SLOVAK REPUBLIC

NATIONAL INVENTORY REPORT 2012

Greenhouse gas emission inventory 1990 – 2010

Submission under the UNFCCC including reporting elements under the Kyoto Protocol

Slovak Hydrometeorological Institute
Ministry of the Environment of the Slovak Republic

Bratislava, August 2012

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 the decision 15/CMP.1) contains the following parts:

- National greenhouse gas emission inventory report of the Slovak Republic 1990 – 2010 (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 – 2010 are included.
- CRF data tables of the Slovak Republic's greenhouse gas emissions for the years 1990 – 2010. The CFR tables are compiled with the latest UNFCCC CRF Reporter software (version 3.6.2), 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 as of 31st December 2011 and transfers of the units during the year 2011.

The Slovak Hydrometeorological Institute (SHMU) (Miroslav Mikovec, Silvia Srenkelova and Janka Szemesova), the Profing company (Jan Judak), the Ecosys company (Jiri Balajka), the National Forest Centre in Zvolen with the cooperation of the Ministry of Agriculture of the Slovak Republic (Tibor Priwitzer), the Slovak Research Institute of Transport with the cooperation of the Ministry of Transport of the Slovak Republic (Jiri Dufek), the Slovak Agricultural University Nitra (Bernard Siska), the Slovak Technical University in Bratislava (Vladimir Danielik), the Faculty of Mathematics, Physics & Informatics in Bratislava (Martin Gera), the Slovak Energy Agency, the Slovak Statistical Office, the Slovak Cooling and Air Conditions Association (Peter Tomlein), the SPIRIT Information Systems (Jozef Skakala) and the Slovak Centre of Waste Management (Juraj Farkas) are directly 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 this National Inventory Report.

During the process of changes in the organizational structure of the SHMU (to increase efficiency and to save financial resources) the Department of Emissions was merged with the Department of Air Quality on 1st December 2010. The new unit is named the Department of Emissions and Air Quality Monitoring and serves also as the Single National Entity (SNE) while providing all activities connected with coordination of the National Inventory System for the KP under the Article 5.1. This change has had no practical impact on the function of the SNE. SNE was officially appointed by the decision of the Director General of the SHMU in August 2011. It currently comprises 2.5 experts working on inventory tasks as a full time job. Composition of SNE is: NIS Coordinator, Deputy NIS Coordinator and Quality Manager (for a half time job). Department of Emissions and Air Quality Monitoring is the coordinator of the National Inventory System with the overall responsibility for compilation and finalization of the 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.

All relevant documents have to be approved by the National Focal Point to the UNFCCC, which is the Department of Climate Change Policy of the Ministry of Environment of the Slovak Republic headed by Helena Princová (helena.princova@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 2012. The NIS coordinator, Janka Szemesová (janka.szemesova@shmu.sk) is the contact person at the SHMU for the GHG emission 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 one of the most serious environmental threats for humankind. Carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O) are the most important anthropogenic greenhouse gases with increasing concentration in atmosphere. 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 (NMVOCs) are not greenhouse gases, but they contribute indirectly to the greenhouse effect in the atmosphere. These gases are generally referred to as 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.

In response to the significant increase in GHG emissions since 1992 an urgent need to adopt an additional and efficient instrument that would stimulate mitigation effort has occurred. In 1997, the Parties to the Convention agreed to adopt the Kyoto Protocol (KP) that defines reduction objectives and means to achieve mitigation goals by the countries included in Annex I to the Convention. Developed countries, listed 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 committed itself to an 8% reduction of emissions compared to the base year 1990. The Slovak Republic and the former EU Member States ratified the Kyoto Protocol on 31st May 2002.[1]

Current UNFCCC negotiation process is focused on wide co-operation of developed and developing countries to achieve global goal of 2°C.

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 5.440078 million inhabitants (as of 30th June 2011). The average population density is 110.5 inhabitants per km². The population is concentrated in cities in lowlands and the main basins. Mountain 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 development and implementation of national environmental policy including climate change and air protection objectives. It has the responsibility to develop strategies and further instruments of implementation, such as acts, regulatory measures, economic and market based instruments for cost efficient fulfilment of adopted goals. Both, the conceptual documents as well as legislative proposals are always annotated 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 Slovak Parliament.

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

The Ministry of Environment of the Slovak Republic is the main body to ensure conditions and to monitor progress of Slovakia to meet all commitments and obligations of climate change and adaptation policy.

According to the Governmental Resolution No. 821/2011 from 19 December 2011, the inter-ministerial High Level Committee on Coordination of Climate Change Policy was established. This Committee is created at the state secretary level and will replace previous co-ordinating body, i.e. the High Level Committee on Climate-Energy Package established in August 2008. Committee is chaired by the State Secretary of the Ministry of the Environment, other members are the state secretaries of the Ministry of Economy, Ministry of Agriculture and Rural Development, Ministry of Transport, Construction and Regional Development, Ministry of Education, Science, Research and Sport, Ministry of Health, Ministry of Finance, Ministry of Foreign Affairs and the Head of the Regulatory Office for the Network Industries.

Main objectives of inter-ministerial body are to develop and implement national strategy on mitigation and adaptation and to ensure cost-effective meeting of reduction commitments both in middle and long-term frame. Committee will play an important role also in process of evaluation of fulfilment for our climate change objectives and commitments and will regularly submit report on progress in achievement to be considered by the Slovak Government.

Supporting institutions, founded by the Ministry of the Environment to perform specific tasks linked to the inventory activities, 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 in Zvolen, the National Forest Centre in Zvolen, the Slovak Research Institute of Transport in Žilina, the Slovak Agricultural University in Nitra, the Slovak Technical University in Bratislava, the Faculty of Mathematics, Physics & Informatics, Commenius University in Bratislava, and the Slovak Academy of Science), non-governmental organizations, and associations of interested groups (the Slovak Innovation and Energy Agency (SEIA), PROFING – energy consulting company, the Slovak Cooling and Air Conditions Association (SZCHKT), Detox – company for research in solvent use, SPIRIT – company for information systems, Ecosys – consulting company for energy-related projections) are involved in the process of data collection and other inventory related task.

The last in-country review of the 2011 submission of the Slovak Republic to the UNFCCC took place in Bratislava from 22nd to 27th August 2011. The Expert Review Team (ERT) during the in-country review has identified a number of questions for relevant IPCC sectors. During the review week, most of the questions were answered and accepted by the review team, however Slovakia received the "Saturday paper" document at the end of the review week (Potential Problems and Further Questions from the ERT formulated in the course of the 2011 review of the GHG inventories of Party submitted in 2011). More detailed information on review process is presented in this NIR (Table 10.5). During the 6 weeks period Slovakia has prepared answers to the specific technical questions and developed proposal of the Plan of Action to improve functioning of the National Inventory System of the Slovak Republic. In due time on 10 October 2011 we sent The Responses to the Potential Problems and Further Questions from the ERT formulated in the course of the 2011 review of the GHG inventories of Slovakia submitted in 2011, later on the second response to explain further questions from the ERT (19 October 2011) supplemented by the letter signed by the minister (28 October 2011) to confirm, that proposed Plan of Action will became indisputable part of the plans of actions for the ministry and other involved institutions. The draft report of the individual review of the annual submission of Slovakia submitted in 2011 (ARR) has been delivered to the Ministry of Environment and the SHMU for comments on 20 March 2012 with a question of implementation and two adjustments in N_2O emission factor for road transportation and HFCs emissions in several categories 2.F.

Table ES1: The proposed plan of actions

Action	Deadline	Expected results in relation to current vulnerability of NIS SR
1/ SHMU (Slovak Hydro-meteorological Institute) will hire further employee fully focused on tasks within the National inventory system of GHG emissions (NIS SR)	1st January 2012 at the latest	New staff will focus mostly on energy sector, interlinkages between the RA and SA through the IEA and NEIS databases. This will enhance the space for QA/QC control process directly at the SHMU.
2/ Improvement of procedure for timely approval of all financial transactions related to the NIS functioning	1st February 2012 at the latest	New procedure will enable simplified system to allocate necessary financial resources for NIS SR on annual basis (relation of resources with QA/QC will be a part of this procedure).
3/ Enhance involvement of institutions and further (deputy) experts into the process of preparing GHG emission inventories – see details in text below and Table A.5.	Immediatelly after the ICR, until the 1st December 2011	In order to solve the vulnerability of the system from personal point of view we propose that each of experts will choose an additional substitute either from the same or different institution. This deputy expert will be active from the beginning in the process of inventory and in the end his/her purpose will also be an independent assessment of the results. At the same time we will incorporate stricter provisions in experts' contracts which determine penalties for insufficient quality of results (based on ERT revisions).
4/ Project to establish Quality management system (QMS) for NIS SR according to the Article 5 of the Kyoto Protocol including the Quality assessment and quality control plan	April 2012	Certification of NIS SR according to ISO 9001 as well as enabling conditions of QA/QC on sectoral levels.
5/ Project to enhance inter-linkages among the IPCC sectoral dbases and CRF Reporter	Until August 2012	Additional software tool should enable direct communication between the IPCC sectoral dbases and CRF Reporter table. This step could enhance the space and time for QA/QC procedure.

Source: The Responses to the Potential Problems and Further Questions from the ERT formulated in the course of the 2011 review of the GHG inventories of Slovakia submitted in 2011, 10 October 2011

ES.2 Summary of trends in national emissions and removals

The GHG emissions presented in the National Inventory Report 2012 were updated and recalculated using the last updated methods, national conditions and data published by the Slovak Statistical Office. According to the recommendations of the ERT from the last in-country review (2011), several recalculations and reallocations were performed and reflected in the 2012 submission with the impacts on the previous inventory years 1991 – 2009 and the base year 1990. Due to the late delivery of the ARR, the Slovak National Inventory System was not able fully adopt all recommendations as identified in the ARR.

Total GHG emissions were 45 981.87 Gg of CO_2 equivalents in 2010 (without LULUCF). This represents a reduction by 35.94% against the base year 1990. In comparison with 2009, the emissions increased by almost 4%. Increase in total emissions of 2010 compared to 2009 was due to renewal of economy after depression in previous period.

Latest OECD Environmental Performance Review of the Slovak Republic summaries results in GHG emission reductions since 1990 as follow:

„Significantly reduced CO_2 emissions, combined with strong GDP growth and low population growth rate, resulted in a sharp drop of the economy's carbon intensity as measured by CO_2 emissions per unit of GDP (using purchasing power parities). This was the sharpest decline in any OECD country".[2]

Similarly, ETC/ACM Technical paper states that: "*The fall in emission per GDP observed in Slovakia during 2003 – 2008 is the highest decline of all EU-27 Member States, as result of a small fall in emissions despite a large increase in GDP. Slovakia project further decoupling of emissions and GDP*

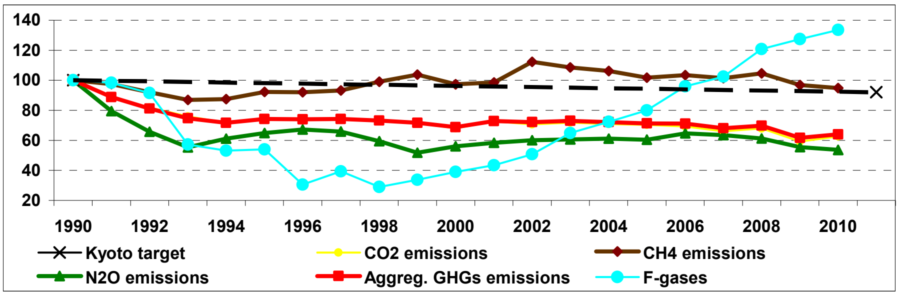
[2] *OECD Environmental Performance Reviews, Slovak Republic, 2011*

but at a slower rate than the impressive rate observed during 2003 – 2008. Based on the trend observed in other Member States, it is fair to assume that Slovakia's emissions per GDP may not continue to fall at the same impressive rate observed in historic years."[3]

We can assume increase mostly in the transport category and there is expected increase in emissions of F-gases (mainly HFCs and SF_6).

Total GHG emissions excluding LULUCF sector have continued to decrease from the base year with the moderate rate in the recent years. Significant changes in methodologies and emission factors were implemented to ensure consistency with the European Emission Trading Scheme (EU ETS), which represent significant progress in quality of estimation through comparison with the verified emissions for all installation included in the EU ETS. Table ES.2 shows the aggregated GHG emissions. In the period 1990 – 2010, 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 15.04.2012

Reduction of emissions in Slovakia is conjunction of different impacts starting from impressive industrial and technological restructuring connected with the fuel switching of fossil fuels from coal and oil to the natural gas (air pollution legislation since 1991 was the main driving force), economy restructuring towards the less energy intensive production (mostly after EU membership) and also by temporary changes in production intensity (driven by global and EU markets). Transport (mostly the road transport), with continuously increasing emissions is an important exception. The continuous pressure is being made in formulating the effective strategy and policy to achieve further reduction of emissions in this sector too. For example combination of regulatory and economic instruments (toll pay for freight vehicles based on their environmental characteristics in combination with fuel and emission standards for new cars).

Table ES.2: Total anthropogenic greenhouse gas emissions by gases in 1990 – 2010

GREENHOUSE GAS EMISSIONS	Base year (1990)	1991	1992	1993	1994	1995	1996	1997
	CO2 equivalent (Gg)							
CO2 emissions including net CO2 from LULUCF	50 423,66	42 924,84	36 585,75	33 694,75	32 086,10	33 891,76	33 845,74	33 699,49
CO2 emissions excluding net CO2 from LULUCF	60 745,23	54 091,96	49 749,76	46 078,75	43 526,70	44 879,11	44 699,10	44 811,47
CH4 emissions including CH4 from LULUCF	4 457,96	4 339,70	4 100,86	3 871,11	3 896,55	4 107,21	4 104,62	4 159,23
CH4 emissions excluding CH4 from LULUCF	4 443,87	4 330,73	4 092,84	3 863,00	3 888,02	4 097,66	4 094,40	4 147,96
N2O emissions including N2O from LULUCF	6 326,79	5 027,93	4 172,26	3 529,21	3 867,73	4 100,47	4 252,78	4 166,69
N2O emissions excluding N2O from LULUCF	6 314,70	5 021,91	4 146,10	3 498,08	3 864,53	4 096,97	4 243,39	4 163,50
HFCs	NA,NO	NA,NO	NA,NO	NA,NO	2,91	22,15	37,58	61,13
PFCs	271,37	266,94	248,42	155,42	132,06	114,32	34,51	34,62
SF6	0,03	0,03	0,04	0,06	9,27	9,91	10,76	11,34
Total (including LULUCF)	**61 479,81**	**52 559,45**	**45 107,34**	**41 250,54**	**39 994,61**	**42 245,83**	**42 286,00**	**42 132,50**
Total (excluding LULUCF)	**71 775,20**	**63 711,58**	**58 237,17**	**53 595,32**	**51 423,49**	**53 220,12**	**53 119,74**	**53 230,01**

[3] *Assessment of the member States` projections submitted under the EU Monitoring Mechanism in 2012, ETC/ACM Technical paper 2011/2, February 2012*

GREENHOUSE GAS EMISSIONS	Base year (1990)	1998	1999	2000	2001	2002	2003	2004
	CO2 equivalent (Gg)							
CO2 emissions including net CO2 from LULUCF	50 423,66	31 141,89	33 014,77	31 035,52	34 227,65	32 586,48	33 934,09	34 058,10
CO2 emissions excluding net CO2 from LULUCF	60 745,23	44 324,34	43 434,62	41 367,41	44 168,53	42 886,59	43 609,64	43 028,80
CH4 emissions including CH4 from LULUCF	4 457,96	4 415,41	4 628,37	4 335,85	4 393,62	5 001,30	4 837,26	4 738,28
CH4 emissions excluding CH4 from LULUCF	4 443,87	4 404,14	4 615,57	4 324,09	4 379,35	4 987,26	4 822,15	4 721,08
N2O emissions including N2O from LULUCF	6 326,79	3 758,30	3 272,53	3 578,53	3 688,13	3 798,08	3 829,69	3 867,70
N2O emissions excluding N2O from LULUCF	6 314,70	3 757,27	3 269,33	3 541,24	3 684,94	3 796,75	3 823,40	3 863,30
HFCs	NA,NO	40,96	65,39	80,97	88,54	109,04	139,16	160,57
PFCs	271,37	25,40	13,60	11,65	15,59	13,75	21,65	19,91
SF6	0,03	12,24	12,69	13,25	13,84	14,78	15,39	15,89
Total (including LULUCF)	**61 479,81**	**39 394,20**	**41 007,35**	**39 055,77**	**42 427,37**	**41 523,43**	**42 777,24**	**42 860,45**
Total (excluding LULUCF)	**71 775,20**	**52 564,35**	**51 411,20**	**49 338,61**	**52 350,79**	**51 808,16**	**52 431,39**	**51 809,55**

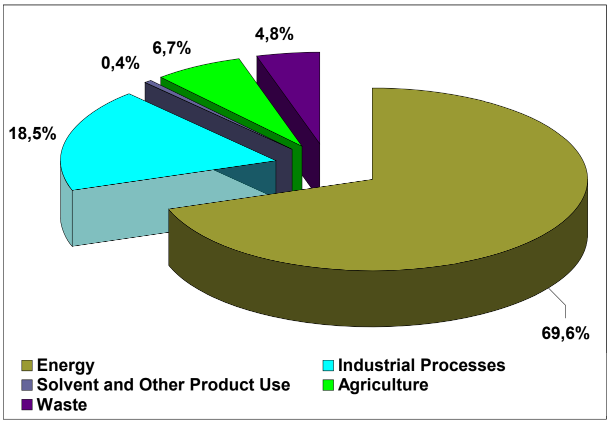
GREENHOUSE GAS EMISSIONS	Base year (1990)	2005	2006	2007	2008	2009	2010	Change from base to 2010
	CO2 equivalent (Gg)							(%)
CO2 emissions including net CO2 from LULUCF	50 423,66	37 350,31	34 158,31	32 272,64	34 103,85	28 774,62	31 908,59	-36,72
CO2 emissions excluding net CO2 from LULUCF	60 745,23	42 659,75	42 096,82	40 079,57	41 225,58	36 030,96	38 024,57	-37,40
CH4 emissions including CH4 from LULUCF	4 457,96	4 543,57	4 613,75	4 523,78	4 669,09	4 326,55	4 233,19	-5,04
CH4 emissions excluding CH4 from LULUCF	4 443,87	4 521,13	4 594,85	4 505,04	4 648,04	4 305,78	4 210,28	-5,26
N2O emissions including N2O from LULUCF	6 326,79	3 819,82	4 091,09	4 016,01	3 878,27	3 515,34	3 389,39	-46,43
N2O emissions excluding N2O from LULUCF	6 314,70	3 814,48	4 087,92	4 007,84	3 876,43	3 508,30	3 384,74	-46,40
HFCs	NA,NO	180,48	207,43	235,65	273,19	308,87	321,23	100,00
PFCs	271,37	20,25	35,82	24,88	36,16	17,76	21,15	-92,20
SF6	0,03	16,61	17,15	17,44	18,51	19,39	19,90	64 954,69
Total (including LULUCF)	**61 479,81**	**45 931,05**	**43 123,56**	**41 090,40**	**42 979,08**	**36 962,53**	**39 893,45**	**-35,11**
Total (excluding LULUCF)	**71 775,20**	**51 212,71**	**51 040,00**	**48 870,43**	**50 077,91**	**44 191,07**	**45 981,87**	**-35,94**

Total aggregated GHGs emission without LULUCF, emissions are determined as of 15.04.2012

ES.3 Overview of source and sink category

The energy sector (including transport) with the share of 69.61% was the main contributor to total GHG emissions in 2010. Within this sector, transport with 20.79% share contributes significantly to the GHG emissions and it shows the most increasing trend. The share of transport in total emissions has increased by 11.46% 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 2010 with its 18.53% share in total GHG emissions, producing mainly technological emissions from processing mineral products, chemical production and steel and iron production. The reduction of emissions from technological processes is very costly and there exist specific technical limits, therefore the emissions have not been changed since the reference year as significantly as for other categories. Their level is influenced mostly by the production volume in industrial processes. The most growing emissions within the IP sector are HFCs and SF_6 emissions as result of industrial demand and use of these substances in construction, insulation of building, electro-technical and/or automobile industry. In 2010, the share of agriculture sector on total GHG emissions was 6.67% and the trend in decrease of emissions has remained relatively stable since 1999. The most significant reduction of emissions from agriculture was achieved at the beginning of nineties as result of reduction in breeding livestock number together with restricted use of fertilizers. Sector waste contributed by 4.83% to total GHG emissions in 2010. Using 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 100% compared to the base year 1990. Similar trend is expected to remain in future years, although the increase should not be so substantial as before. Volume of emissions from landfills depends, to a large extent, on applied methodology to evaluate landfills and also on the scale of implementation energy recovery of landfill gases by landfill operators. Sector solvents use is the least significant sector with respect 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. Nevertheless, increase in transport emissions and 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, represent most important anthropogenic source of CO_2 emissions (Figure ES.2, Table ES.3).

