obtained. From the computed result precision an increase in emissions is observed. In spite of high inaccuracy on the input data at the beginning of the examined period (this uncertainty has influenced current uncertainty), relatively valuable results have been obtained.

8.2.2.5 Source specific QA/QC and verification

Regarding solid waste, activity data and verification are based on information published annually by the Statistical Office of the Slovak Republic in publication "Odpady" (Waste) since 1993. Also, to verify this information and gain more details, interviews were held with representatives of the following companies:

- Waste service companies: Marius Pedersen Slovakia, Brantner Slovakia, SITA Slovakia, A.S.A. Slovakia, T+T Žilina (landfill gas recovery).

Table 8.10: Results for uncertainty assessment in the SWDS for period 2000 – 2009

Year	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Median	40,54	40,78	46,88	49,94	47,98	49,36	50,85	52,39	55,91	57,60
Average	40,51	40,65	46,64	49,59	47,55	48,81	50,20	51,63	55,02	56,61
St.dev	16,38	16,28	18,51	19,51	18,57	19,07	19,59	20,13	21,29	21,94
0,025	9,77	9,89	11,42	12,22	11,77	11,87	12,05	12,22	13,16	13,28
0,975	76,15	75,72	86,12	90,81	86,45	88,44	90,56	92,84	98,28	100,90
Min	0,82	0,84	0,98	1,06	1,01	0,65	0,37	0,06	0,16	0,00
Max	112,16	111,43	126,64	133,45	126,95	129,95	133,14	136,51	144,38	148,34
Per_2.5	**-75,87**	**-75,68**	**-75,51**	**-75,35**	**-75,25**	**-75,68**	**-75,99**	**-76,32**	**-76,08**	**-76,54**
Per_97.5	**87,99**	**86,26**	**84,66**	**83,14**	**81,81**	**81,19**	**80,41**	**79,82**	**78,64**	**78,24**

8.2.2.6 Source specific recalculations

No recalculations in the submission 2011 focused on the base year 1990 or the other inventory years were provided.

8.2.2.7 Source specific planned improvements

It is planned, that the activity data on solid waste will be reviewed in details, removing out-lying data and replacing them with interpolations/extrapolations. This was not possible to perform in the past, as the waste data are collected according to the European Waste Classification (EWC) since 2002 and only now discrepancies in data become visible.

The national census in 2011 will provide new data on the heating distribution structure, which will be used for updating the DOC.

8.2.3 Source category description – Unmanaged waste disposal on land (CRF 6.A.2)

Emissions are not occurring from this category, the unmanaged waste disposal sites are not occurring in the Slovak Republic.

8.2.4 Source category description – Other – Agricultural and industrial waste (CRF 6.A.3)

The methane emissions for industrial solid waste are included in this category since 1997, before this year the emissions from industrial waste disposal were not estimated because of lack of activity data. The total emissions of methane from ISW disposed to industrial SWDSs reached 26.56 Gg in 2009. The interpolation method was used for methane emission estimation in the period 1990 – 1996, the estimate is not included in the emission inventory submission 2011, but can be considered in the next submission if no other data will be available.

Table 8.11: Activity data and methane emissions for industrial solid waste disposal in 1997 – 2009 with the proposal (*) of interpolated data for 1990 – 1996

Industrial and agricultural waste disposal on land (CRF 6A.3)			
Year	**Total ISW (kt)**	**Biodegradable ISW (kt)**	**CH_4 emissions (Gg/yr)**
1990	NA	NA	***15.0****
1991	NA	NA	***15.0****
1992	NA	NA	***15.0****
1993	NA	NA	***15.0****
1994	NA	NA	***15.0****
1995	NA	NA	***15.0****
1996	NA	NA	***15.0****
1997	3 085,00	115,00	**7,40**
1998	2 861,00	372,00	**18,61**
1999	2 642,00	525,00	**30,06**
2000	2 313,00	222,00	**14,96**
2001	2 470,00	220,00	**15,00**
2002	2 915,00	753,00	**42,36**
2003	3 322,00	612,00	**38,32**
2004	4 262,00	666,00	**42,69**
2005	2 888,00	553,00	**35,63**
2006	5 772,00	659,00	**40,61**
2007	4 269,00	586,00	**36,23**
2008	3 212,00	594,00	**36,84**
2009	2 671,00	368,00	**26,56**

8.2.4.1 Methodological issues – methods

The “Tier 0” methodology is still considered as the most appropriate method for the estimation of methane emissions from ISW disposal in SWDSs in the Slovak Republic. The key problem is the unavailability of consistent time series needed for Tier 2. The option of estimating amount of ISW from GDP (Tier 1) is not suitable, as there were/are too many changes (political, technological, ownership) significantly influencing ISW management. The number of companies producing larger amounts of waste is relatively small, thus fluctuations in their production and/or waste generation strongly influence ISW balance in the Slovak Republic.

8.2.4.2 Methodological issues – emission factors and parameters

The default IPCC parameters listed in IPCC 2006 GL were used for the estimation of methane from ISW disposed in solid waste disposal sites. The default DOC values were assigned to individual groups of waste, defined in the old and new classification systems.

This parameter is used in the same manner as for MSW landfills, because co-disposal of MSW and ISW ended with the entry of the Slovak Republic to the EU (2004). The following hypothesis is used:

- Before 1992 all ISW was disposed of in SWDSs on which very little or no data exist = IPCC category uncategorised sites.
- Since 2000 all ISW is disposed of in managed landfills = IPCC category managed anaerobic sites.
- Period 1993 – 1999 is a period of transition when managed sites were gradually developed = linear growth of MCF.

Recommended IPCC default values are used for the remaining parameters DOC_F (0.5), F (0.5), R (0) and OX (0.1).

8.2.4.3 Activity data

The structure of data collected by the Statistical Office of the Slovak Republic allowed identification of waste streams which contain mainly biodegradable carbon.

The extrapolation of emissions from ISW disposal is not supported by sufficient information and should be understood as informational only from following reasons:

- The system of waste classification has changes in 2002; this is splitting the available data to two non-compatible sets.
- ISW data are published only since 1997; previous data are not reliable and not compatible with current data.
- The waste management practice has changed significantly in the period 1990 – 2000 towards controlled landfilling this makes extrapolation difficut.
- The political system has changed in 1989 and economic transformation started in 1990, the following decade is full of economic turbulences, e.g. closing of old factories and starting of new enterprises.

8.2.4.4 Uncertainties and time consistency

Industrial waste data are available for the period 1997 – 2001 (according to the Slovak waste classification system) and 2002 – 2009 (according to the European Waste Classification). Information is collected for recalculation of waste amounts from the Slovak system to EWC system to obtain uniform time series and extrapolate to 1990.

8.2.4.5 Source specific QA/QC and verification

Data on ISW are collected annually by the Waste Management Centre of the Slovak Environmental Agency, also according to the EWC. This resource was used when more detailed data were needed, than provided by the Statistical Office of the Slovak Republic. The activity data on methane recovery from landfills was obtained directly from landfill operators.

8.2.4.6 Source specific recalculations

Methane emissions based on activity data for industrial solid waste disposal were recalculated according to the European Waste Classification and in line with the updated parameters of biodegradable fraction of ISW (Table 8.11). The results of recalculation are summarised in the following table. The changes in volume of ISW disposal were not occurred. Recalculation led to decrease in methane emissions in comparison with previous submission.

Table 8.12: The comparison of 2010 and 2011 submissions of methane emissions estimation in category 6A3 in 2001 – 2008

	CH_4 emissions (Gg/yr)		Changes in %
Year	Submission 2010	Submission 2011	2011/2010
2001	14,99	15,00	100,07%
2002	49,20	42,36	86,10%
2003	41,70	38,32	91,89%
2004	46,50	42,69	91,81%
2005	38,70	35,63	92,07%
2006	44,20	40,61	91,88%
2007	39,40	36,23	91,95%
2008	40,00	36,84	92,10%

8.2.4.7 Source specific planned improvements

Additional data were collected which will be used for recalculation of data based on the waste classification system used in the period 1997 – 2001 to the structure defined in the EWC. We expect that the result will allow preparation of consistent time series from 1997 and extrapolation to the base year.

8.3 Wastewater handling (CRF 6.B)

8.3.1 Source category description

For the estimation of GHG emissions from wastewater treatment and discharge the IPCC 2006 GL were used for the first time. Therefore the overall approach to the wastewater sector activity data was reviewed and emission estimates were completely recalculated:

- Domestic and commercial wastewater treatment and discharge
- Industrial wastewater treatment and discharge

Methane and nitrous oxide emissions were estimated for both of these categories. The Statistical Office of the Slovak Republic regularly publishes the information on BOD and COD generated and discharged from many sources. This information was used as activity data, both for domestic and industrial wastewater emission estimation. In 2009, the total methane emissions from wastewater treatment were 17.36 Gg. This is a slight decrease compared to the previous year but the trend is almost stable. In 2009, the total N_2O emissions from wastewater treatment were 0.26 Gg. The trend is almost stable although the slight decrease compared to the previous years has occurred.

For each category in this subsector, the estimation of CH_4 emissions from wastewater handling requires three basic steps:

- Determine the total amount of organic material in the wastewater produced for each wastewater handling system. The principal factor in determining the CH_4 generation potential of wastewater is the amount of degradable organic material in the wastewater. The most common parameters used to measure the degradable organic component (DC) of the wastewater are the BOD (Biochemical Oxygen Demand – 5 days) and COD (Chemical Oxygen Demand). Data permitting, COD is the recommended parameter for estimating the DC of wastewater. The DC indicator, usually indicated in units of mass DC per unit volume (e.g., kg COD per m^3 wastewater) is multiplied by the volume of the source of wastewater (e.g., industry or domestic) to estimate the total amount of organic wastewater produced.
- Estimate emissions factors for each wastewater handling system in kg CH_4 per kg DC. The emissions factors depend on the fraction of wastewater managed by each wastewater

handling method, maximum CH_4 producing capacity of the wastewater, and the characteristics of the wastewater handling process (principally, the degree to which it is anaerobic).

- Multiply the emissions factor for each wastewater handling system by the total amount of organic material in the wastewater produced for each system, and sum across the wastewater system to estimate total CH_4 emissions.

The main source of nitrous oxide emissions from wastewater are the emissions generated from discharge of nitrogen to watercourses. These are sub-divided to emissions from treated discharge and emissions from other discharges. A minor source of nitrous oxide emissions are aerobic processes with nitrification/denitrification stage. The nitrous emissions estimations are based on municipal wastewater and represent full recalculation since 1990.

Table 8.13: GHG emissions in individual categories in wastewater handling in 1990 – 2009

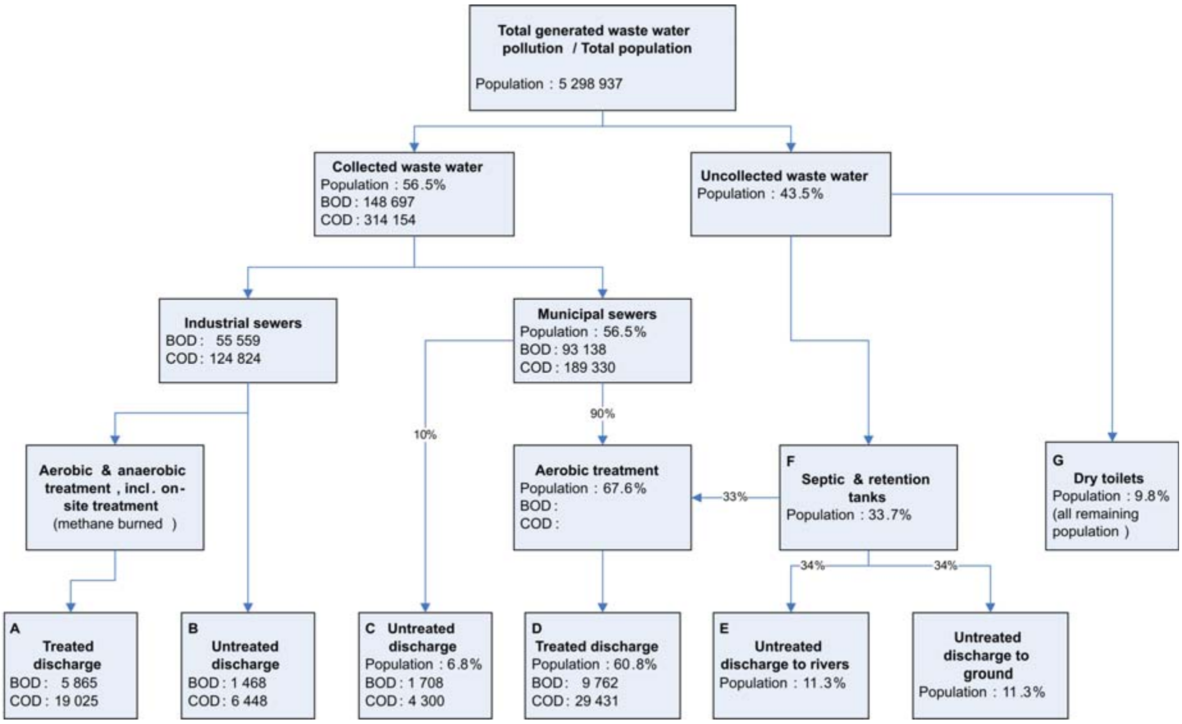
	Wastewater Handling (CRF 6B)					
	Industrial Wastewater			Domestic and Commercial Wastewater		
	Wastewater Treatment (m^3)	CH_4 (Gg)	N_2O (Gg)	Population 1000/number	CH_4 (Gg)	Human Sewage N_2O (Gg)
1990	72 351,800	1,250	0,065	5 297,770	18,456	0,383
1991	73 589,300	1,250	0,065	5 283,400	18,365	0,362
1992	55 180,700	1,250	0,050	5 306,540	18,434	0,338
1993	42 559,300	1,019	0,040	5 324,630	18,504	0,338
1994	43 256,000	1,211	0,041	5 347,310	18,121	0,338
1995	38 782,100	0,845	0,039	5 363,680	17,825	0,352
1996	43 440,600	0,701	0,042	5 373,790	17,890	0,352
1997	41 474,100	0,662	0,040	5 383,230	17,842	0,352
1998	44 166,600	0,669	0,041	5 390,870	17,952	0,341
1999	36 705,300	0,631	0,036	5 395,320	17,989	0,328
2000	30 295,000	0,726	0,030	5 400,680	18,043	0,299
2001	12 623,000	0,681	0,030	5 379,780	17,880	0,288
2002	34 578,000	0,637	0,072	5 378,810	17,932	0,281
2003	37 763,300	0,664	0,031	5 378,950	17,860	0,264
2004	34 296,750	0,551	0,039	5 382,574	17,783	0,251
2005	31 631,640	0,422	0,043	5 387,285	17,656	0,257
2006	32 865,403	0,324	0,040	5 393,640	17,716	0,256
2007	32 424,285	0,315	0,040	5 400,998	17,651	0,247
2008	28 601,759	0,324	0,033	5 412,254	17,520	0,235
2009	28 111,451	0,342	0,029	5 418,374	17,020	0,236

The structure of WWT plants in the Slovak Republic was analysed and information regarding WWT sludge generation, share of WWT plants with nitrification/denitrification and efficiency of nitrification/denitrification process was used in estimation of nitrous oxide emissions. The following expectations were considered:

- Data on WWT sludge were identified from 1998. As there are no exact data on generation of WWT sludge prior to 1998, expert estimation was used based on stable/constant generation of WWT sludge. Also, the content of nitrogen in sewage sludge was estimated to 4%. These data allow estimation of the amount of nitrogen removed from waste water with sludge.
- WWT plants started to introduce nitrification/denitrification process in 1998. The database of SHMU indicates that in 2005 – 2007 the amount of waste water treated in WWT plants with nitrification/denitrification represents about 60% of total treated wastewater. The share for the period 1999 – 2004 was interpolated.
- The process generating nitrous oxides is a combination of nitrification (oxidation of ammonia to nitrates) and denitrification (reduction of nitrates to nitrogen). The effectiveness of these processes in national conditions is estimated to 80% for nitrification and 50% for denitrification. The resulting effectiveness of the entire process is then 40%.

- The IPCC 2006 GL provide methodology (Box 6.1 of the IPCC 2006 GL) for estimation of N_2O emissions from advanced centralised wastewater treatment (WWT) plants. Using the default parameters, these emissions were estimated, summarising all three sources of nitrous oxide emission for waste water.

Figure 8.7: Wastewater pathways in the Slovak Republic



8.3.2 Source category description – Industrial Wastewater (CRF 6.B.1)

Total methane emissions were 0.34 Gg and total N_2O emissions were 0.03 Gg from industrial wastewater treatment in 2009. The pathways A and B (Figure 8.7) are included in the estimation of methane emissions. The following table shows the activity data and resulting estimation of emissions.

Table 8.14: Summary of activity data and emissions from IWW by pathways in 1990 – 2009

	Generated IWW (m^3/y)	Discharged IWW (COD t/y)	CH_4 (Gg)	EF (CH_4) (kg/kg DC)	N_2O (Gg)	EF (N_2O) (kg/kg DC)
1990	72 351,800	50,000	1,250	0,025	0,065	0,0013
1991	73 589,300	50,000	1,250	0,025	0,065	0,0013
1992	55 180,700	50,000	1,250	0,025	0,050	0,0010
1993	42 559,300	40,757	1,019	0,025	0,040	0,0010
1994	43 256,000	48,457	1,211	0,025	0,041	0,0008
1995	38 782,100	33,814	0,845	0,025	0,039	0,0011
1996	43 440,600	28,054	0,701	0,025	0,042	0,0015
1997	41 474,100	26,489	0,662	0,025	0,040	0,0015
1998	44 166,600	26,751	0,669	0,025	0,041	0,0015
1999	36 705,300	25,220	0,631	0,025	0,036	0,0014
2000	30 295,000	29,035	0,726	0,025	0,030	0,0010
2001	12 623,000	27,254	0,681	0,025	0,030	0,0011
2002	34 578,000	25,473	0,637	0,025	0,072	0,0028
2003	37 763,300	26,555	0,664	0,025	0,031	0,0012
2004	34 296,750	22,049	0,551	0,025	0,039	0,0018
2005	31 631,640	16,880	0,422	0,025	0,043	0,0026
2006	32 865,403	12,947	0,324	0,025	0,040	0,0031
2007	32 424,285	12,603	0,315	0,025	0,040	0,0032
2008	28 601,759	12,951	0,324	0,025	0,033	0,0026
2009	28 111,451	13,668	0,342	0,025	0,029	0,0021

8.3.2.1 Methodological issues – methods

As recommended by the IPCC 2006 GL, COD values were used for the estimation of methane emissions from industrial waste water (IWW), these direct data are available starting from 1993. Although there may be a similar effect of overestimated pollution at the beginning of nineties and incomplete reporting of pollution after 2003, it is assumed that using the reported COD data will provide better estimates of emissions that estimating pollution according to the methodology provided in chapter 6.2.3.3 of the IPCC 2006 GL. Only methane emissions from IWW discharged into rivers by separate industrial sewers were considered here as a source of methane emissions, IWW discharged to public sewers is included in domestic wastewater. It is expected, if anaerobic treatment of IWW was used, that all methane from this treatment was burned (with or without energy utilisation).

The ISI methodology is used for industrial wastewater N_2O emission estimation. The ISI methodology expects that wastewater treatment plant without biological nitrification have no N_2O emission. Only data for treatment plant where biological nitrification and denitrification take place were used for emission balance. The number of this type of treatment for industrial wastewater has increased; therefore it is expected also increasing of N_2O emission in the future.

8.3.2.2 Methodological issues – emission factors and parameters

The population can be exchanged by the population of equivalents, calculated from COD in the inlet in wastewater treatment and production of BOD for one person (0.05 kg/person/day). Data on treatment plant where the concentration is in the case of k(denit) can be eliminated from the estimation.

According to the national data, 100% of industrial wastewaters are treated, from that 95% in anaerobic treatment process and 5% in aerobic treatment process.

Methane emission factor is rather constant through time series (0.025 kg per kg of degradable carbon), emission factor for N_2O estimation is dynamic and changing from year to year. It depends on direct measurements of industrial wastewater treatment operators. The list of emission factors for N_2O emission from industrial wastewater treatment is shown in Tables 8.14 and 8.15.

Table 8.15: Summary of wastewater treatment in industry in 1990 – 2009

	Fertilisers		Food and Beverages		Organic Chemicals		Other Streams	
	WW output	COD	WW output	COD	WW output	COD	WW output	COD
1990	62 208,00	0,20	NO	NO	10 143,80	0,40	NO	NO
1991	63 849,60	0,20	NO	NO	9 739,70	0,40	NO	NO
1992	46 125,40	0,20	NO	NO	9 055,30	0,40	NO	NO
1993	33 722,00	0,20	NO	NO	8 837,30	0,40	NO	NO
1994	34 014,20	0,20	NO	NO	9 241,80	0,40	NO	NO
1995	28 215,40	0,20	NO	NO	10 566,70	0,40	NO	NO
1996	32 601,40	0,20	NO	NO	10 839,20	0,40	NO	NO
1997	32 324,30	0,20	NO	NO	9 149,80	0,40	NO	NO
1998	35 699,40	0,20	NO	NO	8 467,20	0,40	NO	NO
1999	28 022,20	0,20	NO	NO	8 683,10	0,40	NO	NO
2000	22 086,00	0,20	NO	NO	8 209,00	0,40	NO	NO
2001	NO	NO	3 439,00	0,04	9 184,00	0,82	NO	NO
2002	21 524,00	0,41	3 291,00	0,05	9 763,00	0,95	NO	NO
2003	19 697,00	0,24	4 131,40	0,05	10 717,70	0,28	3 217,20	0,03
2004	19 506,00	0,38	3 999,45	0,04	7 742,00	0,30	3 049,30	0,03
2005	17 122,91	0,47	6 064,56	0,04	5 393,18	0,49	3 050,99	0,03
2006	19 865,12	0,44	5 001,07	0,04	5 393,18	0,22	2 606,03	0,02
2007	18 967,80	0,47	5 565,50	0,04	5 393,18	0,22	2 497,81	0,05
2008	17 090,67	0,46	5 524,05	0,04	4 169,78	0,12	1 817,26	0,05
2009	16 821,15	0,38	5 098,52	0,05	4 904,38	0,16	1 287,40	0,05

8.3.2.3 Activity data

Information about industrial wastewater is registered in the database of wastewaters at SHMU, the Department of Water Quality. Complete time series from major polluters are known since 1990. Actual decrease in N_2O emissions is reasoning from the decreasing of industrial production and decreasing of volume of treated wastewater.

8.3.2.4 Uncertainties and time consistency

Methods used for the estimation of GHG emissions from industrial wastewater are based on equations introduced in the IPCC 2006 GL, with the exception of the ISI methodology for N_2O emission estimation in industrial wastewater. For the uncertainties associated with activity data, the default IPPC values were used. The data available in statistical reports are verified by comparison of the same category in various years. To minimise the uncertainties associated with activity data, the available data sets are reviewed and selected waste streams are used for emissions estimation.

Additional uncertainty is related to the date of published information. The wastewater category is affected by this issue. Wastewater parameters are published with a one year delay. Therefore expert estimate is used for the current year and data from the previous year are recalculated according to the published information. The information on protein consumption is published with two years delay. Similarly, expert estimates are used and emissions are adjusted according to the latest available information. For the uncertainties associated with parameters, the IPCC default parameters were used.

In all cases, the time series consistency is ensured.

8.3.2.5 Source specific QA/QC and verification

Data on ISW are collected annually by the Waste Management Centre of the Slovak Environmental Agency, according to the EWC. This resource was used when more detailed data were needed, than provided by the Slovak Statistical Office. Data on wastewater are based on population censuses done in 1991 and 2001. It is expected, that the next census in 2011 may cause some reconsideration and will lead to changes in trends currently extrapolated. These data are supported by annually published information on population, COD, BOD also published by the Statistical Office. Additional information was collected from the Ministry of Environment, the Slovak Environmental Agency – the Centre of Waste Management (COHEM), from the Slovak Hydrometeorological Institute and from the Association of Wastewater treatment experts (AČE SR).

8.3.2.6 Source specific recalculations

The correction in reporting of total generated IWW in 2008 was taking place. The correct value is 28 601.76 m^3 (instead of 30 621.75 m^3) as reported in the previous NIR. The reported N_2O emissions were recalculated to 0.033 Gg in 2008 (from 0.041 Gg). The recalculation was based on correction of data in wastewater database.

8.3.2.7 Source specific planned improvements

The wastewater activity data will be reviewed in 2012, after publication of national census results in 2011.

8.3.3 Source category description – Domestic and Commercial Wastewater (CRF 6.B.2)

Total methane emissions were 17.02 Gg and total N_2O emissions were 0.24 Gg from domestic wastewater treatment in 2009. The pathways C – F (Figure 8.7) are included in the estimation of methane emissions. The following table shows the activity data and resulting estimation of methane emissions.

Table 8.16: Summary of methane emissions from D&C WW by pathways in 1990 – 2009

	Total Organic Product (Gg)	Methane Emissions (Gg)					
		Pathway C	Pathway D	Pathway E	Pathway F	Pathway G	Total
1990	145,027	1,130	1,260	0,920	13,570	1,570	18,456
1991	144,633	0,790	1,370	0,920	13,640	1,510	18,365
1992	145,267	0,830	1,350	0,930	13,810	1,520	18,434
1993	145,762	1,000	1,330	0,940	13,970	1,450	18,504
1994	146,383	1,010	0,880	0,960	14,130	1,480	18,121
1995	146,831	0,770	0,810	0,970	14,290	1,320	17,825
1996	147,108	0,580	0,810	0,980	14,420	1,260	17,890
1997	147,366	0,390	0,700	0,990	14,550	1,180	17,842
1998	147,575	0,480	0,700	1,000	14,680	1,140	17,952
1999	147,697	0,460	0,670	1,010	14,810	1,050	17,989
2000	147,844	0,440	0,630	1,020	14,930	1,030	18,043
2001	147,271	0,330	0,550	1,030	14,870	0,980	17,880
2002	147,245	0,310	0,560	1,030	14,950	0,960	17,932
2003	147,249	0,400	0,550	1,030	15,040	0,930	17,860
2004	147,348	0,240	0,570	1,030	15,130	0,840	17,783
2005	147,477	0,450	0,440	1,040	15,230	0,820	17,656
2006	147,451	0,370	0,450	1,040	15,320	0,800	17,716
2007	147,541	0,210	0,480	1,050	15,430	0,620	17,651
2008	148,016	0,200	0,300	1,050	15,450	0,520	17,520
2009	148,328	0,190	0,300	1,000	15,130	0,400	17,020

8.3.3.1 Methodological issues – methods

The IPCC 2006 GL (Volume 5, Chapter 6, page 6.11) recommend the following approach by domestic wastewater methane emission estimation:

- Step 1: estimation of the total organically degradable carbon in wastewater.
- Step 2: Identification of wastewater pathways.
- Step 3: Estimation of methane emissions from wastewater.