Figure ES.2: GHG emissions share by sectors in 2010 (%) in the Slovak Republic



Category	CO_2 Eq. (Gg)	Share (%)
Energy	32 007,79	69,61%
Industrial Processes	8 522,07	18,53%
Solvent and Other Product Use	164,35	0,36%
Agriculture	3 065,33	6,67%
Waste	2 222,15	4,83%

Table ES.3: Total anthropogenic greenhouse gas emissions by sectors

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	Base year (1990)	1991	1992	1993	1994	1995	1996	1997
	CO2 equivalent (Gg)							
1. Energy	53 905,54	48 741,91	44 617,12	40 846,95	37 992,45	39 008,15	39 007,26	38 873,56
2. Industrial Processes	9 543,26	7 737,66	7 400,44	7 242,93	8 025,77	8 562,82	8 561,06	8 788,12
3. Solvent and Other Product Use	147,15	126,64	110,00	101,65	102,96	121,53	115,50	97,62
4. Agriculture	7 087,91	5 999,47	4 999,64	4 284,76	4 127,29	4 294,91	4 142,30	3 986,27
5. Land Use, Land-Use Change and Forestry(5)	-10 295,39	-11 152,13	-13 129,83	-12 344,78	-11 428,88	-10 974,29	-10 833,74	-11 097,51
6. Waste	1 091,33	1 105,90	1 109,98	1 119,03	1 175,03	1 232,71	1 293,62	1 484,45
7. Other	NA	NA	NA	NA	NA	NA	NA	NA
Total (including LULUCF)	**61 479,81**	**52 559,45**	**45 107,34**	**41 250,54**	**39 994,61**	**42 245,83**	**42 286,00**	**42 132,50**

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	Base year (1990)	1998	1999	2000	2001	2002	2003	2004
	CO2 equivalent (Gg)							
1. Energy	53 905,54	38 008,92	36 926,13	35 723,27	38 220,25	36 420,60	37 387,86	35 844,28
2. Industrial Processes	9 543,26	8 954,78	8 881,80	8 298,09	8 756,68	9 131,68	9 006,25	10 110,80
3. Solvent and Other Product Use	147,15	94,45	90,52	85,04	99,74	131,92	137,35	163,49
4. Agriculture	7 087,91	3 677,37	3 420,02	3 455,17	3 463,27	3 539,48	3 397,98	3 223,62
5. Land Use, Land-Use Change and Forestry(5)	-10 295,39	-13 170,15	-10 403,85	-10 282,84	-9 923,42	-10 284,74	-9 654,15	-8 949,10
6. Waste	1 091,33	1 828,83	2 092,74	1 777,04	1 810,85	2 584,46	2 501,90	2 467,29
7. Other	NA	NA	NA	NA	NA	NA	NA	NA
Total (including LULUCF)	**61 479,81**	**39 394,20**	**41 007,35**	**39 055,77**	**42 427,37**	**41 523,43**	**42 777,24**	**42 860,45**

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	Base year (1990)	2005	2006	2007	2008	2009	2010	Change from base to 2010
	CO2 equivalent (Gg)							(%)
1. Energy	53 905,54	36 100,02	34 962,78	33 112,59	34 549,08	30 540,55	32 007,79	-40,62
2. Industrial Processes	9 543,26	9 381,76	10 211,48	9 961,18	9 839,54	8 303,32	8 522,07	-10,70
3. Solvent and Other Product Use	147,15	171,54	170,59	166,25	166,59	164,38	164,35	11,68
4. Agriculture	7 087,91	3 213,16	3 162,43	3 267,68	3 152,56	3 018,59	3 065,33	-56,75
5. Land Use, Land-Use Change and Forestry(5)	-10 295,39	-5 281,66	-7 916,44	-7 780,03	-7 098,83	-7 228,54	-6 088,42	-40,86
6. Waste	1 091,33	2 346,13	2 532,60	2 362,59	2 369,99	2 164,06	2 222,15	103,62
7. Other	NA	NA	NA	NA	NA	NA	NA	0,00
Total (including LULUCF)	**61 479,81**	**45 931,05**	**43 123,56**	**41 090,40**	**42 979,08**	**36 962,53**	**39 893,45**	**-35,11**

Emissions are determined as of 15.04.2012

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

According to the *"Report on the estimation of assigned amount units 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 2010, total CO_2 removals from afforestation/reforestation activities were -511.99 Gg of CO_2 (changes in 30.25 kha to the end of 2010). Total CO_2 emissions from deforestation were 180.63 Gg of CO_2 (changes in 6.66 kha to the end of 2010). In 2010, total emissions under the Article 3.3 of the KP were 331.36 Gg with the changed area of 37.69 kha.

Table ES.4: Emissions and removals resulting from the activities under Article 3.3 of the KP

Activities	2008	2009	2010	Total
	Net CO2 (Gg)			
A. Article 3.3 activities	-278,64	-187,08	-331,36	**-797,09**
A.1. Afforestation and Reforestation	-453,12	-469,30	-511,99	**-1 434,41**
A.1.1. Units of land not harvested since the beginning of the commitment period	-453,12	-469,30	-511,99	**-1 434,41**
A.1.2. Units of land harvested since the beginning of the commitment period	NA	NA	NA	**NA**
A.2. Deforestation	174,47	282,22	180,63	**637,32**

ES.5 Indirect greenhouse gases

A major source of SO_2, NO_x and CO emissions is power and heat generation. 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 monitored by 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 due this revaluation of EFs was 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 occur 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 provisions of 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 technically very complicated to provide information on emissions and emission factors according to the classification as required by standard tables. NM VOC emissions have slightly increased in the sector solvent and other product use as result of increased 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.

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 1990 – 2009 was based on the updated model COPERT IV. Model COPERT IV was used also for the calculation of emissions in 2010. Minor recalculations for NO_x, NM VOC, heavy metal emissions from stationary sources were performed in 2010 (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 (hospital 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 done for stationary sources in 2007 (only for sector energy – category 1A1a), due to the change in the plant statistics of operators in the database NEIS. The recalculation was also done for sector agriculture in category synthetic N-fertilizers for NH_3 emissions up to year 2000.

Table ES.5: Anthropogenic emissions of NO_x, CO, NM VOC and SO_2 (Gg) in 1990 – 2010

Year	**1990**	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**
CO	**521,38**	**497,08**	**455,31**	**466,57**	**442,15**	**426,85**	**366,48**	**364,31**	**347,37**	**334,93**
Stationary	351,26	340,23	299,99	301,05	272,63	258,90	208,18	205,61	187,61	185,36
Transport	164,00	151,87	151,29	161,36	165,92	163,93	153,84	153,97	155,12	144,22
Other*	6,12	4,97	4,03	4,16	3,60	4,02	4,46	4,74	4,64	5,36
NO_x	**226,59**	**204,42**	**190,54**	**181,54**	**171,31**	**179,07**	**135,53**	**127,44**	**132,79**	**120,62**
Stationary	160,46	150,21	141,73	135,26	122,39	128,01	89,42	82,10	86,43	77,41
Transport	61,48	50,72	45,65	43,59	44,84	46,59	45,62	44,84	45,89	42,72
Other*	4,66	3,50	3,16	2,70	4,07	4,48	0,49	0,50	0,47	0,49
NM VOC	**133,60**	**NA,NE**	**NA,NE**	**102,47**	**NA,NE**	**91,10**	**86,95**	**80,84**	**74,72**	**68,01**
Energy	41,02	NA,NE	NA,NE	34,43	NA,NE	27,52	28,30	27,28	24,09	22,85
Industry	8,79	NA,NE	NA,NE	5,87	NA,NE	2,82	2,68	2,67	1,58	1,51
Transport	25,73	NA,NE	NA,NE	25,44	NA,NE	22,99	21,59	21,01	18,21	14,61
Solvent Use	52,87	NA,NE	NA,NE	34,97	NA,NE	37,07	33,80	29,29	30,18	28,41
Agriculture	0,65	NA,NE	NA,NE	0,44	NA,NE	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
SO_2	**524,13**	**443,93**	**388,27**	**326,96**	**243,88**	**244,84**	**229,12**	**203,20**	**182,55**	**172,96**
Stationary	522,69	442,77	387,24	326,04	242,91	243,80	228,06	202,14	181,39	171,88
Transport	1,44	1,16	1,03	0,92	0,97	1,04	1,06	1,06	1,16	1,09

Year	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**
CO	**305,91**	**310,49**	**295,85**	**298,40**	**299,34**	**281,40**	**280,42**	**252,04**	**253,67**	**217,71**	**230,64**
Stationary	185,16	175,59	165,14	184,20	189,56	181,39	193,51	183,33	178,41	148,05	165,68
Transport	114,89	128,97	124,86	107,73	102,67	90,64	78,97	60,78	66,55	60,93	55,42
Other*	5,86	5,92	5,85	6,47	7,11	9,36	7,94	7,93	8,71	8,73	9,55
NO_x	**107,75**	**108,10**	**100,54**	**98,16**	**99,45**	**102,39**	**96,80**	**96,05**	**94,23**	**83,43**	**89,09**
Stationary	70,32	67,58	59,70	58,37	56,51	55,39	52,09	46,84	45,79	41,08	42,69
Transport	36,89	39,97	40,30	39,22	42,30	46,20	43,99	48,49	47,70	41,53	45,52
Other*	0,54	0,54	0,53	0,57	0,64	0,80	0,73	0,72	0,75	0,82	0,88
NM VOC	**67,09**	**68,75**	**66,89**	**68,78**	**70,48**	**71,46**	**68,74**	**67,24**	**65,60**	**64,28**	**62,40**
Energy	21,97	22,48	20,29	21,33	23,00	24,87	22,77	22,25	22,12	21,37	21,51
Industry	1,37	1,32	1,39	1,68	1,69	1,59	1,56	1,53	1,38	1,26	1,25
Transport	16,14	15,66	13,62	12,92	12,44	10,85	9,16	9,31	7,77	7,73	7,19
Solvent Use	26,98	28,72	31,02	32,27	32,76	33,56	34,63	33,58	33,78	33,33	31,86
Agriculture	0,44	0,44	0,44	0,44	0,44	0,44	0,44	0,44	0,44	0,44	0,44
Waste	0,19	0,13	0,13	0,14	0,15	0,15	0,18	0,14	0,12	0,13	0,15
SO_2	**126,95**	**131,11**	**103,35**	**105,50**	**96,19**	**89,01**	**87,75**	**70,56**	**69,41**	**64,08**	**69,41**
Stationary	126,09	130,24	102,55	105,29	95,97	88,77	87,53	70,31	69,15	63,85	69,12
Transport	0,86	0,87	0,79	0,21	0,22	0,24	0,22	0,25	0,26	0,24	0,28

**Biomass burning and forest fires, emissions are determined as of 15.02.2012.*

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 in Slovakia increased by about 1.6°C (more in the season from January to August) and the annual atmospheric precipitation in totals decreased by about 3.4% (in the south of the territory the decrease was more than 10%; in the north and northeast of the territory the increase up to 3% has occurred temporarily). A significant decrease in the relative air humidity was recorded (in the south of the territory 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 have not been changed significantly (except for a transitional decrease in the period from 1965 to 1985). Similar trend continues also after 2000.[4]

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 is 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

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[4] *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 4 t 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 years.) 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 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[5] 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 submitted in April 2012, in 2010 the Slovak Republic total anthropogenic emissions of greenhouse gasses expressed as CO_2 equivalent decreased by 35.94% without LULUCF, if compared with the base year 1990. This achievement is the result of impacts of several processes and factors, mainly:

- Higher share of services on the GDP.
- Technological restructuring and change in structure of industries.

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[5] 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.

- Higher share of gaseous fuels on consumption of primary energy resources.
- Gradual decrease in energy consumption for certain energy intensive sectors (except for metallurgy).
- Impact of air protection legislation which regulates directly or indirectly generation of greenhouse gas emissions.
- 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).

ETC/ACM Technical paper states that: "*The fall in emission per GDP observed in Slovakia during 2003 – 2008 is the highest decline of all EU-27 Member States, as result of a small fall in emissions despite a large increase in GDP. Slovakia project further decoupling of emissions and GDP but at a slower rate than the impressive rate observed during 2003 – 2008. Based on the trend observed in other Member States, it is fair to assume that Slovakia's emissions per GDP may not continue to fall at the same impressive rate observed in historic years.*" However, the share of greenhouse gasses per capita still remains one of the highest in Europe.

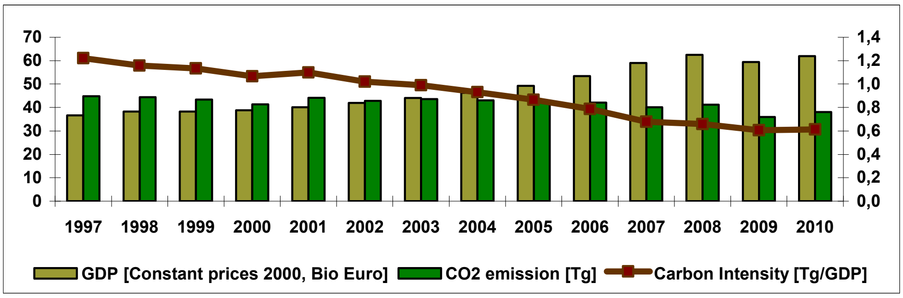
In May 2004, the Slovak Republic joined the European Union. Relevant European legislation has brought additional positive direct and indirect effects to the reduction of GHG emissions, mainly in energy sector. The introduction of emission trading scheme will allow the implementation of further reduction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

Table 1.1: Carbon intensity per GDP from 1997 in the Slovak Republic

Year	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
GDP [Constant prices 2000, Bio Euro]	36,68	38,27	38,29	38,81	40,16	42,01	44,01	46,24	49,31	53,43	59,04	62,51	59,44	61,97
CO_2 emission [Tg]	44,81	44,32	43,43	41,37	44,17	42,89	43,61	43,03	42,66	42,10	40,08	41,23	36,03	38,02
Carbon Intensity [Tg/GDP]	**1,22**	**1,16**	**1,13**	**1,07**	**1,10**	**1,02**	**0,99**	**0,93**	**0,87**	**0,79**	**0,68**	**0,66**	**0,61**	**0,61**

The values are absolute, GDP after recalculation in 2010 up to 1997, data before 1994 are not available in the same methodology

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



The Slovak Statistical Office recalculated GDP and Value Added according to the NACErev.2 methodology only back to the year 1997

1.1.3 International agreements

The instrument to tackle 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 that enables adapting of ecosystems. Currently UNFCCC covers 195 countries or international communities, including the Slovak Republic, and the EU which is also the Party to the Convention. The Convention requires to adopt mitigation measures to reduce GHG emission in developed countries by 25-40 % by 2020 compared to 1990.

The Framework Convention on Climate Change (UNFCCC) – 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 stabilization of greenhouse gas concentrations in the atmosphere at a level that 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 prepare and submit to the UNFCCC secretariat greenhouse gas emission inventory on yearly base.

In response to the significant increase in GHG emissions since 1992 an urgent need to adopt an additional and efficient instrument that would stimulate mitigation effort has occurred. In 1997, the Parties to the Convention agreed to adopt the Kyoto Protocol (KP) that defines reduction objectives and means to achieve mitigation goals by the countries included in Annex I to the Convention. Developed countries, listed 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 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 committed itself to an 8% reduction of emissions compared to the base year 1990. The Slovak Republic and the former EU Member States ratified the Kyoto Protocol on 31st May 2002.[6]

Current UNFCCC negotiation process is focused on wide co-operation of developed and developing countries to achieve global goal of 2°C.

After joining the European Union (May 1st, 2004) by the Slovak Republic, set of new environmental legislative requirements have been adopted, including climate change and air protection. The European Union (EU) considers climate change as one of the four environmental priorities.[7] The Slovak Republic submits the preliminary data on GHG emission inventory for the year X-2 in required scope by January 15th each year (Annual Report), 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.[8] Basic objectives of the Decision are:

- 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 European Commission asses the preliminary data submitted in the Annual Report of the Slovak Republic on 15 March 2012.

In view of urgency and need to solve problems of climate change, energy efficiency and security, the heads of states and governments adopted a political decision regarding middle-term objectives for EU 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 a new international agreement.
- Increase in energy efficiency by 20% by 2020.

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

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

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

- Achieving 20% share of renewable resources on 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-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 Government of the Slovak Republic 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.

Setting up the National Inventory System (NIS) of emissions in compliance with the Kyoto Protocol requirements was framed with functions which it should fulfill according to the decision 19/CMP.1 The basic characteristics of the NIS are as follows:

- To ensure linkages and co-operation among involved institutions, bodies and individuals to perform all activities for monitoring and estimation of GHG emissions from all sectors/categories according to the UNFCCC guidelines and relevant decisions and according to the approved IPCC methodologies. To enable using of all relevant data from national and international databases for preparing and improving GHG emission inventory.
- To define role and competencies of all involved stakeholders including the role of National Focal Point to the UNFCCC.
- To define and regularly implement quality assurance and quality control (QA/QC) process in two lines; both internally and also externally by appropriate body.
- To ensure ongoing process of development capacities; financial, technical and expert sources in relation to QA/QC but also in relation to new tasks rising from the international process.

The National Inventory System (http://ghg-inventory.shmu.sk/) has been established and officially announced by Decision of the Ministry of the 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).[9] In agreement with paragraph 30(f) of Annex to decision 19/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.

[9] *"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*

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

The Ministry of the Environment of the Slovak Republic (MŽP) (www.enviro.gov.sk) is responsible for implementation of national environmental policy including climate change and air protection. It serves also as the National Focal Point to the UNFCCC.

It has the responsibility to develop strategies and further instruments of implementation, such as acts, regulatory measures, economic and market based instruments for cost efficient fulfilment of adopted goals. Both, the conceptual documents as well as legislative proposals are always annotated 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 Slovak Parliament.

The Ministry of the Environment of the Slovak Republic is the main body to ensure conditions and to monitor progress of Slovakia in fulfilment of all commitments and obligations in climate change and adaptation policy.

According to the Governmental Resolution No. 821/2011 from 19 December 2011, the inter-ministerial High Level Committee on Coordination of Climate Change Policy was established. This Committee is created at the state secretary level and will replace previous coordinating body, i.e. the High Level Committee on Climate-Energy Package established in August 2008. Committee is chaired by the State Secretary of the Ministry of Environment, other members are the state secretaries of the Ministry of Economy, Ministry of Agriculture and Rural Development, the Ministry of Transport, Construction and Regional Development, the Ministry of Education, Science, Research and Sport, the Ministry of Health, the Ministry of Finance, the Ministry of Foreign Affairs and the Head of the Regulatory Office for the Network Industries.

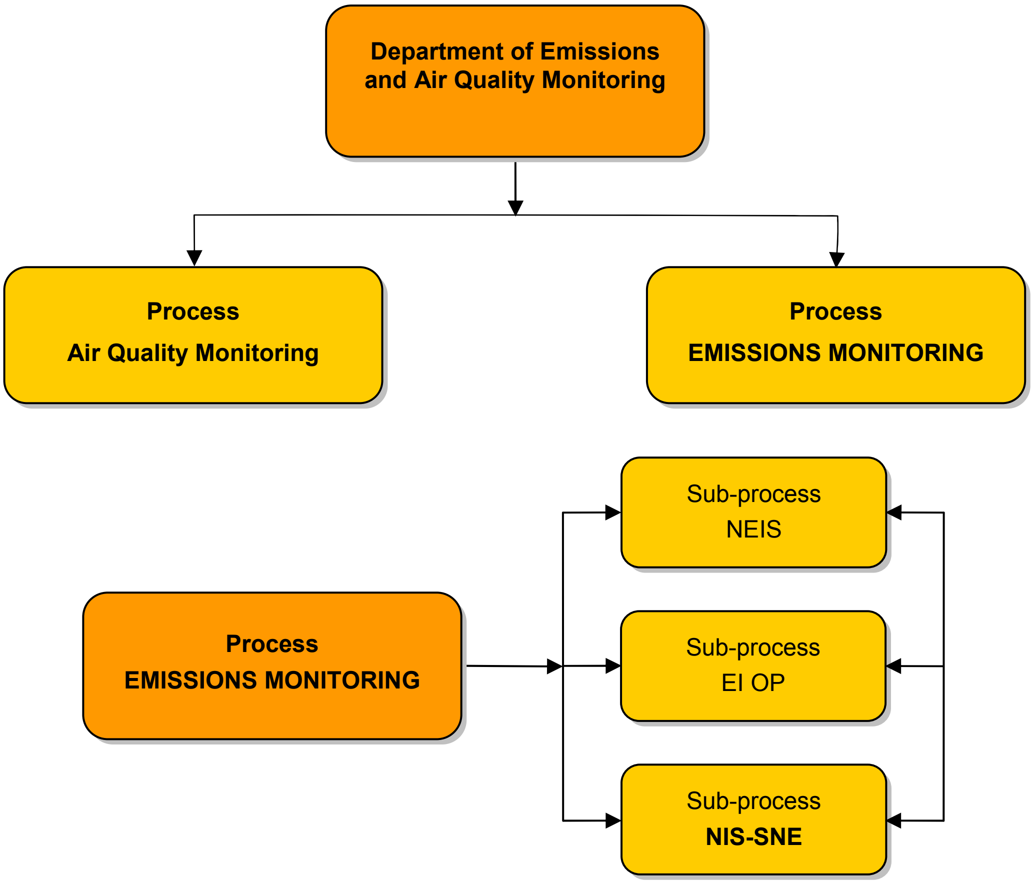
Main objectives of inter-ministerial body are to develop and implement national strategy on mitigation and adaptation and to ensure cost-effective meeting of reduction commitments both in middle and long-term frame. Committee will play an important role also in process of evaluation of fulfilment for our climate change objectives and commitments and will regularly submit report on progress in achievement to be considered by the Slovak Government.

District and regional environmental offices are decision-making bodies according to Act No. 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 Act No. 137/2010 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 No. 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 (SHMU) www.shmu.sk is authorised by the Ministry of the 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 SHMU activities are described in the Plan of Main Tasks. The plan, commented by all stakeholders is after approval published at the website of the SHMU http://www.shmu.sk/File/SHMU_Kontrakt_2012.pdf. Deadline for the approval of this plan by the ministry is 31st December each year.

Structure and the processes within the Department of Emissions and Air Quality Monitoring



NEIS = National Emission Information System, EI OP = Emission inventory for other pollutants, NIS-SNE = National Inventory System coordinator under the Article 5.1 KP and the Single National Entity.

Organisational changes occurred after the year 2011 at the SHMU (the new structure of SHMU is presented at http://www.shmu.sk/File/organizacna%20struktura(1.1.2012).pdf. They resulted in establishment of the Department of Emissions and Air Quality Monitoring (OEAQM) as the Single National Entity with delegated responsibilities. The process of preparing and management of emission inventories is the main workload of the OEAQM. Permanent staff of emission experts working at the Department is complemented by several external experts from relevant institutions working on annual contracts renewed each year.

Contracts with external institutions and sectoral experts are fully in competence of the SHMU after previous approval by the Ministry of Environment. The Department of Emissions and Air Quality Monitoring is fulfilling inventory tasks fully in line with approved Plan of Main Tasks and with financial resources allocated by the ministry. The Department of Emissions and Air Quality Monitoring has usually three main projects per year: Emission Inventory of GHGs, Emission Inventory of Other Pollutants and National Emission Information System. From the 1^{st} January until 15^{th} February at the latest the external contracts between the SHMU and co-operating institutions or experts are signed.

To specify main objectives for given year, kick-off workshop with participation of ministry, SHMÚ and external co-operating bodies and experts is organised regularly, usually at the beginning of February. This workshop is also an official forum for closing and summing up outcomes from the previous year and preparing the activities, including the QA/QC plan and responsibilities for the current year.

The SHMU 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 (https://www.spirit.sk/en/index.php). 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 SHMU 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.

The Department of Emissions and Air Quality Monitoring at the SHMU is responsible for the coordination of the National Inventory System for the KP under Article 5.1 as the Single National Entity. The Department of Emissions and Air Quality Monitoring has 30 full-time experts, 5.5 experts for emissions tasks. The emission experts are 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.*

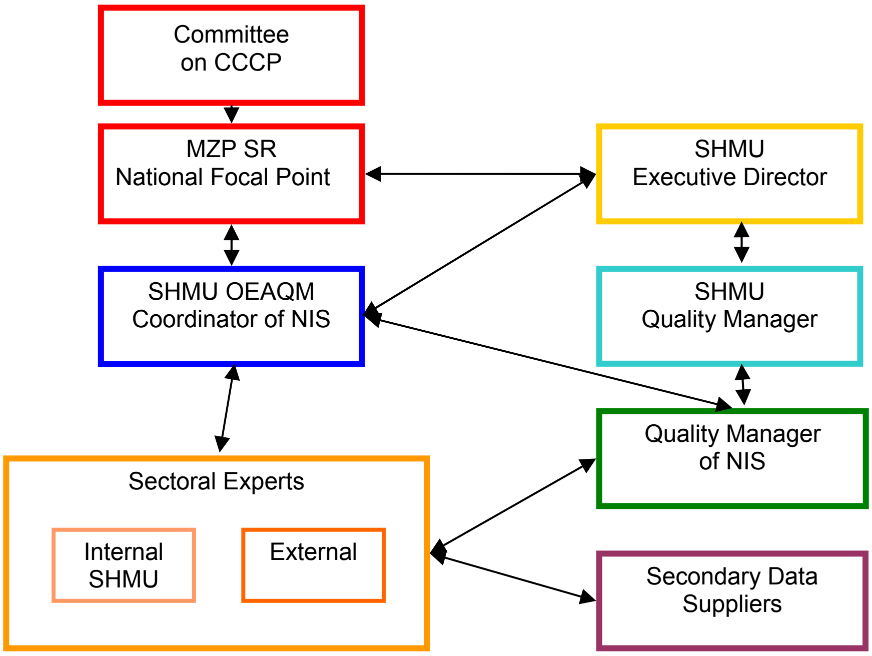
The cooperation with the Transport Research Centre in Brno is based on the consultations in road transport issues (recalculations COPERT V, disaggregation of vehicles, emission factors). SNE co-operates closely also with the Research Institute of Transport in Žilina and ensures communication among both institutions.

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

External Experts/Institutions		
Institution	**Name**	**Responsibility**
Ecosys Slovakia – company for environmental services in energy	Mr. Jiri BALAJKA	Consultations in energy and emission projections
Profing – company for environmental services in GHG	Mr. Jan JUDAK	Reference approach and fugitive emissions preparation
Spirit – IT services, databases provider	Mr. Jozef SKAKALA	NEIS[1] provider, consultation about the NACE classification of sources
Motran Research – company for transport research	Mr. Jiri DUFEK	GHG inventory in transport sector
Transport Research Institute		Data provider in transport sector
Prima Banka Slovakia	Mr. Miroslav HROBAK	National Registry focal point
Statistical Office of the Slovakia	Ms. Maria LEXOVA	Statistical data provider
Faculty of Chemical and Food Technology	Mr. Vladimir DANIELIK	GHG inventory in industrial processes and solvent use sectors
Slovak Association of refrigeration and air conditioning engineers	Mr. Peter TOMLEIN	GHG inventory in F-gases
Slovak Agricultural University	Mr. Bernard SISKA	GHG inventory in agriculture
National Forest Research Centre	Mr. Tibor PRIWITZER	GHG inventory in LULUCF and KP LULUCF
veQ – company for w aste management research	Mr. Juraj FARKAS	GHG inventory in w aste sector
Slovak Environmental Agency	Ms. Alena BODIKOVA	Data provider for w aste sector
Faculty of Mathematic, Physic and Informatics	Mr. Martin GERA	Uncertainty analyses
Ministry of Finance – Taxation and Customs Section		Data provider for biofuels
Internal experts - SHMU		
Department	**Name**	**Responsibility**
Dept. of Emissions and Air Quality Monitoring	Ms. Janka SZEMESOVA	NIS coordinator
Dept. of Emissions and Air Quality Monitoring	Mr. Miroslav MIKOVEC	Deputy of NIS coordinator, energy sector coordinator
Dept. of Emissions and Air Quality Monitoring	Ms. Lydia OSTRADICKA	Data Manager of NIS, other pollutants expert
Dept. of Emissions and Air Quality Monitoring	Ms. Silvia SRENKELOVA	Quality manager for NIS
Dept. of Emissions and Air Quality Monitoring	Mr. Jozef UHLIK	NEIS expert
Dept. of Emissions and Air Quality Monitoring	Ms. Monika JALSOVSKA	NEIS expert
Dept. of Water Quality	Ms. Lea MRAFKOVA	GHG inventory in w astew ater sector

The sectoral expert for LULUCF in cooperation with the National Forest Centre in Zvolen is responsible for the Kyoto Protocol reporting requirements under Article 3.3. Unlike in the previous period, Ministry of Agriculture and Rural Development will directly guarantee for some of the activities under the reporting obligation for the LULUCF sector in the year 2012 on the basis of contract with the National Forest Centre with defined scope and approved budget.

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 its operation from 19th October 2009. The NR was successfully connected with ITL of other EU countries in October 2008 and since it has been functional. The National Registry is available on the internet address http://co2.primabanka.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:	Slovak National Emission Registry, Prima banka Slovensko, a.s.
Address:	Hodzova 11
City:	Žilina
Postcode:	010 11
Country:	Slovak Republic
Phone No.:	tel. +421 - 41 - 5111 461
Facsimile number:	fax. +421 - 41 - 5111 190
Website:	http://w w w .dexia.sk/C12571BE004847DE/en/101
E-mail:	e-mail: miroslav.hrobak@primabanka.sk
	co2@primabanka.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 decentralized according to the definition of Article 5.1 of the KP. Individual sectors are fully under the responsibilities of external institutions and sectoral experts, who are authorized 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 and Air Quality Monitoring of the SHMU. 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 harmonized 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/plyn/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 and Air Quality Monitoring of the SHMU, where they are checked, reported and archived. Members of the Committee for the Climate Change Policy should comment on the emission inventory each year.

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 external institutions and managed by sectoral experts. All other relevant documents, papers and reports are stored in electronic and printed forms at the Department of Emissions and Air Quality Monitoring.

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	Assiciation 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 harbours.

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% of total GHGs 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 2010, the Slovak Republic determined 29 key source categories by the level assessment with LULUCF and 26 key source categories without LULUCF. The trend assessment determined 31 key source categories with LULUCF and 28 key source categories without LULUCF in 2010. 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).

Table 1.5: Summary of the key sources by level and trend assessment in 2010

Source Category Analysis Summary (2010 GHGs Inventory) with LULUCF			
Quantitative Method Used: TIER 1			
IPCC Source Categories	**Direct GHG**	**Key Source Category Flag**	**Criteria for Identification**
ENERGY SECTOR			
1.A.1 Energy Industries - solid	CO_2	yes	Level, Trend
1.A.1 Energy Industries - gaseous	CO_2	yes	Level, Trend
1.A.1 Energy Industries - liquid	CO_2	yes	Level, Trend
1.A.2 Manufacturing Industries and Construction - solid	CO_2	yes	Level, Trend
1.A.2 Manufacturing Industries and Construction - gaseous	CH_4	yes	Level, Trend
1.A.2 Manufacturing Industries and Construction - liquid	N_2O	yes	Level, Trend
1.A.4 Other sector - gaseous	CO_2	yes	Level, Trend
1.A.4 Other sector - solid	CH_4	yes	Level, Trend
1.A.3.b Transport - Road Transportation - liquid	CO_2	yes	Level, Trend
1.A.5.a Other non-specified - gaseous	CO_2	yes	Level, Trend
1.B.1.a Coal Mining and Handling	CH_4	yes	Level, Trend
1.B.1.b Fugitive Emission from Oil, Natural Gas and Other	CH_4	yes	Level, Trend
INDUSTRIAL SECTOR			
2(I).A.1 Cement Production	CO_2	yes	Level, Trend
2(I).A.2 Lime Production	CO_2	yes	Level, Trend
2(I).A.3 Limestone and Dolomite Use	CO_2	yes	Level, Trend
2(I).A.7 Magnezite Use	CO_2	yes	Level, Trend
2(I).B.1 Ammonia Production	CO_2	yes	Level, Trend
2(I).B.2 Nitric Acid Production	N_2O	yes	Level, Trend
2(I).B.4 Calcium Carbide Production	CO_2	yes	Trend
2(I).C.1 Iron and Steel Production	CO_2	yes	Level, Trend
2(I).C.3 Aluminium Production	CO_2	yes	Trend
2(I).F HFCs emissions	HFCs	yes	Level, Trend
AGRICULTURE SECTOR			
4.A Enteric Fermentation - Cattle	CH_4	yes	Level, Trend
4.B Manure Management	N_2O	yes	Level, Trend
4.D Agricultural Soils - indirect	N_2O	yes	Level, Trend
4.D Agricultural Soils - direct	N_2O	yes	Level, Trend
LULUCF SECTOR			
5.A Forest Land	CO_2	yes	Level, Trend
5.B Cropland	CO_2	yes	Level, Trend
5.C Grassland	CO_2	yes	Level, Trend
WASTE SECTOR			
6.A Solid Waste Disposal on Land	CH_4	yes	Level, Trend
6.B Wastewater Handling	CH_4	yes	Level, Trend

Table 1.5 – cont.: Summary of the key sources by level and trend assessment in 2010

Source Category Analysis Summary (2010 GHGs Inventory) without LULUCF			
Quantitative Method Used: TIER 1			
IPCC Source Categories	**Direct GHG**	**Key Source Category Flag**	**Criteria for Identification**
ENERGY SECTOR			
1.A.1 Energy Industries - solid	CO_2	yes	Level, Trend
1.A.1 Energy Industries - gaseous	CO_2	yes	Level, Trend
1.A.1 Energy Industries - liquid	CO_2	yes	Level, Trend
1.A.2 Manufacturing Industries and Construction - solid	CO_2	yes	Level, Trend
1.A.2 Manufacturing Industries and Construction - gaseous	CO_2	yes	Level, Trend
1.A.2 Manufacturing Industries and Construction - liquid	CO_2	yes	Level, Trend
1.A.4 Other sector - gaseous	CO_2	yes	Level, Trend
1.A.4 Other sector - solid	CO_2	yes	Level, Trend
1.A.3.b Transport - Road Transportation - liquid	CO_2	yes	Level, Trend
1.A.5.a Other non-specified - gaseous	CO_2	yes	Level, Trend
1.B.1.a Coal Mining and Handling	CH_4	yes	Level, Trend
1.B.1.b Fugitive Emission from Oil, Natural Gas and Other	CH_4	yes	Level, Trend
INDUSTRIAL SECTOR			
2(I).A.1 Cement Production	CO_2	yes	Level, Trend
2(I).A.2 Lime Production	CO_2	yes	Level, Trend
2(I).A.3 Limestone and Dolomite Use	CO_2	yes	Level, Trend
2(I).A.7 Magnezite Use	CO_2	yes	Level, Trend
2(I).B.1 Ammonia Production	CO_2	yes	Level, Trend
2(I).B.2 Nitric Acid Production	N_2O	yes	Level, Trend
2(I).B.4 Calcium Carbide Production	CO_2	yes	Trend
2(I).C.1.1 Steel Production	CO_2	yes	Level, Trend
2(I).C.3 Aluminium Production	CO_2	yes	Trend
2(I).F HFCs emissions	HFCs	yes	Level, Trend
AGRICULTURE SECTOR			
4.A Enteric Fermentation - Cattle	CH_4	yes	Level, Trend
4.B Manure Management	N_2O	yes	Level, Trend
4.D Agricultural Soils - indirect	N_2O	yes	Level, Trend
4.D Agricultural Soils - direct	N_2O	yes	Level, Trend
WASTE SECTOR			
6.A Solid Waste Disposal on Land	CH_4	yes	Level, Trend
6.B Wastewater Handling	CH_4	yes	Level, Trend

1.6 Information on the QA/QC plan including verification

The Ministry of the 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.

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 SHMU as a global standard, the certification itself proceeds according to the partial processes inside of the SHMU 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 and Air Quality Monitoring formally fulfils the QMS requirements in the area of controlled documents and records in accordance with the QMS of the SHMU. The controlled documents and records are available at the quality manager of NIS and Ari Quality Monitoring in Slovak language. The quality manager 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.

Quality control process

The sectoral experts must adopt adequate procedures for development and modification of the spreadsheets to minimise emission calculation errors. Checks ensure compliance with the established procedures as well as allow detecting the remaining errors. Parameters, emission units and conversion factors used for the calculations must be clearly singled out and specified. Also, additional procedures should be followed to ensure that the parameters and emission factors are correctly written down and that relevant conversion factors are used:

- Emission units, parameters and conversion factors shall not be directly included in the formulas; any value used for the calculations more than once shall be given in the spreadsheets (preferably at the top of the page and in bold) and in the calculations, where they should be taken from one cell as a reference.
- Units shall be properly marked and correctly maintained during the entire calculation.
- Correct conversion factors shall be used and updated annually.
- Temporary coefficients shall be used correctly.

The experts must ensure data consistency in the databases and spreadsheets.

- Confirm that respective data processing steps have been correctly represented in the spreadsheets (e.g. correct formulas have been used).
- Confirm that data relations have been properly presented (e.g. that the data is of the same year and given in the same units).
- Clearly distinguish between the input data and the calculable data in the spreadsheets (including formulas or macros).

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

	Activity	Date of output	Form of output	Responsibility	QA/QC	Date of QA/QC	Output of QA/QC
1.	Annual Report 2012 -submission according to the Dec. 280/2004/EC, Art. 3.1.a-k 1. Preliminary GHG emission inventory for year 2010 2. Preliminary National Inventory Report SR 2012 (NIR)	15. January	Publicly available on CDR (Central data Repository) http://cdr.eionet.europa.eu/sk/eu	NIS coordinator	Completeness check of the Annual Report SR 2012 MoE SR - NFP	10.1.2012	Comments to the Annual Report SR 2012
2.	Inter-ministerial comments to the *Report on the actual status of fullfilment of adopted international commitments of the Slovak Republic in scope of climate change policy* – compliance of Gov. Res. B.3 UV SR No. 821/2011 – as of 19 December 2011; The report w ill include also results of the NIR SR 2012.	5. March	Evaluation table from the inter-ministerial comments to the document	MoE SR – NFP	Corection of the Report – based on comments	10.3.2012	Final *Report on the actual status of fullfilment of adopted international commitments of the Slovak Republic in scope of climate change policy* and revised text of the NIR SR 2012 according to the QA/QC outcomes - Report submitted to the Government al approval until the end of March 2012; - NIR SR 2012 uploaded to the oficial SR w eb site
3.	Submission of the revised Annual Report SR 2012 according to the Dec. 280/2004/EC art. 3.1.a-k: 1. GHG emission inventory report for the year 2010 2. NIR SR 2012 3. Evaluation of the key sources and total uncertainties of the GHG emission inventory for the year 2010	15. March	Uploaded to the CDR dbase	NIS coordinator	MoE-NFP	15.3.2012	Control after uploading Official announcement to the DG Climate Action
4.	Independent control of the preliminary GHG inventory and follow ing resubmissions according to the Decision No 280/2004/EC of the European Parliament and of the Council of 11 February 2004 concerning a mechanism for monitoring Community greenhouse gas emissions and for implementing the Kyoto Protocol performed by the experts from the EC.	15. January - 15. March	Questions-Answ ers, EC IR	NIS coordinator, NIS experts	European Commission	15.3.2012	Comments to the national inventory submission and the NIR.
5.	NIR SR 2012 – preparing for submission to the UNFCCC secretariat	30. March	First draft	NIS coordinator	Review and corections of the NIR SR 2012 first draft - MoE SR – NFP, SEs, Deputies of SE	5.4.2012	Final version of the NIR SR 2012
6.	Submission of the NIR SR 2012 to the UNFCCC secretariat: 1. GHG emission inventory for the year 2010 2. NIR SR 2012 3. Evaluation of the key sources and total uncertainties for the year 2010 4. KP-LULUCF tables for the year 2010 5. Reports from the National Emission Register for the year 2010	15.April	Publicated to the UNFCCC portal: https://unfccc.int/submisionportal/w ebportal/submissionstatusCompo nent	NIS coordinator		15.4.2012	Final version of the emission submission for the year 2010
7.	Release of the NIR SR 2012 and GHG emission inventory 2010 at official NIS w eb site	30.April	NIS w eb site upload w w w .ghg-inventory.shmu.sk	NIS coordinator	NIS deputy coordinator, Quality manager MoE SR - NFP	5.5.2012	

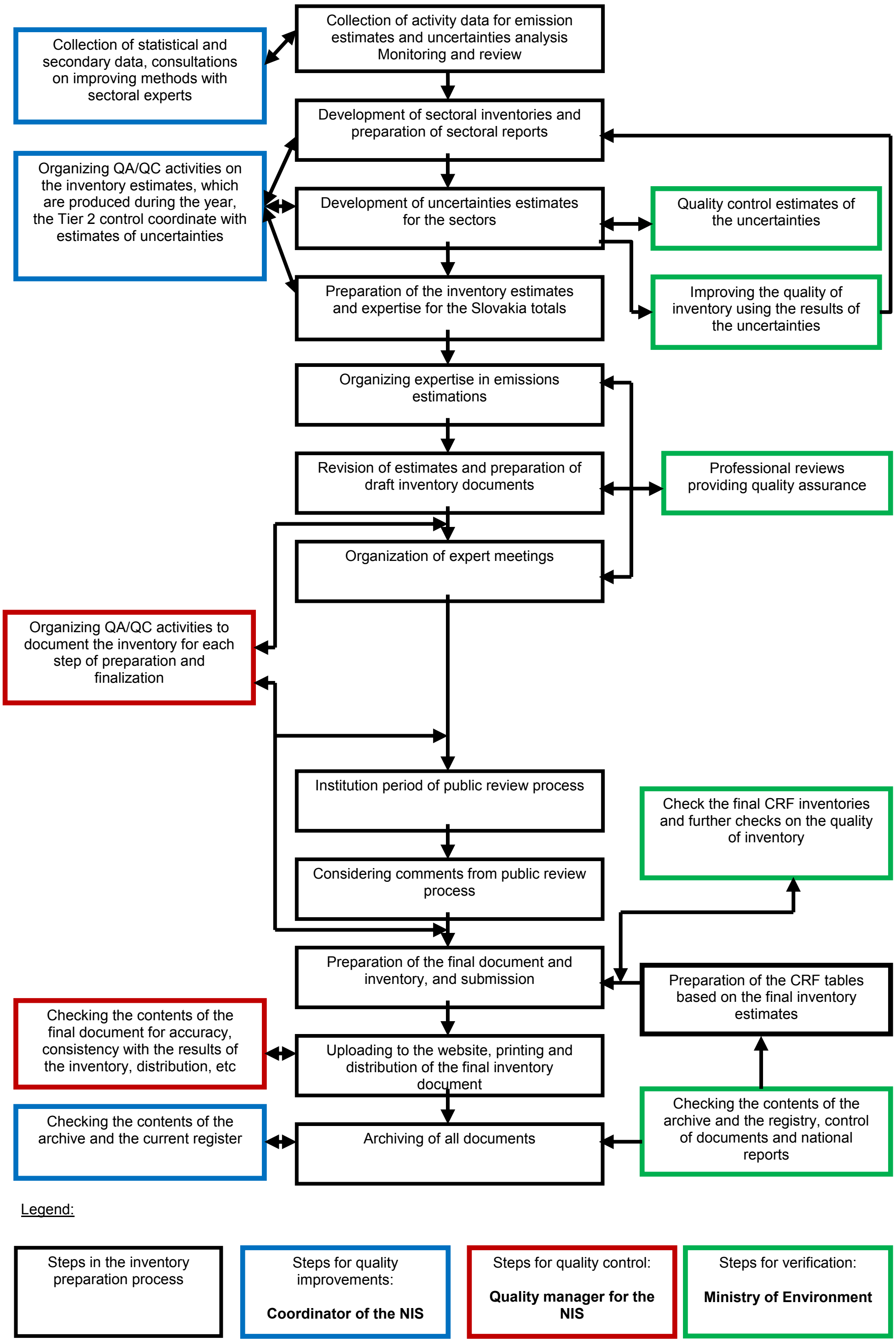
Table 1.6: Quality Assurance/Quality Control Plan – External – cont.