This approach was used both for domestic and industrial wastewaters, because information on BOD and COD are known and are used as activity data. The total organically degradable carbon in wastewater (TOW) was estimated using the equation 6.3 (IPCC 2006 GL).

The following parameters were used:

- P - total population of the Slovak Republic (the Statistical Office of the Slovak Republic).
- BOD per capita - BOD in inventory year (60 g/person/day - country specific value).
- I - correction factor for additional industrial BOD discharged into sewers (1.25).

The emissions of methane from domestic wastewater were estimated from pathways C, D, E, F and G using equations 6.1 and 6.2 from the IPCC 2006 GL.

The comparison of the data indicates a good correlation for the data in the middle of Table 8.17, start and end data indicate deficiencies in reporting. The start data may be influenced by old style of data reporting (similar overestimation of data was experienced also in MSW) and data after 2003 may be influenced by the privatisation of water sector. Therefore TOW estimated according to the IPCC 2006 GL will be used for emission estimations.

Public sewers in the Slovak Republic collect wastewater from households, commerce, industry (may be mechanically or chemically pre-treated on-site) and rainwater. The amount of wastewater discharged without treatment is decreasing, due to the development of new wastewater treatment plants.

The aerobic process is used for treatment of the majority of domestic wastewater. The overloading of wastewater treatment plants is minimal, due to modernisation of plants and significant decrease in water consumption by households. The parameter Rem was included to take in account treatment efficiency. This parameter was estimated from monitored BOD values.

Table 8.17: The comparison of TOW estimation results using the IPCC 2006 GL with BOD – generated pollution reported by the Statistical Office of the Slovak Republic

	Population not using WW treatment plants	Population using WW treatment plants	Total Organic Product (Gg DC)	BOD reported (kg/1000 person/year)	Population (1000 persons)
1990	48,000	52,000	145,027	204 000,000	5 297,770
1991	50,200	49,800	144,633	225 000,000	5 283,400
1992	52,000	48,000	145,267	213 000,000	5 306,540
1993	53,600	46,400	145,762	160 385,000	5 324,630
1994	54,900	45,100	146,383	152 363,000	5 347,310
1995	59,000	41,000	146,831	155 758,000	5 363,680
1996	59,400	40,600	147,108	149 683,000	5 373,790
1997	59,800	40,200	147,366	152 860,000	5 383,230
1998	60,200	39,800	147,575	153 329,000	5 390,870
1999	60,600	39,400	147,697	152 303,000	5 395,320
2000	61,000	39,000	147,844	137 606,000	5 400,680
2001	61,100	38,900	147,271	144 974,000	5 379,780
2002	61,400	38,600	147,245	148 697,000	5 378,810
2003	63,200	36,800	147,249	130 837,000	5 378,950
2004	65,300	34,700	147,348	68 144,000	5 382,574
2005	66,600	33,400	147,477	106 436,000	5 387,285
2006	66,700	33,300	147,451	102 129,000	5 393,640
2007	68,600	31,400	147,541	108 075,000	5 400,998
2008	67,600	32,400	148,016	107 192,000	5 412,254
2009	68,500	31,500	148,328	105 900,000	5 418,374

According to the expert opinion, from about one third of septic and retention tanks in the Slovak Republic, the content is delivered and discharged to wastewater treatment plants. It is expected that there are no emissions from the treatment process, but remaining pollution discharged to water courses may be a source of methane emissions.

Septic and retention tanks are used in places with no access to sewers. According to the expert estimate, the content from one third of them is delivered to wastewater treatment plants, as required by law. But, although the following practices are not legal, one third of these tanks are discharged on/to ground and one third has a discharge to watercourses. Direct emissions from septic and retention tanks are currently the largest source of methane emissions.

The category of dry toilets includes citizens who reported in censuses the use of them (80% of this category) and also population which did not provided any information on their wastewater system (20% of this category).

8.3.3.2 Methodological issues – emission factors and parameters

Wastewater (WW) pathways (see Figure 8.7) were identified using information from two population censuses in 1991 and 2001 and from the Statistical Office of the Slovak Republic (data on generated and discharged pollution). The following pathways were identified as potential sources of methane emissions and activity data were collected to estimate methane emissions.

Table 8.18: Identification of wastewater pathways in the Slovak Republic

Pathways	Emission factors			Population using pathway		
	Bo	MCF	EF	1991	2001	2009
A – Industrial WW treated	0.6	0.1	0.06			
B – Industrial WW untreated	0.6	0.1	0.06			
C – Collected WW untreated	0.6	0.1	0.06	37.7%	6.7%	2.1%
D – Collected WW treated	0.6	0.1	0.06	39.8%	50.0%	57.3%
E – Untreated discharge from septic tanks	0.6	0.1	0.06	10.6%	11.6%	11.2%
F – Emissions from septic & retention tanks	0.6	0.5	0.30	31.4%	33.7%	34.0%
G – Dry toilets	0.6	0.1	0.06	15.7%	9.8%	4,50%

The sum of “Population using pathway” does not equals 100%

The main source of nitrous oxide emissions from waste water according to the IPCC 2006 GL are emissions generated from discharge of nitrogen to watercourses. These are sub-divided to emissions from treated discharge and emissions from other discharges. A minor source of nitrous oxide emissions are aerobic processes with nitrification/denitrification stage. The nitrous emissions estimations are based on municipal wastewaters and represent full recalculation from 1990.

8.3.3.3 Activity data – Human Sewage (CRF 6.B.2.2)

The protein consumption data are published by the Statistical Office of the Slovak Republic, but with one year delay (statistical reports for 2009 include protein consumption data of 2008). The value for actual year was extrapolated from data on the consumption of selected kinds of food.

The nitrous oxide emissions from treated wastewater discharge to watercourses were estimated from:

- Protein consumption per person per day.
- Share of population using WWT plants, this includes share of population directly connected to public sewers and population disposing septic tanks to WWT plants.
- Sludge generation at WWT plants.
- Share of WWT plants with nitrification/denitrification.
- Efficiency of nitrification/denitrification process.

The nitrous oxide emissions from other discharges include all other identified pathways, covering the remaining population. The IPCC 2006 GL provide methodology (Box 6.1) for the estimation of N_2O emissions from advanced centralised wastewater treatment (WWT) plants. This is the first attempt to estimate direct N_2O emissions from WWT plants with nitrification/denitrification stage; it aimed at the identification how this type of emissions influences the overall balance of nitrous emissions from waste water. The estimated amount of N_2O emissions from WWT plants with nitrification/denitrification stage represents about 10% of total emission of nitrous oxide based on ISI methodology or based on total emissions of nitrogen to water courses. This could lead to conclusion, that this type of emissions does not need to be calculated separately. On the other hand, 47% of WWT pants have nitrification/denitrification stage and their share will grow in the future, thus the separation of these emissions may be reasonable.

Table 8.19: Summary of sources of nitrous oxide emission for domestic and commercial wastewater

	From treated wastewater (Gg)	From other discharges (Gg)	Direct from WWT plants (Gg)	Total N_2O emissions (Gg)
1990	0,198	0,185	0,000	0,383
1991	0,203	0,160	0,000	0,362
1992	0,186	0,151	0,000	0,338
1993	0,182	0,155	0,000	0,338
1994	0,181	0,157	0,000	0,338
1995	0,204	0,148	0,000	0,352
1996	0,213	0,138	0,000	0,352
1997	0,224	0,128	0,000	0,352
1998	0,214	0,127	0,000	0,341
1999	0,205	0,123	0,002	0,328
2000	0,184	0,115	0,004	0,299
2001	0,179	0,109	0,005	0,288
2002	0,172	0,108	0,007	0,281
2003	0,155	0,109	0,009	0,264
2004	0,152	0,100	0,011	0,251
2005	0,145	0,113	0,012	0,257
2006	0,145	0,111	0,013	0,256
2007	0,150	0,097	0,013	0,247
2008	0,144	0,091	0,014	0,235
2009	0,143	0,093	0,015	0,236

Stabilisation of sewage sludge is an integral part of wastewater treatment plants in the Slovak Republic. All sludge leaving a wastewater treatment plant was aerobically or anaerobically stabilised, thus its organic content is reduced. Aerobic stabilisation is done in shallow sludge beds. This practice is used by smaller WWTPs. Anaerobic stabilisation is done in sludge tanks and generated biogas is used for energy generation, mainly for maintaining operational temperature in sludge tanks. The latest trend is to use biogas for co-generation of heat and electricity. Dewatered stabilised sludge is then used in agriculture and for remediation of land and old industrial disposal sites and part of it is disposed in landfills.

A recent study[16] analysed the energy recovery in wastewater treatment plants (WWTP) in the Slovak republic. In total, 45 WWTP were included in the study, representing about 80% of treated domestic wastewater. All these WWTP have anaerobic stabilisation of sewage sludge facilities and generated about 18 million m^3 of biogas in 2007. Eighteen of these WWTP have installed a co-generation unit and produced 12.7 GWh of electricity in 2007.

8.3.3.4 Uncertainties and time consistency

See chapter 8.3.2.4.

8.3.3.5 Source specific QA/QC and verification

See chapter 8.3.2.5.

8.3.3.6 Source specific recalculations

Based on the recommendations of the ERT during centralized review on the annual emission inventory in 2010, the N_2O emissions from domestic and commercial wastewater treatment were recalculated. The previous estimation didn't include direct N_2O emissions from wastewater treatment plants (Table 8.19). The emission estimations are compared in the following table.

Table 8.20: The comparison of submissions 2010 and 2011 for domestic and commercial wastewater

Total N_2O emissions (Gg) in 6.B.2			
	Submission 2010	Submission 2011	Changes 2011/2010 in %
1990	0,252	0,383	152,30%
1991	0,239	0,362	151,89%
1992	0,227	0,338	148,77%
1993	0,223	0,338	151,41%
1994	0,221	0,338	153,28%
1995	0,229	0,352	153,97%
1996	0,227	0,352	154,76%
1997	0,226	0,352	155,57%
1998	0,220	0,341	155,10%
1999	0,213	0,328	154,15%
2000	0,195	0,299	153,06%
2001	0,189	0,288	152,03%
2002	0,186	0,281	150,83%
2003	0,177	0,264	149,08%
2004	0,170	0,251	147,41%
2005	0,165	0,257	156,05%
2006	0,161	0,256	159,44%
2007	0,160	0,247	154,33%
2008	0,152	0,235	154,49%

8.3.3.7 Source specific planned improvements

The wastewater activity data will be reviewed in 2012, after the publication of national census results in 2011.

[16] Možnosti a perspektívy zvyšovania produkcie bioplynu na komunálnych ČOV s prídavkom externých substrátov, I. Bodík, M. Hutňan, S. Sedláček, M. Lazor,, 2009 (Potential and perspectives for increase of biogas generation in municipal WWTP by addition external substrates), in Slovak language only.

8.4 Waste Incineration (CRF 6.C)

8.4.1 Source category description

Incineration of waste produces mainly CO_2, N_2O and CH_4 emissions. Emissions of CO_2 from waste incineration are significantly greater than N_2O emissions. Methane emissions are observed during open burning of waste or inefficient (incomplete) incineration of waste and are not occurring in the Slovak Republic. Currently, waste incineration is more common in developed countries, although it is common for both developed and developing countries to incinerate clinical waste. Open burning of waste occurs in developing countries or in countries where this method is traditional.

Incineration of waste is an accepted practice in the Slovak Republic. It is regulated in accordance with EU waste legislation. The number of facilities incinerating waste is decreasing in general. This does not mean that less waste is thermally treated, but small old facilities are replaced by modern, bigger ones. Also, the large facilities are undergoing reconstruction and modernisation, aimed at improvement of environmental standards to comply with EU requirements. These two facts are introducing significant uncertainty into the estimation of GHG emissions from incineration.

The Ministry of Environment published a list of waste incinerators operating in 2009, which includes:

- Two MSW incinerators
- Five ISW incinerators (one of them is co-incinerating waste water sludge)
- Seven clinical waste incinerators
- One industrial waste water sludge incinerator
- One cadaver incinerator
- Four facilities co-incinerating ISW (cement and lime kilns).

The number of incineration plants has significantly decreased due to the expiration of transition period for selected incinerators in 2006, as was defined in the EU accession agreement. Statistical (quantitative) data on incineration are published annually. Data on situation in this sector (qualitative) are updated once in four/five years, when a new National Waste Management Plan is published.

In 2009, the total CO_2 emissions reported in category 6.C from waste incineration were 5.00 Gg. This is a decrease compared to the previous year caused by the increasing in energy use waste incineration mostly in industrial waste. In 2009, the total N_2O emissions reported in category 6.C from waste incineration were 0.0086 Gg. The trend is almost stable with the slight decrease in the recent years.

The methodology is fully based on the IPCC 2006 GL and applies to incineration with and without energy recovery and to open burning of waste. Emissions from waste incineration without energy recovery and open burning of waste are reported in the waste sector, while emissions from incineration with energy recovery are reported in the energy sector (Table 8.16). For reasons of completeness, first all emissions are estimated and then those without energy recovery are included into results.

Five waste streams are defined, which differ in their content of fossil fuel carbon, thus have different emission potential. These are:

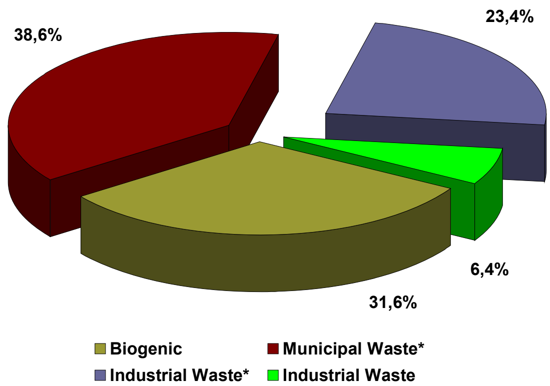
- Municipal solid waste (MSW)
- Industrial waste (ISW)
- Hazardous waste (HW)
- Clinical waste (CW)
- Sewage sludge (SS)

The estimation of CO_2 emissions from waste incineration is summarised based on these conclusions:

- MSW incineration generates CO_2 emissions, but gained heat is used for steam and electricity generation. Thus, MSW incineration does not affect GHG balance of the waste sector, but the results are used in energy sector.
- ISW incineration generates CO_2 emissions, but only about 20% of ISW is incinerated without energy recovery. Thus, ISW incineration does affect GHG balance of the waste sector.
- Sewage sludge is not considered as a CO_2 source as it does not contain fossil carbon.

Clinical waste incineration is small and there are not sufficiently reliable data. It is assumed, that the emissions from CW incineration are included in ISW incineration data.

Figure 8.8: The share of individual categories on emissions in waste incineration in 2009



Category	GHG (Gg CO_2 eq.)	Share (%)
Biogenic	38,00	31,61%
Municipal Waste*	46,41	38,60%
Industrial Waste*	28,14	23,41%
Industrial Waste	7,67	6,38%

** Emissions are reported under energy sector, category 1A1a – Public electricity and heat production, other fuels*

Table 8.21: Activity data and emissions from waste incineration in 1990 – 2009

Waste Incineration (CRF 1A1a and 6C)												
	Municipal Waste Incineration*			Industrial Waste Incineration*			Industrial Waste Incineration			Biogenic Waste Incineration		
	Quantity (TJ)	CO_2 (Gg)	N_2O (Gg)	Quantity (TJ)	CO_2 (Gg)	N_2O (Gg)	Quantity (TJ)	CO_2 (Gg)	N_2O (Gg)	Quantity (TJ)	CO_2 (Gg)	N_2O (Gg)
1990	1 307,045	43,000	0,005	IE	127,300	0,011	280,700	62,700	0,009	125,000	110,000	NO
1991	1 307,045	43,000	0,005	IE	127,300	0,011	280,700	62,700	0,009	125,000	110,000	NO
1992	1 503,093	44,357	0,004	IE	127,300	0,011	280,700	62,700	0,009	125,000	110,000	NO
1993	1 614,280	47,639	0,005	IE	127,300	0,011	280,700	62,700	0,009	125,000	110,000	NO
1994	1 409,033	41,582	0,003	IE	127,300	0,011	280,700	62,700	0,009	125,000	110,000	NO
1995	1 314,201	38,783	0,003	IE	127,300	0,011	280,700	62,700	0,009	125,000	110,000	NO
1996	1 289,151	38,044	0,003	IE	127,300	0,011	280,700	62,700	0,009	125,000	110,000	NO
1997	1 404,659	41,453	0,003	IE	91,700	0,010	220,000	45,300	0,008	107,500	93,000	NO
1998	1 567,065	46,245	0,004	IE	184,900	0,010	401,000	91,100	0,011	195,400	166,000	NO
1999	1 520,477	44,870	0,004	IE	128,800	0,011	279,000	63,200	0,008	130,300	116,000	NO
2000	1 816,223	53,598	0,004	IE	127,200	0,010	278,000	62,800	0,009	129,900	116,000	NO
2001	1 142,095	33,704	0,003	IE	105,800	0,011	226,000	52,200	0,007	99,600	93,000	NO
2002	1 363,659	40,243	0,003	IE	85,700	0,038	455,000	24,700	0,016	73,000	84,000	NO
2003	1 416,038	41,788	0,003	IE	70,200	0,057	638,000	26,400	0,013	70,000	78,000	NO
2004	1 604,256	47,343	0,003	IE	51,600	0,023	301,000	28,000	0,017	73,000	81,000	NO
2005	1 593,283	47,019	0,002	IE	16,100	0,030	407,000	21,900	0,018	103,000	131,000	NO
2006	1 655,518	48,856	0,002	IE	15,300	0,027	364,000	48,500	0,016	99,000	98,000	NO
2007	1 570,341	46,342	0,002	IE	17,900	0,016	246,000	7,500	0,013	85,000	118,000	NO
2008	1 370,620	40,448	0,002	IE	20,800	0,043	495,000	5,700	0,012	66,000	92,000	NO
2009	1 548,816	45,707	0,002	IE	22,900	0,017	198,000	5,000	0,009	29,000	38,000	NO

** Emissions are reported under energy sector, category 1A1a – Public electricity and heat production, other fuels*
IE – quantity of IW in category 1A1a is included into category 6.C.2

8.4.2 Source category description – Biogenic (CRF 6.C.1)

The estimation of CO_2 emissions from biogenic waste incineration was calculated as a difference between total CO_2 emissions and CO_2 emissions from C-fossil waste fraction. This was separately done for MSW and for ISW and the results are summarised in the following table. The figures for 1990 – 1996 were estimated based on expert judgment (in italic).

Table 8.22: Activity data and emissions from biogenic waste incineration in 1990 – 2009

Biogenic waste incineration 6.C.1					
	Incinerated waste				Biogenic CO_2
Year	Total	No En Rec	Total CO_2	Total Biogenic CO_2	No En Rec
1990			*500,00*	*455,00*	*110,00*
1991			*500,00*	*455,00*	*110,00*
1992			*500,00*	*455,00*	*110,00*
1993			*500,00*	*455,00*	*110,00*
1994			*500,00*	*455,00*	*110,00*
1995			*500,00*	*455,00*	*110,00*
1996			*500,00*	*455,00*	*110,00*
1997	219,60	107,50	409,00	368,00	93,00
1998	400,90	195,40	688,00	642,00	166,00
1999	279,00	130,30	505,00	460,00	116,00
2000	278,30	129,90	521,00	467,00	116,00
2001	225,50	99,60	403,00	369,00	93,00
2002	454,70	73,00	756,00	605,00	84,00
2003	637,90	70,00	1 031,00	893,00	78,00
2004	301,20	73,00	542,00	416,00	81,00
2005	406,90	103,00	699,00	614,00	131,00
2006	364,20	99,00	639,00	526,00	98,00
2007	246,30	85,00	459,00	387,00	118,00
2008	494,90	66,00	816,00	749,00	92,00
2009	198,40	29,00	387,00	321,00	38,00

8.4.3 Source category description – Municipal Waste Burning (CRF 6.C.2)

The amount of incinerated MSW is published by the Statistical Office of the Slovak Republic since 1993. There are two municipal waste incinerators in the country, in Bratislava and in Košice. The MSW incinerator in Bratislava was put in operation in 1977 and significantly modernised in 2003. Installed capacity is 130 Gg/y, the incinerator can be characterised as continuously operated stoker, and generated heat is used for the production of steam and electric energy. The MSW incinerator in Košice was put in full operation in 1992, and modernised in 2005. Analysis of the 2009 activity data shows that the report from Košice district does not include amount of incinerated waste. Other source[17] confirmed that waste was incinerated and figure from this source was used for emissions estimation. The availability of emission monitoring data (before and after reconstruction of this MSW incinerator) allows documenting the importance on modernisation and the impact on estimation of emissions. Both incineration plants are fully use waste incineration for electricity production. For this reason, the CO_2 and N_2O emissions are included in energy sector, category 1A1a Public electricity and heat production.

Table 8.23: Air emissions from MSW incinerators – comparison before and after reconstructions

Parameter (t/y)	Emissions before Reconstruction (2004) t/y	Emissions after Reconstruction (2006) t/y
Amount of Incinerated Waste	43 444,00	72 607,00
Solid Particulates	13,05	0,67
SO2	45,02	2,45
Nox	48,86	55,93
CO	41,85	8,39
HCl	7,16	3,50
HF	0,70	0,10
Hq+Cd+Tl	0,11	0,01
Pb+Cu+Mn+As+Ni+Cr+Co+Sb+V	8,24	0,04

[17] *Správa o prevádzke a kontrole spaľovacieho zariadenia, KOSIT, 2009 (Report on operation and monitoring of incinerator).*

8.4.3.1 Methodological issues – methods

Consistently with the general IPCC guidelines, only CO_2 emissions resulting from the incineration of carbon in waste of fossil origin (e.g. plastics, certain textiles, rubber, liquid solvents, and waste oil) should be included in emissions estimates. The carbon fraction that is derived from biomass materials (e.g. paper, food waste, and wooden material) is not included. Tier 2a methodology for the estimation of CO_2 emissions from waste incineration and open burning is using the same equation as Tier 1 approach but is based on country-specific data regarding waste generation, composition and management practices.

Nitrous oxide is emitted in combustion processes at relatively low combustion temperatures between 500 and 950°C. Other important factors affecting the emissions are the type of air pollution control device, type and nitrogen content of the waste and the fraction of excess air. Although N_2O emissions are not directly monitored, the results of NO_X (as NO_2) monitoring is generally available and it was used as verification tool (emissions of N_2O must not be higher than those of NO_2). The formula for the estimation of emissions is based on multiplying the incinerated waste stream amount by emission factor specific for that waste stream. The equation shown in the IPCC 2000 GPG was used for estimation of N_2O emissions from incineration. It should be noted, that the reconstruction of both incinerators has lead to significant decrease of EF_{NOX} by ca 40%. Also, there is one information on ISW incineration (includes incineration of sewage sludge). Obtaining information on NO_X emissions from ISW is more difficult, as companies publish their emission data as one aggregated number for all emission sources within a company.

8.4.3.2 Methodological issues – emission factors and parameters

For CO_2 emission estimation from MSW incineration, IPPC default parameters and Slovak specific parameters on waste composition were used. The oxidation factor is considered 100%. The emission factor for CO_2 emissions is 29.51 t/TJ in 2009.

Emission of N_2O were estimated using country specific parameters, taking in account emission levels before modernisation (EF=20 g N_2O/t), after modernisation (EF=12 g N_2O/t) and emissions from small incinerators used in the past (EF=50 g N_2O/t). The default N_2O emission factors (wet weight) were selected from the IPCC 2006 GL, Table 5.6. The selection is based on incinerated waste types and technologies used. Waste amounts are normally given as wet weight in the Slovak Republic. Although the IPCC 2006 GL recommend using emission factor 50 for MSW, quotations from Europe indicate different values.

Table 8.24: IPCC input parameters

MSW Component	Dry Matter Content (% wet weight)	Total C Content (% dry weight)		Fossil C Fraction (% C)	
	Default	Default	Range	Default	Range
Paper/Cardboard	90,00	46,00	42-50	1	0-5
Textiles	80,00	50,00	25-50	20	0-50
Food	40,00	38,00	20-50		
Wood	85,00	50,00	46-54		
Garden and Park	40,00	49,00	45-55	0	0
Nappies	40,00	70,00	54-90	10	10
Rubber and Lether	84,00	67,00	67	20	20
Plastics	100,00	75,00	67-85	100	95-100
Metal, Glass and Inert	100 (90)	NA (less than 3)	NA (less than 5)	NA (100)	50-100

Further review of available NO_X emission factors resulted in formulation of two hypotheses:

- Emission factors observed in Germany and Austria may be more suitable for the Slovak Republic, as many Slovak incinerators are of German origin.
- Emission factors for reconstructed plants should be decreased, it is expected that the decrease of EF for NO_X (before and after reconstruction) is the same as for N_2O.

Thus, the calculation was repeated with the EF=20 g N_2O/t MSW and the results are 3 times bigger that the estimate obtained in deposition calculation, which is within the range of the EF (0.002 – 0.05). For estimation for MSW incinerated in smaller units, the EF=1.46 kg N_2O/TJ was used in 2009.

8.4.3.3 Activity data

Although there are available data directly from each incinerator, the requirement to work with one consistent set of data got a priority. Also, although there is identification of "incineration with energy recovery" and "incineration without energy recovery", these categories do not seem to be correctly used. The information from MSW incinerator operators were used for the indication of proper option. The change of waste classification in 2002 does not seem to have impact on recorded amounts of incinerated MSW.

8.4.3.4 Uncertainties and time consistency

The default IPPC uncertainties for activity data are used.

The data available in the statistical reports are verified by comparison of the same category in various years. Example: if incinerated amount of waste in group 54 in three consecutive years is 20 Gg/y and the following year is stated 500 Gg/y, the 500 is the most probably wrong and an explanation must be found.

The consistency of time series is influenced by changes in reporting system:

- 1993 – Implementation of first waste legislation, introduction of first regular waste monitoring in the Slovak Republic.
- 2002 – Preparation for accession to EU, adoption of EWC.

The impact of these changes is difficult to assess, depending on the level of detail. For example, the total amount of MSW practically was not changed, but the amount of incinerated clinical waste was changed significantly as a result of changes in the waste classification system.

8.4.3.5 Source specific QA/QC and verification

Regarding solid waste, this report is based on information published annually by the SOSR in publication "Odpady" (Waste) since 1993. Also, to verify this information and gain more details, interviews were held with representatives of the following institutions and companies:

- COHEM SAZP (Waste Management Centre of Slovak Environmental Agency) on ISW data.
- Waste service companies: Marius Pedersen Slovakia, Brantner Slovakia, SITA Slovakia, A.S.A. Slovakia, T+T Žilina (landfill gas recovery).
- ACE (Assotiation of Experts on Waste Water Treatment) on sewage sludge management.

Additionally, web-sites of following companies and institutions were used for this report:

- OLO Bratislava, KOSIT Košice (municipal waste incineration).
- Slovnaft, Duslo, Fecupral (industrial waste incineration).
- Enviroportal (info page of the Slovak Environmental Agency).

8.4.3.6 Source specific recalculations

Due to the new information based on annual report[17] from waste incineration plant in Košice, the time series was completely recalculated.

Table 8.25: The comparison of 2010 and 2011 submissions of CO_2 and N_2O emissions estimation in municipal waste incineration with energy use in 2001 – 2008

Category Municipal Waste Incineration with energy use							
	Submission 2010			Submission 2011			Changes in CO_2 eq. in %
Year	MSW Incinerated (TJ)	CO_2 Emissions (Gg)	N_2O Emissions (Gg)	MSW Incinerated (TJ)	CO_2 Emissions (Gg)	N_2O Emissions (Gg)	2011/2010
1990	100,0000	30,0000	0,0030	1 307,0447	43,0000	0,0046	143,63%
1991	150,0000	43,0000	0,0046	1 307,0447	43,0000	0,0046	100,00%
1992	150,0000	43,0000	0,0046	1 503,0926	44,3574	0,0040	102,64%
1993	185,0000	47,9000	0,0046	1 614,2803	47,6386	0,0046	99,50%
1994	161,0000	41,6900	0,0035	1 409,0333	41,5816	0,0035	99,74%
1995	151,0000	39,1000	0,0031	1 314,2012	38,7830	0,0031	99,21%
1996	148,0000	38,3200	0,0031	1 289,1512	38,0438	0,0030	99,26%
1997	160,6000	41,6900	0,0033	1 404,6591	41,4525	0,0034	99,48%
1998	184,0000	47,6400	0,0039	1 567,0646	46,2452	0,0037	97,01%
1999	174,0000	45,0500	0,0036	1 520,4772	44,8704	0,0036	99,61%
2000	208,0000	53,8600	0,0043	1 816,2231	53,5981	0,0043	99,51%
2001	131,0000	33,9200	0,0027	1 142,0947	33,7040	0,0027	99,39%
2002	156,0000	40,3900	0,0032	1 363,6589	40,2426	0,0032	99,65%
2003	162,0000	41,9500	0,0033	1 416,0382	41,7883	0,0025	99,07%
2004	184,0000	47,6400	0,0032	1 604,2561	47,3428	0,0028	99,13%
2005	183,0000	47,3800	0,0023	1 593,2831	47,0189	0,0023	99,23%
2006	190,0000	49,1300	0,0024	1 655,5182	48,8555	0,0024	99,47%
2007	180,0000	46,6600	0,0023	1 570,3410	46,3419	0,0023	99,31%
2008	157,0000	40,7300	0,0019	1 370,6202	40,4480	0,0019	99,32%

8.4.3.7 Source specific planned improvements

No specific improvements are planned for the next submission.

8.4.4 Source category description – Industrial Waste Incineration (CRF 6.C.2)

From the total of 37 ISW incinerators only a few have installed capacity exceeding 1 ton per hour. These are located in the following companies:

- Duslo a.s. Šaľa, operating rotary kiln and fluid bed furnace (5 ton/hour).
- Petrochema a.s., Dubová – two rotary kilns (5.5 ton/hour).
- Slovnaft a.s., Bratislava – rotary kiln and chamber furnace (3.5 ton/hour).
- Helpeco s.r.o, Považská Bystrica – rotary kiln (1 ton/hour).

The remaining facilities are smaller units, mostly various versions of HOVAL, rotary kilns or chamber furnaces. Very few of these units comply with EU environmental requirements, thus have to be modernised (equipped with air pollution control) or decommissioned. There is growing interest of cement industries to incinerate waste with high calorific value, but the Statistical Office does not monitor this type of waste treatment. The company Ecorec processes about 25 000 tons of waste annually – this is about 6% of all ISW incinerated.

Total emissions of CO_2 from industrial waste incineration were estimated to 27.9 Gg in 2009, but the emissions without energy use were only 5 Gg of CO_2 in 2009. The total N_2O emissions from industrial waste incineration were estimated to 0.055 Gg in 2009, but the emissions without energy use were 0.012 Gg of N_2O in 2009.

8.4.4.1 Methodological issues – methods

The CO_2 emissions from industrial solid waste incineration were obtained using activity data and default IPCC parameters. The dry matter content of ISW was estimated to 90% of wet weight. The oxidation factor was estimated to 90%, to compensate for old incinerators.

Although the total amount of incinerated ISW seems to be stable, the share of waste streams rich on fossil carbon is decreasing. The share of incinerated clinical waste is small and there are no reliable data. CO_2 emissions from clinical waste incineration are included in the ISW incineration data.

8.4.4.2 Methodological issues – emission factors and parameters

Consistently with the general IPCC guidelines, only CO_2 emissions resulting from the incineration of carbon in waste of fossil origin (e.g. plastics, certain textiles, rubber, liquid solvents, and waste oil) were included in emissions estimates. The carbon fraction that is derived from biomass materials (e.g. paper, food waste, and wooden material) is not included. The dry matter content of ISW was estimated to 90% of wet weight. The oxidation factor was estimated to 90%, to compensate for old incinerators. The biogenic CO_2 emissions are estimated as a difference between all carbon incinerated and fossil carbon incinerated.

8.4.4.3 Activity data

The data on incinerated ISW is published in a detailed structure – by Chapters of the European Waste Catalogue. This allowed identifying waste streams of significant share of fossil carbon for estimation of CO_2 emissions. Industrial solid waste has been recorded by Statistical Office since 1997 and only since 2002 the Statistical Office provides information on “incineration with energy recovery” and “incineration without energy recovery”. The analysis of the data allows to make a conclusion, that about 20% of total ISW is incinerated without energy recovery and this means that about 35% of “fossil carbon rich” waste is incinerated without energy recovery. Also, further comparison of “fossil carbon rich” waste streams destined for incineration results in conclusion, that industrial solid waste and hazardous waste are nearly identical (or there is very little non-hazardous industrial “fossil carbon rich” waste incinerated), thus in the further the terms “incinerated hazardous waste” and “incinerated ISW” define the same waste.

8.4.4.4 Uncertainties and time consistency

See section 8.4.3.4.

8.4.4.5 Source specific QA/QC and verification

See section 8.4.3.5.

8.4.4.6 Source specific recalculations

Due to the methodological change in the connection with biogenic emission estimation, the recalculation of industrial solid waste incineration was provided in the submission 2011.

Table 8.26: The comparison of 2010 and 2011 submissions of CO_2 and N_2O emissions estimation in industrial waste incineration with and without energy use in 2001 – 2008

Category Industrial Waste Incineration with energy use							
	Submission 2010			Submission 2011			Changes in CO_2 eq. in %
Year	ISW Incinerated (TJ)	CO_2 Emissions (Gg)	N_2O Emissions (Gg)	ISW Incinerated (TJ)	CO_2 Emissions (Gg)	N_2O Emissions (Gg)	2011/2010
1990	IE	123,700	0,015	IE	127,3000	0,0112	101,94%
1991	IE	123,700	0,015	IE	127,3000	0,0112	101,94%
1992	IE	123,700	0,015	IE	127,3000	0,0112	101,94%
1993	IE	123,700	0,015	IE	127,3000	0,0112	101,94%
1994	IE	123,700	0,015	IE	127,3000	0,0112	101,94%
1995	IE	123,700	0,015	IE	127,3000	0,0112	101,94%
1996	IE	123,700	0,015	IE	127,3000	0,0112	101,94%
1997	IE	89,200	0,014	IE	91,7000	0,0098	101,31%
1998	IE	179,100	0,013	IE	184,9000	0,0099	102,59%
1999	IE	124,200	0,014	IE	128,8000	0,0107	102,86%
2000	IE	123,600	0,014	IE	127,2000	0,0098	101,87%
2001	IE	102,700	0,014	IE	105,8000	0,0109	102,06%
2002	297,433	73,200	0,014	IE	85,7000	0,0381	125,76%
2003	415,235	61,100	0,014	IE	70,2000	0,0568	134,50%
2004	203,061	47,300	0,013	IE	51,6000	0,0228	114,23%
2005	262,332	23,300	0,013	IE	16,1000	0,0304	93,18%
2006	236,818	39,700	0,013	IE	15,3000	0,0265	53,77%
2007	84,500	15,670	0,014	IE	17,9000	0,0162	113,85%
2008	322,046	16,330	0,039	IE	20,8000	0,0429	119,98%

Category Industrial Waste Incineration without energy use							
	Submission 2010			Submission 2011			Changes in CO_2 eq. in %
Year	ISW Incinerated (TJ)	CO_2 Emissions (Gg)	N_2O Emissions (Gg)	ISW Incinerated (TJ)	CO_2 Emissions (Gg)	N_2O Emissions (Gg)	2011/2010
1990	280,700	66,700	0,005	280,7000	62,7000	0,0088	95,78%
1991	280,700	66,700	0,005	280,7000	62,7000	0,0088	95,78%
1992	280,700	66,700	0,005	280,7000	62,7000	0,0088	95,78%
1993	280,700	66,700	0,005	280,7000	62,7000	0,0088	95,78%
1994	280,700	66,700	0,005	280,7000	62,7000	0,0088	95,78%
1995	280,700	66,700	0,005	280,7000	62,7000	0,0088	95,78%
1996	280,700	66,700	0,005	280,7000	62,7000	0,0088	95,78%
1997	219,600	48,051	0,004	220,0000	45,3000	0,0082	97,00%
1998	400,900	96,596	0,008	401,0000	91,1000	0,0111	95,51%
1999	279,000	67,074	0,005	279,0000	63,2000	0,0083	95,72%
2000	278,300	66,580	0,005	278,0000	62,8000	0,0092	96,25%
2001	225,500	55,327	0,004	226,0000	52,2000	0,0071	96,06%
2002	385,300	39,423	0,009	455,0000	24,7000	0,0157	70,04%
2003	567,900	32,900	0,012	638,0000	26,4000	0,0134	83,11%
2004	238,200	25,442	0,006	301,0000	28,0000	0,0172	122,18%
2005	304,000	12,526	0,008	407,0000	21,9000	0,0175	182,82%
2006	265,300	22,500	0,007	364,0000	48,5000	0,0163	217,08%
2007	161,800	8,430	0,004	246,0000	7,5000	0,0134	122,08%
2008	172,954	8,770	0,010	495,0000	5,7000	0,0124	80,40%

8.4.4.7 Source specific planned improvements

No specific improvements are planned for the next submission.

8.4.5 Source category description – Sewage Sludge Incineration (CRF 6.C.2)

Only two incinerators incinerate sewage sludge in the Slovak Republic, in both cases it is the sludge from industrial wastewater treatment. The oil refinery Slovnaft a.s., Bratislava has developed specialised incinerator for burning sewage sludge for company owned wastewater treatment plant in 1986. This facility was significantly improved during reconstruction in 2006. The operational capacity is 24.5 Gg/y of dewatered sludge (20% dry mass). The incinerator is a stacked furnace type, designed to operate continuously. There is no energy recovery. The chemical factory Duslo a.s., Šaľa operates a fluidised bed furnace, incinerating (except of other waste) about 1.7 Gg/y of sewage sludge. This furnace was put in operation in 1985 and was reconstructed in 2006. The heat is used for the generation of steam. Sewage sludge does not contain fossil carbon thus there are no CO_2 emissions to estimate. Sewage sludge is incinerated in two main plants[18]. The amount of incinerated sewage sludge is published annually in reports on incineration plant operation since 2007. The following information is available:

Wastewater Sludge Incineration (Gg/yr)			
	Slovnaft a.s. Bratislava	Duslo a.s. Šaľa	
	Total (only sludge)	Total	Sludge
2007	3,32	7,52	1,83
2008	4,50	7,01	1,57
2009	4,02	6,18	1,88

These two waste streams represent about 2% of total incinerated industrial waste in the Slovak republic. Therefore for estimation of CO_2 emissions individual calculation of these waste streams is not done and incinerated amounts are included in the sum of industrial waste. However, due to higher emission factors for N_2O emissions from sewage sludge incineration, these emissions are estimated separately.

[18] *Správy o prevádzke a kontrole ZZO 1.24 Spaľovňa odpadov Duslo Šaľa 2007-9 (Operation and inspection reports on waste incinerator in Duslo Šaľa 2007-9) and Spaľovňa kalov – Prevádzkovanie spaľovne Slovnaft a.s. Bratislava v r. 2007-9 (Sludge incinerator – operation report 2007-9, Slovnaft a.s. Bratislava).*

The available data indicate that about 2.5 – 3 Gg of waste from the health sector are incinerated annually. Currently the clinical waste incineration is included in the ISW incineration, but monitoring of this waste stream will continue and can be assessed individually in the future.

8.5 Other – Composting (CRF 6.D)

8.5.1 Source category description

This chapter is aimed at review of preparedness of the Slovak Republic to provide estimates of GHG emissions from the following processes:

- Composting
- Anaerobic digestion of organic waste

Table 8.27: The overview of municipal and industrial composting in 1990 – 2009

	MSW Composting (Gg)	CH_4 (Gg)	N_2O (Gg)	ISW Composting (Gg)	CH_4 (Gg)	N_2O (Gg)
1990	20	0,080	0,006	NO	NO	NO
1991	20	0,080	0,006	NO	NO	NO
1992	20	0,080	0,006	NO	NO	NO
1993	21,400	0,086	0,006	NO	NO	NO
1994	19,100	0,076	0,006	NO	NO	NO
1995	35,400	0,142	0,011	NO	NO	NO
1996	31,500	0,126	0,010	NO	NO	NO
1997	38,800	0,155	0,012	NO	NO	NO
1998	38,000	0,152	0,011	NO	NO	NO
1999	39,300	0,157	0,012	NO	NO	NO
2000	36,300	0,145	0,011	NO	NO	NO
2001	43,500	0,174	0,013	NO	NO	NO
2002	39,300	0,157	0,012	1 133,500	4,534	0,3401
2003	40,700	0,163	0,012	1 156,600	4,626	0,3470
2004	40,900	0,164	0,012	411,500	1,646	0,1235
2005	20,800	0,083	0,006	579,100	2,316	0,1737
2006	51,600	0,206	0,016	800,800	3,203	0,2402
2007	76,100	0,304	0,023	528,000	2,112	0,1584
2008	80,200	0,321	0,024	583,100	2,332	0,1749
2009	88,900	0,356	0,027	592,400	2,37	0,1777

The EU requirement to reduce the amount of landfilled biodegradable waste supports the installation of mechanical–biological treatment facilities, which may include also composting or anaerobic treatment. It is expected that the share of waste treated in MF facilities will grow, resulting in higher GHG emissions, which should be included in national balances.

8.5.2 Methodological issues – methods

Because no data on anaerobic treatment were available, only emissions from composting were estimated, separately for MSW and ISW. Default IPCC emission factors for wet weight were used. In case of MSW, emission data were extrapolated back to 1990 using 1993 and 1994 data as a base. Tier 1 is used for emission estimation.

8.5.3 Methodological issues – emission factors and parameters

Table 8.28: IPCC default parameters for EFs

Treatment	EF (CH_4)		EF (N_2O)	
	Dry Weight	Wet Weight	Dry Weight	Wet Weight
Composting	10	4	0,6	0,3
	(0,08-20)	(0,03-8)	(0,2-1,6)	(0,06-6)
Anaerobic Digestion	2	1	0	0
	(0-20)	(0-8)	(negligible)	(negligible)

8.5.4 Activity data

The Slovak Statistical Office has been publishing data on composted MSW since 1993. The reported amount of composted MSW remain stable, about 35 – 40 Gg/y. The data on composted ISW are from the same source and have been published since 2002. The reported data are too few and in too big variation to identify a trend in emissions. There are no centrally collected data on anaerobic treatment or on recovery of methane emissions from composting.

8.5.5 Uncertainties and time consistency

See section 8.4.3.4.

8.5.6 Source specific QA/QC and verification

See section 8.4.3.5.

8.5.7 Source specific recalculations

No recalculations in the submission 2011 focused on the base year 1990 or the other inventory years were provided.

8.5.8 Source specific planned improvements

No specific improvements are planned for the next submission.

CHAPTER 9: OTHER (CRF 7)

The Slovak Republic does not report any emissions under the other sector.

CHAPTER 10: RECALCULATIONS AND IMPROVEMENTS

10.1 Explanations and justifications for recalculations, including for KP-LULUCF inventory

The list of recalculations made in the 2011 submission is summarized in the Table 10.1.

10.2 Implications for emission levels

UNFCCC national inventory recalculation:

Reflecting the QA/QC activities for improving the emission inventory of GHG and recommendations provided by the experts during the review process for inventory submissions under UNFCCC, the experts involved in the National Inventory System of the Slovak Republic proposed the recalculations of several subsectors and categories (Table 10.1). The recalculations are based on updated or revised methodologies (e.g. COPERT IV version 7.1) or updated statistical information (e.g. input data in IP sector). The following table presents recalculation difference with the comparison of previous emission inventory submission (version 2.2 from November 2010). Table 10.2 presents the recalculation differences of national total GHG emissions for all years.

Table 10.1: List of recalculations in the 2011 submission with short explanation

Recalculated Category		Year	GHG	Explanation
1.AA.1a	Public Electricity and Heat Production	1990-2008	CO2, N2O	Recalculation of Municipal Solid Waste Incineration with energy recovery under Other Fuels. Correction of activity data.
1.AA.1a	Public Electricity and Heat Production	1990-2009	CO2, N2O	Recalculation of Industrial Solid Waste Incineration with energy recovery under Other Fuels. Correction of activity data.
1.AA.2c	Manufacturing Industries and Construction - Chemicals	2008	CO2, CH4, N2O	Correction of activity data of Light Heating Oil.
1.AA.3b	Road Transportation	2000-2008	CO2	Recalculation by COPERT V model
1.AA.3b	Road Transportation	2000-2008	CH4	Recalculation by COPERT V model
1.AA.3b	Road Transportation	2000-2008	N2O	Recalculation by COPERT V model
1.AA.3d	Domestic Navigation	1990-2008	CO2, CH4, N2O	Including new estimation for domestic navigation.
2.C.1.5	Iron and Steel Production - Other	1990-2008	CO2	Including estimation from EAF steel production.
2.C.2	Ferroalloys Production	1990-2008	CO2	Correction of plant specific emission factors based on detail data from producers.
2.IIA.F.1.2	Commercial Refrigeration	2008	HFC32	Correction of activity data.
3.A	Paint Application	1990-2008	CO2	New estimation based on national appropriate methodology.
3.B	Degreasing and Dry Cleaning	1990-2008	CO2	New estimation based on national appropriate methodology.
3.C	Chemical Products, Manufacturing and Processing	1990-2008	CO2	New estimation based on national appropriate methodology.
4.B(b)	Manure Management, Emissions from Liquid Systems	1990-2008	N2O	Correction of nitrogen excretion value per liquid system for swine and poultry.
4.B(b)	Manure Management, Emissions from Solid Systems	1990-2008	N2O	Correction of nitrogen excretion value per solid system for swine and poultry.
4.D.1.1	Direct Soil Emissions from Synthetic Fertilizers	1997-2005	N2O	Correction in national statistics of synthetic fertilizers used.
4.D.3.1	Indirect Soil Emissions	1997-2005	N2O	Correction in national statistics of synthetic fertilizers used.
5.	LULUCF	1990-2008	CO2	Complete recalculation of all land categories: Forestland, Cropland, Grassland, Settlements and Other Land based on new estimation of area.
6.A.3	SWDS - Agricultural and Industrial Waste	2001-2008	CH4	Recalculation of several parameters in estimation. Share of C-fossil stream in SWDS
6.B.2.1	Domestic and Commercial Wastewater	1990-2008	N2O	Including direct N2O emissions from WWT plants into estimation and reallocation N2O emissions in the category Human Sewage.
6.C.1	Biogenic Waste Incineration	1990-2008	CO2	Completing estimation.
6.C.2	Industrial Waste Incineration	1990-2008	CO2, N2O	Recalculation of Industrial Solid Waste Incineration with energy recovery under Other Fuels. Correction of activity data.

10.3 Implications for emission levels

UNFCCC national inventory recalculation:

Reflecting the QA/QC activities for improving the emission inventory of GHG and recommendations provided by the experts during the review process for inventory submissions under UNFCCC, the experts involved in the National Inventory System of the Slovak Republic proposed the recalculations of several subsectors and categories (Table 10.1). The recalculations are based on updated or revised methodologies (e.g. COPERT IV version 7.1) or updated statistical information (e.g. input data in IP sector). The following table presents recalculation difference with the comparison of previous emission inventory submission (version 2.2 from November 2010). Table 10.2 presents the recalculation differences of national total GHG emissions for all years.

Table 10.2: Recalculation difference of national total GHG emissions without LULUCF

	National GHG Inventory without LULUCF		
	Submission 2010	Submission 2011	Recalculation Difference
	Gg of CO_2 equivalents		*%*
1990	73 931,46	74 111,61	0,24
1991	66 317,72	66 317,16	0,00
1992	61 612,50	61 553,62	-0,10
1993	56 251,38	56 179,25	-0,13
1994	54 447,13	54 393,47	-0,10
1995	53 373,09	53 310,58	-0,12
1996	51 860,40	51 814,00	-0,09
1997	50 710,40	50 697,56	-0,03
1998	51 144,67	51 137,96	-0,01
1999	50 457,45	50 419,03	-0,08
2000	49 261,72	49 202,92	-0,12
2001	50 677,41	50 590,33	-0,17
2002	49 936,28	49 753,96	-0,37
2003	51 096,07	50 982,88	-0,22
2004	50 855,33	50 750,72	-0,21
2005	50 174,32	50 086,65	-0,17
2006	49 947,42	49 863,84	-0,17
2007	47 881,71	47 836,42	-0,09
2008	48 999,01	48 165,86	-1,70

Total GHG emissions (excluding LULUCF) for the base year are higher by 0.24% than those reported last year. The value for 2008 estimated this year is 1.7% lower compared to other submissions. However, the trend for 1990 to 2008 remains quite decreasing character. The lower emissions during 2000 – 2008 are caused by the recalculations in road transport sector.

Table 10.3: Recalculation difference of national total GHG emissions with LULUCF

	National GHG Inventory with LULUCF		
	Submission 2010	Submission 2011	Recalculation Difference
	Gg of CO_2 equivalents		*%*
1990	71 542,96	71 200,15	-0,48
1991	62 821,68	62 548,60	-0,43
1992	57 473,00	55 908,94	-2,72
1993	51 979,29	51 433,27	-1,05
1994	51 141,19	50 639,31	-0,98
1995	50 689,00	50 004,53	-1,35
1996	49 451,75	48 735,71	-1,45
1997	49 322,24	48 296,91	-2,08
1998	49 218,65	48 292,82	-1,88
1999	48 837,43	47 774,61	-2,18
2000	46 875,52	46 164,10	-1,52
2001	45 469,64	44 326,79	-2,51
2002	44 710,37	43 277,98	-3,20
2003	46 281,35	45 199,91	-2,34
2004	46 722,70	45 673,76	-2,25
2005	49 422,29	48 682,29	-1,50
2006	47 016,23	45 757,60	-2,68
2007	44 782,81	43 900,74	-1,97
2008	46 922,65	45 011,81	-4,07

Total GHG emissions (with LULUCF) for the base year are lower by 0.48% than those reported last year. The value for 2008 estimated this year is 4.07% lower compared to other submissions. However, the trend for 1990 to 2008 remains quite decreasing character. The recalculation of LULUCF sector is the driving force for changing of national totals.

KP LULUCF recalculation:

According to the changes in the LULUCF sector and recalculations made since base year, the recalculation of KP LULUCF took place in this submission. The recommendations for improving LULUCF and KP LULUCF emission estimation were raised during the previous review of the national

GHG inventories. Since the previous submission was performed following recalculations in KP LULUCF sector and accounting:

- Calculation all carbon stock changes for ARD activities and all carbon pools in 1991 due to complement of missing ARD areas for this year.
- Recalculation of all carbon stock changes by reason of assessment more precisely areas of AR activities and partially areas of D activities in individual years since 1990.
- Recalculation of living biomass carbon stocks separately for above-ground and below-ground parts in ARD activities.
- Calculation of dead wood carbon stocks for deforestation activity.

The above mentioned changes influence KP accounting in 2008 under Article 3.3 from emissions (1 350.58 Gg of CO_2) to sinks (-272.29 Gg of CO_2).

Table 10.4: Recalculation difference of 2010 and 2011 submissions of KP accounting 2008

Activities	Submission 2010	Submission 2011	Recalculation Difference
	Gg of CO_2 equivalents		
A. Article 3.3 activities	**1 350,58**	**-272,29**	**-1 622,87**
A.1. Afforestation and Reforestation	-1 701,33	-453,04	**1 248,30**
A.1.1. Units of land not harvested since the beginning of the commitment period	-1 701,33	-453,04	**1 248,30**
A.1.2. Units of land harvested since the beginning of the commitment period	NA	NA	**NA**
A.2. Deforestation	3 051,91	180,74	**-2 871,17**

10.4 Implications for emission trends, including time series consistency

The emission trend without LULUCF in the submission 2011 differs slightly from the emission trend reported in the previous submission 2010 v 2.2 from November 2010. The emission reduction without LULUCF between 1990 and 2008 was 33.72% in 2010 submission and 35% in the submission 2011 (Figure 10.1). The emission reduction with LULUCF between 1990 and 2008 was 33.41% in 2010 submission and 36.78% in the submission 2011 (Figure 10.2).