8.	Completion and resubmission of the NIR SR 2012 according to the UNFCCC Annual Status Report	27.May	Response to the Status Report	NIS coordinator		27.5.2012	
9.	Official control day – by MoE SR, control of quality and timing of fulfilment of the specific task included in the Plan of the Main tasks of the Slovak Environmental Agency for 2012 under the supervision of Climate Change Policy Dept. It concerns Task No 57: Preparation of Documents and Examination of Outputs during the Fulfilment of the Slovak Republic's Reporting Commitments in the Field of Greenhouse Gas Inventories for the Waste Sector	31. May	Report from the control.	MoE SR		31.5.2012	
10.	Official control day – by MoE SR, control of the fulfilment of the relevant tasks w hich are set in the Plan of the Main tasks of the SHMÚ for 2012 (Task No. 4224: Reporting obligations to the UNFCCC and EC; Task No. 2023: National Climate Programme) under the supervision of Climate Change Policy Dept.	30. June	Report from the control.	MoE SR		30.6.2012	
11.	Submission of GHG emission data to the Statistical Office of the SR. Distribution of the final NIR SR 2012 to the relevant subjects. Preparation of the Air Quality Report – chapter 5 for the SHMÚ.	31.August	Statistical yearbook - GHG emisssion data Air Quality Annual Report	NIS coordinator	Control of the fullfilment of the NIS tasks MoE SR - NFP	5.9.2012	Minutes from control day
12.	International review of the NIR SR 2012 coordinated by the UNFCCC secretariat.	July - October	UNFCCC Annual Review Report according to the desk, centralized or in-country review	NIS coordinator SEs Deputies of SEs MoE-NFP	ERT	TBD	Annual Review Report of the NIR SR 2012
13.	Official control day – by MoE SR, control of quality and timing of fulfilment of the specific task included in the Plan of the Main tasks of the Slovak Environmental Agency for 2012 under the supervision of Climate Change Policy Dept. It concerns Task No 57: Preparation of Documents and Examination of Outputs during the Fulfilment of the Slovak Republic's Reporting Commitments in the Field of Greenhouse Gas Inventories for the Waste Sector	30. November	Report from the control.	MoE SR		30.11.2012	
14.	Measures and objectives for improvements in QA/QC procedure for GHG emission inventory for relevant sectors pursuant to the outcomes of review process	30. October - 15. November	Proposals of measures, proposal of QA/QC plan for 2013	NIS coordinator SEs Deputies of SEs MoE-NFP	Adequacy check of the draft measures in relation to the financial sources and Plan of the main tasks of the MoE SR and SHMÚ for 2013	20.11.2012	Minutes from QA/QC meeting, draft proposals of the Plan of the main tasks of the SHMÚ, SAŽP (Slovak environment al agency) and MoE for the year 2013
15.	Official control day – by MoE SR, control of the fulfilment of the relevant tasks w hich are set in the Plan of the Main tasks of the SHMÚ for 2012 (Task No. 4224: Reporting obligations to the UNFCCC and EC; Task No. 2023: National Climate Programme) under the supervision of Climate Change Policy Dept.	31. December	Report from the control.	MoE SR		31.12.2012	

Table 1.7: Quality Assurance/Quality Control Plan - Internal

	Activity	Responsibility	Quality control	Time schedule	Record of actions
1.	Training a new employee for the position: Energy sector expert.	NIS Coordinator	Quality Manager	31.12.2012	Description of work activity
					Regular assessment of outcomes
2.	Specification of tasks and objectives for the year 2012, conclusion of annual contracts with all IPCC sectoral experts	NIS Coordinator,	External audit	31.1.2012	Framework agreement,
		Deputy of NIS Coordinator,	SHMU Director		Appendixes for the year concerned,
		Sectoral experts (SEs)	MoE SR – NFP		Official nominations of the IPCC sectoral experts by MoE
3.	Ensuring SE`s substitutability	SEs	NIS Coordinator	31. 3. 2012	Responsibility matrices,
	for all IPCC sectors	+ Deputies of SE	Quality Manager		Description of work activity,
			Deputy of NIS Coordinator		Contracts of work for the year 2012 for Deputies of SE
			MoE SR – NFP		
4.	Uncertainty assessment of the verified inventory data 2010 for each sector	Expert for the uncertainty,	NIS Coordinator	15. 1. 2012	Uncertainty assessment report
		SEs	Quality Manager		
			Deputy of NIS Coordinator		
5.	Final decision on 2010 inventory data for each sector on the basis of the Uncertainty assessment report and Assessment review report (ARR) SVK from the year 2011	NIS Coordinator,	Quality Manager	28. 2. 2012	Verification Protocol, proposal of changes- if appropriate
		Deputy of NIS Coordinator,	MoE SR - NFP		
		SEs			
6.	Participation in the individual evaluations and cooperation in preparing national responses within the review process of the UNFCCC secretariat.	SEs	NIS Coordinator	continuously	Responses to the review outcomes
			Quality Manager		
			Deputy of NIS		
7.	Throughout checking of work in progress for preparing emission inventory 2011	SEs	NIS Coordinator	30. 6. 2012	Minutes of the meeting
			Deputy of NIS Coordinator		
			Quality Manager		
			MoE SR – NFP		
8.	Update of methodologies and recalculation of data for individual sectors	SEs	NIS Coordinator	30. 11. 2012	Sectoral report
			Deputy of NIS Coordinator		
			Quality Manager		
9.	Approval of final reports for individual IPCC sectors	NIS Coordinator	MoE SR – NFP	30. 11. 2012	Approval protocol
		Deputy of NIS Coordinator			Individual reports for all followed IPCC sectors
		Quality Manager			
10.	Evaluation meeting of SEs, MoE- NFP and NIS Coordinator:	SEs,	Quality Manager	November 2012	Minutes of the meeting
	Agenda- evaluation of results and outcomes based on conclusions of internal and external NIR review process, proposals of measure to improve the quality of NIS for the next year	NIS Coordinator			
		Deputy of NIS Coordinator			
		MoE SR - NFP			
11.	Development of special software tool with inventory data accessible to all IPCC experts ;training on use of software for all SEs and Deputies of SE – planned actions, implementation depends on availability of resources	NIS Coordinator	Quality Manager	31. 12. 2012	Training certificate
			MoE SR – NFP		

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



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 of NIS.

QC procedures encourage quality in two ways:

- General procedures, which are intended for experts of individual sectors and used for documentation, data collection and emission calculation.

- Special activities to control and maintain data quality. Also, the procedures involve checks that should be carried out every year as part of QC activities. The checks involve verification of compliance with standardized procedures as well as provision of forms for documentation of non-compliance and corrective actions.

When checking the quality of data of each sector, the NIS coordinator and quality manager of NIS must conduct the following general activities:

- **Checking:** Check whether the data in the sectoral reports (calculations and documents) for each sector conform both to the general and specific procedures.
- **Documentation:** Write down all verification results filling out a checklist, including conclusions and irregularities to be corrected. Such documentation helps to identify potential ways for improving the inventory as well as stores evidence of the material that was checked and of the time when the check was performed.
- **Follow-up of corrective actions:** All corrective actions necessary for documenting the activities carried out and the results achieved must be taken. If such check does not provide a clear clue concerning the steps to be taken, the quality control, bilateral discussion between expert and NIS coordinator will take place.
- **Data transference:** All checking documentation (including the final questionnaire and all annexes) shall be put into the project file and copies shall be forwarded to all NIS experts. Since the data quality supervision procedures must be observed all the time, it is not mandatory to conduct all checks annually during the inventory preparation. Certain activities, such as verification of the electronic data quality or project documentation for checking whether all documents have been provided, must be carried out every year or at least at set intervals. Some checks may be conducted only once (however, comprehensively) and then only from time to time.

Quality control involves the following steps:

1. Evaluation of the data collection procedure, to establish whether:
   - the necessary methods, activity data and emission factors (i.e. those in conformity with the IPCC Good Practice Guidance) have been used;
   - the calculations have been made correctly;
   - all-time series data has been provided and calculated;
   - the data and results for the current year have been compared with the data and results of the previous years;
   - the notes and comments contain all necessary information on the data sources, calculation methods, etc.
2. Evaluation of the emission calculation, to establish:
   - consistency of the emission factors used;
   - correctness of the emission parameters, units, conversion factors used;
   - correctness of the data transferred from spreadsheets to CRF tables;
   - correctness of recalculations.
3. Evaluation of the preparation of respective chapters of the National Inventory Report, to establish:
   - integrity of the structures of the inventory data;
   - completeness of the inventory;
   - consistency of time series;
   - whether the emission estimates have been compared with previous estimates;

- whether the data tables of the National Inventory Report correspond to the text;
- whether all necessary information on the data sources, assumptions and calculation methodology has been provided.

The steps in QA/QC activities are managed and documented in several protocols (verification protocol, recalculation protocol, contracts or sectoral reports) which are in full compliance with internal documentation. 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. The results of the check are recorded in a verification protocol, the form of which is given in the quality management system of the SHMU. The sectoral experts shall fill out the first article, sign and shall respond to the comments, specify the actions taken in response to the comments (if necessary, correct the data, calculation methodology or the report accordingly). Quality manager shall fill out the second article, check and sign. NIS coordinator shall fill out the third article, check, sign and return the verification protocol for archiving.

1.6.3 Archiving

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

The archiving is controlled by rules for archiving systems in organizations at the SHMU 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 SHMU (intranet). Printed documents are archiving in central archive of the SHMU and at the Department of Emissions and Air Quality Monitoring.

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 7.77% level uncertainty and the 4.78% trend uncertainty in 2010.

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 -75.65; +72.03% in 2010. The Tier 2 uncertainty analyses for fuel combustion in energy sector according to the fuels classification was estimated in the range of confidence interval -2.84%; +3.89% in 2010.

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 -2.49%; +2.52% in 2010. Results were published in following papers[10,11] and detail are descript in Chapters 3 – 9 of this report.

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

[11] *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 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 2012 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 in-country review for the annual GHG inventory submission 2011 several categories were completed which were not reported in the previous submission and which are the following:

- Industrial Processes – F-Gases consumption, category 2.F.2 – Foam Blowing agents and category 2.F.4 – Aerosols.

No NE categories are occurring in 2012 submission for 2010. The IE categories and gases are explained in Table 9(a) CRF and the description will be included in the NIR 2012.

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).

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

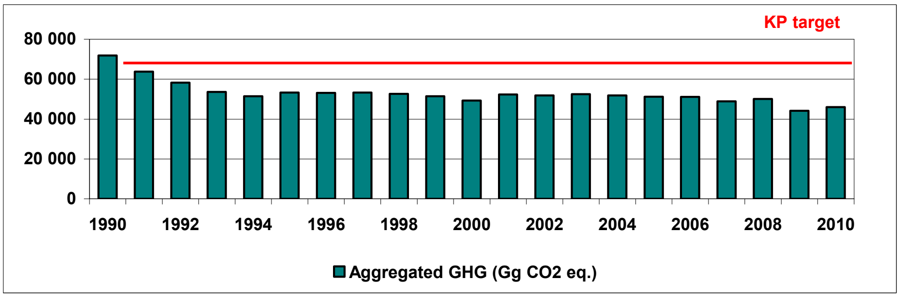
A complete set of CRF tables are provided for all years and the estimates are calculated in a consistent manner. The detail information is provided in Annex 4.

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 2012 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 in-country review of the Slovak Republic were taken into account only partly by the inventory compilation 2012 because of the late delivery of the draft Annual Review Report 2011 (March 2012) and subsequent final ARR 2012. Total GHG emissions were 45 981.87 Gg in 2010 (without LULUCF). This represents a reduction by 35.94% in comparison with the reference (base) year 1990. In comparison with 2009, the emissions increased by 4%. Total GHG emissions in the Slovak Republic slightly increased in 2010 in comparison with the previous year, which is a signal of recovery of economy after the economic and financial crises 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 stable trend 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 – 2010, 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 15.04.2012

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 in 1990 – 2010

GREENHOUSE GAS EMISSIONS	Base year (1990)	1991	1992	1993	1994	1995	1996	1997
	CO2 equivalent (Gg)							
CO2 emissions including net CO2 from LULUCF	50 423,66	42 924,84	36 585,75	33 694,75	32 086,10	33 891,76	33 845,74	33 699,49
CO2 emissions excluding net CO2 from LULUCF	60 745,23	54 091,96	49 749,76	46 078,75	43 526,70	44 879,11	44 699,10	44 811,47
CH4 emissions including CH4 from LULUCF	4 457,96	4 339,70	4 100,86	3 871,11	3 896,55	4 107,21	4 104,62	4 159,23
CH4 emissions excluding CH4 from LULUCF	4 443,87	4 330,73	4 092,84	3 863,00	3 888,02	4 097,66	4 094,40	4 147,96
N2O emissions including N2O from LULUCF	6 326,79	5 027,93	4 172,26	3 529,21	3 867,73	4 100,47	4 252,78	4 166,69
N2O emissions excluding N2O from LULUCF	6 314,70	5 021,91	4 146,10	3 498,08	3 864,53	4 096,97	4 243,39	4 163,50
HFCs	NA,NO	NA,NO	NA,NO	NA,NO	2,91	22,15	37,58	61,13
PFCs	271,37	266,94	248,42	155,42	132,06	114,32	34,51	34,62
SF6	0,03	0,03	0,04	0,06	9,27	9,91	10,76	11,34
Total (including LULUCF)	**61 479,81**	**52 559,45**	**45 107,34**	**41 250,54**	**39 994,61**	**42 245,83**	**42 286,00**	**42 132,50**
Total (excluding LULUCF)	**71 775,20**	**63 711,58**	**58 237,17**	**53 595,32**	**51 423,49**	**53 220,12**	**53 119,74**	**53 230,01**

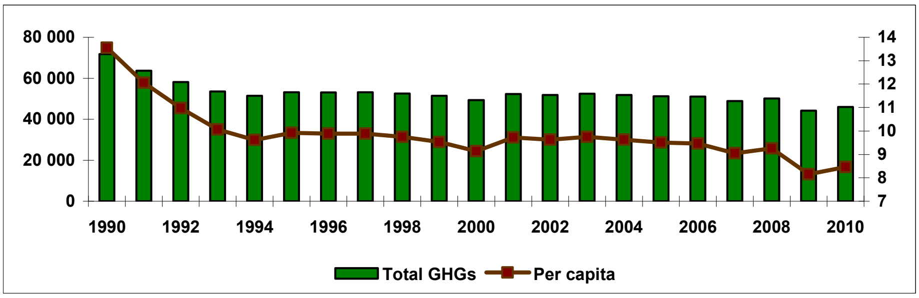
GREENHOUSE GAS EMISSIONS	Base year (1990)	1998	1999	2000	2001	2002	2003	2004
	CO2 equivalent (Gg)							
CO2 emissions including net CO2 from LULUCF	50 423,66	31 141,89	33 014,77	31 035,52	34 227,65	32 586,48	33 934,09	34 058,10
CO2 emissions excluding net CO2 from LULUCF	60 745,23	44 324,34	43 434,62	41 367,41	44 168,53	42 886,59	43 609,64	43 028,80
CH4 emissions including CH4 from LULUCF	4 457,96	4 415,41	4 628,37	4 335,85	4 393,62	5 001,30	4 837,26	4 738,28
CH4 emissions excluding CH4 from LULUCF	4 443,87	4 404,14	4 615,57	4 324,09	4 379,35	4 987,26	4 822,15	4 721,08
N2O emissions including N2O from LULUCF	6 326,79	3 758,30	3 272,53	3 578,53	3 688,13	3 798,08	3 829,69	3 867,70
N2O emissions excluding N2O from LULUCF	6 314,70	3 757,27	3 269,33	3 541,24	3 684,94	3 796,75	3 823,40	3 863,30
HFCs	NA,NO	40,96	65,39	80,97	88,54	109,04	139,16	160,57
PFCs	271,37	25,40	13,60	11,65	15,59	13,75	21,65	19,91
SF6	0,03	12,24	12,69	13,25	13,84	14,78	15,39	15,89
Total (including LULUCF)	**61 479,81**	**39 394,20**	**41 007,35**	**39 055,77**	**42 427,37**	**41 523,43**	**42 777,24**	**42 860,45**
Total (excluding LULUCF)	**71 775,20**	**52 564,35**	**51 411,20**	**49 338,61**	**52 350,79**	**51 808,16**	**52 431,39**	**51 809,55**

GREENHOUSE GAS EMISSIONS	Base year (1990)	2005	2006	2007	2008	2009	2010	Change from base to 2010
	CO2 equivalent (Gg)							(%)
CO2 emissions including net CO2 from LULUCF	50 423,66	37 350,31	34 158,31	32 272,64	34 103,85	28 774,62	31 908,59	-36,72
CO2 emissions excluding net CO2 from LULUCF	60 745,23	42 659,75	42 096,82	40 079,57	41 225,58	36 030,96	38 024,57	-37,40
CH4 emissions including CH4 from LULUCF	4 457,96	4 543,57	4 613,75	4 523,78	4 669,09	4 326,55	4 233,19	-5,04
CH4 emissions excluding CH4 from LULUCF	4 443,87	4 521,13	4 594,85	4 505,04	4 648,04	4 305,78	4 210,28	-5,26
N2O emissions including N2O from LULUCF	6 326,79	3 819,82	4 091,09	4 016,01	3 878,27	3 515,34	3 389,39	-46,43
N2O emissions excluding N2O from LULUCF	6 314,70	3 814,48	4 087,92	4 007,84	3 876,43	3 508,30	3 384,74	-46,40
HFCs	NA,NO	180,48	207,43	235,65	273,19	308,87	321,23	100,00
PFCs	271,37	20,25	35,82	24,88	36,16	17,76	21,15	-92,20
SF6	0,03	16,61	17,15	17,44	18,51	19,39	19,90	64 954,69
Total (including LULUCF)	**61 479,81**	**45 931,05**	**43 123,56**	**41 090,40**	**42 979,08**	**36 962,53**	**39 893,45**	**-35,11**
Total (excluding LULUCF)	**71 775,20**	**51 212,71**	**51 040,00**	**48 870,43**	**50 077,91**	**44 191,07**	**45 981,87**	**-35,94**

Total aggregated GHGs emission without LULUCF, emissions are determined as of 15.04.2012

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 economic growth, GHG per capita is a different case where you can get very impressive results even without any 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 – 2010



2.2 Description and interpretation of emission trends by gas

Total anthropogenic emissions of carbon dioxide excluding LULUCF have decreased by 37.40% compared to the base year (1990). Nowadays the amount is 38 024.57 Gg of CO_2. Compared to the previous inventory year, the increase is visible. The reason for the increase in CO_2 emissions in 2010 is caused mainly by increasing CO_2 emissions in energy and industrial processes sectors. In 2010, CO_2 emissions including LULUCF sector decreased by 36.72% compared to the base year, and they increased by approximately 3 000 Gg compared to the previous year. In 2010, CO_2 emissions increased mainly due to the increase of industrial production and the decrease in LULUCF sinks.

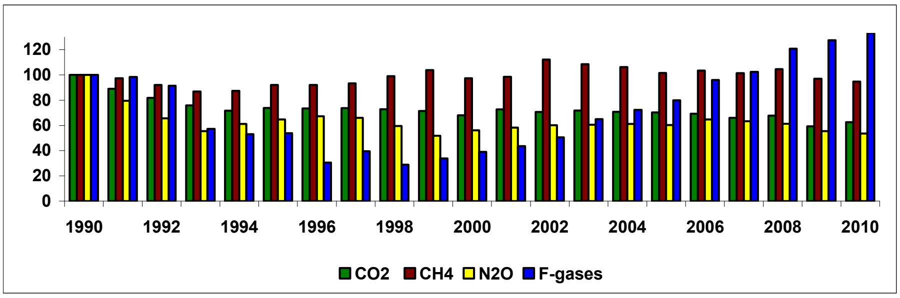
Total anthropogenic emissions of methane without LULUCF decreased compared to the base year (1990) by 5.26% and currently the emissions are 4 210.28 Gg of CO_2 equivalents. In absolute value,

CH_4 emissions were 200.49 Gg without LULUCF. Methane emissions from LULUCF sector are 1.09 Gg of CH_4 caused by forest fires. The trend has been relatively 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 46.40% and currently the emissions are 3 384.74 Gg of CO_2 equivalents. Emissions of N_2O in absolute value were 10.92 Gg without LULUCF. Emissions of N_2O from LULUCF sector are 0.02 Gg from forest fires. Emissions decreased compared to the previous year 2009 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 32.22 Gg of HFCs, 21.15 Gg of PFCs and 19.90 Gg of SF_6 in CO_2 equivalents. Emissions of HFCs have 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.

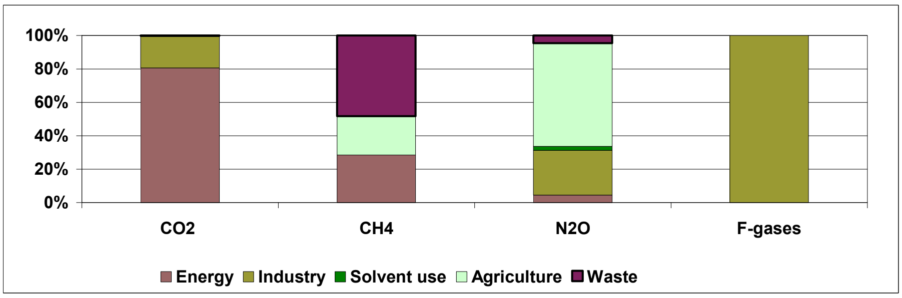
Figure 2.3: Emission trends by gas for the years 2000 – 2010 relative to the 1990 level (100%)



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 80.60% share from the total carbon dioxide emissions in 2010 inventory, 19.08% of CO_2 is produced in industrial processes and negligible amount is produced in waste (0.10%) and solvent use sectors (0.22%). The energy related CO_2 emissions from waste incineration are included in energy sector. The 48.24% of CH_4 emissions is produced in waste sector (SWDS), 28.54% of methane emissions is produced in energy sector and 23.18% in agriculture sector. More than 61.73% of N_2O emissions are produced in agriculture sector (fermentation), 26.71% in industrial processes sector (nitric acid production) and 4.63% 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 2010



Aggregated GHG emissions from energy sector based on sectoral approach data in 2010 were estimated to be 32 007.79 Gg of CO_2 equivalents including transport emissions (6 654.12 Gg of CO_2 equivalents), which represent the decrease by 40.62% compared to the base year and 4.8% increase in comparison with 2009. Transport sub-sector increased by 7.8% compared to 2009 and in comparison with the base year it raised by 32.3%.

Total emissions from industrial processes sector were 8 522.07 Gg of CO_2 equivalents in 2010, which was decreased by 10.70% compared to the base year and the increased by 2.6% compared to the previous year. Intensive increase of industrial production has caused the increase in emissions. Total emissions from sector of solvent use were estimated to be 164.35 Gg of CO_2 equivalents, which is the increased by about 11.68% compared to the base 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.

Emissions from agriculture sector were estimated to be 3 065.33 Gg of CO_2 equivalents. It is 56.75% decrease in comparison with the base year and 1.5% increase in comparison to the previous year. The agriculture sector is the sector with the most significant decrease compared to the base year 1990, because of the decreasing trend in cattle numbers.

Emissions from waste sector were estimated to be 2 222.15 Gg of CO_2 equivalents. The increase is 2.7% compared to the previous inventory year and the time series are stable for last years. Compared to the base year, the increase was 103.62%, because of increased methane emissions from solid waste disposal sites. The emissions from waste incineration with energy use are included 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 1991 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

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	Base year (1990)	1991	1992	1993	1994	1995	1996	1997
	CO2 equivalent (Gg)							
1. Energy	53 905,54	48 741,91	44 617,12	40 846,95	37 992,45	39 008,15	39 007,26	38 873,56
2. Industrial Processes	9 543,26	7 737,66	7 400,44	7 242,93	8 025,77	8 562,82	8 561,06	8 788,12
3. Solvent and Other Product Use	147,15	126,64	110,00	101,65	102,96	121,53	115,50	97,62
4. Agriculture	7 087,91	5 999,47	4 999,64	4 284,76	4 127,29	4 294,91	4 142,30	3 986,27
5. Land Use, Land-Use Change and Forestry(5)	-10 295,39	-11 152,13	-13 129,83	-12 344,78	-11 428,88	-10 974,29	-10 833,74	-11 097,51
6. Waste	1 091,33	1 105,90	1 109,98	1 119,03	1 175,03	1 232,71	1 293,62	1 484,45
7. Other	NA	NA	NA	NA	NA	NA	NA	NA
Total (including LULUCF)	**61 479,81**	**52 559,45**	**45 107,34**	**41 250,54**	**39 994,61**	**42 245,83**	**42 286,00**	**42 132,50**

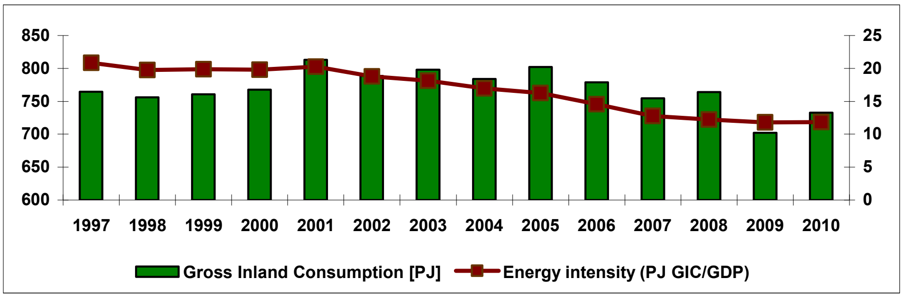
GREENHOUSE GAS SOURCE AND SINK CATEGORIES	Base year (1990)	1998	1999	2000	2001	2002	2003	2004
	CO2 equivalent (Gg)							
1. Energy	53 905,54	38 008,92	36 926,13	35 723,27	38 220,25	36 420,60	37 387,86	35 844,28
2. Industrial Processes	9 543,26	8 954,78	8 881,80	8 298,09	8 756,68	9 131,68	9 006,25	10 110,80
3. Solvent and Other Product Use	147,15	94,45	90,52	85,04	99,74	131,92	137,35	163,49
4. Agriculture	7 087,91	3 677,37	3 420,02	3 455,17	3 463,27	3 539,48	3 397,98	3 223,62
5. Land Use, Land-Use Change and Forestry(5)	-10 295,39	-13 170,15	-10 403,85	-10 282,84	-9 923,42	-10 284,74	-9 654,15	-8 949,10
6. Waste	1 091,33	1 828,83	2 092,74	1 777,04	1 810,85	2 584,46	2 501,90	2 467,29
7. Other	NA	NA	NA	NA	NA	NA	NA	NA
Total (including LULUCF)	**61 479,81**	**39 394,20**	**41 007,35**	**39 055,77**	**42 427,37**	**41 523,43**	**42 777,24**	**42 860,45**

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	Base year (1990)	2005	2006	2007	2008	2009	2010	Change from base to 2010
	CO2 equivalent (Gg)							(%)
1. Energy	53 905,54	36 100,02	34 962,78	33 112,59	34 549,08	30 540,55	32 007,79	-40,62
2. Industrial Processes	9 543,26	9 381,76	10 211,48	9 961,18	9 839,54	8 303,32	8 522,07	-10,70
3. Solvent and Other Product Use	147,15	171,54	170,59	166,25	166,59	164,38	164,35	11,68
4. Agriculture	7 087,91	3 213,16	3 162,43	3 267,68	3 152,56	3 018,59	3 065,33	-56,75
5. Land Use, Land-Use Change and Forestry(5)	-10 295,39	-5 281,66	-7 916,44	-7 780,03	-7 098,83	-7 228,54	-6 088,42	-40,86
6. Waste	1 091,33	2 346,13	2 532,60	2 362,59	2 369,99	2 164,06	2 222,15	103,62
7. Other	NA	NA	NA	NA	NA	NA	NA	0,00
Total (including LULUCF)	**61 479,81**	**45 931,05**	**43 123,56**	**41 090,40**	**42 979,08**	**36 962,53**	**39 893,45**	**-35,11**

Emissions are determined as of 15.04.2012

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 2010. Energy intensity is still higher than the average in the EU-15 (member states before 2004 enlargement), in spite of its continual decrease. Reason for that is the adversely high share of energy intensive industry in GDP. This trend can be illustrated 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 1997 – 2010 (estimated by the revised statistical approach NACErev.2)



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 V version 8.1. 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 2010 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 2010 methodology. Emissions are recalculated according to the 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.[12]

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 NMVOC are regularly estimated within the National Program of NMVOC 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 NMVOC 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 (No. 478/2002 Coll.) 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 NMVOC 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

[12] *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*

and import of solvent paints. New emission factors respect that asphalt mixture contains 5.5% of asphalt and others are created by aggregate.

Emissions in road transportation were prepared by the model of COPERT IV version 8.1 and the time series were recalculated. Calculation in model COPERT IV is based on EMEP/EEA Guidebook methodology. This methodology is balancing fifteen different emissions including greenhouse gases from road transport. Preparation of basic pollutants inventory is based on sequence calculation for each vehicle category and summing. Emission factors are set by model and are different for all types of fuel, different vehicle categories and different technological level. Vehicle fleet of road transport has been divided into 6 basic categories and 83 subcategories. These subcategories are divided to urban, road and highway transportation.

Major recalculations in 2011´s submission were provided in road transport category. The recalculated emissions were prepared by using the new model version of COPERT IV, 8.1. Version 8.1 updates new technical parameters for the individual vehicles categories and country specific factors. The more detail disaggregation of vehicles categories were provided based on age, type of energy used and weight. The recalculated emissions present impact of economic situation and economic crises, which influenced the fuel consumption in Slovakia. The gasoline consumption in road transport decreased in comparison with the previous year by 5% in 2010. On the other hand the diesel oil consumption increased by 12% at the same period. The increasing trend in road transport emission is continuing with consistency in increasing of vehicles numbers and number of trip. The NMVOC emissions in waste sector were recalculated due to the updating of activity data for industrial and hospital waste incineration (new statistical information is available)

Table 2.3: Anthropogenic emissions of NO_x, CO, NM VOC and SO_2 (Gg) in 1990 – 2010

Year	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
CO	**521,38**	**497,08**	**455,31**	**466,57**	**442,15**	**426,85**	**366,48**	**364,31**	**347,37**	**334,93**
Stationary	351,26	340,23	299,99	301,05	272,63	258,90	208,18	205,61	187,61	185,36
Transport	164,00	151,87	151,29	161,36	165,92	163,93	153,84	153,97	155,12	144,22
Other*	6,12	4,97	4,03	4,16	3,60	4,02	4,46	4,74	4,64	5,36
NO_x	**226,59**	**204,42**	**190,54**	**181,54**	**171,31**	**179,07**	**135,53**	**127,44**	**132,79**	**120,62**
Stationary	160,46	150,21	141,73	135,26	122,39	128,01	89,42	82,10	86,43	77,41
Transport	61,48	50,72	45,65	43,59	44,84	46,59	45,62	44,84	45,89	42,72
Other*	4,66	3,50	3,16	2,70	4,07	4,48	0,49	0,50	0,47	0,49
NM VOC	**133,60**	**NA,NE**	**NA,NE**	**102,47**	**NA,NE**	**91,10**	**86,95**	**80,84**	**74,72**	**68,01**
Energy	41,02	NA,NE	NA,NE	34,43	NA,NE	27,52	28,30	27,28	24,09	22,85
Industry	8,79	NA,NE	NA,NE	5,87	NA,NE	2,82	2,68	2,67	1,58	1,51
Transport	25,73	NA,NE	NA,NE	25,44	NA,NE	22,99	21,59	21,01	18,21	14,61
Solvent Use	52,87	NA,NE	NA,NE	34,97	NA,NE	37,07	33,80	29,29	30,18	28,41
Agriculture	0,65	NA,NE	NA,NE	0,44	NA,NE	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
SO_2	**524,13**	**443,93**	**388,27**	**326,96**	**243,88**	**244,84**	**229,12**	**203,20**	**182,55**	**172,96**
Stationary	522,69	442,77	387,24	326,04	242,91	243,80	228,06	202,14	181,39	171,88
Transport	1,44	1,16	1,03	0,92	0,97	1,04	1,06	1,06	1,16	1,09

Year	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
CO	**305,91**	**310,49**	**295,85**	**298,40**	**299,34**	**281,40**	**280,42**	**252,04**	**253,67**	**217,71**	**230,64**
Stationary	185,16	175,59	165,14	184,20	189,56	181,39	193,51	183,33	178,41	148,05	165,68
Transport	114,89	128,97	124,86	107,73	102,67	90,64	78,97	60,78	66,55	60,93	55,42
Other*	5,86	5,92	5,85	6,47	7,11	9,36	7,94	7,93	8,71	8,73	9,55
NO_x	**107,75**	**108,10**	**100,54**	**98,16**	**99,45**	**102,39**	**96,80**	**96,05**	**94,23**	**83,43**	**89,09**
Stationary	70,32	67,58	59,70	58,37	56,51	55,39	52,09	46,84	45,79	41,08	42,69
Transport	36,89	39,97	40,30	39,22	42,30	46,20	43,99	48,49	47,70	41,53	45,52
Other*	0,54	0,54	0,53	0,57	0,64	0,80	0,73	0,72	0,75	0,82	0,88
NM VOC	**67,09**	**68,75**	**66,89**	**68,78**	**70,48**	**71,46**	**68,74**	**67,24**	**65,60**	**64,28**	**62,40**
Energy	21,97	22,48	20,29	21,33	23,00	24,87	22,77	22,25	22,12	21,37	21,51
Industry	1,37	1,32	1,39	1,68	1,69	1,59	1,56	1,53	1,38	1,26	1,25
Transport	16,14	15,66	13,62	12,92	12,44	10,85	9,16	9,31	7,77	7,73	7,19
Solvent Use	26,98	28,72	31,02	32,27	32,76	33,56	34,63	33,58	33,78	33,33	31,86
Agriculture	0,44	0,44	0,44	0,44	0,44	0,44	0,44	0,44	0,44	0,44	0,44
Waste	0,19	0,13	0,13	0,14	0,15	0,15	0,18	0,14	0,12	0,13	0,15
SO_2	**126,95**	**131,11**	**103,35**	**105,50**	**96,19**	**89,01**	**87,75**	**70,56**	**69,41**	**64,08**	**69,41**
Stationary	126,09	130,24	102,55	105,29	95,97	88,77	87,53	70,31	69,15	63,85	69,12
Transport	0,86	0,87	0,79	0,21	0,22	0,24	0,22	0,25	0,26	0,24	0,28

**Biomass burning and forest fires, emissions are determined as of 15.02.2012.*

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 No. 478/2002 Coll. on Air Protection as amended and Decree of the Ministry of Environment of the Slovak Republic No. 705/2002 Coll. 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 2010, total CO_2 removals from afforestation/reforestation activities were -511.99 Gg of CO_2 (changed in 30.25 kha at the end of 2010). Total CO_2 emissions from deforestation were 180.63 Gg of CO_2 (changed in 6.66 kha at the end of 2010). In 2010, total emissions under the Article 3.3 of the KP -331.36 Gg with the changed area of 37.69 kha.

Table 2.4: Emissions and removals resulting from activities 3.3 of the KP in 2008 – 2010

Activities	2008	2009	2010	Total
	Net CO2 (Gg)			
A. Article 3.3 activities	-278,64	-187,08	-331,36	**-797,09**
A.1. Afforestation and Reforestation	-453,12	-469,30	-511,99	**-1 434,41**
A.1.1. Units of land not harvested since the beginning of the commitment period	-453,12	-469,30	-511,99	**-1 434,41**
A.1.2. Units of land harvested since the beginning of the commitment period	NA	NA	NA	**NA**
A.2. Deforestation	174,47	282,22	180,63	**637,32**

Table 2.5: Total areas and changes in 2010

		Article 3.3 activities		Article 3.4 activities				Other	Total area at the beginning of the current inventory year
		Afforestation and Reforestation	Deforestation	Forest Management	Cropland Management	Grazing Land Management	Revegetation		
		(kha)							
Article 3.3 activities	**Afforestation and Reforestation**	30,26	NO						30,26
	Deforestation		7,44						7,44
Article 3.4 activities	**Forest Management**		NA	NA					NA
	Cropland Management	NA	NA		NA	NA	NA		NA
	Grazing Land Management	NA	NA		NA	NA	NA		NA
	Revegetation	NA			NA	NA	NA		NA
Other		2,73	0,33	NA	NA	NA	NA	4 863,04	4 866,10
Total area at the end of the current inventory year		32,99	7,77	NA	NA	NA	NA	4 863,04	**4 903,79**

Emissions are determined as of 15.04.2012

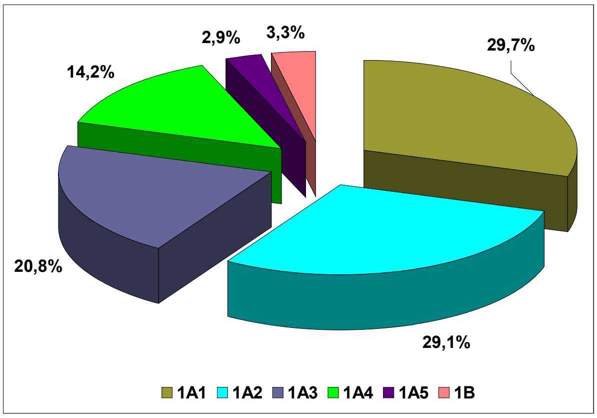
CHAPTER 3: ENERGY (CRF 1)

3.1 Overview of sector (CRF 1)

Energy sector is the main contributor to overall GHG emissions with its share of 69.6% and 32 007.79 Gg of CO_2 equivalents in 2010. Within this sector, transport contributes 21% to GHG emissions and it shows the most increasing trend. The share of transport in total emissions has increased since 1990 by 11.5% up to 2010. 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 transmission/transport/distribution, processing and storage 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 as 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 2010



1A1	Energy Industries	29,70%
1A2	Manufacturing Industries and Construction	29,11%
1A3	Transport	20,79%
1A4	Other Sectors	14,20%
1A5	Other	2,93%
1B	Fugitive Emissions from Fuels	3,27%

Figure 3.2: Trend in aggregated emissions by categories within energy sector in 1990 – 2010