Figure 10.1: Comparison of emissions trend with the previous submission without LULUCF

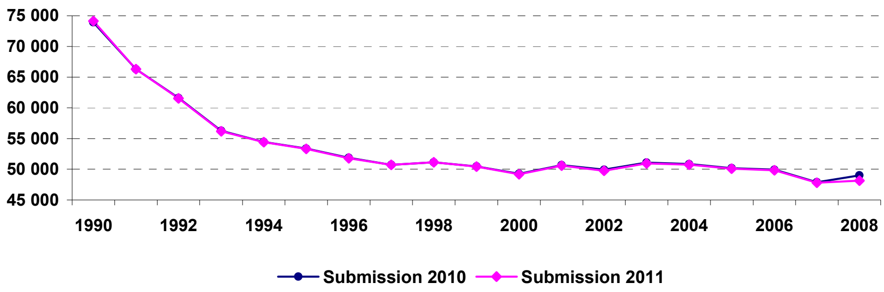
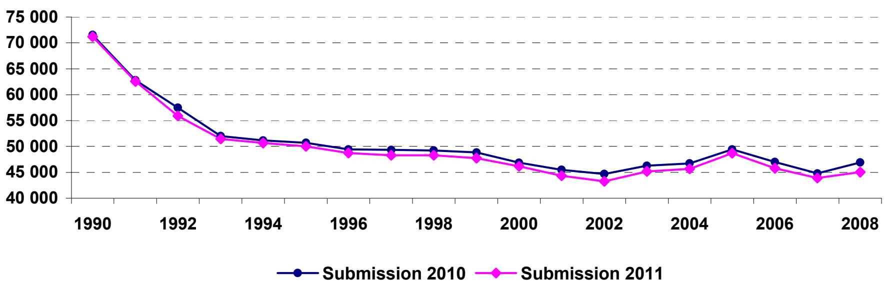


Figure 10.2: Comparison of emissions trend with the previous submission with LULUCF



10.5 Recalculations, including in response to the review process, and planned improvements to the inventory

The Annual Review Report FCCC/ARR/2010/SVK of the individual review of the annual submission of the Slovak Republic was published on March 2011 on http://unfccc.int/resource/docs/2011/arr/svk.pdf. This report covers the centralised review of the 2010 annual submission of the Slovak Republic, coordinated by the UNFCCC secretariat, in accordance with decision 22/CMP.1. The review took place from 13th to 18th September 2010 in Bonn. No questions of implementation were identified by the ERT during the review. In the conclusions and recommendations summarized in the ARR the ERT concludes that the inventory submission has been prepared and reported mostly in accordance with the UNFCCC reporting guidelines. The annual submission is complete in terms of geographical coverage, years and sectors, as well as mostly complete in terms of categories and gases. No NE categories have been reported in the 2010 submission.

Due to the late delivery of final ARR 2010 report (March 2011), the Slovak National Inventory System is not in position to include improvements for all recommendations identified in the ARR. The manager of NIS will be summarized and evaluated in terms of QA/QC system the list of recommendations made by ERT and implement further steps in line with the IPCC 2000 GPG in next submission.

Table 10.5: Response to the review of the 2010 inventory submission

CRF	Issue Identified by the ERT	Slovakia responses
1. ENERGY	**CRF 1.A.3d Navigation (domestic)** - Slovakia reported CO_2, N_2O and CH_4 emissions from small domestic inland shipping as not occurring.	The emission estimation of emissions of CO_2, N_2O and CH_4 from small domestic inland shipping w as completed.
2. INDUSTRIAL PROCESSES	**CRF 2.C.1 Steel Production from EAF technology** - Slovakia has not included CO_2 emissions from consumed electrodes for steel production in electric arc furnaces (EAF) in its 2010 annual submission.	The emission estimation from consumed electrodes in EAF w as completed and reported for 2000-2008.
3. INDUSTRIAL PROCESSES	**CRF 2.F.9 Consumption of Halocarbons and SF_6 - Other** - The ERT identified in the CRF tables that actual emissions from consumption of halocarbons and SF_6 are reported as NO and that potential emissions are reported.	The verification of the potential and actual SF_6 emissions w as provided and occur only from electrical equipment in Slovakia and therefore is not reason for reporting of SF_6 emissions in the category 2.F.9. The notation key "NO" shall be use in the category 2.F.9. The potential SF_6 emissions from category 2.F.9 – Other w ere reallocated to the category 2.F.8 – Electrical Equipment.
4. SOLVENT USE	**CRF 3.A Paint Application** **CRF 3B Degreasing and Dry Cleaning** **CRF 3C Chemical Products, Manufacture and Processing** - The ERT identified that the reported CO_2 emissions estimates do not follow the methodology described in NIR and are underestimated.	The recalculation of time series w as corrected and the estimation of CO_2 emissions from the categories 3A, 3B and 3C w as reported.
5. WASTE	**CRF 6.A.1 Solid Waste Disposal on Managed Landfills** - The ERT identified that to estimate CH_4 emissions from solid w aste disposal sites, using the IPCC methodology, Slovakia deducted the methane recovered from the emissions generated tw ice.	The estimation w as review ed in term of avoiding double deduction of methane flared in landfill gas by operator and eventually corrected the data in CRF tables.
6. WASTE	**CRF 6.B.2 N_2O from Domestic Wastewater** - The ERT identified that the calculated values for emissions of N_2O from domestic w astew ater had not been correctly entered into the CRF table.	The estimation w as completed by including information on new stream for w astew ater handling. The new methodology includes direct N_2O emissions from WWT plants, w hich w ere not included in previous approach.

PART II: SUPPLEMENTARY INFORMATION REQUIRED UNDER ARTICLE 7, PARAGRAPH 1

CHAPTER 11: KP-LULUCF

11.1 General information

The information provided in this Chapter follows the content and the structure specified in the “Guidelines for the preparation of the information required under Article 7 of the Kyoto Protocol” (Annex to decision 15/CMP.1, FCCC/KP/CMP/2005/8/Add.2 page 56 ff).

11.1.1 Definition of forest and any other criteria

The Slovak Republic has selected as threshold values for the forest definition for reporting under Article 3.3 (ARD activities: afforestation, reforestation and deforestation) the following: forest land includes the land with minimum tree crown cover of 20% for trees capable to reach minimum height of 5 m in situ. The minimum area for forest is 0.3 ha. Temporarily unstocked areas are included (forest regeneration areas). For linear formations, a minimum width of 20 m is applied.

Table 11.1: Selected parameters defining forest in the Slovak Republic for reporting under the KP

Parameter	Range	Selected value
Minimum land area	0.05 -1 ha	0.3 ha
Minimum crown cover	10 - 30%	20%
Minimum height	2 - 5 m	5 m

The selected threshold values are consistent with those values used in the reporting to the Food and Agriculture Organisation of the United Nations (the GFRA 2005), the National Forest Inventory, and the MCPFE criteria and indicators of sustainable forest management).

11.1.2 Elected activities under Article 3, paragraph 4, of the Kyoto Protocol

The Slovak Republic has chosen to account for the activities under Article 3.3 (afforestation, reforestation and deforestation) for the whole commitment period.

The Slovak Republic has decided not to use any activities under Article 3.4 (forest management, cropland management, grazing land management and revegetation) for meetings its commitment under the first commitment period of the Kyoto Protocol.

11.1.3 Description of how the definitions of each activity under Article 3.3 and each elected activity under Article 3.4 have been implemented and applied consistently over time

The linkage between the ARD activities and the reported land use changes from and to forests in the UNFCCC GHG inventory is as follows:

- AR activities represent the conversion of Cropland to Forest land and conversion Grassland to Forest land. D activity represents the conversion of Forest Land to Other Land.

The information about ARD areas is based on the data from the Geodesy, Cartography and Cadastre Authority of the Slovak Republic (GCCA). This institute issues yearly the Statistical Yearbook of the Soil Resources in the Slovak Republic. It provides annually the updated cadastral information not only on land use areas but also the information about the areas which were afforested/reforested and deforested. The Cadastre information is completed by the data from the national program:

“Afforestation of the land unavailable for agricultural production”. This program was running from 1995 to 1999 and was guaranteed by the Government of the Slovak Republic. All land use changes from and to forests are considered to be human induced in the Slovak Republic. AR activities will be reported together.

11.1.4 Description of precedence conditions and/or hierarchy among Article 3.4 activities, and how they have been consistently applied in determining how land was classified

Not relevant in the Slovak Republic.

11.2 Land-related information

11.2.1 Spatial assessment unit used for determining the area of the units of land under Article 3.3

To meet the reporting requirements of the Marrakesh Accords, general information on activities under Articles 3.3 must include the geographical boundaries of areas encompassing units of land subject to afforestation, reforestation and deforestation. To achieve this, reporting method 1 (see Chapter 4.2.2.2. figure 4.2.3. of the IPCC 2003 LULUCF GPG) could be chosen. The method entails delineating areas that include multiple land units subject to Article 3.3 activities by using legal and administrative boundaries. The data published by the Statistical Yearbook of the Soil Resources in the Slovak Republic permits spatial assessment and identification of AR and D activities at the level of Slovak districts. The GCCA database of eight land districts since 1996 and three districts from 1990 to 1995 (see the following figures).

Figure 11.1: Eight Slovak regional districts established in 1996

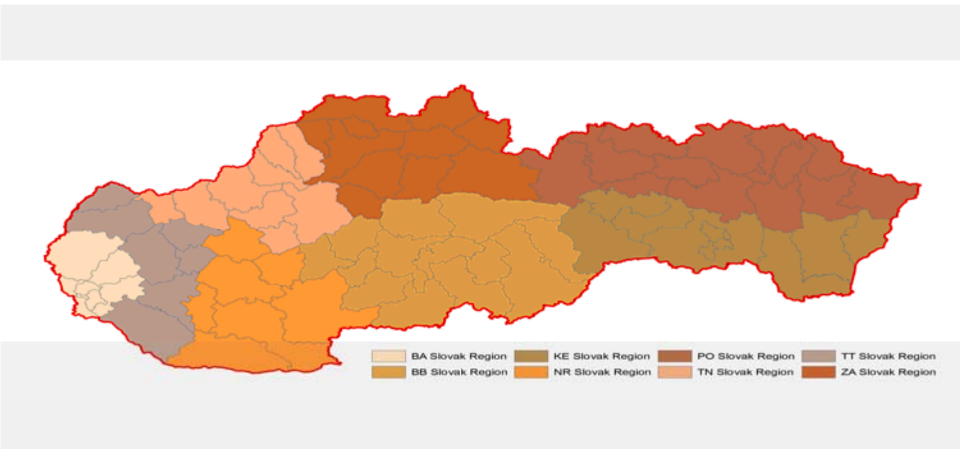
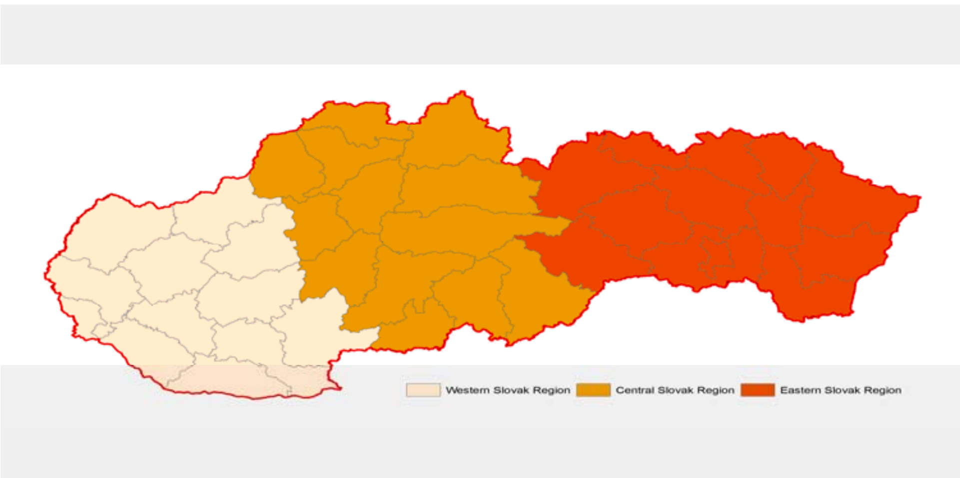


Figure 11.2: Three Slovak regional districts used for the assessment of ARD activities since 1990



Geographical boundaries of these districts are georeferenced by the means of the S – JTST Krovak system. All maps used in the Slovak Republic are made in coordinate system of uniform trigonometric cadastral network.

Considering a small area of the country and its specific conditions, there is no applicable stratification that would justify reporting on a smaller unit than the country-level unit. Total areas of ARD activities in different years are small, no more than 3 800 ha (AR) or 988 ha (D) for the whole country. The following tables are examples of percentage of areas AR activities from total area of each district.

Table 11.2: The areas of ARD activities for total territory and particular districts in 1990 – 1995

ARF/REF	Total SR [ha]	WS [ha]	CS [ha]	ES [ha]	DEF	WS total [ha]	CS [ha]	ES [ha]	ES [ha]
1990	**3 770,00**	313,97	2 537,73	918,30	**1990**	**809,00**	83,00	313,00	413,00
1991	**1 963,00**	97,04	1 654,36	184,61	**1991**	**988,00**	68,00	179,00	741,00
1992	**1 467,00**	383,87	386,31	696,83	**1992**	**324,00**	114,00	167,00	43,00
1993	**722,00**	311,21	248,97	161,83	**1993**	**366,00**	99,00	27,00	240,00
1994	**559,00**	222,95	145,40	190,64	**1994**	**351,00**	58,00	75,00	218,00
1995	**721,00**	15,32	572,56	133,13	**1995**	**135,00**	51,00	18,00	66,00

Table 11.3: The areas of AR activities for total territory and particular districts in 1996 – 2009

A/R	Total SR [ha]	BA [ha]	TT [ha]	TN [ha]	NR [ha]	ZA [ha]	BB [ha]	PO [ha]	KE [ha]
1996	**1,577**	0,001	0,004	0,011	0,004	0,207	0,803	0,353	0,195
1997	**3,395**	0,059	0,214	0,018	0,000	1,498	0,155	1,427	0,024
1998	**2,288**	0,000	0,068	0,005	0,000	0,844	0,865	0,495	0,012
1999	**2,102**	0,000	0,120	0,139	0,091	0,470	0,447	0,344	0,490
2000	**1,292**	0,003	0,000	0,010	0,022	0,698	0,159	0,356	0,044
2001	**1,178**	0,003	0,011	0,121	0,024	0,636	0,013	0,121	0,250
2002	**0,793**	0,029	0,008	0,074	0,003	0,449	0,103	0,020	0,109
2003	**1,648**	0,008	0,008	0,124	0,060	0,718	0,351	0,046	0,332
2004	**0,851**	0,000	0,029	0,320	0,017	0,131	0,058	0,222	0,073
2005	**0,842**	0,008	0,076	0,012	0,003	0,600	0,082	0,057	0,003
2006	**1,945**	0,076	0,023	0,066	0,154	0,726	0,016	0,825	0,059
2007	**0,656**	0,030	0,011	0,040	0,093	0,017	0,208	0,217	0,040
2008	**1,438**	0,010	0,013	0,459	0,200	0,159	0,244	0,184	0,170
2009	**1,048**	0,018	0,012	0,089	0,031	0,023	0,235	0,504	0,136

Table 11.4: The areas of D activities for total territory and particular districts in 1996 – 2009

D	Total SR [ha]	BA [ha]	TT [ha]	TN [ha]	NR [ha]	ZA [ha]	BB [ha]	PO [ha]	KE [ha]
1996	**0,468**	0,015	0,039	0,017	0,033	0,043	0,029	0,197	0,095
1997	**0,388**	0,034	0,029	0,087	0,019	0,015	0,046	0,013	0,145
1998	**0,378**	0,006	0,016	0,011	0,035	0,009	0,040	0,143	0,118
1999	**0,297**	0,014	0,026	0,073	0,026	0,032	0,016	0,096	0,014
2000	**0,127**	0,010	0,007	0,024	0,010	0,020	0,016	0,030	0,010
2001	**0,302**	0,057	0,006	0,015	0,027	0,076	0,029	0,031	0,061
2002	**0,149**	0,019	0,026	0,005	0,022	0,008	0,022	0,041	0,006
2003	**0,321**	0,040	0,021	0,130	0,009	0,051	0,026	0,016	0,028
2004	**0,025**	0,002	0,000	0,002	0,001	0,011	0,002	0,006	0,001
2005	**0,534**	0,209	0,021	0,187	0,017	0,012	0,037	0,035	0,016
2006	**0,239**	0,018	0,008	0,026	0,010	0,004	0,035	0,121	0,017
2007	**0,454**	0,026	0,052	0,047	0,066	0,061	0,023	0,161	0,018
2008	**0,323**	0,026	0,029	0,033	0,017	0,059	0,091	0,026	0,041
2009	**0,462**	0,199	0,023	0,053	0,044	0,049	0,010	0,043	0,041

In the following table is an example of percentage of areas with realized AR activities from total area of individual districts. The values fluctuated between 0.0003% and 0.2207% and it has reached neither 0.5% of total district areas.

Table 11.5: The areas (%) of AR activities for total territory and particular districts in 1996 – 2009

A/R	SK	BA	TT	TN	NR	ZA	BB	PO	KE
	%	%	%	%	%	%	%	%	%
1996	0,0322	0,0006	0,0009	0,0024	0,0006	0,0305	0,0850	0,0392	0,0289
1997	0,0692	0,0290	0,0516	0,0040	0,0000	0,2207	0,0163	0,1587	0,0035
1998	0,0467	0,0000	0,0163	0,0010	0,0000	0,1243	0,0915	0,0551	0,0017
1999	0,0429	0,0000	0,0289	0,0310	0,0144	0,0693	0,0472	0,0383	0,0726
2000	0,0263	0,0014	0,0000	0,0023	0,0035	0,1028	0,0168	0,0396	0,0065
2001	0,0240	0,0013	0,0025	0,0269	0,0037	0,0936	0,0014	0,0135	0,0370
2002	0,0162	0,0140	0,0018	0,0164	0,0005	0,0660	0,0109	0,0022	0,0161
2003	0,0336	0,0040	0,0020	0,0275	0,0094	0,1055	0,0372	0,0052	0,0492
2004	0,0174	0,0000	0,0071	0,0711	0,0027	0,0193	0,0061	0,0248	0,0109
2005	0,0172	0,0041	0,0182	0,0026	0,0005	0,0881	0,0087	0,0064	0,0005
2006	0,0397	0,0368	0,0055	0,0146	0,0243	0,1066	0,0017	0,0919	0,0088
2007	0,0134	0,0148	0,0026	0,0088	0,0146	0,0025	0,0220	0,0242	0,0059
2008	0,0293	0,0048	0,0031	0,1020	0,0315	0,0233	0,0258	0,0205	0,0252
2009	0,0214	0,0086	0,0030	0,0197	0,0049	0,0033	0,0248	0,0562	0,0202

11.2.2 Methodology used to develop the land transition matrix

The land transition matrix is based on the results of land use changes from and to forest derived from the Geodesy, Cartography and Cadastre Authority of the Slovak Republic (GCCA). This institute annually updates the cadastral information about the areas which have been afforested/reforested and deforested.

The AR area represented 30.3 kha in total and 1.5 kha on average by the year in Slovak conditions from 1990 to 2009. In the same time period the total deforestation areas amounted to 7.4 kha in total resp. 0.37 kha on average. The differences between AR and D correspond to the net increment of cadastral forest land between 0.21 and 3.01 kha.

The identified land-use change from Cropland, Grassland and Other Land converted to Forest Land, categorized as A/R (kha/year) and land use change from Forest Land to Cropland, Grassland, Settlements and Other Land represent D (kha/year) in Slovak conditions for the period 1990 – 2009.

Table 11.6: The differences between AR and D activities during 1990 – 2009

Year	Afforestation/Reforestation (AR, kha/year)				Deforestation (D, kha/year)					
	C to FL	G to FL	OL to FL	Total	FL to C	FL to G	FL to S	FL to OL	Total	Difference
1990	0,088	2,266	1,416	3,770	0,010	0,353	0,028	0,418	0,809	2,961
1991	0,012	0,325	1,626	1,963	0,045	0,678	0,075	0,190	0,988	0,975
1992	0,202	0,196	1,069	1,467	0,002	0,146	0,063	0,113	0,324	1,143
1993	0,220	0,135	0,367	0,722	0,002	0,175	0,071	0,118	0,366	0,356
1994	0,019	0,308	0,232	0,559	0,014	0,186	0,025	0,126	0,351	0,208
1995	0,028	0,556	0,137	0,721	0,002	0,063	0,023	0,047	0,135	0,586
1996	0,107	1,113	0,357	1,577	0,098	0,280	0,032	0,058	0,468	1,109
1997	0,130	0,311	2,954	3,395	0,026	0,203	0,065	0,094	0,388	3,007
1998	0,067	0,845	1,376	2,288	0,004	0,294	0,000	0,080	0,378	1,910
1999	0,067	0,831	1,204	2,102	0,009	0,086	0,029	0,173	0,297	1,805
2000	0,096	0,693	0,503	1,292	0,005	0,023	0,008	0,091	0,127	1,165
2001	0,013	0,422	0,743	1,178	0,039	0,101	0,040	0,122	0,302	0,876
2002	0,008	0,509	0,276	0,793	0,006	0,064	0,021	0,058	0,149	0,644
2003	0,050	1,110	0,488	1,648	0,009	0,185	0,065	0,062	0,321	1,327
2004	0,086	0,765	0,000	0,851	0,005	0,020	0,000	0,000	0,025	0,826
2005	0,023	0,455	0,364	0,842	0,015	0,219	0,038	0,262	0,534	0,308
2006	0,044	0,504	1,397	1,945	0,000	0,109	0,024	0,106	0,239	1,706
2007	0,065	0,365	0,226	0,656	0,068	0,144	0,047	0,195	0,454	0,202
2008	0,084	0,847	0,507	1,438	0,010	0,119	0,058	0,136	0,323	1,115
2009	0,044	0,472	0,532	1,048	0,014	0,050	0,262	0,136	0,462	0,586

11.2.3 Maps and/or database to identify the geographical locations, and the system of identification codes for the geographical locations

Each cadastral unit is a part of the Slovak Cadastral system. Maps in digital format are available at the web page of www.geoportal.sk. Beside this since 1st February 2004 a Cadastral Portal (KAPOR) has been established at the web site www.katasterportal.sk. The KAPOR establishment was supported by Decree of the Slovak Government No. 540/2002, which has enacted the publication of real estate cadastre data at the Internet. KAPOR operation has been supported also by the European Union within the framework of PHARE project. KAPOR enables the access of users to the real estate cadastre data. KAPOR is available only in Slovak language.

11.3 Activity-specific information

11.3.1 Methods for carbon stock change and GHG emission and removal estimates

11.3.1.1 Description of the methodologies and the underlying assumptions used

The estimation of emissions and/or removals of CO_2 are quantified for changes in five ecosystems carbon pools, namely above-ground biomass, below-ground biomass, dead wood, litter and soil organic matter in the KP LULUCF reporting. Methods of carbon stock changes calculation for ARD activities are divided into three sub-sections: Change in Carbon Stocks in Living Biomass, Change in Carbon Stocks in Dead Organic Matter, Change in Carbon Stocks in Soils.

Change in Carbon Stocks in Living Biomass for Afforestation/Reforestation

Annual changes in carbon stocks in living biomass were estimated following the default approach Tier 1 of IPCC 2003 GPG LULUCF. Changes in carbon stocks in living biomass on land converted to forest through artificial regeneration were estimated with the use of Equation 3.2.22:

Equation 3.2.22: Annual change in carbon stocks in living biomass in afforested land

$$\Delta C_{LFLB} = \Delta C_{LFGROWTH} – \Delta C_{LFLOSS}$$

Where:

ΔC_{LFLB} - annual change in carbon stocks in living biomass in afforested land, tonnes C yr^{-1}, $\Delta C_{LFGROWTH}$ - annual increase in carbon stocks in living biomass due to growth in land converted to forest land, tonnes C yr^{-1}, ΔC_{LFLOSS} - annual decrease in carbon stocks in living biomass due to losses from harvesting, fuel wood gathering and disturbances in land converted to forest, tonnes C yr^{-1}

Annual Increase in Carbon Stocks in Living Biomass

The method follows Equation 3.2.4, Section 3.2.1 Forest land Remaining Forest land, which refers to Category 5A Changes in Forest and Other Woody Biomass Stocks" of the IPCC 2003 GPG LULUCF. The calculations are made according to Equation 3.2.23:

Equation 3.2.23: Annual increase in carbon stocks in living biomass in land converted to forest land

$$\Delta C_{LFGROWTH} = (\sum A \bullet G_{TOTAL}) \bullet CF$$

Where:

$\Delta C_{LFGROWTH}$ - annual increase in carbon stocks in living biomass due to growth in land converted to forest land, tonnes C yr^{-1}, A - area of land converted to forest (including plantations), ha, G_{Total} - annual growth rate of biomass in forest (including plantations), tonnes d.m. ha^{-1} yr^{-1}, CF = carbon fraction of dry matter (default = 0.5), tonnes C (tonne d.m.)$^{-1}$

The carbon increment is proportional to the extent of afforested/reforested areas and the yearly growing biomass. The new afforested areas were determined from cadastral database. The annual increment of the above-ground and below-ground tree biomass for four main tree species including Norway spruce, Scotch pine, European beech and Sessile oak were selected from experimental database of the National Forest Centre. The annual increment of the above-ground biomass for the four main tree species included in the inventory are following: spruce 2.74 t dm/ha/y, pine 3.17 t dm/ha/y, beech 2.32 t dm/ha/y, oak 1.23 t dm/ha/y. The annual increment of the below-ground biomass for the four main tree species included in the inventory are following: spruce 0.56 t dm/ha/y, pine 0.40 t dm/ha/y, beech 0.90 t dm/ha/y and oak 0.57 t dm/ha/y. The proportion of main tree species from total artificial regeneration areas for accounting years was selected from database of the Slovak Statistical Office and represented 34% for spruce, 12% for pine, 47% for beech and 7% for oak in 2009.