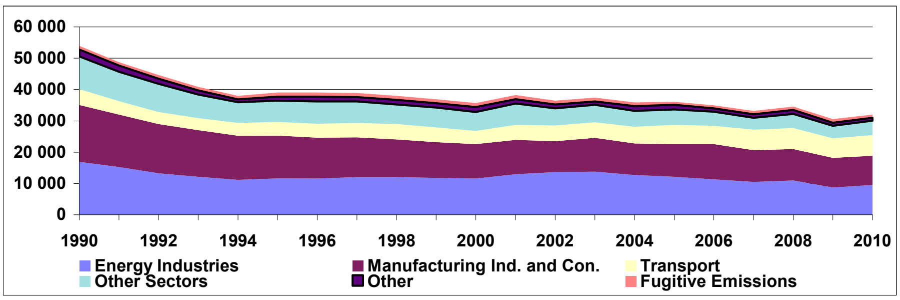


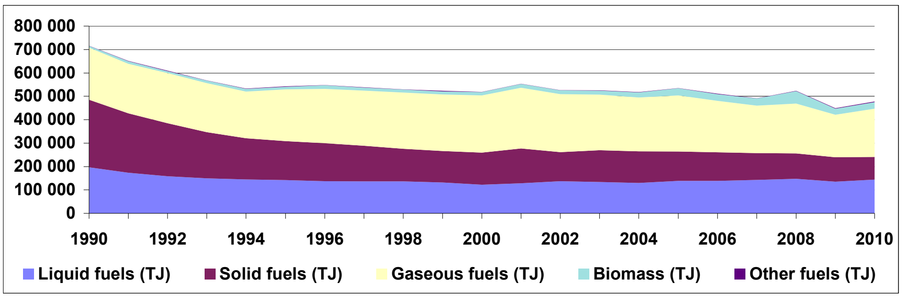
Table 3.1: The share of GHG emissions by categories within energy sector in 1990 – 2010

	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	**52 469,54**	52 469,39	0,15	**55,95**	4,30	51,65	**0,84**	0,84	2,05E-05
1991	**47 281,95**	47 281,82	0,13	**58,81**	5,02	53,79	**0,73**	0,73	1,45E-05
1992	**43 188,95**	43 188,82	0,13	**58,61**	4,43	54,18	**0,64**	0,64	1,28E-05
1993	**39 427,20**	39 427,06	0,13	**58,94**	5,24	53,70	**0,59**	0,59	1,17E-05
1994	**36 517,87**	36 517,73	0,14	**61,89**	5,39	56,50	**0,56**	0,56	1,33E-05
1995	**37 476,77**	37 476,62	0,15	**64,44**	5,61	58,83	**0,57**	0,57	1,59E-05
1996	**37 432,82**	37 432,66	0,16	**66,32**	6,52	59,80	**0,59**	0,59	1,45E-05
1997	**37 297,95**	37 297,79	0,16	**66,56**	5,97	60,59	**0,57**	0,57	1,33E-05
1998	**36 381,72**	36 381,55	0,17	**69,14**	5,96	63,18	**0,57**	0,57	1,20E-05
1999	**35 337,47**	35 337,30	0,17	**67,47**	5,99	61,49	**0,55**	0,55	9,84E-06
2000	**34 107,55**	34 107,37	0,18	**69,08**	6,19	62,88	**0,53**	0,53	8,00E-06
2001	**36 609,42**	36 609,23	0,19	**68,12**	6,93	61,19	**0,58**	0,58	9,05E-06
2002	**34 860,42**	34 860,24	0,18	**66,12**	6,68	59,44	**0,55**	0,55	8,18E-06
2003	**35 861,62**	35 861,43	0,19	**64,11**	7,06	57,04	**0,58**	0,58	1,08E-05
2004	**34 362,81**	34 362,63	0,18	**62,39**	8,29	54,09	**0,55**	0,55	7,61E-06
2005	**34 674,82**	34 674,65	0,17	**58,87**	10,74	48,13	**0,61**	0,61	6,78E-06
2006	**33 594,35**	33 594,17	0,17	**56,74**	9,94	46,80	**0,57**	0,57	8,94E-06
2007	**31 721,67**	31 721,52	0,15	**58,27**	9,31	48,96	**0,54**	0,54	5,91E-06
2008	**32 936,28**	32 936,13	0,15	**66,99**	16,14	50,86	**0,66**	0,66	4,70E-06
2009	**29 074,51**	29 074,27	0,24	**62,29**	7,60	54,69	**0,51**	0,51	4,75E-06
2010	**30 649,39**	30 649,21	0,19	**57,23**	7,32	49,91	**0,51**	0,51	4,79E-06

In 2010, the consumption of brown coal was only 6% of its 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 decline in gaseous fuels is 14%. By comparison, the consumption of biomass was 5 times higher in 2010 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 – 2010



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 of total GHG emissions in CO_2 equivalents. It is especially public energy provided for power and heat supplies, industrial energy – energy production for technological processes, road transport and the last but not the least district heating – heat supply for block of flats and dwelling houses, public equipment and services and objects of non-productive sphere.

Total aggregated emissions from fuel combustion, including transport, based on sectoral approach methodology represented 30 649.39 Gg of CO_2 equivalents in 2010. This amount increased by more than 5% compared to the previous year and decreased by 41% 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 terminated provision of the subsidies for 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 electric power, 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 2010

	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 uses 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 2010, total aggregated fugitive emissions in category 1.B represented 1 048.23 Gg of CO_2 equivalents. This amount decreased by almost 9% comparable to the previous year and decreased by 5% 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 – 2010 were calculated based on the coal production from underground mines, obtained from the official statistical sources and mine 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 – 2010

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**
2010	2 370,00	13,796	0,032	1,429	**15,225**

Table 3.4: Reported emissions in category fugitive emissions within energy sector in 2010

	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 – 2010

	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	**52 469,392**	16 819,207	18 093,021	4 894,55740	10 442,830	2 219,775	4,296	0,84235
1991	**47 281,817**	15 167,458	16 723,758	4 116,95671	9 341,967	1 931,677	5,017	0,72570
1992	**43 188,822**	13 211,296	15 622,082	3 790,12428	8 920,191	1 645,129	4,435	0,63658
1993	**39 427,063**	12 101,965	14 794,507	3 765,66503	7 402,491	1 362,435	5,236	0,58744
1994	**36 517,729**	11 080,101	14 048,161	4 006,04226	6 524,296	859,129	5,391	0,56440
1995	**37 476,617**	11 601,222	13 572,669	4 249,62805	6 686,118	1 366,980	5,613	0,57434
1996	**37 432,662**	11 486,217	13 071,345	4 301,72589	7 034,102	1 539,272	6,518	0,58620
1997	**37 297,793**	12 019,120	12 659,266	4 464,48769	6 720,249	1 434,669	5,965	0,57386
1998	**36 381,552**	12 011,788	12 009,627	4 742,30368	6 174,187	1 443,646	5,963	0,56505
1999	**35 337,300**	11 728,697	11 363,394	4 629,00151	6 216,817	1 399,391	5,986	0,55398
2000	**34 107,373**	11 489,803	10 991,223	4 151,96954	5 921,593	1 552,786	6,194	0,53260
2001	**36 609,231**	12 883,265	10 982,179	4 702,71732	6 623,831	1 417,239	6,933	0,58140
2002	**34 860,243**	13 521,073	9 910,298	4 837,06112	5 406,362	1 185,449	6,677	0,55406
2003	**35 861,425**	13 714,988	10 717,788	4 949,56707	5 387,750	1 091,332	7,063	0,58072
2004	**34 362,633**	12 638,695	10 050,811	5 210,93444	4 932,643	1 529,549	8,295	0,55280
2005	**34 674,652**	12 063,670	10 358,914	6 164,34701	4 660,263	1 427,459	10,742	0,60932
2006	**33 594,171**	11 250,946	11 229,223	5 763,35851	4 301,560	1 049,083	9,941	0,57058
2007	**31 721,518**	10 468,208	10 087,792	6 425,06151	3 602,799	1 137,657	9,307	0,53944
2008	**32 936,133**	10 898,136	9 995,288	6 616,27697	4 124,181	1 302,250	16,136	0,66437
2009	**29 074,271**	8 615,604	9 519,180	6 082,50020	3 879,117	977,869	7,604	0,50925
2010	**30 649,206**	9 469,701	9 290,953	6 558,63300	4 395,899	934,020	7,319	0,50530

According to several recommendations of the ERT during previous in-country reviews under UNFCCC in 2009 and 2011, 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 – 2010

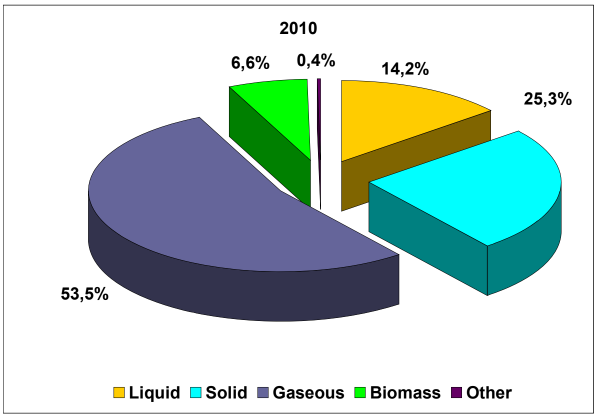
	CH_4/Gg							CH_4/Gg	CO_2/Gg	N_2O/t
	1B2A Oil			1B2B NG				1B2	1B2	1B2
Year	1B2A Oil	1B2C11 Venting	1B2C21 Flaring	1B2B NG	1B2C12 Venting	1B2C22 Flaring	1B2D Storage			
1990	0,2168	0,0197	0,0197	21,3546	2,7216	0,1155	0,0042	**24,4522**	**0,1457**	**0,0205**
1991	0,2077	0,0193	0,0193	21,8585	2,7216	0,1350	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**
2010	0,1034	0,0035	0,0035	31,3073	2,7240	0,1075	0,4326	**34,6818**	**0,1878**	**0,0048**

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 – 2010 are presented in Table 3.7.

Figure 3.4: The share of different fuels consumption within energy sector's categories in 2010



Subsector 1.AA Fuel Combustion without Transport	TJ	Share
Liquid	54 374,06	14,15%
Solid	97 191,49	25,30%
Gaseous	205 531,04	53,49%
Biomass	25 535,54	6,65%
Other	1 598,68	0,42%
Total	**384 230,80**	**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 2010. 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 – 2010

Year	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	**47 574,83**	14 834,84	665,42	1 318,95	2 681,61	1 239,04	4 907,45	2 329,29
1991	**43 164,86**	12 548,98	1 302,62	1 315,86	2 369,54	1 044,58	5 182,35	2 028,64
1992	**39 398,70**	10 968,68	929,84	1 312,77	2 240,26	877,26	5 311,97	1 769,91
1993	**35 661,40**	9 808,63	983,66	1 309,68	2 304,47	734,64	5 315,69	1 549,28
1994	**32 511,69**	8 778,27	995,24	1 306,60	2 373,69	614,59	5 211,82	1 363,23
1995	**33 226,99**	8 508,14	1 789,57	1 303,51	2 447,40	514,98	5 018,65	1 208,18
1996	**33 130,94**	8 460,54	1 725,25	1 300,42	2 525,09	433,67	4 754,48	1 080,60
1997	**32 833,31**	8 292,69	2 429,09	1 297,33	2 613,85	368,52	4 437,61	1 028,49
1998	**31 639,25**	8 398,30	2 319,24	1 294,25	2 690,39	317,39	4 086,33	893,64
1999	**30 708,30**	8 532,32	1 905,22	1 291,16	2 776,99	278,14	3 718,95	827,15
2000	**29 955,40**	9 022,50	1 218,71	1 248,60	2 774,13	269,91	3 397,34	690,70
2001	**31 906,51**	9 988,80	1 697,72	1 196,74	3 072,76	260,48	3 130,08	604,30
2002	**30 023,18**	9 747,53	2 509,09	1 264,46	2 934,72	261,94	2 471,94	628,67
2003	**30 911,86**	10 528,91	1 828,57	1 357,51	3 321,40	226,09	2 417,71	599,33
2004	**29 151,70**	9 924,78	1 490,77	1 223,14	3 165,26	182,65	2 419,74	534,21
2005	**28 510,31**	9 085,47	1 629,71	1 348,49	3 387,00	172,49	2 874,59	528,88
2006	**27 830,81**	8 385,32	1 503,83	1 361,80	3 911,82	170,77	2 892,84	521,33
2007	**25 296,46**	7 559,95	1 532,85	1 375,41	3 392,14	158,04	2 715,69	485,60
2008	**26 319,86**	8 031,30	1 600,31	1 266,53	3 583,81	171,92	2 829,98	518,61
2009	**22 991,77**	6 724,31	688,92	1 202,37	3 637,47	142,83	2 692,88	622,36
2010	**24 090,57**	6 329,92	1 831,59	1 308,20	3 742,43	183,96	2 596,77	396,20

Year	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	7 069,81	45,24	2 219,78	3,100	0,490
1991	1 040,56	5 058,08	2 922,07	6 377,87	42,03	1 931,68	3,913	0,447
1992	953,95	4 468,74	2 567,66	6 310,66	41,88	1 645,13	3,338	0,397
1993	879,12	4 011,30	2 260,38	5 097,59	44,52	1 362,43	4,060	0,364
1994	814,83	3 670,01	1 996,51	4 478,26	49,53	859,13	4,160	0,331
1995	759,84	3 623,62	1 772,33	4 857,32	56,47	1 366,98	4,367	0,317
1996	712,93	3 564,57	1 584,12	5 385,07	64,91	1 539,27	5,324	0,321
1997	695,67	3 515,13	1 428,16	5 217,67	74,43	1 434,67	4,786	0,297
1998	638,39	3 383,48	1 300,72	4 788,89	84,58	1 443,65	4,759	0,278
1999	608,30	3 153,86	1 198,09	4 923,79	94,94	1 399,39	4,861	0,273
2000	569,22	3 289,92	1 012,22	4 806,14	103,23	1 552,79	5,226	0,280
2001	559,53	3 355,03	1 085,57	5 424,05	114,21	1 417,24	5,867	0,301
2002	551,05	3 061,98	1 004,07	4 283,55	118,75	1 185,45	5,668	0,293
2003	495,88	3 657,38	926,87	4 358,84	102,04	1 091,33	6,073	0,329
2004	478,85	3 270,10	836,88	3 983,26	112,50	1 529,55	7,337	0,311
2005	436,19	2 959,77	834,24	3 706,78	119,25	1 427,46	9,800	0,343
2006	416,82	3 315,65	822,39	3 370,66	108,51	1 049,08	9,074	0,319
2007	359,35	2 976,97	688,98	2 824,52	89,30	1 137,66	8,464	0,292
2008	335,11	2 555,86	806,09	3 215,58	102,51	1 302,25	15,302	0,403
2009	303,73	2 119,91	753,55	3 026,61	98,95	977,87	6,865	0,264
2010	306,00	2 065,59	769,73	3 517,75	108,42	934,02	6,597	0,246

3.2.2 Methodological issues – methods

There are 3 sources of activity for GHG emission calculation:

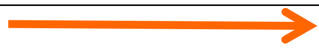
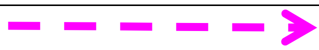
- National Energy Statistics (NES) –based on the data from the Statistical Office of the Slovak Republic which is used mainly for the Reference Approach (RA) inventory, but is taken into consideration also during the Sectoral Approach (SA) preparation.
- National Emission Information System (NEIS) – national database of stationary sources of air pollution.
- ETS reports from operators and verifiers included in the National Allocation Plan I and II for 2005 – 2010.

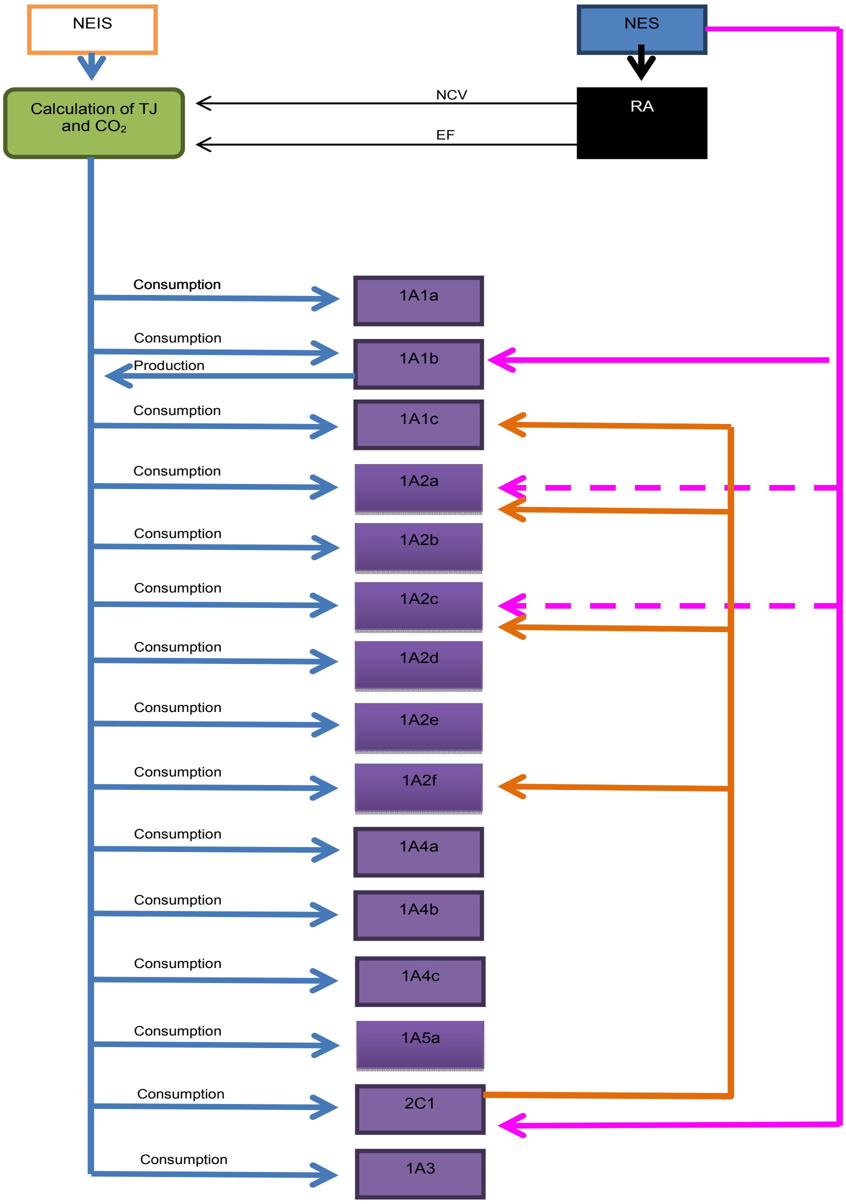
Although top-down approach enables to follow total national balance as the black box, it is impossible to split these data by the detail IPCC CRF categories. On the other side, this approach is used as the standard and there is assured that any data of fuel consumption are omitted. In the RA some secondary fuels as heating oil, refinery gas, coking gas, blast furnace gas and convertory gas are not available since they are included in primary fuels crude oil and coking coal.

Bottom-up approach using NEIS fuel consumption database enables to split this consumption by the detail IPCC CRF categories. On the other hand, in some cases double counting can arise. It is the case of metallurgical data where the coking coal conversion is included in coke and technical gases. Coke consumption in blast furnace is included in database together with blast furnace gas, arising from coking coal conversion. Usage of both data can cause the double counting. There are other similar cases in other sectors. The other case is the oil refineries. Both, crude oil and coking coal are not included in NEIS database because they are not used for combustion (therefore no basic pollutant emissions are produced). In order to avoid the above mentioned mistakes following QA/QC activities for the SA were elaborated:

1. Using the data of NCV and EF fuel consumption in metric units [kt, mil. m^3] was converted into energy one [TJ].
2. The apparent consumption of fuel in individual sectors was calculated as the difference of input – output. It was the case of CRF categories where the apparent consumption was calculated as the consumption – production of refinery products. The consumption of primary fuels as crude oil and natural gas had to be added as the main refinery input. In other sectors practically only fuel consumptions were used.
3. In some cases the NEIS does not cover all fuel consumption. As mentioned above it was the case of hard coal and/or coke in metallurgy, and NG in chemistry (fuels not used for heating or electricity production). Therefore the harmonisation of its consumption was done adding the difference of consumption from the NES and the NEIS.
4. Special case represents the metallurgy production, sector 2C1 which is described in the IPPU chapter. This sector is using coking coal, and is producing the technical gases as are blast furnace gas and coking gas, used in sectors 1A1c, 1A2a, 1A2c and 1A2f.

Figure 3.5: Scheme illustrates the SA inventory process

Data from the NEIS database	
Data from the NES crude oil, coking coal, refinery products etc.	
Backward flow of blast furnace gas and coking gas from 2C1 sector	
Harmonisation of coal and NG consumption with the NES	



The National Emission Information System (NEIS) is 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 began operated. It replaced an old system EAPSI (Emission and Air Pollution Source Inventory). 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 No. 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 SHMU central database in electronic form (in the NEIS BU format) for the next processing. The SHMU 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 SHMU. In 2010, the new system contained 846 (703 of it in operation) large point sources collected from 79 of the NEIS BU district databases. The sources of 50 MW and above are included to the registration of large point sources. In year 2010, the NEIS system registered 12 817 (10 876 of it in operation) medium sources of the heating output of 0.3-50 MW. The emission balances in 2000 – 2010 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 Coll., since 2004 according to Decree No. 53/2004 Coll.), 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 from 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 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 Coll. amending Regulation of the Ministry of Environment No. 284/2001 Coll. on Waste Catalogue and Directive 2000/76/EC on Waste Incineration).

Modules of NEIS:

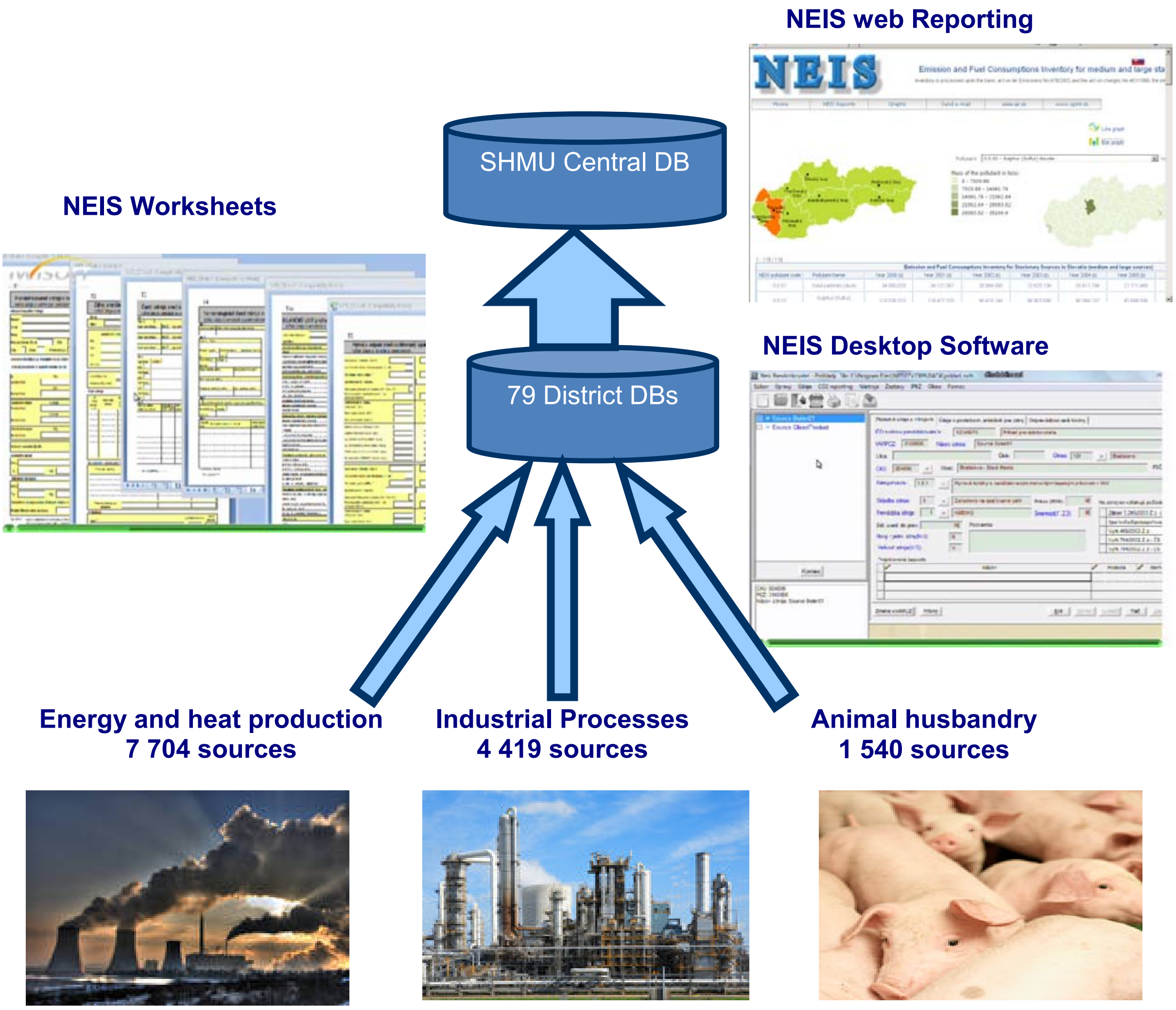
- NEIS QF printed questionnaire form for air pollution sources reporting (used by 6 300 operators).
- NEIS PZ electronic questionnaire form for air pollution sources reporting (used by 160 operators).
- NEIS BU basic unit – the module for district offices in relation to data collection, data processing, data verifying and printing decisions on air polluting fees.
- NEIS CU central unit – the central database module of the SHMU 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 CRF 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 rev.2 classification codes are compared with IPCC CRF categories and included into NEIS database and check annually for new or renamed sources (Table 3.2). Activity data (the quantity of fuel burned in physical units) included in each CRF category collected in the NEIS database for the actual year are provided in mass units (thousands 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 SHMU and forwarded in a special report to the sectoral expert for energy. The emission estimation is performed in excel sheets according to the IPCC 2000 GPG. The bottom-up sectoral energy balance 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 equipment.

Figure 3.6: 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. The information can be found also in the ETS reports. The inventory experts used the most specific NCVs based on plant to estimate CO_2 emissions in the sectoral approach. As in the reference approach average NCVs published by the Statistical Office are used, the differences may occur in both approaches.

According to the direct information about the quantity of fuels combusted (in tons or mil. m^3) and their specific net 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 2006 GL). The emission factors for CO_2 were improved based on plant specific information from the ETS Reports and are annually updated on plant level. Carbon emission factors (t C/TJ) are estimated for individual fuel types based on the international methodologies (IPCC, OECD, IAEA) and national measurements (expert judgment, Profing Ltd., sectoral expert, plant ETS Reports, industrial associations). Carbon emission factors are estimated from known fuel composition and available average net calorific values of the most used 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 to the source of origin (Slovak, Ukraine, the Czech Republic) since 2000, for coke since 2000 and for coke gas since 2000. The revised emission factors depend 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 precise measurements and calculation published every month by Slovak Gas Industry Ltd, Slovak Energy Industry LtD., refinery plant Slovnaft for liquid fuels, a.s. 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 the 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 2010

Gas	Fuel	EF (CO_2)	Unit	NCV	Unit	IPCC Category
CO_2	Coal (energy)	97,52	tCO2/TJ	25,947	tC/TJ	1A1A
CO_2	Coking Coal	94,96	tCO2/TJ	28,951	tC/TJ	1A2A
CO_2	Coal	97,52	tCO2/TJ	25,947	tC/TJ	other
CO_2	Coke	109,32	tCO2/TJ	26,721	GJ/t	all
CO_2	Brow n Coal (SR)	104,39	tCO2/TJ	10,221	tC/TJ	all
CO_2	Brow n Coal (CR)	96,85-100,85	tCO2/TJ	13,83-18,70	tC/TJ	vary depending on NCV
CO_2	Natural Gas	55,34	tCO2/TJ	34,421	GJ/tis.m3	all
CO_2	Coke Ow en/Coke Gas	109,40	tCO2/TJ	26,721	tC/TJ	all
CO_2	Lignite	104,39	tCO2/TJ	10,221	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	3,15	tC/TJ	all
CO_2	Convertory Gas	166,00	tCO2/TJ	8,34	tC/TJ	all
CO_2	Coking Gas	47,36	tCO2/TJ	17,222	tC/TJ	all

Carbon emission factors are recalculated to CO_2 emission factors and considered by the oxidation factors according to the type of fuel group (0.99 for liquid, 0.98 for solid and 0.995 for gaseous fuels).

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 the Environment of the Slovak Republic. The emission factors are published at the http://www.spp.sk/download/emisie/Kvalita_ZP_emisny_faktor_sk_2010.pdf (Tables 3.9, 3.10). Weighted averages are calculated based on monthly announced consumption by the Slovak Gas Industry. Despite the fact, that the Slovak Gas Industry was not exclusive natural gas supplier (89% of the total NG supply in 2010), the parameters of the NG are consistent in all consumers due to the common origin of natural gas distributed by the

Slovak Gas Industry – Distribution. The complete sets of consumptions, emission factors, NCVs and emissions (CO_2, CH_4 and N_2O) by allocation of fuels according to the IPCC categories are included in the chapter 3.2.4 and partly in Annex 3 of this report.

Table 3.9: Parameters of natural gas published by the Slovak Gas Industry on-line in 2010

2010	Natural gas [mol %]									
Month	CH_4	C_2H_6	C_3H_8	i-C_4H_{10}	n-C_4H_{10}	i-C_5H_{12}	n-C_5H_{12}	C_6H_{14}	CO_2	N_2
I.	96,73	1,51	0,47	0,07	0,08	0,02	0,01	0,02	0,24	0,86
II.	96,80	1,47	0,46	0,07	0,08	0,02	0,01	0,02	0,23	0,85
III.	97,04	1,34	0,43	0,06	0,07	0,01	0,01	0,01	0,18	0,83
IV.	96,94	1,40	0,42	0,06	0,07	0,01	0,01	0,01	0,24	0,83
V.	96,95	1,41	0,43	0,06	0,07	0,01	0,01	0,01	0,20	0,83
VI.	96,83	1,53	0,48	0,07	0,08	0,02	0,01	0,01	0,16	0,81
VII.	97,07	1,39	0,44	0,07	0,07	0,01	0,01	0,01	0,13	0,81
VIII.	96,87	1,51	0,48	0,07	0,08	0,02	0,01	0,01	0,15	0,81
IX.	97,04	1,41	0,44	0,07	0,07	0,01	0,01	0,01	0,14	0,80
X.	97,31	1,24	0,39	0,06	0,06	0,01	0,01	0,01	0,13	0,79
XI.	97,20	1,29	0,39	0,06	0,06	0,01	0,01	0,01	0,17	0,79
XII.	97,04	1,38	0,42	0,06	0,07	0,01	0,01	0,01	0,18	0,82
Weighted Average	**96,98**	**1,41**	**0,44**	**0,07**	**0,07**	**0,01**	**0,01**	**0,01**	**0,19**	**0,82**

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)

2010	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.	0,5757	0,7054	34,452	38,200	13,98	0,07	55,40
II.	0,5752	0,7049	34,445	38,192	13,99	0,09	55,39
III.	0,5735	0,7028	34,402	38,146	13,92	0,10	55,33
IV.	0,5741	0,7035	34,394	38,135	13,98	0,10	55,36
V.	0,5739	0,7032	34,409	38,153	13,99	0,03	55,34
VI.	0,5748	0,7044	34,506	38,261	14,02	0,02	55,36
VII.	0,5731	0,7023	34,445	38,192	14,01	0,01	55,31
VIII.	0,5745	0,7040	34,506	38,257	14,02	0,00	55,35
IX.	0,5733	0,7026	34,448	38,196	14,01	0,00	55,32
X.	0,5714	0,7003	34,366	38,110	14,00	0,01	55,26
XI.	0,5723	0,7013	34,373	38,113	13,99	0,04	55,30
XII.	0,5734	0,7026	34,409	38,153	13,99	0,06	55,33
Average	**0,5738**	**0,7031**	**34,421**	**38,176**	**13,99**	**0,04**	**55,34**

After multiplying the CO_2 emission factor for natural gas with the oxidation factor 0.995, the value of used EF(CO_2) is 55.11 t/TJ in 2010.

3.2.4 Activity data

Activity data on emission factors, NCVs, fuel consumption and emissions are collected from several official sources. Main source of activity is still the NEIS central database where the information from stationary sources is allocated according to the NACE categorization based on identification number of installation. The basic information from the NEIS database are compared with the information provided by the Statistical Office of the Slovak Republic (energy statistics) and with the information provided in the ETS Reports for those installations which are included in the NAP II. In the questionable cases (if the activity data are not corresponding), direct request for clarification is formulated to the operators. The systems have been better harmonizing from year to year and only several cases for clarification occurred in 2010. Major issues for clarification were iron and steel industry, ammonia producers and natural gas supplier in 2010.

Since 2011, the harmonization process between NEIS economical classification of sources and statistical classification based on NACE Rev.2 is ongoing in line with the Regulation (EU) 691/2011 of the European Parliament and of the Council of 6 July 2011 on European environmental economic accounts. The project is evaluated in cooperation of the SHMU and the Statistical Office of the Slovak Republic. Based on the manual provided by the Eurostat, the classification is associated with this

SNAP-NRF/CRF-NACE correspondence table as a matrix of coefficients that provides the user a key to convert data from inventories to NACE activities. This matrix will be handed out during the data collection phase later this year. The fuels according to the basic categories in the sectoral approach are listed in Table 3.11. Biomass balance is based on direct information from NEIS database and includes biogas and wood consumption directly reported by producers.

Table 3.11: List of fuels according to the categories in sectoral approach in 2010

Solid - primary	Solid- secondary	Liquid - primary	Liquid - secondary
Anthracite	Blast-Furnace Gas	Crude Oil	Gasoline
Coking Coal	Coke Owen/Coke Gas	Natural Gas (liquid)	Jet Kerosene
Other Bituminous Coal	Other Gaseous		Other Kerosene
Sub-bituminous Coal	Convertory gas		Shale Oil
Lignite	Briquettes		Gas / Diesel Oil
Gaseous	**Biomass**	**Other**	Residual Fuel Oil
Natural Gas	Wood	Waste Municipal	LVO
	Biogas	Waste Industrial	LPG
		Cogeneration Gas	Ethane
			Naphtha
			Bitumen
			Lubricants
			Refinery gas
			Petroleum Coke
			Refinery Feedstocks
			Other Oil

Category 1A1A – Public electricity and heat production

Total volume of fuels in this category represented 84 628.52 TJ in 2010. Total CO_2 emissions were 6 329.92 Gg, total CH_4 emissions were 0.22 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.

Fuel category 1A1a	Weighted EF (CO2) t/TJ	Fuel type	EF (C) t/TJ	Oxidation Factor	EF (CO2) t/TJ
Liquid	79,84	Gas / Diesel Oil	20,28	0,99	73,62
		Residual Fuel Oil	22,03	0,99	79,95
Solid	100,3	Other Bit. Coal	26,62	0,98	95,64
		Lignite	28,49	0,98	102,38
		Coke Oven/Gas Coke	29,84	0,98	107,21
Gaseous	55,11	Natural Gas	15,10	0,995	55,11
Biomass	100,54	solid - w ood	27,34		100,25
		gaseous - biogas	30,45		111,64
Other	107,71	Methane cogeneration	15,10		55,34
		MSW	8,05		29,51
		ISW			IE (783,06)

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).

The measurements of the methane content in cogeneration gas are not representative and well documented and therefore the NG´s emission factor and NCV was used for emission estimation.

Table 3.12: The activities included in category 1A1A Other fuel in 2010

	Cogeneration (mining)				MSW Incineration			IW Incineration		
	Consumption	CO_2	CH_4	N_2O	Consumption	CO_2	N_2O (t)	Consumption	CO_2	N_2O
Year	[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	566,87	38,10
2003	NO	NO	NO	NO	1 416,04	41,79	2,54	IE	843,32	56,80
2004	NO	NO	NO	NO	1 604,26	47,34	2,79	IE	338,28	22,80
2005	NO	NO	NO	NO	1 593,28	47,02	2,26	IE	451,45	30,40
2006	NO	NO	NO	NO	1 655,52	48,86	2,43	IE	394,05	26,50
2007	11,59	639,53	0,012	0,001	1 570,34	46,34	2,26	IE	240,20	16,20
2008	9,36	514,89	0,009	0,001	1 370,62	40,45	1,91	IE	637,17	42,90
2009	5,44	300,40	0,005	0,001	1 548,82	45,71	2,26	IE	251,84	16,90
2010	1,66	91,79	0,002	0,000	1 597,02	47,13	2,29	IE	124,97	8,39

Category 1A1B – Petroleum refining

Total volume of fuels in this category explicated in energy units represented 66 247.86 TJ in 2010. Total CO_2 emissions were 1 831.59 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.

Fuel category 1A1b	Weighted EF (CO2) t/TJ	Fuel type	EF (C) t/TJ	Oxidation Factor	EF (CO2) t/TJ
Liquid	8,69	Refinery Gas	18,20	0,99	66,07
		Petroleum Coke	27,51	0,99	99,86
Solid	107,21	Coke Oven/Gas Coke	29,84	0,98	107,21
Gaseous	55,11	Natural Gas	15,10	0,995	55,11

Within category 1A1b main source of fuel balance are oil and natural gas, which are used for heating and as source of hydrogen for processing of oil products (hydrocracking). Fuel refinery gas for which country specific NCV and EF are used is a mixture of various gases of different quality. Refinery gas is within secondary fuels used in refinery technology i.e. in category 1A1b and in category 1A2c (chemical industry). Production of secondary liquid fuels (gasoline, gas/diesel oil, LGP and others) is a balance of production, import, export, stock change and reflux of products back to the process within 1A1b and within other categories (mainly transport).

CRF	Fuel	Unit	Consumption	Production
1A1a	Gas / Diesel Oil	1000 t	0,15	0,00
1A1b	Gas / Diesel Oil	1000 t	0,00	2 682,60
1A1c	Gas / Diesel Oil	1000 t	0,00	0,00
1A2a	Gas / Diesel Oil	1000 t	0,00	0,00
1A2b	Gas / Diesel Oil	1000 t	0,00	0,00
1A2c	Gas / Diesel Oil	1000 t	0,00	0,00
1A2d	Gas / Diesel Oil	1000 t	0,00	0,00
1A2e	Gas / Diesel Oil	1000 t	0,00	0,00
1A2f	Gas / Diesel Oil	1000 t	0,16	0,00
1A4a	Gas / Diesel Oil	1000 t	1,48	0,00
1A4c	Gas / Diesel Oil	1000 t	0,55	0,00
1A5a	Gas / Diesel Oil	1000 t	0,05	0,00
2C1	Gas / Diesel Oil	1000 t	0,00	0,00
1A4b	Gas / Diesel Oil	1000 t	0,00	0,00
1A3	Gas / Diesel Oil	1000 t	1 450,21	0,00

Implied emission factor for liquid fuels is aggregated emission factor and was automatically calculated by dividing Actual CO_2 emissions and Apparent consumption [TJ]. The result of this calculation is not real value of EF (liquid) because the apparent consumption is influenced by the input-output carbon balance, and is different in individual years, so unexpected fluctuations of IEF are caused. It is a consequence of allocating high share of secondary fuels to other categories. Table 3.13 demonstrates balance of liquid fuels in category 1A1b as well as CO_2 emissions calculated directly from amount of fuels produced (column Products + Reflux), in which reflux back to the production is included. Direct consumption of fuels is used for calculation of CH_4 and N_2O emissions. Weighted national value of EF for liquid fuels 69.09 tCO_2/TJ in 1A1b category is fully in relation with value for this type of fuels.

Similarly as in other categories this calculation process avoids inconsistencies between RA and SA.

Table 3.13: Schematically demonstrated balance of liquid fuels in refinery

	Production	Emissions	Weighted average EF	Products + Reflux	Emissions
Fuels/Units	*TJ*	*GgCO2*	*tCO2/TJ*	*TJ*	*GgCO2*
Crude Oil				227 745,67	16 936,19
Orimulsion				0,00	0,00
Natural Gas Liquids				111,00	6,93
Gasoline	0,00	0,00	0,00	-54 763,11	-3 922,13
Jet Kerosene	0,00	0,00	0,00	-291,63	-21,27
Other Kerosene	0,00	0,00	0,00	0,00	0,00
Shale Oil	0,00	0,00	0,00	0,00	0,00
Gas / Diesel Oil	0,00	0,00	0,00	-113 254,15	-8 337,36
Residual Fuel Oil	0,00	0,00	0,00	-24 234,24	-1 937,56
LVO	0,00	0,00	0,00	0,00	0,00
LPG	0,00	0,00	0,00	1 220,03	-199,03
Ethane	0,00	0,00	0,00	0,00	-2,31
Naphtha	0,00	0,00	0,00	479,60	-1 327,55
Bitumen	0,00	0,00	0,00	4 866,02	0,00
Lubricants	0,00	0,00	0,00	1 267,83	46,02
Refinery gas	16 585,66	1 095,75	66,07	-247,50	-16,35
Petroleum Coke	1 629,95	162,78	99,87	2 827,44	282,36
Refinery Feedstocks	0,00	0,00	0,00	0,00	-760,05
Other Oil	0,00	0,00	0,00	-5 119,43	-395,06
1A1b	**18 215,61**	**1 258,52**	**69,09**	**40 607,53**	**352,84**

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

The total volume of fuels in this category explicated in energy units represented 7 418 TJ in 2010. Total CO_2 emissions were 1 308.20 Gg, total CH_4 emissions were 0.01 Gg and total N_2O emissions were 0.001 Gg in this category. The fuels are allocated among liquid, solid, gaseous and biomass fuels´ categories.