Annual Decrease in Carbon Stocks in Living Biomass Due to Losses

In case of harvesting, fuel wood gathering and disturbances can be attributed to land converted to forest, annual losses in biomass should be estimated with the use of Equation 3.2.24 that repeats the good practice approach given in Equation 3.2.6, Section 3.2.1, Forest land Remaining Forest land:

Equation 3.2.24: Annual decrease in carbon stocks in living biomass due to losses in land converted to forest land

$$\Delta C_{LFLOSS} = L_{fellings} + L_{fuelwood} + L_{\text{other losses}}$$

Where:

ΔC_{LFLOSS} - annual decrease in carbon stocks in living biomass due to losses in land converted to forest land, tonnes C yr^{-1}, $L_{fellings}$ - biomass loss due to harvest of industrial wood and saw logs in land converted to forest land, tonnes C yr^{-1}, $L_{fuelwood}$ - biomass loss due to fuelwood gathering in land converted to forest land, tonnes C yr^{-1}, $L_{\text{other losses}}$ - biomass loss due to fires and other disturbances in land converted to forest land, tonnes C yr^{-1}

The carbon loss connected with living biomass due to by silvicultural cuttings in the afforested/reforested land was assumed to be insignificant (zero). Main reason is that the first significant thinning occurs in older age forest stands in the Slovak condition. Beside this, only total area where the silvicultural cuttings were realized has been registered in the forest database. The data of wood biomass amount removed from forest during first 40 years are not available in the Slovak condition.

Change in Carbon Stocks in Living Biomass for Deforestation

The method requires the estimates of carbon in living biomass stocks prior to deforestation, based on the estimates of the areas of land deforested during the period between land-use surveys. As a result of deforestation, it is assumed that the dominant vegetation is removed entirely, resulting in no carbon remaining in living biomass after deforestation. The difference between initial and final living biomass carbon pools is used to calculate change in carbon stocks due to deforestation using Equation 3.7.2.

The average change in carbon stocks estimated on a per area basis is to be equal to the change in carbon stocks due to the removal of living biomass from initial forests. Given the definition of the deforestation, the default assumption is that carbon stock after this activity is zero.

Equation 3.7.2: Annual change in carbon stocks in living biomass in land converted to other land

$$\Delta C_{LOLB} = A_{Conversion} \bullet (B_{After} - B_{Before}) \bullet CF$$

Where:

ΔC_{LOLB} - annual change in carbon stocks in living biomass in land converted to Other Land, tonnes C yr^{-1}, $A_{Conversion}$ - area of annually deforested land from some initial land uses, ha yr^{-1}, B_{After} - amount of living biomass immediately after deforestation, tonnes d.m. ha^{-1}, B_{Before} - amount of living biomass immediately before deforestation, tonnes d.m. ha^{-1}, CF = carbon fraction of dry matter (default = 0.5), tonnes C (tonnes d.m.)$^{-1}$

Tier 1 and tier 2 methods were used for calculation. It follows the approach in the IPCC 2003 GPG LULUCF, Section 5.2.3 (Forest and Grassland Conversion) where the amount of aboveground biomass that is removed is estimated by multiplying the forest area deforested annually to other land by the average annual carbon content of biomass in the land prior to deforestation. It is assumed that the entire biomass is removed in the year of deforestation. The default assumption for the tier 1 calculation is that all carbon in biomass is released to the atmosphere through decay processes either on- or off-site.

For calculation of above ground biomass carbon stocks on forest land prior conversion, the annually updated average growing stock volumes, BCEFs (0.7 for conifers and 1.2 for broadleaf) and default carbon content (0.5) were used. The average growing stock (m^3/ha) were estimated on the basis of forest taxation data in the Forest Management Plans (FMP), differently for the individual Slovak districts.

For calculation of below-ground biomass stocks were used the default coefficient for the root/shoot ratio (R) - 0.20 for coniferous above ground biomass 150 t/ha and 0.24 for broadleaves above ground biomass 150 t/ha, tab. 4.4 GPG (IPCC 2006).

Change in Carbon Stocks in Dead Organic Matter for ARD

Methods to quantify emissions and removals of carbon in dead organic matter pools (dead wood and litter) following conversion of land to forest land (afforestation/deforestation) or forest land to another type of land use (deforestation) require estimates of the carbon stocks just prior to and just following conversion, and the estimates of the areas of lands converted during the period. Most of the land uses categories (cropland, grassland, settlements, other lands) does not produce dead wood or litter (grassland is producing litter, but this data does not exist in Slovakia), so that corresponding carbon pools prior to afforestation/reforestation can be taken as zero, as a default assumption.

For the estimation of carbon stock in deadwood prior to deforestation was used the data obtained from the first National Forest Inventory realised from 2005 to 2006. It provides data on the mean deadwood biomass stocks (m^3/ha) separately for coniferous and broadleaves in the following categories: standing dead trees, stumps, coarse laying deadwood and small-sized laying deadwood. Each of mentioned categories was classified in four categories according to decomposition degree as a fresh, hard, soft and decomposed deadwood. The deadwood carbon stock was estimated from mean deadwood biomass stocks (m^3/ha), dry wood density weighted by mean growing stock volume of coniferous (0.425 t/m^3) and broadleaves (0. 675 t/m^3) tree species, reduction coefficient 0.8, 0.5., 0.5 and 0.2 and applicable to above described decomposition degrees and default carbon content (0.5 t C/t biomass).

Carbon stocks change in litter was estimated together with mineral soils as a part of soil organic matter for A/R activity as well as D activities. The methodology used for this estimation was identical as for estimation of mineral soil carbon stock change. The notation key "IE" (included elsewhere), used in CRF tables, indicates that the litter carbon stock change was estimated together with changes in the mineral soil carbon pool.

Change in Carbon Stocks in Soils for ARD

Carbon stock changes in mineral soils are calculated based on the data from the soil inventory with the default assumption of 20 years period for carbon stock equilibrium in „new land use" conditions, see chapter Land converted to Forest Land (5.A.2) for AR activity and chapters (5.B.2, 5.C.2, 5.E.2, 5.F.2) concerning Forest Land converted to other land use categories for D activity. Calculations of stock carbon changes in mineral soils as a result of ARD activities carried out as follows GPG LULUCF (IPCC 2003). The net carbon stock change in mineral soils was estimated using the country specific tier 2 method described in detail in Chapter LULUCF (7). For estimation of net carbon stock change in mineral soil were used the average carbon stock per hectare noted above (Category 5.A.2. Land converted to Forest land.) These values are based on existing data sets from soil inventories and published information with the default assumption of 20 years period for carbon stock equilibrium in „new land use" conditions.

The mean soil organic carbon stocks for main soil units and land use categories in Slovakia calculated from above mentioned data vary between 16 and 200 Mg C ha^{-1}. For respective land use categories following values (calculated as weighted average) were used for calculations of stock carbon changes in mineral soils as a result of land use change:

- Forest Land 166.1 Mg C ha^{-1}
- Grassland 129.7 Mg C ha^{-1}
- Cropland 108.6 Mg C ha^{-1}
- Other Land 97.3 Mg C ha^{-1}

As mentioned in 5.A.1, we use the same values as in previous reports as validation and final data management from NFI plots has not been finished yet and for this reason the results are not yet used for improvement of calculation of carbon stocks and changes.

11.3.1.2 Justification when omitting any carbon pool or GHG emissions/removals from activities under Article 3.3 and elected activities under Article 3.4

No carbon pool is omitted.

Net carbon stock changes in litter were reported inherently with changes in the soil carbon pool. All values of carbon stocks used for calculations include the total carbon amount of organic carbon in soil including the surface organic layer (litter layer). So the estimates of the soil C stock changes account for the changes in the litter. Any further estimates for the litter layer would therefore lead to a double accounting of this carbon pool. Besides this that carbon pool is not occurring during D activities, for example some land uses categories (cropland, settlements, other lands) does not produce litter pools.

There is no practice of biomass burning, lime application and N fertilization at ARD areas in Slovakia. Because deforestation activities are mostly connected with the change of forests to Settlements or Other land in Slovakia, the N_2O emissions from disturbance associated with land use conversion to cropland, no occurred too.

11.3.1.3 Information on whether or not indirect and natural GHG emissions and removals have been factored out

The indirect and natural GHG emissions/removals have not been factored out.

11.3.1.4 Changes in data and methods since the previous submission (recalculations)

Since the previous submission was performed following recalculations:

- Calculation all carbon stock changes for ARD activities and all carbon pools in 1991 due to complement of missing ARD areas for this year.
- Recalculation of all carbon stock changes by reason of assessment more precisely areas of AR activities and partially areas of D activities in individual years since 1990.
- Recalculation of living biomass carbon stocks separately for above-ground and below-ground parts in ARD activities.
- Calculation of dead wood carbon stocks for deforestation activity.

11.3.1.5 Uncertainty estimates

The uncertainty calculation is still under construction for the purpose of the KP reporting.

11.3.1.6 Information on other methodological issues

No other information is available.

11.3.1.7 The year of the onset of an activity, if after 2008

Not relevant.

11.4 Article 3.3

11.4.1 Information that demonstrates that activities under Article 3.3 began on or after 1 January 1990 and before 31 December 2012 and are direct human-induced

The cadastral information is annually updated by the GCCA. This is an official state institution and it is managed in accordance with the Slovak laws.

The change of land use classification is always initiated by land owners in the Slovak Republic. The owners have interest to make the ARD activity. For making afforestation he need a special plan. Deforestation is allowed only by the law.

11.4.2 Information on how harvesting or forest disturbance that is followed by the re-establishment of forest is distinguished from deforestation

The temporarily (no more than 2 years) unstocked areas (e.g. harvested area, disturbances) are still consider as forest area and are not accounted as deforestation. Deforestation means by the cadastral law that the category of forest land was definitely and permanently changed to another land use category.

11.4.3 Information on the size and geographical location of forest areas that have lost forest cover but which are not yet classified as deforested

This is not possible to recognize from actually available data in the Slovak Republic.

11.4.4 Information on estimated emissions and removals of activities under Article 3.3

The estimated removals from afforestation/reforestation AR activities represented -469.23 Gg CO_2 in 2009. Deforestation showed emissions 280.11 Gg CO_2 in 2009. The details are noted in the corresponding CRF tables of KP LULUCF.

11.5 Article 3.4

The Slovak Republic has not elected reporting under Article 3.4 of the KP.

11.6 Other information

11.6.1 Key category analysis for Article 3.3 activities and any elected activities under Article 3.4

According to the GPG LULUCF (page 5.39) forest management is a key category since Forest land is a key category in the UNFCCC reporting (Section 7.1.3).

11.7 Information relating to Article 6

There are no activities connected to Article 6 in the Slovak Republic.

CHAPTER 12: INFORMATION ON ACCOUNTING OF KYOTO UNITS

12.1 Background information

According to the Initial Report of the Slovak Republic revised version based on FCCC/IRR/2007/SVK from 19th September 2007[19] was quantified emission limitation or reduction commitment of 92% from the base year level has been accepted by the Slovak Republic in Annex B of the Kyoto Protocol. The calculation of assigned amount for the Slovak Republic pursuant to Article 3.7 of the Kyoto Protocol is based on the base year (1990) inventory of anthropogenic emissions by sources and removals by sinks of greenhouse gases not controlled by the Montreal Protocol to the UNFCCC and the base year for F-gases is 1995. The assigned amount of the Slovak Republic for the first commitment period (2008 – 2012) pursuant to Article 3.7 and 3.8 of the Kyoto Protocol has been calculated in accordance with Decision 13/CMP.1 as the total GHG emissions in 1990, excluding LULUCF (in tones of carbon dioxide equivalents), multiplied by the quantified emission limitation commitment (92%) and multiplied by 5 (years):

$$72\,050\,764*0.92*5 = 331\,433\,516 \text{ tones of } CO_2 \text{ equivalent}$$

The assigned amount of the Slovak Republic averaged over the first commitment period is:

$$331\,433\,516/5 = 66\,286\,703 \text{ tones of } CO_2 \text{ equivalent}$$

Table 12.1: The assigned amount of the Slovak Republic for period 2008 – 2012

Item	Unit [tonnes of CO_2 equivalents]
Base year emissions excluding LULUCF (1990)	72 050 764
F-gases emissions in 1990	271 403
Percentage corresponding to the reduction commitment	1
Estimated assigned amount for the first commitment period	**331 433 516**
Assigned amount averaged over the first commitment period	66 286 703

12.2 Summary of information reported in the SEF tables

The standard electronic format tables are included in the submission for the third time (SEF_SK_2011_1_11-28-5 31-3-2011.xls). The tables include all required information on the AAU, ERU, CER, t-CER, l-CER and RMU in the Slovak National Registry for the year 2010 as well as information on transfers of the units in 2010 to and from other Parties of the Kyoto Protocol. The SEF tables have been filled automatically using SEF reporting module in Seringas software. The Standard Electronic Format report for 2010 has been submitted to the UNFCCC Secretariat electronically and the contents of the report can also be found in Annex 6 of this document. According to the information from Slovak National Emission Registry was the current status of the units and reductions of the year 2010 summarized in the following Table 12.2.

Table 12.2: Statistics of the year 2010 from the Slovak National Emission Registry

	AAU	CERs	ERUs	RMUs
Issuance	0	0	0	0
Acquisition	0	1 588 931	18 596	0
Holding	153 571 296	4 458 367	18 596	0
Transfer	0	103 013	0	0
Cancellation	0	0	0	0
Withdrawal	0	0	0	0
Carryover	0	0	0	0

[19] http://unfccc.int/resource/docs/2007/irr/svk.pdf

12.3 Discrepancies and notifications

Reports R-2 to R-5 are providing information on discrepant transactions, CDM notifications, non-replacements and invalid units in the registry during reported period.

To minimize discrepancies, internal checks and routines are implemented, as far as possible, including:

- Checks concerning the handling of tCERs and lCERs (such as replacement, expiry date change, cancellations).
- Checks concerning carry-over procedures.
- Checks concerning the handling of notifications.
- Checks concerning net source cancellations and non-compliance cancellations and other procedures that are performed after notification from the ITL.
- Commitment period reserve checks.

Measures to deal with discrepancies, measures to prevent or handle communication problems and measures to prevent the reoccurrence of discrepancies have been established and implemented in order to correct problems in the event of a discrepancy or a communication problem.

During reported period no discrepant transactions were identified in Slovak National Registry, no CDM notifications were received, no non-replacements occurred and there were no invalid units identified. Therefore no additional actions or changes to established measures were necessary to be undertaken in order to address discrepancies.

The R-2 to R-5 reports (SIAR_Report_R-2_2010-SK.xls, SIAR_Report_R-3_2010-SK.xls, SIAR_Report_R-4_2010-SK.xls and SIAR_Report_R-5_2010-SK.xls) have been filled automatically using SEF reporting module in Seringas software and can be found in submission 2011.

12.4 Publicly accessible information

The National Registry is available through the internet address http://co2.dexia.sk in English and Slovak versions. Clients can enter the public internet page through user’s name and password and browse also in secure protocols. Web site includes non-confidential information stated in UN and EU legislation; especially account information, joint implementation project information, overall unit holdings and overall transaction information, authorized legal entities information and compliance information

12.5 Calculation of the commitment period reserve (CPR)

The commitment period reserve of the Slovak Republic is calculated in accordance with Decision 11/CMP.1 (Modalities, rules and guidelines for emission trading under Article 17 of the KP) as 90% of the proposed assigned amount or 100% of its most recently reviewed inventory times five, whichever value is the lowest. Due to substantive methodology improvements and fulfilled recalculations the Slovak Republic decided to use emission inventory 2009 submitted in 2011 as an alternate to estimate the commitment period reserve. The CPR value will be recalculated every year according to the latest inventory submission data.

Using the 100% of this value multiplied by five gives the number 217 130 347 tones of CO_2 equivalent. This number is lower than the 90% of the calculated assigned amount, which is 298 290 164 tones of CO_2 equivalent. Following the decision 11/CMP.1 we would give an estimated commitment period reserve for the Slovak Republic as equal to the 217 130 347 tones of CO_2 equivalent for the submission 2011 emission inventory 2009.

12.6 KP-LULUCF accounting

The Slovak Republic has chosen to account for the activities under Article 3.3 (afforestation, reforestation and deforestation) for the whole commitment period. In 2009, total CO_2 removals from afforestation/reforestation activities were -469.23 Gg of CO_2 (changes in 29.21 kha to the end of 2009). Total CO_2 emissions from deforestation were 280.11 Gg of CO_2 (changes in 6.98 kha to the end of 2009). In 2009, total emissions under the Article 3.3 of the KP 460.85 Gg with the changed area of 37.7 kha.

Table 12.3: Emissions and removals resulting from activities 3.3 of the KP in 2008 and 2009

Activities	2008	2009	Total
	Net CO_2 (Gg)		
A. Article 3.3 activities			
A.1. Afforestation and Reforestation	-453,04	-469,23	**-922,26**
A.1.1. Units of land not harvested since the beginning of the commitment period	-453,04	-469,23	**-922,26**
A.1.2. Units of land harvested since the beginning of the commitment period	NA	NA	**NA**
A.2. Deforestation	180,74	280,11	**460,85**

Emissions are determined as of 15.04.2011

CHAPTER 13: INFORMATION ON CHANGES IN NATIONAL SYSTEM

The official report about the Slovak National Inventory System for GHG emissions and projection under the Article 5 of the Kyoto Protocol was published in the Official Journal of the Ministry of Environment of the Slovak Republic http://www.enviro.gov.sk/servlets/files/16715.[20] The revised report of the National Inventory System dated on November 2008 focusing on the changes in the institutional arrangement, quality assurance/quality control plan, planned improvement in the National Inventory System is available in the National Inventory Report of the Slovak Republic 2010, submitted on 27th August 2010.

During last year (2010) no changes has been occurred in the National Inventory System under article 5.1 the Kyoto Protocol. The first phase of the announced project for ISO certification was successfully completed in February 2010 with the confirmation of certificate dated on 29th March 2010 (Annex 6). The second phase of the project has been not started yet due to the capacity reasons.

CHAPTER 14: INFORMATION ON CHANGES IN NATIONAL REGISTRY

14.1 The changes in the national registry software

The Slovak National Emission Registry Administrator is using software SERINGAS, developed by French company CDC Climat for maintaining its National Registry. During the reported period there have been three updates of the SERINGAS software:

- 28th April 2010, version 5.0.2,
- 6th June 2010, minor patch,
- 28th November 2010, version 5.0.3 plus NMF and NAP modules.

[20] *Vestnik, Ministry of Environment, XV, 3, 2007, page 19: National inventory system of the Slovak republic for the GHG emissions and sinks under the Article 5, of the Kyoto Protocol*

The only change concerning operation of the National Registry from UNFCCC point of view was deployment of NMF (New Message Flow) deployed to Production environment in November 2010. ITL (International Transaction Log) moved to NMF on 2^{nd} October 2010. Since the New Message Flow implementation in ITL is backward compatible and NMF is not mandatory for all registries this change was not deemed significant. Therefore no testing under UNFCCC supervision or change to readiness documentation was required.

Other releases dealt with minor bugs' corrections and new functionalities under EU ETS scheme. Two of the releases have been deemed as significant changes from the EU ETS point of view and the Slovak National Registry performed EU ETS Conformity testing under EC supervision in April and November 2010. Slovak EU ETS obligations are out of scope of this report and kept here only for completeness reasons.

- P1.3.1 15/CMP.1 annex II.E paragraph 32(a)

<u>The change of name or contact:</u>

No change in the name or contact information of the registry administrator occurred during the reported period.

- P1.3.2 15/CMP.1 annex II.E paragraph 32.(b)

<u>The change of cooperation arrangement:</u>

No change of cooperation arrangement occurred during the reported period.

- P1.3.3 15/CMP.1 annex II.E paragraph 32.(c)

<u>The change to the database or the capacity of National Registry:</u>

No change to the database or to the capacity of the national registry occurred during the reported period.

- P1.3.4 15/CMP.1 annex II.E paragraph 32.(d)

<u>The change of conformance to technical standards:</u>

No significant change in the registry's conformance to technical standards from UNFCCC point of view occurred for the reported period. The Slovak National Registry moved to New Message Flow on 28^{th} November 2010, but no testing under UNFCCC supervision or change to documentation has been required.

- P1.3.5 15/CMP.1 annex II.E paragraph 32.(e)

<u>The change of discrepancy procedures:</u>

No change of discrepancies procedures occurred during the reported period. No discrepancy occurred during reported period.

- P1.3.6 15/CMP.1 annex II.E paragraph 32.(f)

<u>The change of security:</u>

No change of security measures occurred during the reporting period. No security breach has been identified during reported period.

- P1.3.7 15/CMP.1 annex II.E paragraph 32.(g)

<u>The change of list of publicly available information:</u>

No change to the list of publicly available information occurred during the reporting period.

- P1.3.8 15/CMP.1 annex II.E paragraph 32.(h)

The change of Internet address:

No change of the registry Internet address occurred during the reporting period. The Internet address is https://co2.dexia.sk from the start of the National Registry.

- P1.3.9 15/CMP.1 annex II.E paragraph 32.(i)

The change of data integrity measures:

No change of data integrity measures occurred during the reporting period. No incidents that may have put integrity of the data in danger occurred during reported period.

- P1.3.10 15/CMP.1 annex II.E paragraph 32.(j)

The change of test results:

No change of test results from UNFCCC point of view occurred during the reporting period.

14.2 The previous annual review recommendations

Article 6 project information has been made publicly available on the National Registry website. The information is displayed on https://co2.dexia.sk and has been made available in English.

SEF tables have been made publicly available on the National Registry website.

The National Registry website has been enhanced so the representative identifiers information is displayed.

14.3 Public Information

- P1.4.1 13/CMP Annex II paragraph 45

Account information is public and accessible through registry's website.

- P1.4.2 13/CMP Annex II paragraph 46

Information about JI project is available on www.enviro.gov.sk.

- P1.4.3 13/CMP Annex II paragraph 47

Holding and transaction information is confidential.

- P1.4.4 13/CMP Annex II paragraph 48

Information about legal entities is public and accessible through registry's website.

14.4 Accounting of Kyoto Protocol Units

- 15/CMP.1 annex I.E paragraph 12

No discrepant transactions occurred in 2010.

- 15/CMP.1 annex I.E paragraph 13 & 14

No CDM notifications occurred in 2010.

- 15/CMP.1 annex I.E paragraph 15

No non-replacements occurred in 2010.

- 15/CMP.1 annex I.E paragraph 16

No invalid units exist as at 31st December 2010.

- P.1.2.13 15/CMP.1 annex I.E paragraph 17

14.5 Actions and changes to address discrepancies

No actions were taken or changes made to address discrepancies for the period under review.

CHAPTER 15: INFORMATION ON MINIMIZATION OF ADVERSE IMPACTS IN ACCORDANCE WITH ARTICLE 3, PARAGRAPH 14

Economy of the Slovak Republic, being a small open economy does not allow for a significant impact of its internal price mechanism on the development of world prices. From this point of view, any potential impacts of the measures adopted in the Slovak Republic on other countries can be considered as minimal. This situation has changed to some extent following our accession to the EU and integration into the single European market. Historically, a major bulk of the adopted measures within the environmental policy was of command and control type of regulatory measures. By the end of nineties a shift has occurred towards an increasing application of the polluter pays principle penalizing polluters and providing incentives for adoption of more environmentally sound technologies in particular through fiscal policy instruments. Their major benefit expected was an increasing emphasize on cost effective compliance with the adopted environmental target through the function of the price mechanism. The fundamental ideal of the price liberalization was establishment of a competitive environment, where market generates an equilibrium price of commodities. An adequate regulation is acceptable in case of a lasting existence of market imperfections. In charge of supervision on the price development founded by the macroeconomic fundamentals are independent regulatory institutions, which are also responsible to correct the existing market distortions.

15.1 Coal industry

State aid granted to the coal industry consists of three main pillars: coal, steel and electricity markets. The Slovak Republic has fully privatized the former state owned mines and continues in granting the coal industry investment aid. Report prepared by the EC notes that mines in the Slovak Republic are in terms of production costs competitive with respect to the prevailing world prices. Subsidies granted to the coal industry affect only the provision of the coal resources, i.e. the decision whether to buy own or imported coal. However, the other regulation such as compulsory utilization of home extracted coal does also affect the composition of the energy mix, i.e. the share of coal on the electricity production. European Commission has highlighted the potential impact of these decisions on the internal electricity market. Impacts of similar types of measures adopted within the coal industry on the steel markets have not been observed. Within the period of 2003 – 2006 coal prices on world markets remained more stable in comparison with other fossil fuels such as oil and gas. The Slovak Republic does not export its coal to the other countries. On the base of the mentioned facts we can conclude that the economy of the Slovak Republic has minimal impact on the existing structure of the international trade with coal and pricing.

15.2 Flexible mechanism KP

During the first commitment period of the Kyoto Protocol (2008 – 2012) the emission allowances for the EU ETS sectors are allocated free of charge. No quantitative study has yet examined the potential transmission of the emission allowances prices on the producer prices and the price of electricity within EU ETS sectors. No significant impact of the variation of emission allowance prices on the oil consumption within the Slovak Republic in the near term future is expected. Any influence originating from the actions taken by the regulators on the potential revenues of the oil exporting countries will be insignificant. The Slovak Republic is hosting one JI project and at this stage does not participate in any CDM project in developing countries.

15.3 Utilization of biofuels

Policies supporting the utilisation of the biofuels are closely linked to the EU trade and common agricultural policies. Strategies to faze in the alternative sources of motor fuels have been developed within the National Program of Development of Biofuels, while their practical implementation has been regulated by the Directive 246/2006 Coll. which entered into force the 1st May 2006. This directive has set the minimum levels of biofuels in motor gasoline and diesel oil. A range of programs with focus on enhancement of biofuels utilisation within European Union[21] has provided a significant stimulus for the production of biofuels as well as to the stronger growth of the international trade with biofuels, often with negative side impacts on the economies of developing countries. Despite increasing imports of biofuels we perceive the impact of the Slovak Republic on the world prices of biofuels as negligible.

15.4 Carbon leakage

Carbon leakage due to the decreasing share of allocation of emission allowances through grandfathering pro bono of auctions and benchmarks requires detailed and continuous analysis. A potential solution to minimize the risk of carbon leakage and reallocation of the industrial base in the countries with less stringent environmental policies is subsequent rise of the shares of allowances to be allocated through auctioning. This measure is relevant for the sectors, where the risk of the carbon leakage has been identified.

15.5 Foreign aid

According to the preliminary assessment of the bilateral and specific projects of the foreign development policy of the Slovak Republic within 2004 – 2008, more than 21% of these projects focused on the support of the utilization of renewable energy resources and energy efficiency, on the adaptation measures including construction of the early warning systems, adjustments and efficiency improvements of the water management as well as for capacity building and improvement in the infrastructure for the compliance with Convention and Kyoto Protocol (Serbia, Kazakhstan). The Slovak Republic as a country with rich experiences within this area, participates on aid delivered in order to strengthen practical implementation of the Kyoto Protocol and compliance with its commitments and preparation of the legislative framework for implementation of the market mechanisms and emission trading systems (administration and national emission registries, emission audits, monitoring systems and emission balances). The Slovak Republic is able to deliver projections of hydro power plants, complex delivery of the relevant technology as well as inspection of construction. Currently, we have not been carrying out any programs of assistance for oil exporting countries. Recently Slovak oil imports have remained stable with slightly increasing trend, what is not expected to have any negative impacts on oil exporting economies. In addition to the delivered development aid, the Slovak Republic has expanded the provisions of preferential market access for the developing and the least developed countries.

[21] *A strong demand growth for biofuels has contributed also a combination of different supporting policies in the EU and USA.*

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ANNEXES TO THE NATIONAL INVENTORY REPORT

Annex 1: Key categories

Description of methodology used for identifying key categories, including for KP-LULUCF

The key source categories by level assessment and trend assessment were chosen those, whose cumulative contribution is less than 95% and are enclosed in the excel file followed the Good Practice Guidance (IPCC, 2000 and 2003). Using tables 7.1 and 5.4.1 of IPCC (2000) and IPCC (2003) as a basis, the key category analysis consists of 100 category-gas combinations. The identification includes all reported greenhouse gases CO_2, CH_4, N_2O, HFCs, PFCs and SF_6 and all IPCC source categories with or without LULUCF performed with the detailed categorization of the CRF categories.

The Slovak Republic determined in year 2009 27 key source categories by level assessment with LULUCF and 23 key source categories without LULUCF. The Slovak Republic determined in year 2009 32 key source categories by trend assessment with LULUCF and 27 key source categories without LULUCF. The most important key source categories in the Slovak Republic remain fuel combustion, road transport and the emissions of N_2O from agricultural soil and methane emissions from SWDS etc. Key categories are summarized in CRF Table 7 for every year from 1990. Key categories for KP LULUCF are included in CRF Table NIR-3.

Tables 7.A1 - 7.A3 of the IPCC good practice guidance

Table A1.1: Table 7.A1 Tier 1 Analyses – Level Assessment with LULUCF for 2009

A	B	C	D	E	F
IPCC Source Categories	Direct GHG	Base Year Estimate (1990)	Current Year Estimate (2009)	Level Assesment	Cumulative Total of Column E
1.A.3.b Transport - Road Transportation - liquid	CO2	4 500,94	6 006,83	12,59	12,59
1.A.1 Energy Industries - solid	CO2	11 552,58	4 756,41	9,97	22,56
2(I).C.1 Iron and Steel Production	CO2	5 380,51	4 447,08	9,32	31,88
1.A.4 Other sector - gaseous	CO2	2 841,82	3 654,00	7,66	39,54
1.A.1 Energy Industries - gaseous	CO2	2 844,44	3 601,69	7,55	47,08
5.A Forest Land	CO2	3 035,43	2 834,15	5,94	53,02
1.A.2 Manufacturing Industries and Construction - gaseous	CO2	5 723,56	2 805,39	5,88	58,90
1.A.2 Manufacturing Industries and Construction - solid	CO2	9 825,68	2 271,53	4,76	63,66
6.A Solid Waste Disposal on Land	CH4	469,77	1 584,45	3,32	66,99
1.A.1 Energy Industries - liquid	CO2	1 540,39	1 381,33	2,90	69,88
2(I).B.2 Nitric Acid Production	N2O	1 148,71	1 238,82	2,60	72,48
1.A.2 Manufacturing Industries and Construction - liquid	CO2	4 163,11	1 234,34	2,59	75,06
4.D.1 Agricultural Soils - Direct	N2O	2 414,06	1 209,38	2,53	77,60
2(I).A.1 Cement Production	CO2	1 438,01	1 198,66	2,51	80,11
1.A.5.a Other non-specified - gaseous	CO2	1 639,63	974,78	2,04	82,15
1.B.1.b Fugitive Emission from Oil, Natural Gas and Other	CH4	513,50	793,08	1,66	83,82
4.A Enteric Fermentation - Cattle	CH4	1 802,03	757,80	1,59	85,40
5.B Cropland	CO2	148,33	695,61	1,46	86,86
2(I).A.2 Lime Production	CO2	770,42	689,43	1,44	88,31
2(I).B.1 Ammonia Production	CO2	616,97	618,40	1,30	89,60
5.C Grassland	CO2	346,84	425,52	0,89	90,49
4.B Manure Management	N2O	1 074,32	377,00	0,79	91,29
6.B Wastew ater Handling	CH4	413,83	364,60	0,76	92,05
1.B.1.a Coal Mining and Handling	CH4	571,15	355,40	0,74	92,79
4.D.3 Agricultural Soils - Indirect	N2O	995,23	350,36	0,73	93,53
1.A.4 Other sector - solid	CO2	7 679,65	323,43	0,68	94,21
2(I).F HFCs emissions	HFCs	0,00	299,61	0,63	94,83
2(I).A.7.2 Magnezite Production	CO2	431,94	265,69	0,56	95,39
5.F Other Land	CO2	426,45	261,80	0,55	95,94
5.E Settlements	CO2	123,34	216,66	0,45	96,39
2(I).C.3 Aluminium Production	CO2	121,32	183,57	0,38	96,78
2(I).B.4 Carbide Production	CO2	0,00	144,72	0,30	97,08
4.B Manure Management	CH4	368,66	124,81	0,26	97,34
2(I).A.3 Limestone and Dolomite Use	CO2	41,83	118,92	0,25	97,59
4.A Enteric Fermentation	CH4	188,13	107,44	0,23	97,82
2(I).C.2 Ferroalloys Production	CO2	270,04	104,42	0,22	98,04
4.D.2 Agricultural Soils - PRP	N2O	221,71	91,79	0,19	98,23
3.D Other Solvent Use	CO2	130,10	86,99	0,18	98,41
1.A.3.c Transport - Railw ays - liquid	CO2	376,77	85,90	0,18	98,59
3.D Other Solvent Use	N2O	17,05	77,40	0,16	98,75
1.A.1 Energy Industries - other	CO2	170,30	68,91	0,14	98,90
6.C Waste Composting	N2O	1,86	63,36	0,13	99,03
1.A.3.b Transport - Road Transportation - liquid	N2O	71,61	60,14	0,13	99,16
6.B Wastew ater Handling	N2O	95,60	60,11	0,13	99,28
6.C Waste Composting	CH4	1,68	57,24	0,12	99,40
2(I).B.1 Ammonia Production	CH4	24,57	22,83	0,05	99,45
5.A Forest Land	CH4	14,09	20,76	0,04	99,49
1.A.1 Energy Industries - solid	N2O	52,38	20,24	0,04	99,54
2(I).F SF6 emissions	SF6	0,03	19,39	0,04	99,58
1.A.3.b Transport - Road Transportation - gaseous	CO2	0,00	19,26	0,04	99,62
2(I).C.3 Aluminium Production	PFCs	271,37	17,76	0,04	99,65
1.A.4 Other sector - solid	CH4	350,07	16,08	0,03	99,69
2(I).A.7.1 Glass Production	CO2	7,88	13,19	0,03	99,72
1.A.2 Manufacturing Industries and Construction - solid	N2O	41,44	12,68	0,03	99,74
1.A.3.b Transport - Road Transportation - liquid	CH4	20,98	12,02	0,03	99,77
1.A.3.c Transport - Railw ays - liquid	N2O	50,19	11,44	0,02	99,79
1.A.4 Other sector - liquid	CO2	386,64	9,23	0,02	99,81
1.A.2 Manufacturing Industries and Construction - solid	CH4	21,85	7,25	0,02	99,83
1.A.2 Manufacturing Industries and Construction - liquid	CH4	2,69	7,25	0,02	99,84
5.A Forest Land	N2O	12,09	7,04	0,01	99,86
1.A.4 Other sector - gaseous	CH4	5,38	6,95	0,01	99,87
2(I).B.1 Ammonia Production	N2O	7,25	6,74	0,01	99,88
1.A.1 Energy Industries - other	N2O	4,90	5,94	0,01	99,90
1.A.3.a Transport - Civil Aviation - jet kerosen	CO2	7,00	5,88	0,01	99,91
1.A.5.a Other non-specified - solid	CO2	34,99	5,36	0,01	99,92
6.C Waste Incineration	CO2	62,70	5,00	0,01	99,93
1.A.2 Manufacturing Industries and Construction - gaseous	CH4	10,96	4,79	0,01	99,94
1.A.5.a Other non-specified - liquid	CO2	34,99	4,40	0,01	99,95
1.A.2 Manufacturing Industries and Construction - liquid	N2O	10,79	2,87	0,01	99,96
6.C Waste Incineration	N2O	2,73	2,67	0,01	99,96
1.A.1 Energy Industries - liquid	CH4	1,29	2,16	0,00	99,97
1.A.4 Other sector - gaseous	N2O	1,59	2,05	0,00	99,97
1.A.5.a Other non-specified - gaseous	CH4	3,10	1,85	0,00	99,98
1.A.1 Energy Industries - gaseous	CH4	1,87	1,80	0,00	99,98
1.A.3.e Transport - Other - liquid	CO2	7,00	1,54	0,00	99,98
1.A.1 Energy Industries - gaseous	N2O	1,53	1,52	0,00	99,99
1.A.2 Manufacturing Industries and Construction - gaseous	N2O	3,24	1,41	0,00	99,99
1.A.4 Other sector - solid	N2O	31,12	1,37	0,00	99,99
1.A.1 Energy Industries - solid	CH4	2,53	0,98	0,00	99,99
1.A.3.b Transport - Road Transportation - gaseous	CH4	0,00	0,85	0,00	99,99
1.A.1 Energy Industries - liquid	N2O	3,80	0,71	0,00	100,00
1.A.5.a Other non-specified - gaseous	N2O	0,92	0,55	0,00	100,00
1.A.3.a Transport - Civil Aviation - av. Gasoline	CO2	0,73	0,36	0,00	100,00
1.B.1.b Fugitive Emission from Oil, Natural Gas and Other	CO2	0,15	0,24	0,00	100,00
1.A.3.a Transport - Civil Aviation - jet kerosen	N2O	0,24	0,20	0,00	100,00
1.A.3.c Transport - Railw ays - liquid	CH4	0,62	0,11	0,00	100,00
2(I).C.2 Ferroalloys Production	CO2	0,00	0,10	0,00	100,00
1.A.3.e Transport - Other - liquid	N2O	0,24	0,05	0,00	100,00
1.A.5.a Other non-specified - solid	N2O	0,93	0,02	0,00	100,00
1.A.4 Other sector - liquid	CH4	1,07	0,02	0,00	100,00
1.A.5.a Other non-specified - solid	CH4	0,45	0,01	0,00	100,00
1.A.5.a Other non-specified - liquid	CH4	0,10	0,01	0,00	100,00
1.A.3.d Transport - Civil Aviation - jet kerosen	CH4	0,01	0,01	0,00	100,00
1.A.5.a Other non-specified - liquid	N2O	0,09	0,01	0,00	100,00
1.A.4 Other sector - liquid	N2O	0,95	0,01	0,00	100,00
1.A.3.d Transport - Civil Aviation - av. Gasoline	CH4	0,01	0,00	0,00	100,00
1.A.3.a Transport - Civil Aviation - av. gasoline	N2O	0,01	0,00	0,00	100,00
1.A.3.e Transport - Other - liquid	CH4	0,09	0,00	0,00	100,00
1.B.1.b Fugitive Emission from Oil, Natural Gas and Other	N2O	0,01	0,00	0,00	100,00
1.A.1 Energy Industries - other	CH4	0,00	0,00	0,00	100,00

Table A1.2: Table 7.A1 Tier 1 Analyses – Level Assessment without LULUCF for 2009

A	B	C	D	E	F
IPCC Source Categories	Direct GHG	Base Year Estimate (1990)	Current Year Estimate (2009)	Level Assesment	Cumulative Total of Column E
1.A.3.b Transport - Road Transportation - liquid	CO2	4 500,94	6 006,83	13,89	13,89
1.A.1 Energy Industries - solid	CO2	11 552,58	4 756,41	11,00	24,88
2(I).C.1 Iron and Steel Production	CO2	5 380,51	4 447,08	10,28	35,17
1.A.4 Other sector - gaseous	CO2	2 841,82	3 654,00	8,45	43,61
1.A.1 Energy Industries - gaseous	CO2	2 844,44	3 601,69	8,33	51,94
1.A.2 Manufacturing Industries and Construction - gaseous	CO2	5 723,56	2 805,39	6,49	58,43
1.A.2 Manufacturing Industries and Construction - solid	CO2	9 825,68	2 271,53	5,25	63,68
6.A Solid Waste Disposal on Land	CH4	469,77	1 584,45	3,66	67,34
1.A.1 Energy Industries - liquid	CO2	1 540,39	1 381,33	3,19	70,54
2(I).B.2 Nitric Acid Production	N2O	1 148,71	1 238,82	2,86	73,40
1.A.2 Manufacturing Industries and Construction - liquid	CO2	4 163,11	1 234,34	2,85	76,25
4.D.1 Agricultural Soils - Direct	N2O	2 414,06	1 209,38	2,80	79,05
2(I).A.1 Cement Production	CO2	1 438,01	1 198,66	2,77	81,82
1.A.5.a Other non-specified - gaseous	CO2	1 639,63	974,78	2,25	84,08
1.B.1.b Fugitive Emission from Oil, Natural Gas and Other	CH4	513,50	793,08	1,83	85,91
4.A Enteric Fermentation - Cattle	CH4	1 802,03	757,80	1,75	87,66
2(I).A.2 Lime Production	CO2	770,42	689,43	1,59	89,26
2(I).B.1 Ammonia Production	CO2	616,97	618,40	1,43	90,68
4.B Manure Management	N2O	1 074,32	377,00	0,87	91,56
6.B Wastew ater Handling	CH4	413,83	364,60	0,84	92,40
1.B.1.a Coal Mining and Handling	CH4	571,15	355,40	0,82	93,22
4.D.3 Agricultural Soils - Indirect	N2O	995,23	350,36	0,81	94,03
1.A.4 Other sector - solid	CO2	7 679,65	323,43	0,75	94,78
2(I).F HFCs emissions	HFCs	0,00	299,61	0,69	95,47
2(I).A.7.2 Magnezite Production	CO2	431,94	265,69	0,61	96,09
2(I).C.3 Aluminium Production	CO2	121,32	183,57	0,42	96,51
2(I).B.4 Carbide Production	CO2	0,00	144,72	0,33	96,84
4.B Manure Management	CH4	368,66	124,81	0,29	97,13
2(I).A.3 Limestone and Dolomite Use	CO2	41,83	118,92	0,27	97,41
4.A Enteric Fermentation	CH4	188,13	107,44	0,25	97,66
2(I).C.2 Ferroalloys Production	CO2	270,04	104,42	0,24	97,90
4.D.2 Agricultural Soils - PRP	N2O	221,71	91,79	0,21	98,11
3.D Other Solvent Use	CO2	130,10	86,99	0,20	98,31
1.A.3.c Transport - Railw ays - liquid	CO2	376,77	85,90	0,20	98,51
3.D Other Solvent Use	N2O	17,05	77,40	0,18	98,69
1.A.1 Energy Industries - other	CO2	170,30	68,91	0,16	98,85
6.C Waste Composting	N2O	1,86	63,36	0,15	99,00
1.A.3.b Transport - Road Transportation - liquid	N2O	71,61	60,14	0,14	99,13
6.B Wastew ater Handling	N2O	95,60	60,11	0,14	99,27
6.C Waste Composting	CH4	1,68	57,24	0,13	99,41
2(I).B.1 Ammonia Production	CH4	24,57	22,83	0,05	99,46
1.A.1 Energy Industries - solid	N2O	52,38	20,24	0,05	99,50
2(I).F SF6 emissions	SF6	0,03	19,39	0,04	99,55
1.A.3.b Transport - Road Transportation - gaseous	CO2	0,00	19,26	0,04	99,59
2(I).C.3 Aluminium Production	PFCs	271,37	17,76	0,04	99,64
1.A.4 Other sector - solid	CH4	350,07	16,08	0,04	99,67
2(I).A.7.1 Glass Production	CO2	7,88	13,19	0,03	99,70
1.A.2 Manufacturing Industries and Construction - solid	N2O	41,44	12,68	0,03	99,73
1.A.3.b Transport - Road Transportation - liquid	CH4	20,98	12,02	0,03	99,76
1.A.3.c Transport - Railw ays - liquid	N2O	50,19	11,44	0,03	99,79
1.A.4 Other sector - liquid	CO2	386,64	9,23	0,02	99,81
1.A.2 Manufacturing Industries and Construction - solid	CH4	21,85	7,25	0,02	99,82
1.A.2 Manufacturing Industries and Construction - liquid	CH4	2,69	7,25	0,02	99,84
1.A.4 Other sector - gaseous	CH4	5,38	6,95	0,02	99,86
2(I).B.1 Ammonia Production	N2O	7,25	6,74	0,02	99,87
1.A.1 Energy Industries - other	N2O	4,90	5,94	0,01	99,89
1.A.3.a Transport - Civil Aviation - jet kerosen	CO2	7,00	5,88	0,01	99,90
1.A.5.a Other non-specified - solid	CO2	34,99	5,36	0,01	99,91
6.C Waste Incineration	CO2	62,70	5,00	0,01	99,92
1.A.2 Manufacturing Industries and Construction - gaseous	CH4	10,96	4,79	0,01	99,94
1.A.5.a Other non-specified - liquid	CO2	34,99	4,40	0,01	99,95
1.A.2 Manufacturing Industries and Construction - liquid	N2O	10,79	2,87	0,01	99,95
6.C Waste Incineration	N2O	2,73	2,67	0,01	99,96
1.A.1 Energy Industries - liquid	CH4	1,29	2,16	0,00	99,96
1.A.4 Other sector - gaseous	N2O	1,59	2,05	0,00	99,97
1.A.5.a Other non-specified - gaseous	CH4	3,10	1,85	0,00	99,97
1.A.1 Energy Industries - gaseous	CH4	1,87	1,80	0,00	99,98
1.A.3.e Transport - Other - liquid	CO2	7,00	1,54	0,00	99,98
1.A.1 Energy Industries - gaseous	N2O	1,53	1,52	0,00	99,98
1.A.2 Manufacturing Industries and Construction - gaseous	N2O	3,24	1,41	0,00	99,99
1.A.4 Other sector - solid	N2O	31,12	1,37	0,00	99,99
1.A.1 Energy Industries - solid	CH4	2,53	0,98	0,00	99,99
1.A.3.b Transport - Road Transportation - gaseous	CH4	0,00	0,85	0,00	99,99
1.A.1 Energy Industries - liquid	N2O	3,80	0,71	0,00	100,00
1.A.5.a Other non-specified - gaseous	N2O	0,92	0,55	0,00	100,00
1.A.3.a Transport - Civil Aviation - av. Gasoline	CO2	0,73	0,36	0,00	100,00
1.B.1.b Fugitive Emission from Oil, Natural Gas and Other	CO2	0,15	0,24	0,00	100,00
1.A.3.a Transport - Civil Aviation - jet kerosen	N2O	0,24	0,20	0,00	100,00
1.A.3.c Transport - Railw ays - liquid	CH4	0,62	0,11	0,00	100,00
2(I).C.2 Ferroalloys Production	CO2	0,00	0,10	0,00	100,00
1.A.3.e Transport - Other - liquid	N2O	0,24	0,05	0,00	100,00
1.A.5.a Other non-specified - solid	N2O	0,93	0,02	0,00	100,00
1.A.4 Other sector - liquid	CH4	1,07	0,02	0,00	100,00
1.A.5.a Other non-specified - solid	CH4	0,45	0,01	0,00	100,00
1.A.5.a Other non-specified - liquid	CH4	0,10	0,01	0,00	100,00
1.A.3.d Transport - Civil Aviation - jet kerosen	CH4	0,01	0,01	0,00	100,00
1.A.5.a Other non-specified - liquid	N2O	0,09	0,01	0,00	100,00
1.A.4 Other sector - liquid	N2O	0,95	0,01	0,00	100,00
1.A.3.d Transport - Civil Aviation - av. Gasoline	CH4	0,01	0,00	0,00	100,00
1.A.3.a Transport - Civil Aviation - av. gasoline	N2O	0,01	0,00	0,00	100,00
1.A.3.e Transport - Other - liquid	CH4	0,09	0,00	0,00	100,00
1.B.1.b Fugitive Emission from Oil, Natural Gas and Other	N2O	0,01	0,00	0,00	100,00
1.A.1 Energy Industries - other	CH4	0,00	0,00	0,00	100,00

Table A1.3: Table 7.A2 Tier 1 Analyses – Trend Assessment with LULUCF for 2009

A	B	C	D	E	F	G
IPCC Source Categories	Direct GHG	Base Year Estimate (1990)	Current Year Estimate (2009)	Trend Assesment	% Contribution to Trend	Cummulative total of Column F
1.A.3.b Transport - Road Transportation - liquid	CO2	4 500,94	6 006,83	11,15	11,05	11,05
1.A.1 Energy Industries - solid	CO2	11 552,58	4 756,41	7,91	7,84	18,90
2(I).C.1 Iron and Steel Production	CO2	5 380,51	4 447,08	3,96	3,93	22,82
1.A.4 Other sector - gaseous	CO2	2 841,82	3 654,00	6,56	6,51	29,33
1.A.1 Energy Industries - gaseous	CO2	2 844,44	3 601,69	6,38	6,32	35,65
5.A Forest Land	CO2	3 035,43	2 834,15	3,35	3,32	38,97
1.A.2 Manufacturing Industries and Construction - gaseous	CO2	5 723,56	2 805,39	2,38	2,36	41,33
1.A.2 Manufacturing Industries and Construction - solid	CO2	9 825,68	2 271,53	12,81	12,70	54,03
6.A Solid Waste Disposal on Land	CH4	469,77	1 584,45	4,44	4,41	58,44
1.A.1 Energy Industries - liquid	CO2	1 540,39	1 381,33	1,50	1,49	59,93
2(I).B.2 Nitric Acid Production	N2O	1 148,71	1 238,82	1,84	1,82	61,75
1.A.2 Manufacturing Industries and Construction - liquid	CO2	4 163,11	1 234,34	4,50	4,46	66,20
4.D.1 Agricultural Soils - Direct	N2O	2 414,06	1 209,38	0,92	0,91	67,11
2(I).A.1 Cement Production	CO2	1 438,01	1 198,66	1,09	1,08	68,20
1.A.5.a Other non-specified - gaseous	CO2	1 639,63	974,78	0,10	0,10	68,29
1.B.1.b Fugitive Emission from Oil, Natural Gas and Other	CH4	513,50	793,08	1,64	1,63	69,92
4.A Enteric Fermentation - Cattle	CH4	1 802,03	757,80	1,18	1,17	71,09
5.B Cropland	CO2	148,33	695,61	2,07	2,05	73,14
2(I).A.2 Lime Production	CO2	770,42	689,43	0,75	0,74	73,88
2(I).B.1 Ammonia Production	CO2	616,97	618,40	0,83	0,82	74,70
5.C Grassland	CO2	346,84	425,52	0,73	0,72	75,43
4.B Manure Management	N2O	1 074,32	377,00	0,96	0,95	76,38
6.B Wastewater Handling	CH4	413,83	364,60	0,38	0,38	76,76
1.B.1.a Coal Mining and Handling	CH4	571,15	355,40	0,02	0,02	76,78
4.D.3 Agricultural Soils - Indirect	N2O	995,23	350,36	0,89	0,88	77,65
1.A.4 Other sector - solid	CO2	7 679,65	323,43	14,99	14,85	92,51
2(I).F HFCs emissions	HFCs	0,00	299,61	1,03	1,02	93,53
2(I).A.7.2 Magnezite Production	CO2	431,94	265,69	0,01	0,01	93,53
5.F Other Land	CO2	426,45	261,80	0,00	0,00	93,54
5.E Settlements	CO2	123,34	216,66	0,48	0,48	94,02
2(I).C.3 Aluminium Production	CO2	121,32	183,57	0,37	0,37	94,39
2(I).B.4 Carbide Production	CO2	0,00	144,72	0,50	0,49	94,88
4.B Manure Management	CH4	368,66	124,81	0,34	0,34	95,22
2(I).A.3 Limestone and Dolomite Use	CO2	41,83	118,92	0,32	0,32	95,54
4.A Enteric Fermentation	CH4	188,13	107,44	0,03	0,03	95,56
2(I).C.2 Ferroalloys Production	CO2	270,04	104,42	0,21	0,21	95,77
4.D.2 Agricultural Soils - PRP	N2O	221,71	91,79	0,15	0,15	95,92
3.D Other Solvent Use	CO2	130,10	86,99	0,03	0,03	95,94
1.A.3.c Transport - Railways - liquid	CO2	376,77	85,90	0,50	0,49	96,43
3.D Other Solvent Use	N2O	17,05	77,40	0,23	0,23	96,66
1.A.1 Energy Industries - other	CO2	170,30	68,91	0,12	0,12	96,78
6.C Waste Composting	N2O	1,86	63,36	0,21	0,21	96,99
1.A.3.b Transport - Road Transportation - liquid	N2O	71,61	60,14	0,06	0,06	97,05
6.B Wastewater Handling	N2O	95,60	60,11	0,01	0,01	97,05
6.C Waste Composting	CH4	1,68	57,24	0,19	0,19	97,24
2(I).B.1 Ammonia Production	CH4	24,57	22,83	0,03	0,03	97,27
5.A Forest Land	CH4	14,09	20,76	0,04	0,04	97,31
1.A.1 Energy Industries - solid	N2O	52,38	20,24	0,04	0,04	97,35
2(I).F SF6 emissions	SF6	0,03	19,39	0,07	0,07	97,42
1.A.3.b Transport - Road Transportation - gaseous	CO2	0,00	19,26	0,07	0,07	97,48
2(I).C.3 Aluminium Production	PFCs	271,37	17,76	0,51	0,50	97,99
1.A.4 Other sector - solid	CH4	350,07	16,08	0,68	0,67	98,66
2(I).A.7.1 Glass Production	CO2	7,88	13,19	0,03	0,03	98,69
1.A.2 Manufacturing Industries and Construction - solid	N2O	41,44	12,68	0,04	0,04	98,73
1.A.3.b Transport - Road Transportation - liquid	CH4	20,98	12,02	0,00	0,00	98,73
1.A.3.c Transport - Railways - liquid	N2O	50,19	11,44	0,07	0,07	98,80
1.A.4 Other sector - liquid	CO2	386,64	9,23	0,78	0,77	99,57
1.A.2 Manufacturing Industries and Construction - solid	CH4	21,85	7,25	0,02	0,02	99,59
1.A.2 Manufacturing Industries and Construction - liquid	CH4	2,69	7,25	0,02	0,02	99,61
5.A Forest Land	N2O	12,09	7,04	0,00	0,00	99,61
1.A.4 Other sector - gaseous	CH4	5,38	6,95	0,01	0,01	99,62
2(I).B.1 Ammonia Production	N2O	7,25	6,74	0,01	0,01	99,63
1.A.1 Energy Industries - other	N2O	4,90	5,94	0,01	0,01	99,64
1.A.3.a Transport - Civil Aviation - jet kerosen	CO2	7,00	5,88	0,01	0,01	99,65
1.A.5.a Other non-specified - solid	CO2	34,99	5,36	0,05	0,05	99,70
6.C Waste Incineration	CO2	62,70	5,00	0,11	0,11	99,82
1.A.2 Manufacturing Industries and Construction - gaseous	CH4	10,96	4,79	0,01	0,01	99,82
1.A.5.a Other non-specified - liquid	CO2	34,99	4,40	0,06	0,06	99,88
1.A.2 Manufacturing Industries and Construction - liquid	N2O	10,79	2,87	0,01	0,01	99,89
6.C Waste Incineration	N2O	2,73	2,67	0,00	0,00	99,90
1.A.1 Energy Industries - liquid	CH4	1,29	2,16	0,00	0,00	99,90
1.A.4 Other sector - gaseous	N2O	1,59	2,05	0,00	0,00	99,90
1.A.5.a Other non-specified - gaseous	CH4	3,10	1,85	0,00	0,00	99,90
1.A.1 Energy Industries - gaseous	CH4	1,87	1,80	0,00	0,00	99,91
1.A.3.e Transport - Other - liquid	CO2	7,00	1,54	0,01	0,01	99,92
1.A.1 Energy Industries - gaseous	N2O	1,53	1,52	0,00	0,00	99,92
1.A.2 Manufacturing Industries and Construction - gaseous	N2O	3,24	1,41	0,00	0,00	99,92
1.A.4 Other sector - solid	N2O	31,12	1,37	0,06	0,06	99,98
1.A.1 Energy Industries - solid	CH4	2,53	0,98	0,00	0,00	99,98
1.A.3.b Transport - Road Transportation - gaseous	CH4	0,00	0,85	0,00	0,00	99,98
1.A.1 Energy Industries - liquid	N2O	3,80	0,71	0,01	0,01	99,99
1.A.5.a Other non-specified - gaseous	N2O	0,92	0,55	0,00	0,00	99,99
1.A.3.a Transport - Civil Aviation - av. Gasoline	CO2	0,73	0,36	0,00	0,00	99,99
1.B.1.b Fugitive Emission from Oil, Natural Gas and Other	CO2	0,15	0,24	0,00	0,00	99,99
1.A.3.a Transport - Civil Aviation - jet kerosen	N2O	0,24	0,20	0,00	0,00	99,99
1.A.3.c Transport - Railways - liquid	CH4	0,62	0,11	0,00	0,00	99,99
2(I).C.2 Ferroalloys Production	CO2	0,00	0,10	0,00	0,00	99,99
1.A.3.e Transport - Other - liquid	N2O	0,24	0,05	0,00	0,00	99,99
1.A.5.a Other non-specified - solid	N2O	0,93	0,02	0,00	0,00	99,99
1.A.4 Other sector - liquid	CH4	1,07	0,02	0,00	0,00	100,00
1.A.5.a Other non-specified - solid	CH4	0,45	0,01	0,00	0,00	100,00
1.A.5.a Other non-specified - liquid	CH4	0,10	0,01	0,00	0,00	100,00
1.A.3.d Transport - Civil Aviation - jet kerosen	CH4	0,01	0,01	0,00	0,00	100,00
1.A.5.a Other non-specified - liquid	N2O	0,09	0,01	0,00	0,00	100,00
1.A.4 Other sector - liquid	N2O	0,95	0,01	0,00	0,00	100,00
1.A.3.d Transport - Civil Aviation - av. Gasoline	CH4	0,01	0,00	0,00	0,00	100,00
1.A.3.a Transport - Civil Aviation - av. gasoline	N2O	0,01	0,00	0,00	0,00	100,00
1.A.3.e Transport - Other - liquid	CH4	0,09	0,00	0,00	0,00	100,00
1.B.1.b Fugitive Emission from Oil, Natural Gas and Other	N2O	0,01	0,00	0,00	0,00	100,00
1.A.1 Energy Industries - other	CH4	0,00	0,00	0,00	0,00	100,00

Table A1.4: Table 7.A2 Tier 1 Analyses – Trend Assessment without LULUCF for 2009

A	B	C	D	E	F	G
IPCC Source Categories	**Direct GHG**	**Base Year Estimate (1990)**	**Current Year Estimate (2009)**	**Trend Assesment**	**% Contribution to Trend**	**Cummulative total of Column F**
1.A.3.b Transport - Road Transportation - liquid	CO2	4 500,94	6 006,83	13,32	12,57	12,57
1.A.1 Energy Industries - solid	CO2	11 552,58	4 756,41	7,92	7,47	20,03
2(I).C.1 Iron and Steel Production	CO2	5 380,51	4 447,08	5,13	4,84	24,87
1.A.4 Other sector - gaseous	CO2	2 841,82	3 654,00	7,86	7,42	32,29
1.A.1 Energy Industries - gaseous	CO2	2 844,44	3 601,69	7,65	7,22	39,50
1.A.2 Manufacturing Industries and Construction - gaseous	CO2	5 723,56	2 805,39	2,15	2,03	41,53
1.A.2 Manufacturing Industries and Construction - solid	CO2	9 825,68	2 271,53	13,74	12,96	54,49
6.A Solid Waste Disposal on Land	CH4	469,77	1 584,45	5,17	4,88	59,37
1.A.1 Energy Industries - liquid	CO2	1 540,39	1 381,33	1,90	1,79	61,16
2(I).B.2 Nitric Acid Production	N2O	1 148,71	1 238,82	2,24	2,11	63,27
1.A.2 Manufacturing Industries and Construction - liquid	CO2	4 163,11	1 234,34	4,75	4,48	67,75
4.D.1 Agricultural Soils - Direct	N2O	2 414,06	1 209,38	0,80	0,76	68,51
2(I).A.1 Cement Production	CO2	1 438,01	1 198,66	1,41	1,33	69,84
1.A.5.a Other non-specified - gaseous	CO2	1 639,63	974,78	0,06	0,06	69,89
1.B.1.b Fugitive Emission from Oil, Natural Gas and Other	CH4	513,50	793,08	1,95	1,84	71,73
4.A Enteric Fermentation - Cattle	CH4	1 802,03	757,80	1,17	1,11	72,83
2(I).A.2 Lime Production	CO2	770,42	689,43	0,94	0,89	73,72
2(I).B.1 Ammonia Production	CO2	616,97	618,40	1,02	0,96	74,68
4.B Manure Management	N2O	1 074,32	377,00	0,99	0,94	75,62
6.B Wastew ater Handling	CH4	413,83	364,60	0,48	0,46	76,07
1.B.1.a Coal Mining and Handling	CH4	571,15	355,40	0,08	0,08	76,15
4.D.3 Agricultural Soils - Indirect	N2O	995,23	350,36	0,92	0,86	77,02
1.A.4 Other sector - solid	CO2	7 679,65	323,43	16,48	15,54	92,56
2(I).F HFCs emissions	HFCs	0,00	299,61	1,18	1,12	93,67
2(I).A.7.2 Magnezite Production	CO2	431,94	265,69	0,05	0,05	93,72
2(I).C.3 Aluminium Production	CO2	121,32	183,57	0,44	0,42	94,14
2(I).B.4 Carbide Production	CO2	0,00	144,72	0,57	0,54	94,68
4.B Manure Management	CH4	368,66	124,81	0,36	0,34	95,02
2(I).A.3 Limestone and Dolomite Use	CO2	41,83	118,92	0,37	0,35	95,37
4.A Enteric Fermentation	CH4	188,13	107,44	0,01	0,01	95,38
2(I).C.2 Ferroalloys Production	CO2	270,04	104,42	0,21	0,20	95,58
4.D.2 Agricultural Soils - PRP	N2O	221,71	91,79	0,15	0,14	95,72
3.D Other Solvent Use	CO2	130,10	86,99	0,04	0,04	95,76
1.A.3.c Transport - Railw ays - liquid	CO2	376,77	85,90	0,53	0,50	96,26
3.D Other Solvent Use	N2O	17,05	77,40	0,27	0,25	96,52
1.A.1 Energy Industries - other	CO2	170,30	68,91	0,12	0,11	96,63
6.C Waste Composting	N2O	1,86	63,36	0,25	0,23	96,86
1.A.3.b Transport - Road Transportation - liquid	N2O	71,61	60,14	0,07	0,07	96,93
6.B Wastew ater Handling	N2O	95,60	60,11	0,02	0,02	96,95
6.C Waste Composting	CH4	1,68	57,24	0,22	0,21	97,16
2(I).B.1 Ammonia Production	CH4	24,57	22,83	0,03	0,03	97,19
1.A.1 Energy Industries - solid	N2O	52,38	20,24	0,04	0,04	97,23
2(I).F SF6 emissions	SF6	0,03	19,39	0,08	0,07	97,30
1.A.3.b Transport - Road Transportation - gaseous	CO2	0,00	19,26	0,08	0,07	97,37
2(I).C.3 Aluminium Production	PFCs	271,37	17,76	0,56	0,53	97,89
1.A.4 Other sector - solid	CH4	350,07	16,08	0,75	0,70	98,60
2(I).A.7.1 Glass Production	CO2	7,88	13,19	0,03	0,03	98,63
1.A.2 Manufacturing Industries and Construction - solid	N2O	41,44	12,68	0,05	0,04	98,67
1.A.3.b Transport - Road Transportation - liquid	CH4	20,98	12,02	0,00	0,00	98,67
1.A.3.c Transport - Railw ays - liquid	N2O	50,19	11,44	0,07	0,07	98,74
1.A.4 Other sector - liquid	CO2	386,64	9,23	0,86	0,81	99,55
1.A.2 Manufacturing Industries and Construction - solid	CH4	21,85	7,25	0,02	0,02	99,57
1.A.2 Manufacturing Industries and Construction - liquid	CH4	2,69	7,25	0,02	0,02	99,59
1.A.4 Other sector - gaseous	CH4	5,38	6,95	0,02	0,01	99,61
2(I).B.1 Ammonia Production	N2O	7,25	6,74	0,01	0,01	99,62
1.A.1 Energy Industries - other	N2O	4,90	5,94	0,01	0,01	99,63
1.A.3.a Transport - Civil Aviation - jet kerosen	CO2	7,00	5,88	0,01	0,01	99,63
1.A.5.a Other non-specified - solid	CO2	34,99	5,36	0,06	0,06	99,69
6.C Waste Incineration	CO2	62,70	5,00	0,13	0,12	99,81
1.A.2 Manufacturing Industries and Construction - gaseous	CH4	10,96	4,79	0,01	0,01	99,81
1.A.5.a Other non-specified - liquid	CO2	34,99	4,40	0,06	0,06	99,87
1.A.2 Manufacturing Industries and Construction - liquid	N2O	10,79	2,87	0,01	0,01	99,89
6.C Waste Incineration	N2O	2,73	2,67	0,00	0,00	99,89
1.A.1 Energy Industries - liquid	CH4	1,29	2,16	0,01	0,01	99,90
1.A.4 Other sector - gaseous	N2O	1,59	2,05	0,00	0,00	99,90
1.A.5.a Other non-specified - gaseous	CH4	3,10	1,85	0,00	0,00	99,90
1.A.1 Energy Industries - gaseous	CH4	1,87	1,80	0,00	0,00	99,90
1.A.3.e Transport - Other - liquid	CO2	7,00	1,54	0,01	0,01	99,91
1.A.1 Energy Industries - gaseous	N2O	1,53	1,52	0,00	0,00	99,91
1.A.2 Manufacturing Industries and Construction - gaseous	N2O	3,24	1,41	0,00	0,00	99,92
1.A.4 Other sector - solid	N2O	31,12	1,37	0,07	0,06	99,98
1.A.1 Energy Industries - solid	CH4	2,53	0,98	0,00	0,00	99,98
1.A.3.b Transport - Road Transportation - gaseous	CH4	0,00	0,85	0,00	0,00	99,98
1.A.1 Energy Industries - liquid	N2O	3,80	0,71	0,01	0,01	99,99
1.A.5.a Other non-specified - gaseous	N2O	0,92	0,55	0,00	0,00	99,99
1.A.3.a Transport - Civil Aviation - av. Gasoline	CO2	0,73	0,36	0,00	0,00	99,99
1.B.1.b Fugitive Emission from Oil, Natural Gas and Other	CO2	0,15	0,24	0,00	0,00	99,99
1.A.3.a Transport - Civil Aviation - jet kerosen	N2O	0,24	0,20	0,00	0,00	99,99
1.A.3.c Transport - Railw ays - liquid	CH4	0,62	0,11	0,00	0,00	99,99
2(I).C.2 Ferroalloys Production	CO2	0,00	0,10	0,00	0,00	99,99
1.A.3.e Transport - Other - liquid	N2O	0,24	0,05	0,00	0,00	99,99
1.A.5.a Other non-specified - solid	N2O	0,93	0,02	0,00	0,00	99,99
1.A.4 Other sector - liquid	CH4	1,07	0,02	0,00	0,00	100,00
1.A.5.a Other non-specified - solid	CH4	0,45	0,01	0,00	0,00	100,00
1.A.5.a Other non-specified - liquid	CH4	0,10	0,01	0,00	0,00	100,00
1.A.3.d Transport - Civil Aviation - jet kerosen	CH4	0,01	0,01	0,00	0,00	100,00
1.A.5.a Other non-specified - liquid	N2O	0,09	0,01	0,00	0,00	100,00
1.A.4 Other sector - liquid	N2O	0,95	0,01	0,00	0,00	100,00
1.A.3.d Transport - Civil Aviation - av. Gasoline	CH4	0,01	0,00	0,00	0,00	100,00
1.A.3.a Transport - Civil Aviation - av. gasoline	N2O	0,01	0,00	0,00	0,00	100,00
1.A.3.e Transport - Other - liquid	CH4	0,09	0,00	0,00	0,00	100,00
1.B.1.b Fugitive Emission from Oil, Natural Gas and Other	N2O	0,01	0,00	0,00	0,00	100,00
1.A.1 Energy Industries - other	CH4	0,00	0,00	0,00	0,00	100,00

Table A1.5: Table 7.A3 Source category analyses summary for 2009

Category	Gas	Level Assessment with LULUCF	Level Assessment	Trend Assessment with LULUCF	Trend Assessment
1.A.1 Energy Industries - gaseous	CO_2	x	x	x	x
1.A.1 Energy Industries - liquid	CO_2	x	x	x	x
1.A.1 Energy Industries - solid	CO_2	x	x	x	x
1.A.2 Manufacturing Industries and Construction - gaseous	CO_2	x	x	x	x
1.A.2 Manufacturing Industries and Construction - liquid	CO_2	x	x	x	x
1.A.2 Manufacturing Industries and Construction - solid	CO_2	x	x	x	x
1.A.3.b Transport - Road Transportation - liquid	CO_2	x	x	x	x
1.A.4 Other sector - gaseous	CO_2	x	x	x	x
1.A.4 Other sector - solid	CO_2	x	x	x	x
1.A.5.a Other non-specified - gaseous	CO_2	x	x	x	x
1.B.1.a Coal Mining and Handling	CH_4	x	x	x	x
1.B.1.b Fugitive Emission from Oil, Natural Gas and Other	CH_4	x	x	x	x
2(I).A.1 Cement Production	CO_2	x	x	x	x
2(I).A.2 Lime Production	CO_2	x	x	x	x
2(I).A.7.2 Magnezite Production	CO_2			x	x
2(I).B.1 Ammonia Production	CO_2	x	x	x	x
2(I).B.2 Nitric Acid Production	N_2O	x	x	x	x
2(I).B.4 Carbide Production	CO_2			x	x
2(I).C.1 Iron and Steel Production	CO_2	x	x	x	x
2(I).C.3 Aluminium Production	CO_2			x	x
2(I).F HFCs emissions	HFCs	x		x	x
4.A Enteric Fermentation - Cattle	CH_4	x	x	x	x
4.B Manure Management	N_2O	x	x	x	x
4.D Agricultural Soils - direct	N_2O	x	x	x	x
4.D Agricultural Soils - indirect	N_2O	x	x	x	x
5.A Forest Land	CO_2	x		x	
5.B Cropland	CO_2	x		x	
5.C Grassland	CO_2	x		x	
5.E Settlements	CO_2			x	
5.F Other Land	CO_2			x	
6.A Solid Waste Disposal on Land	CH_4	x	x	x	x
6.B Wastew ater Handling	CH_4	x	x	x	x

Table NIR.3, as contained in the annex to decision 6/CMP.3

Table A1.6: Table NIR-3 from CRF

KEY CATEGORIES OF EMISSIONS AND REMOVALS	GAS	CRITERIA USED FOR KEY CATEGORY IDENTIFICATION			COMMENTS
		Associated category in UNFCCC inventory is key (indicate w hich category)	Category contribution is greater than the smallest category considered key in the UNFCCC inventory (including LULUCF)	Other	
Specify key categories according to the national level of disaggregation used					
Afforestation and Reforestation	CO_2	Forest land remaining forest land, Conversion to cropland, Conversion to grassland, Conversion to other land	Yes	NO	Level assessment
Deforestation	CO_2	Forest land remaining forest land, Conversion to cropland, Conversion to grassland, Conversion to other land	Yes	NO	Level assessment

Annex 2: Description of NEIS database

For more information see section 3.2. and Figure 3.5 – The structure of NEIS database.

Annex 3: Other detailed methodological descriptions for individual source or sink categories, including for KP-LULUCF activities

Energy – sectoral approach

Table A3.1: The list of fuels, EFs NCVs and emissions (CO_2, CH_4 and N_2O) according to the IPCC categories in 2009

		Consumption	Consumption	NCV	CO_2	CH_4	N_2O	EF CO_2	EF CH_4	EF N_2O
		[TJ]	[t, thou.m^3]	[GJ/t, GJ/thou.m^3]	[t]	[t]	[t]	[t/TJ]	[kg/TJ]	[kg/TJ]
1.A.1a	Natural Gas	35 908,17	1 043 746,98	34,40	1 982 225	35,9082	3,5908	55,20	1,00	0,10
	Waste Other	66,23	5 300,76	12,49	0	0,0000	0,0000	0,00	0,00	0,00
	Other Solid	230,34	20 368,17	11,31	0	0,0000	0,0000	0,00	0,00	0,00
	Diesel Oil	7,23	161,53	44,74	525	0,0217	0,0043	72,60	3,00	0,60
	Coke	2,59	99,22	26,11	287	0,0026	0,0036	110,63	1,00	1,40
	Biogas	58,30	2 984,06	19,54	6 508	0,5830	0,2332	111,64	10,00	4,00
	Wood	2 298,71	218 506,87	10,52	230 446	68,9615	9,1949	100,25	30,00	4,00
	Coal	14 653,52	574 235,30	25,52	1 454 016	14,6535	20,5149	99,23	1,00	1,40
	HHO	241,58	5 931,00	40,73	18 356	0,7248	0,1450	75,98	0,60	0,60
	Braun Coal (CZ)	6 995,50	492 048,66	14,22	702 553	6,9955	9,7937	100,43	1,00	1,40
	Other Gaseous	22,85	7 694,52	2,97	1 131	0,1143	0,0023	49,51	5,00	0,10
	Braun Coal (SR,Ukr)	23 484,97	2 305 731,00	10,19	2 434 681	23,4850	32,8790	103,67	1,00	1,40
	Total	**83 969,99**	**4 676 808,06**		**6 830 728**	**151,4498**	**76,3616**			
1.A.1b	Natural Gas	3 000,69	87 221,52	34,40	165 646	3,0007	0,3001	55,20	1,00	0,10
	Coke	1 465,39	56 132,11	26,11	162 120	1,4654	2,0515	110,63	1,00	1,40
	Refinery Gas	20 324,00	401 556,34	50,61	1 349 513	101,6200	2,0324	66,40	5,00	0,10
	HHO	113,39	2 799,81	40,50	8 616	0,3402	0,0680	75,98	20,93	0,99
	Other Liquid	44,19	4 909,92	9,00	3 208	0,1326	0,0265	72,60	0,03	0,60
	Other Gaseous	2 851,57	297 282,56	9,59	141 181	14,2579	0,2852	49,51	0,05	0,10
	LHO	14,47	353,00	41,00	1 104	0,0434	0,0087	76,30	0,12	0,60
	Total	**27 813,70**	**850 255,26**		**1 831 389**	**120,8601**	**4,7724**			
1.A.1c	Natural Gas	1 115,54	32 425,65	34,40	61 581	1,1155	0,1116	55,20	1,00	0,10
	Coke Gas	1 822,49	106 503,37	17,11	86 313	9,1124	0,1822	47,36	5,00	0,10
	Lignite	12,13	1 154,00	10,51	1 194	0,0121	0,0170	98,42	1,00	1,40
	Diesel Oil	0,09	1,87	45,49	6	0,0003	0,0001	72,60	3,00	0,60
	Blast-Furnace Gas	4 453,67	1 306 061,32	3,41	1 163 387	22,2683	0,4454	261,22	5,00	0,10
	Biogas	2,45	206,03	11,90	274	0,0245	0,0098	111,64	10,00	4,00
	WOOD	3,82	297,00	12,86	383	0,1146	0,0153	100,25	30,00	4,00
	Other Gaseous	4,49	299,33	15,00	222	0,0225	0,0004	49,51	5,00	0,10
	Braun Coal (SR,Ukr)	15,08	1 480,72	10,19	1 564	0,0151	0,0211	103,67	1,00	1,40
	Total	**7 429,76**	**1 448 429,29**		**1 314 924**	**32,6853**	**0,8028**			
1.A.2a	Natural Gas	1 769,41	51 431,69	34,40	97 676	8,8471	0,1769	55,20	5,00	0,10
	Coke Gas	5 337,50	311 950,74	17,11	252 784	26,6875	0,5338	47,36	5,00	0,10
	Propan-Butan	2,78	60,00	46,40	177	0,0084	0,0003	63,74	3,00	0,10
	Coventry Gas	1 495,31	179 293,53	8,34	248 221	7,4765	0,1495	166,00	5,00	0,10
	Blast-Furnace Gas	12 434,54	3 651 330,11	3,41	3 248 151	62,1727	1,2435	261,22	5,00	0,10
	Coke	43 574,97	1 549 026,60	28,13	4 796 784	435,7497	61,0050	110,08	10,00	1,40
	Coal	22 594,87	764 544,00	29,55	2 141 973	225,9487	31,6328	94,80	10,00	1,40
	HHO	11,47	283,91	40,40	871	0,0229	0,0069	75,98	0,08	0,17
	LHO	0,08	1,80	42,00	6	0,0002	0,0000	76,30	2,00	0,60
	Total	**87 220,93**	**6 507 922,37**		**10 786 644**	**766,91**	**94,75**			
1.A.2b	Natural Gas	1 364,14	39 651,55	34,40	75 304	6,8207	0,1364	55,20	5,00	0,10
	Propan-Butan	0,36	3,50	102,16	23	0,0011	0,0000	63,74	3,00	0,10
	Coke	121,59	4 657,44	26,11	13 452	1,2159	0,1702	110,63	10,00	1,40
	Coal	347,68	13 469,66	25,81	34 249	3,4768	0,4868	98,51	10,00	1,40
	Other Liquid	0,02	0,50	42,50	2	0,0001	0,0000	72,60	3,01	0,61
	Braun Coal (CZ)	331,16	20 328,90	16,29	32 630	3,3116	0,4636	98,53	10,00	1,40
	Total	**2 164,94**	**78 111,55**		**155 658**	**14,8261**	**1,2571**			
1.A.2c	Natural Gas	8 121,40	236 065,61	34,40	448 322	40,6070	0,8121	55,20	5,00	0,10
	Waste Other	27,60	1 200,00	23,00	0	0,0000	0,0000	0,00	0,00	0,00
	Propan-Butan	1,17	25,16	46,34	74	0,0035	0,0001	63,74	0,00	0,10
	Diesel Oil	0,02	0,35	43,57	1	0,0000	0,0000	72,60	0,03	0,59
	Refinery Gas	457,88	12 625,92	36,26	30 403	2,2894	0,0458	66,40	0,00	0,10
	Wood	10,63	987,00	10,77	1 065	0,3188	0,0425	100,25	0,04	4,00
	Coal	1 373,87	53 226,00	25,81	135 337	13,7387	1,9234	98,51	10,00	1,40
	HHO	12 832,24	317 386,40	40,43	974 994	25,6645	7,6993	75,98	2,00	0,60
	Other Liquid	25,74	1 774,97	14,50	1 869	0,0772	0,0154	72,60	3,00	0,60
	Braun Coal (CZ)	189,28	10 440,00	18,13	18 400	1,8928	0,2650	97,21	10,00	1,40
	Other Gaseous	115,49	1 901,76	60,73	5 718	0,5775	0,0115	49,51	5,00	0,10
	LHO	9,93	230,00	43,18	758	0,0199	0,0060	76,30	2,00	0,60
	Total	**23 165,23**	**635 863,17**		**1 616 941**	**85,1892**	**10,8213**			
1.A.2d	Natural Gas	2 291,03	66 593,62	34,40	126 471	11,4551	0,2291	55,20	5,00	0,10
	Waste Other	23 415,87	1 841 607,69	12,71	0	0,0000	0,0000	0,00	0,00	0,00
	Diesel Oil	0,01	0,36	41,00	1	0,0000	0,0000	72,60	2,03	0,61
	Wood	292,82	29 282,00	10,00	29 355	8,7846	1,1713	100,25	30,00	4,00
	Coal	2 580,82	99 985,27	25,81	254 231	25,8082	3,6131	98,51	10,00	1,40
	HHO	266,13	6 568,37	40,52	20 220	0,5323	0,1597	75,98	2,00	0,60
	Braun Coal (CZ)	49,63	3 589,85	13,83	5 006	0,4963	0,0695	100,85	10,00	1,40
	LHO	0,72	17,63	41,00	55	0,0014	0,0004	76,30	2,00	0,60
	Braun Coal (SR,Ukr)	2 184,63	214 485,00	10,19	226 480	21,8463	3,0585	103,67	10,00	1,40
	Total	**31 081,67**	**2 262 129,78**		**661 819**	**68,9243**	**8,3016**			
1.A.2e	Natural Gas	4 994,99	145 190,01	34,40	275 737	24,9750	0,4995	55,20	5,00	0,10
	Waste Other	39,67	2 320,00	17,10	0	0,0000	0,0000	0,00	0,00	0,00
	Propan-Butan	1,50	14,70	102,16	96	0,0045	0,0002	63,74	3,00	0,10
	Diesel Oil	0,00	0,11	42,50	0	0,0000	0,0000	72,60	2,06	0,62
	Biogas	14,72	669,00	22,00	1 643	0,1472	0,0589	111,64	10,00	4,00
	Wood	1,69	130,65	12,92	169	0,0506	0,0068	100,25	30,00	4,00
	Braun Coal (CZ)	393,67	28 110,98	14,00	39 625	3,9367	0,5511	100,66	10,00	1,40
	LHO	0,00	0,10	40,00	0	0,0000	0,0000	76,30	2,01	0,50
	Braun Coal (SR,Ukr)	0,20	19,96	10,19	21	0,0020	0,0003	103,67	10,00	1,40
	Total	**5 446,46**	**176 455,51**		**317 292**	**29,1161**	**1,1167**			

		Consumption	Consumption	NCV	CO_2	CH_4	N_2O	EF CO_2	EF CH_4	EF N_2O
		[TJ]	[t, thou.m^3]	[GJ/t, GJ/thou.m^3]	[t]	[t]	[t]	[t/TJ]	[kg/TJ]	[kg/TJ]
1.A.2f	Natural Gas	15 182,99	441 325,82	34,40	838 141	75,9150	1,5183	55,20	5,00	0,10
	Coke Gas	4 009,28	235 227,22	17,04	189 880	20,0464	0,4009	47,36	5,00	0,10
	Waste Other	6 659,57	388 520,83	17,14	0	0,0000	0,0000	0,00	0,00	0,00
	Propan-Butan	743,79	14 922,25	49,84	47 409	2,2314	0,0744	63,74	3,00	0,10
	Lignite	469,59	21 809,09	21,53	46 217	4,6959	0,6574	98,42	10,00	1,40
	Other Solid	778,86	48 885,90	15,93	0	0,0000	0,0000	0,00	0,00	0,00
	Diesel Oil	9,54	217,42	43,90	693	0,0191	0,0057	72,60	2,00	0,60
	Blast-Furnace Gas	946,05	285 348,75	3,32	247 127	4,7302	0,0946	261,22	5,00	0,10
	Coke	817,55	31 316,50	26,11	90 448	8,1755	1,1446	110,63	10,00	1,40
	Wood	1 796,62	149 351,26	12,03	180 111	53,8985	7,1865	100,25	30,00	4,00
	Coal	5 274,15	204 329,63	25,81	519 545	52,7415	7,3838	98,51	10,00	1,40
	HHO	1 952,81	48 210,33	40,51	148 375	3,9056	1,1717	75,98	2,00	0,60
	Other Liquid	0,00	0,02	42,50	0	0,0000	0,0000	72,60	3,53	1,18
	Braun Coal (CZ)	171,04	10 131,77	16,88	16 775	1,7104	0,2395	98,08	10,00	1,40
	Other Gaseous	0,15	10,02	14,67	7	0,0007	0,0000	49,51	5,00	0,10
	LHO	108,97	2 591,67	42,05	8 314	0,2179	0,0654	76,30	2,00	0,60
	Braun Coal (SR,Ukr)	16,18	1 588,37	10,19	1 677	0,1618	0,0226	103,67	10,00	1,40
	Total	**38 937,15**	**1 883 786,84**		**2 334 719**	**228,4500**	**19,9654**			
1.A.4a	Natural Gas	12 565,08	365 230,75	34,40	693 625	62,8254	1,2565	55,20	5,00	0,10
	Waste Other	94,39	6 045,63	15,61	0	0,0000	0,0000	0,00	0,00	0,00
	Propan-Butan	40,09	603,32	66,44	2 555	0,1203	0,0040	63,74	3,00	0,10
	Other Solid	6,59	407,43	16,18	0	0,0000	0,0000	0,00	0,00	0,00
	Diesel Oil	9,54	217,77	43,80	692	0,0954	0,0057	72,60	10,00	0,60
	Coke	98,77	3 783,24	26,11	10 927	0,9877	0,1383	110,63	10,00	1,40
	Biogas	129,97	5 666,47	22,94	14 510	1,2997	0,5199	111,64	10,00	4,00
	Wood	540,50	48 334,96	11,18	54 185	162,1497	2,1620	100,25	0,30	0,00
	Briquettes	0,17	8,70	19,05	16	0,0017	0,0002	94,15	10,00	1,40
	Coal	361,93	14 021,64	25,81	35 653	3,6193	0,5067	98,51	10,00	1,40
	HHO	0,79	20,90	38,00	60	0,0079	0,0005	75,98	10,00	0,60
	Other Liquid	2,09	50,23	41,61	152	0,0063	0,0013	72,60	3,00	0,60
	Braun Coal (CZ)	111,74	6 282,46	17,79	10 888	1,1174	0,1564	97,44	10,00	1,40
	LHO	22,82	551,04	41,41	1 741	0,2282	0,0137	76,30	10,00	0,60
	Braun Coal (SR,Ukr)	61,82	6 069,75	10,19	6 409	0,6182	0,0866	103,67	10,00	1,40
	Total	**14 046,28**	**457 294,27**		**831 413**	**233,0770**	**4,8517**			
1.A.4b	Natural Gas	50 334,22	1 463 070,82	34,40	2 778 581	251,6711	5,0334	55,20	0,01	0,00
	Briquettes	79,59	4 178,01	19,05	7 494	23,8774	0,1114	94,15	0,30	0,00
	Coal	604,17	23 406,38	25,81	59 515	181,2496	0,8458	98,51	0,30	0,00
	Braun Coal (SR,Ukr)	1 444,02	141 772,01	10,19	149 701	433,2047	2,0216	103,67	0,30	0,00
	Coke	363,39	13 919,80	26,11	40 203	109,0173	0,5087	110,63	0,30	0,00
	Wood	18 878,53	1 688 241,39	11,18	1 892 572	5 663,5583	75,5141	100,25	0,30	0,00
	Total	**71 703,91**	**3 334 588,41**		**4 928 065**	**6 662,58**	**84,04**			
1.A.4c	Natural Gas	3 288,01	95 573,08	34,40	181 507	16,4401	0,3288	55,20	5,00	0,10
	Waste Other	29,08	1 996,50	14,56	0	0,0000	0,0000	0,00	0,00	0,00
	Propan-Butan	33,16	551,69	60,10	2 113	0,0995	0,0033	63,74	3,00	0,10
	Other Solid	18,58	1 180,00	15,75	0	0,0000	0,0000	0,00	0,00	0,00
	Diesel Oil	15,84	370,66	42,72	1 150	0,1584	0,0095	72,60	10,00	0,60
	Coke	2,48	95,09	26,11	275	1,4478	0,0035	110,63	10,00	1,40
	Biogas	3,02	136,52	22,13	337	0,0302	0,0121	111,64	10,00	4,00
	Wood	28,11	2 287,09	12,29	2 818	8,4328	0,1124	100,25	300,00	4,00
	Coal	0,99	38,18	25,81	97	0,3294	0,0014	98,51	10,00	1,40
	HHO	0,21	4,94	43,00	16	0,0021	0,0001	75,98	10,00	0,60
	Braun Coal (CZ)	12,11	647,66	18,70	1 173	3,6333	0,0170	96,85	10,00	1,40
	Other Gaseous	5,89	196,20	30,00	291	0,0294	0,0006	49,51	5,00	0,10
	LHO	9,78	234,79	41,65	746	0,0978	0,0059	76,30	10,00	0,60
	Braun Coal (SR,Ukr)	10,39	1 020,47	10,19	1 078	6,7586	0,0315	103,67	10,00	1,40
	Total	**3 457,64**	**104 332,87**		**191 601**	**37,4594**	**0,5261**			
1.A.5a	Natural Gas	17 644,51	512 875,16	34,40	974 023	88,2226	1,7645	55,20	5,00	0,10
	Waste Other	319,86	22 590,12	14,16	0	0,0000	0,0000	0,00	0,00	0,00
	Propan-Butan	9,20	116,30	79,09	586	0,0276	0,0009	63,74	3,00	0,10
	Diesel Oil	6,58	147,55	44,60	478	0,0658	0,0039	72,60	10,00	0,60
	Coke	4,76	182,36	26,11	527	0,0476	0,0067	110,63	10,00	1,40
	Biogas	326,64	15 190,40	21,50	36 466	3,2664	1,3066	111,64	10,00	4,00
	Waste Municipal	1 646,70	188 979,51	8,71	0	0,0000	0,0000	0,00	0,00	0,00
	Wood	6,37	428,41	14,88	639	1,9120	0,0255	100,25	300,00	4,00
	Coal	1,54	59,74	25,81	152	0,0154	0,0022	98,51	10,00	1,40
	HHO	43,82	1 083,96	40,43	3 330	0,4382	0,0263	75,98	10,00	0,60
	Braun Coal (CZ)	39,06	2 091,12	18,68	3 783	0,3906	0,0547	96,87	10,00	1,40
	Other Gaseous	15,32	810,75	18,89	758	0,0766	0,0015	49,51	5,00	0,10
	LHO	0,14	3,47	40,84	11	0,0014	0,0001	76,30	10,00	0,60
	Braun Coal (SR,Ukr)	8,65	849,07	10,19	897	0,0865	0,0121	103,67	10,00	1,40
	Total	**20 073,16**	**745 407,93**		**1 021 650**	**94,5507**	**3,2049**			

Annex 4: CO_2 reference approach and comparison with sectoral approach, and relevant information on the national energy balance

For more information see section 3.2.6 (Figure 3.2.1) and section 3.5.

Annex 5: Assessment of completeness

A.5.1 GHG inventory

No NE key categories have been reported in 2011 submission for 1990 – 2009.

The not estimated (NE) non-key category is the agricultural and industrial waste disposal (in the category 3A3) for the years 1990 – 1996. The emissions will be estimated using expert judgment in the next submission.

Annex 6: Tables 6.1 and 6.2 of the IPCC good practice guidance

Annex 7 provides the mandatory reporting table for uncertainty analysis. As the Slovak Republic reports the results of tier 1 analysis (UNFCCC 2006, paragraph 14), the reporting is to be carried out using table 6.1 of the Good Practice Guidance. The Slovak Republic is not provided tier 2 uncertainty analyses according to the table 6.2 of the Good Practice Guidance for the complete sectors, but partly provided tier 2 analyses based on Monte Carlo method for energy, IP and waste sectors. The methodology and results are described in sectoral chapters

Table A6.1: Tier 1 uncertainty calculation and reporting in 2009

IPCC Source Category	Gas	Base year emissions (1990)	Year t emissions (2009)	Activity data uncertainty	Emission factor uncertainty	Combined uncertainty	Combine uncertainty as % of total national emissions in year 2009	Type A sensitivity	Type B sensitivity	Uncertainty in trend in national emissions introduced by EF unc.	Uncertainty in trend in national emissions introduced by a.d.	Uncertainty introduced into the trend in total national emissions	Emission factor quality indicator	Activity data quality indicator
		Gg CO2 ekvivalent		%		%		%						
1.A.1 Energy Industries	CO2	16 091,11	9 808,34	5,00	5,00	7,07	1,74	0,00	0,15	0,01	1,04	1,04	D	D
1.A.2 Manufacturing Industries and Construction	CO2	19 712,35	6 311,26	5,00	5,00	7,07	1,12	-0,08	0,09	-0,41	0,67	0,79	D	D
1.A.3.a Transport - Civil Aviation	CO2	7,74	6,24	1,00	5,00	5,10	0,00	0,00	0,00	0,00	0,00	0,00	D	D
1.A.3.b Transport - Road Transportation	CO2	4 500,94	6 026,09	1,00	5,00	5,10	0,77	0,05	0,09	0,25	0,13	0,28	D	R
1.A.3.c Transport - Railw ays	CO2	376,77	85,90	1,00	2,50	2,69	0,01	0,00	0,00	-0,01	0,00	0,01	D	R
1.A.3.d Transport - Navigation	CO2	0,02	0,04	1,00	5,00	5,10	0,00	0,00	0,00	0,00	0,00	0,00	D	R
1.A.3.e Transport - Other	CO2	7,00	1,54	1,00	5,00	5,10	0,00	0,00	0,00	0,00	0,00	0,00	D	R
1.A.4 Other sector	CO2	10 908,11	3 986,66	5,00	5,00	7,07	0,71	-0,04	0,06	-0,19	0,42	0,46	D	R
1.A.5.a Other non-specified	CO2	1 872,53	984,54	5,00	5,00	7,07	0,17	0,00	0,01	-0,01	0,10	0,11	D	D
1.B.1.b Fugitive Emission from Oil, Natural Gas and Other	CO2	0,15	0,24	2,00	5,00	5,39	0,00	0,00	0,00	0,00	0,00	0,00	M	M
2(I).A.1 Cement Production	CO2	1 438,01	1 198,66	2,00	5,60	5,95	0,18	0,01	0,02	0,03	0,05	0,06	R	R
2(I).A.2 Lime Production	CO2	770,42	689,43	3,00	1,90	3,55	0,06	0,00	0,01	0,01	0,04	0,04	R	R
2(I).A.3 Limestone and Dolomite Use	CO2	41,83	118,92	1,90	1,90	2,69	0,01	0,00	0,00	0,00	0,00	0,01	R	R
2(I).A.7 Magnezite Production	CO2	431,94	265,69	2,00	2,00	2,83	0,02	0,00	0,00	0,00	0,01	0,01	R	R
2(I).A.7 Glass Production	CO2	7,88	13,19	2,00	2,00	2,83	0,00	0,00	0,00	0,00	0,00	0,00	R	R
2(I).B.1 Ammonia Production	CO2	616,97	618,40	2,00	5,00	5,39	0,08	0,00	0,01	0,02	0,03	0,03	R	R
2(I).B.4 Carbide Production	CO2	0,00	144,72	2,00	5,00	5,39	0,02	0,00	0,00	0,01	0,01	0,01	R	R
2(I).C.1 Iron and Steel Production	CO2	294,34	4 447,08	2,00	5,00	5,39	0,60	0,06	0,07	0,32	0,19	0,37	R	R
2(I).C.3 Aluminium Production	CO2	121,32	104,42	2,00	5,00	5,39	0,01	0,00	0,00	0,00	0,00	0,01	R	R
2(I).C.2 Ferroalloys Production	CO2	237,10	183,57	2,00	5,00	5,39	0,02	0,00	0,00	0,00	0,01	0,01	D	D
3. Solvent Use	CO2	0,12	86,99	2,00	5,00	5,39	0,01	0,00	0,00	0,01	0,00	0,01	D	D
5.A Forest Land	CO2	-4 453,98	-2 834,15	100,00	100,00	141,42	-10,03	0,00	-0,04	-0,24	-6,02	6,03	D	D
5.B Cropland	CO2	3 286,66	-695,61	100,00	100,00	141,42	-2,46	-0,04	-0,01	-4,01	-1,48	4,27	D	D
5.C Grassland	CO2	535,88	-425,52	100,00	100,00	141,42	-1,51	-0,01	-0,01	-1,12	-0,90	1,44	D	D
5.E Settlements	CO2	123,34	216,66	100,00	100,00	141,42	0,77	0,00	0,00	0,21	0,46	0,51	D	D
5.F Other Land	CO2	-1 775,15	261,80	100,00	100,00	141,42	0,93	0,02	0,00	1,99	0,56	2,07	D	D
6.C Waste Incineration	CO2	66,70	5,00	5,00	5,00	7,07	0,00	0,00	0,00	0,00	0,00	0,00	R	R
1.A.1 Energy Industries	CH4	5,69	6,41	3,00	50,00	50,09	0,01	0,00	0,00	0,00	0,00	0,00	D	D
1.A.2 Manufacturing Industries and Construction	CH4	37,17	14,11	3,00	50,00	50,09	0,02	0,00	0,00	-0,01	0,00	0,01	D	D
1.A.3.d Transport - Civil Aviation	CH4	0,02	0,01	3,00	5,00	5,83	0,00	0,00	0,00	0,00	0,00	0,00	D	D
1.A.3.b Transport - Road Transportation	CH4	20,98	13,27	3,00	5,00	5,83	0,00	0,00	0,00	0,00	0,00	0,00	D	R
1.A.3.c Transport - Railw ays	CH4	0,62	0,11	1,00	40,00	40,01	0,00	0,00	0,00	0,00	0,00	0,00	D	R
1.A.3.d Transport - Navigation	CH4	0,00	0,00	1,00	40,00	40,01	0,00	0,00	0,00	0,00	0,00	0,00		
1.A.3.e Transport - Other	CH4	0,01	0,00	1,00	40,00	40,01	0,00	0,00	0,00	0,00	0,00	0,00	D	R
2(I).B.1 Ammonia Production	CH4	24,57	22,83	3,00	5,00	5,83	0,00	0,00	0,00	0,00	0,00	0,00	D	R
2(I).C.2 Ferroalloys Production	CH4	0,00	0,10	3,00	5,00	5,83	0,00	0,00	0,00	0,00	0,00	0,00	D	R
1.A.4 Other sector	CH4	389,42	145,60	5,00	40,00	40,31	0,15	0,00	0,00	-0,05	0,02	0,06	D	D
1.A.5.a Other non-specified	CH4	3,65	1,99	3,00	50,00	50,09	0,00	0,00	0,00	0,00	0,00	0,00	D	D
1.B.1.a Coal Mining and Handling	CH4	571,15	355,40	5,00	7,00	8,60	0,08	0,00	0,01	0,00	0,04	0,04	R	R
1.B.1.b Fugitive Emission from Oil, Natural Gas and Other	CH4	513,50	793,08	2,00	5,00	5,39	0,11	0,01	0,01	0,04	0,03	0,05	R	R
4.A Enteric Fermentation	CH4	1 990,16	865,24	5,00	20,00	20,62	0,45	0,00	0,01	-0,10	0,09	0,13	D	D
4.B Manure Management	CH4	368,66	124,81	5,00	45,00	45,28	0,14	0,00	0,00	-0,07	0,01	0,07	D	D
5.A Forest Land	CH4	14,68	20,76	5,00	5,00	7,07	0,00	0,00	0,00	0,00	0,00	0,00	D	D
6.A Solid Waste Disposal on Land	CH4	469,77	1 584,45	5,00	50,00	50,25	1,99	0,02	0,02	0,98	0,17	0,99	D	R
6.B Wastew ater Handling	CH4	413,83	364,60	5,00	50,00	50,25	0,46	0,00	0,01	0,09	0,04	0,10	R	R
6.C Waste Composting	CH4	1,68	57,24	5,00	50,00	50,25	0,07	0,00	0,00	0,04	0,01	0,04	R	R
1.A.1 Energy Industries	N2O	63,23	31,34	3,00	50,00	50,09	0,04	0,00	0,00	0,00	0,00	0,01	D	D
1.A.2 Manufacturing Industries and Construction	N2O	58,75	19,58	3,00	50,00	50,09	0,02	0,00	0,00	-0,01	0,00	0,01	D	D
1.A.3.a Transport - Civil Aviation	N2O	0,25	0,21	1,00	50,00	50,01	0,00	0,00	0,00	0,00	0,00	0,00	D	D
1.A.3.b Transport - Road Transportation	N2O	71,61	62,15	1,00	50,00	50,01	0,08	0,00	0,00	0,01	0,00	0,01	D	R
1.A.3.c Transport - Railw ays	N2O	50,19	1,59	1,00	50,00	50,01	0,00	0,00	0,00	-0,02	0,00	0,02	D	R
1.A.3.d Transport - Navigation	N2O	0,00	0,00	1,00	50,00	50,01	0,00	0,00	0,00	0,00	0,00	0,00	D	R
1.A.3.e Transport - Other	N2O	0,24	0,05	1,00	50,00	50,01	0,00	0,00	0,00	0,00	0,00	0,00	D	R
1.A.4 Other sector	N2O	40,17	27,72	3,00	50,00	50,09	0,03	0,00	0,00	0,00	0,00	0,00	R	R
1.A.5.a Other non-specified	N2O	1,93	0,99	3,00	50,00	50,09	0,00	0,00	0,00	0,00	0,00	0,00	D	D
1.B.1.b Fugitive Emission from Oil, Natural Gas and Other	N2O	0,01	0,00	3,00	50,00	50,09	0,00	0,00	0,00	0,00	0,00	0,00	D	D
2(I).B.2 Nitric Acid Production	N2O	1 148,71	1 238,82	2,00	4,00	4,47	0,14	0,01	0,02	0,03	0,05	0,06	R	R
2(I).B.1 Ammonia Production	N2O	7,25	6,74	2,00	4,00	4,47	0,00	0,00	0,00	0,00	0,00	0,00	R	R
3.D Other Solvent Use	N2O	17,05	77,40	5,00	5,00	7,07	0,01	0,00	0,00	0,01	0,01	0,01	R	D
4.B Manure Management	N2O	1 094,56	377,00	5,00	150,00	150,08	1,42	0,00	0,01	-0,63	0,04	0,63	R	R
4.D Agricultural Soils	N2O	3 582,15	1 651,54	20,00	200,00	201,00	8,31	-0,01	0,02	-1,50	0,70	1,65	R	R
5.A Forest Land	N2O	3,41	7,04	5,00	5,00	7,07	0,00	0,00	0,00	0,00	0,00	0,00	D	D
6.B Wastew ater Handling	N2O	97,99	60,11	5,00	50,00	50,25	0,08	0,00	0,00	0,00	0,01	0,01	R	R
6.C Waste Incineration	N2O	5,95	2,67	5,00	5,00	7,07	0,00	0,00	0,00	0,00	0,00	0,00	R	R
6.C Waste Composting	N2O	1,86	63,36	5,00	50,00	50,25	0,08	0,00	0,00	0,05	0,01	0,05	R	R
Emissions of ODS	HFCs,	271,40	336,75	10,00	0,40	10,01	0,08	0,00	0,01	0,00	0,07	0,07	D	D
	Total:	**66 562,37**	**39 945,18**			**Total H =**	**13,85**	**Level Uncertainty**			**Total M =**	**8,22**	**Trend Uncertainty**	

Annex 7: Additional information to be considered as part of the annual inventory submission

Table A7.1: The certificate of conformity with the standard SHMÚ

ACERT

ACERT, s.r.o., M.R.Štefánika 24/644, SK 914 51 TRENČIANSKE TEPLICE, SLOVAKIA
CERTIFICATION BODY ACCREDITED BY SLOVAK NATIONAL ACCREDITATION SERVICE
FOR CERTIFICATION OF MANAGEMENT SYSTEMS GRANTS

CERTIFICATE

OF CONFORMITY WITH THE STANDARD

EN ISO 9001 : 2008

TO COMPANY

SHMÚ

SLOVENSKÝ HYDROMETEOROLOGICKÝ ÚSTAV

JESÉNIOVA 17
833 15 BRATISLAVA
SLOVAKIA

ACERT confirms:

COMPANY HAS BUILT AND INTRODUCED THE QUALITY MANAGEMENT SYSTEM
ACCORDING THE REQUIREMENTS OF THE ABOVE MENTIONED STANDARD FOR THE FOLLOWING ACTIVITIES:

MONITORING OF THE DETERMINANTS CHARACTERISING THE STATE OF AIR AND WATERS ON THE SLOVAK TERRITORY
ASSESSMENT, ARCHIVING AND INTERPRETATION OF DATA AND INFORMATION ON THE STATE AND REGIME OF AIR AND WATERS
PROVIDING DATA AND INFORMATION ON THE STATE AND REGIME OF AIR AND WATERS
STUDY AND DESCRIPTION OF ATMOSPHERE AND HYDROSPHERE PHENOMENA
EDUCATION AND TRAINING WITHIN THE ACTIVITY OF INSTITUTE

DATE OF ISSUE: 19.4.2010

REG.NO. 14/2010 LEADER OF CERTIFICATION BODY VALIDITY: 18.4.2013

IAF

SNAS Reg. No. 242/Q-034

ACERT

Table A7.2: The certificate of conformity with the standard SHMÚ

ACERT, s.r.o.
M. R. Štefánika 24/644
914 51 Trenčianske Teplice
Accredited Certification Body for certification of management systems

Trenčianske Teplice, 29.3.2010

Based on the results of the recertification audit of the Quality Management System, performed during 15 – 22nd March 2010 at the Slovak Hydrometeorological Institute in Bratislava, we confirm that the Emissions Department has established and maintained quality management system in accordance with the certified quality management system of the Slovak Hydrometeorological Institute.

Ing. Anna Striežovská
Head of ACERT (certification body)

ACERT, s.r.o.
M.R. Štefánika 24/644
914 51 Trenčianske Teplice

ACERT/listy2010/0329