Fuel category 1A1c	Weighted EF (CO2) t/TJ	Fuel type	EF (C) t/TJ	Oxidation Factor	EF (CO2) t/TJ
Liquid	73,62	Gas / Diesel Oil	20,28	0,99	73,62
Solid	193,05	Coking Gas	12,92	0,98	46,41
		Lignite	28,49	0,98	102,38
		Blast-Furnace Gas	71,24	0,98	256,00
Gaseous	55,11	Natural Gas	15,10	0,995	55,11
Biomass	111,64	gaseous - biogas	30,45		111,64

When allocating amounts of fuels consumed in category 1A1c, only direct consumption of secondary fuels as product of coke ovens – coking gas and from blast furnace – blast furnace gas were included.

Other fuels are balanced in category 2C1. Consumption of coking coal was allocated to category 2C1. Following table in case of fuel coking gas demonstrates the allocation of this fuel produced from coking coal in category 2C1 into other categories.

CRF	Fuel	Unit	Consumption	Production
1A1a	Coking gas	mil.m3	0,00	0,00
1A1b	Coking gas	mil.m3	0,00	0,00
1A1c	Coking gas	mil.m3	112,45	0,00
1A2a	Coking gas	mil.m3	264,87	0,00
1A2b	Coking gas	mil.m3	0,00	0,00
1A2c	Coking gas	mil.m3	0,00	0,00
1A2d	Coking gas	mil.m3	0,00	0,00
1A2e	Coking gas	mil.m3	0,00	0,00
1A2f	Coking gas	mil.m3	279,81	0,00
1A4a	Coking gas	mil.m3	0,00	0,00
1A4c	Coking gas	mil.m3	0,00	0,00
1A5a	Coking gas	mil.m3	0,00	0,00
2C1	Coking gas	mil.m3	76,09	733,22

Category 1A2A – Iron and steel

Total volume of fuels in this category explicated in energy units represented 28 762 TJ in 2010. Total CO_2 emissions were 3 742.43 Gg, total CH_4 emissions were 0.03 Gg and total N_2O emissions were 0.02 Gg in this category. The fuels are allocated among liquid, solid and gaseous fuels´ categories.

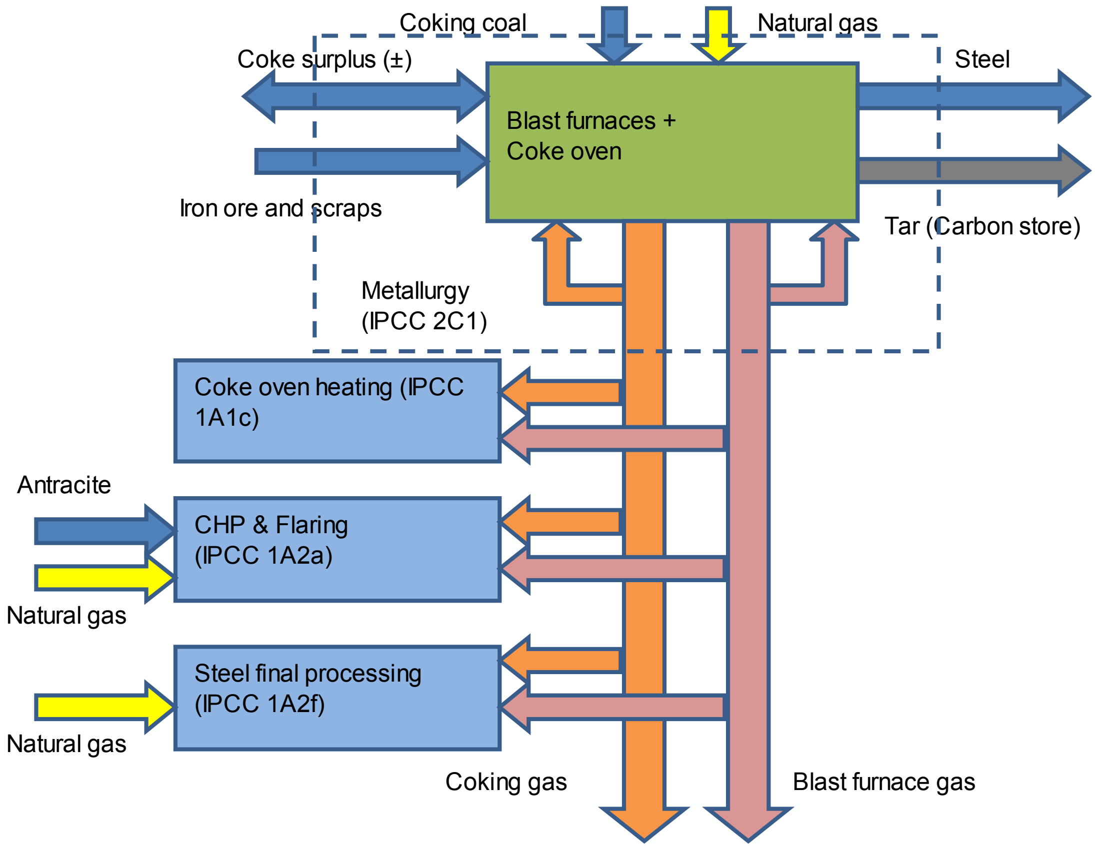
Fuel category 1A2a	Weighted EF (CO2) t/TJ	Fuel type	EF (C) t/TJ	Oxidation Factor	EF (CO2) t/TJ
Liquid	64,60	LPG	17,56	0,99	63,74
		Residual Fuel Oil	22,03	0,99	79,95
Solid	134,18	Anthracite	26,43	0,98	94,97
		Coking Gas	12,92	0,98	46,41
		Blast-Furnace Gas	71,24	0,98	256,00
		Coke Oven/Gas Coke	29,84	0,98	107,21
Gaseous	55,11	Natural Gas	15,10	0,995	55,11

To avoid double counting of the primary and secondary fuels from iron and steel industry, the revised estimation was prepared during last year by consulting company in energy tasks (Profing LtD.) and in cooperation with the sectoral expert on IP sector. The estimation includes and compares information in the iron and steel industry based on the ETS report of one of the biggest iron and steel companies in the Slovak Republic (U.S. Steel). Methodology for emission estimation in this category is described in Annex 3 of this report and on the Figure 3.7.

The material balance in this category was compared with the direct material balance reported by plants in the ETS. The identification of the fuels included into the balance for the second time was possible for the years 2005 – 2010. 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 – 2010. 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.

Consumption of coking coal was relocated to category 2C1 Iron and Steel Production. Coking coal is source of carbon in secondary fuels Coke Oven/Gas coke, Blast furnace gas and Coking gas and production of these fuels is balanced within input-output analysis of category 2C1.

Figure 3.7: Schematically demonstration carbon balance in the iron and steel industry



Category 1A2B – Non-ferrous metals

Total volume of fuels in this category explicated in energy units represented 2 631.65 TJ in 2010. Total CO_2 emissions were 183.96 Gg, total CH_4 emissions were 0.0098 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.

Fuel category 1A2b	Weighted EF (CO2) t/TJ	Fuel type	EF (C) t/TJ	Oxidation Factor	EF (CO2) t/TJ
Liquid	64,13	LPG	17,56	0,99	63,74
		Other Oil	19,82	0,99	71,95
Solid	97,73	Other Bit. Coal	26,62	0,98	95,64
		Lignite	28,49	0,98	102,38
		Coke Oven/Gas Coke	29,84	0,98	107,21
Gaseous	55,11	Natural Gas	15,10	0,995	55,11
Biomass	100,25	solid - w ood	27,34		100,25

Category 1A2C – Chemicals

Total volume of fuels in this category explicated in energy units represented 41 021.36 TJ in 2010. Total CO_2 emissions were 2 596.77 Gg, total CH_4 emissions were 0.18 Gg and total N_2O emissions were 0.01 Gg in this category. The fuels are allocated among solid, liquid, gaseous and biomass fuels´ categories.

Fuel category 1A2c	Weighted EF (CO2) t/TJ	Fuel type	EF (C) t/TJ	Oxidation Factor	EF (CO2) t/TJ
Liquid	79,63	Residual Fuel Oil	22,03	0,99	79,95
		LPG	17,56	0,99	63,74
		Refinery Gas	18,20	1,99	66,07
		Other Oil	19,82	2,99	71,95
Solid	95,33	Anthracite	26,43	0,98	94,97
		Lignite	28,49	0,98	102,38
Gaseous	55,11	Natural Gas	15,10	0,995	55,11
Biomass	100,25	solid - w ood	27,34		100,25

Category 1A2D – Pulp, paper and print

Total volume of fuels in this category explicated in energy units 5 351.63 TJ in 2010. Total CO_2 emissions were 396.20 Gg, total CH_4 emissions were 0.02 Gg and total N_2O emissions were 0.01 Gg in this category. The fuels are allocated among solid, liquid, gaseous and biomass fuels´ categories.

Fuel category 1A2d	Weighted EF (CO2) t/TJ	Fuel type	EF (C) t/TJ	Oxidation Factor	EF (CO2) t/TJ
Liquid	79,95	Residual Fuel Oil	22,03	0,99	79,95
Solid	101,10	Other Bit. Coal	26,62	0,98	95,64
		Lignite	28,49	0,98	102,38
Gaseous	55,11	Natural Gas	15,10	0,995	55,11
Biomass	100,25	solid - wood	27,34		100,25

Category 1A2E – Food processing, beverage and tobacco

Total volume of fuels in this category explicated in energy units represented 5 283.41 TJ in 2010. Total CO_2 emissions were 306.00 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, liquid, gaseous and biomass fuels´ categories.

Fuel category 1A2e	Weighted EF (CO2) t/TJ	Fuel type	EF (C) t/TJ	Oxidation Factor	EF (CO2) t/TJ
Liquid	64,00	Gas / Diesel Oil	20,28	0,99	73,62
		LPG	17,56	0,99	63,74
Solid	102,38	Lignite	28,49	0,98	102,38
Gaseous	55,11	Natural Gas	15,10	0,995	55,11
Biomass	110,88	solid - wood	27,34		100,25
		gaseous - biogas	30,45		111,64

Category 1A2F – Other

In this category are included not allocated industrial productions as is described in the Table 3.2. Total volume of fuels in this category explicated in energy units represented 31 358.02 TJ in 2010. Total CO_2 emissions were 2 065.59 Gg, total CH_4 emissions were 0.15 Gg and total N_2O emissions were 0.02 Gg in this category. The fuels are allocated among solid, liquid, gaseous and biomass fuels´ categories.

Fuel category 1A2f	Weighted EF (CO2) t/TJ	Fuel type	EF (C) t/TJ	Oxidation Factor	EF (CO2) t/TJ
Liquid	76,32	Gas / Diesel Oil	20,28	0,99	73,62
		Residual Fuel Oil	22,03	0,99	79,95
		LPG	17,56	0,99	63,74
Solid	90,52	Anthracite	26,43	0,98	94,97
		Other Bit. Coal	26,62	0,98	95,64
		Lignite	28,49	0,98	102,38
		Coking Gas	12,92	0,98	46,41
		Blast-Furnace Gas	71,24	0,98	256,00
		Coke Oven/Gas Coke	29,84	0,98	107,21
Gaseous	55,11	Natural Gas	15,10	0,995	55,11
Biomass	100,25	solid - wood	27,34		100,25

Category 1A4A – Commercial/Institutional

Total volume of fuels in this category explicated in energy units represented 31 358.02 TJ in 2010. Total CO_2 emissions were 769.73 Gg, total CH_4 emissions were 0.35 Gg and total N_2O emissions in this category were 0.01 Gg in this category. The fuels are allocated among solid, liquid, gaseous and biomass fuels´ categories.

Fuel category 1A4a	Weighted EF (CO2) t/TJ	Fuel type	EF (C) t/TJ	Oxidation Factor	EF (CO2) t/TJ
Liquid	71,88	Gas / Diesel Oil	20,28	0,99	73,62
		Residual Fuel Oil	22,03	0,99	79,95
		LPG	17,56	0,99	63,74
		Other Oil	19,82	0,99	71,95
Solid	99,67	Other Bit. Coal	26,62	0,98	95,64
		Lignite	28,49	0,98	102,38
		Coke Oven/Gas Coke	29,84	0,98	107,21
Gaseous	55,11	Natural Gas	15,10	0,995	55,11
Biomass	102,17	solid - wood	27,34		100,25
		gaseous - biogas	30,45		111,64

Category 1A4B – Residential

Total volume of fuels in this category explicated in energy units represented 77 546.26 TJ in 2010. Total CO_2 emissions were 3 517.75 Gg, total CH_4 emissions were 5.44 Gg and total N_2O emissions were 0.08 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.).

Fuel category 1A4b	Weighted EF (CO2) t/TJ	Fuel type	EF (C) t/TJ	Oxidation Factor	EF (CO2) t/TJ
Solid	95,77	Other Bit. Coal	26,62	0,98	95,64
		Lignite	28,49	0,98	102,38
		BKB & Patent Fuel	25,16	0,98	90,41
		Coke Oven/Gas Coke	29,84	0,98	107,21
Gaseous	55,11	Natural Gas	15,10	0,995	55,11
Biomass	100,25	solid - wood	27,34		100,25

Category 1A4C – Agriculture, forestry and fisheries

Total volume of fuels in this category explicated in energy units represented 1 965.81 TJ in 2010. Total CO_2 emissions were 108.42 Gg, total CH_4 emissions were 0.02 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.

Fuel category 1A4c	Weighted EF (CO2) t/TJ	Fuel type	EF (C) t/TJ	Oxidation Factor	EF (CO2) t/TJ
Liquid	71,85	Gas / Diesel Oil	20,28	0,99	73,62
		Residual Fuel Oil	22,03	0,99	79,95
		LPG	17,56	0,99	63,74
Solid	102,08	Other Bit. Coal	26,62	0,98	95,64
		Lignite	28,49	0,98	102,38
		BKB & Patent Fuel	25,16	0,98	90,41
		Coke Oven/Gas Coke	29,84	0,98	107,21
Gaseous	55,11	Natural Gas	15,10	0,995	55,11
Biomass	104,13	solid - wood	27,34		100,25
		gaseous - biogas	30,45		111,64

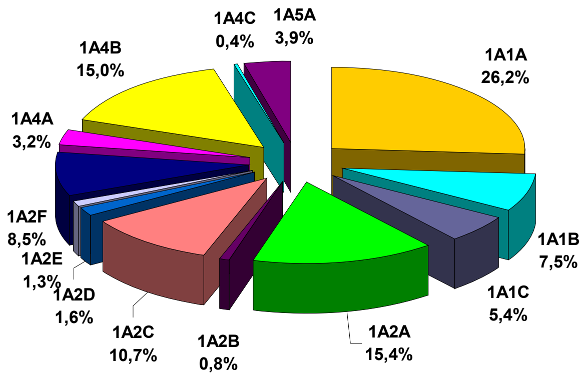
Category 1A5A – Other stationary

Total volume of fuels in this category explicated in energy units represented 17 299.24 TJ in 2010. Total CO_2 emissions were 934.02 Gg, total CH_4 emissions were 0.09 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.

Fuel category 1A5a	Weighted EF (CO2) t/TJ	Fuel type	EF (C) t/TJ	Oxidation Factor	EF (CO2) t/TJ
Liquid	77,07	Gas / Diesel Oil	20,28	0,99	73,62
		Residual Fuel Oil	22,03	0,99	79,95
		LPG	17,56	0,99	63,74
Solid	102,42	Other Bit. Coal	26,62	0,98	95,64
		Lignite	28,49	0,98	102,38
		Coke Oven/Gas Coke	29,84	0,98	107,21
Gaseous	55,11	Natural Gas	15,10	0,995	55,11
Biomass	111,28	solid - w ood	27,34		100,25
		gaseous - biogas	30,45		111,64

According to the detailed analysis of the categories, the major share on emissions represents category 1A1A – Electricity and heat production (26%) followed by the categories 1A2A and 1A4B with the share of 15%. The category of chemical industry represents almost 11% on emissions share.

Figure 3.8: Summary of categories 1A1, 1A2, 1A4 and 1A5 and their shares in 2010



IPCC Category	GHG (CO_2 eq.)	Share (%)
1A1A	6 364,05	26,18%
1A2A	3 748,76	15,42%
1A4B	3 657,18	15,05%
1A2C	2 604,01	10,71%
1A2F	2 073,80	8,53%
1A1B	1 834,21	7,55%
1A1C	1 308,60	5,38%
1A5A	936,99	3,86%
1A4A	779,12	3,21%
1A2D	398,34	1,64%
1A2E	306,86	1,26%
1A2B	184,62	0,76%
1A4C	108,90	0,45%

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 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 utilized. It induces the construction of PDF for all input parameters. The probability density function for variables $a\delta_i$, $e\delta_i$ and $n\delta_i$ was created. 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 (60 000 trials) it seems that the mean value is 22 431 925 tons. Confidence interval (95%) is within the range: <20 897 664, 24 014 577>, which represents the uncertainty by relative values to the mean value: -2.84%; +3.89%. 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%
22 383 244,99	22 431 924,83	378 081,69	21 795 569,24	23 304 063,58
Min	**Max**		**Per_2,5**	**Per_97,5**
20 897 664,20	24 014 576,59		-2,84%	3,89%

Figure 3.9: Probability density function for energy sector – sectoral approach except transport in tons of CO_2

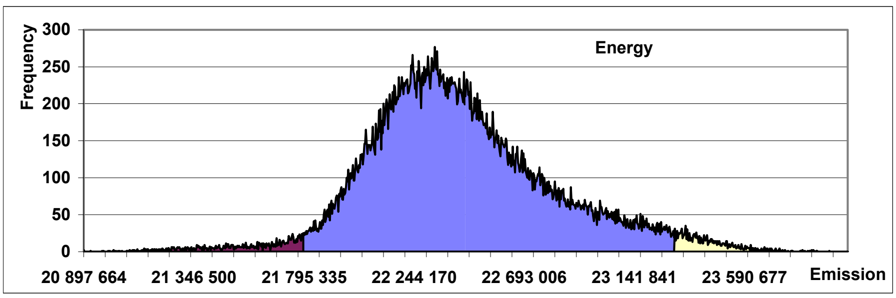


Table 3.15: Selected statistical characteristics for category 1A1A, median, mean value, standard deviation, minimum, maximum of emissions and percentiles

Median	Average	Standard dev.	2,50%	97,50%
6 843 892,07	6 877 941,96	164 295,51	6 634 071,50	7 299 511,48
Min	**Max**		**Per_2,5**	**Per_97,5**
6 340 619,54	7 537 926,01		-3,55%	6,13%

Figure 3.10: Probability density function for category 1A1A in tons of CO_2

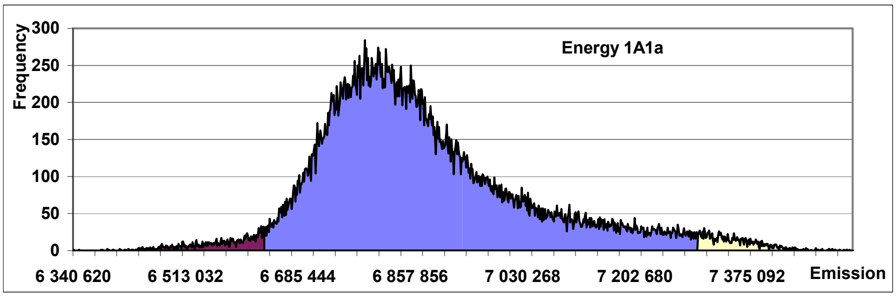


Figure 3.11: Cumulative probability density function for category 1A1A in tons of CO_2

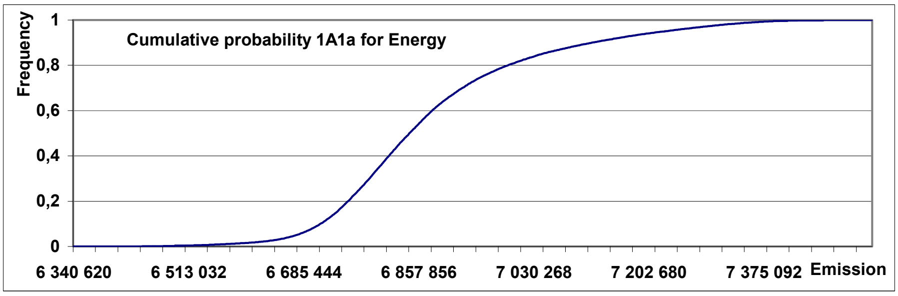


Table 3.16: Selected statistical characteristics for category 1A1B, median, mean value, standard deviation, minimum, maximum of emissions and percentiles

Median	Average	Standard dev.	2,50%	97,50%
1 569 561,99	1 569 901,40	30 719,42	1 510 694,10	1 630 286,89
Min	**Max**		**Per_2,5**	**Per_97,5**
1 430 508,05	1 704 348,23		-3,77%	3,85%

Figure 3.12: Probability density function for category 1A1B in tons of CO_2

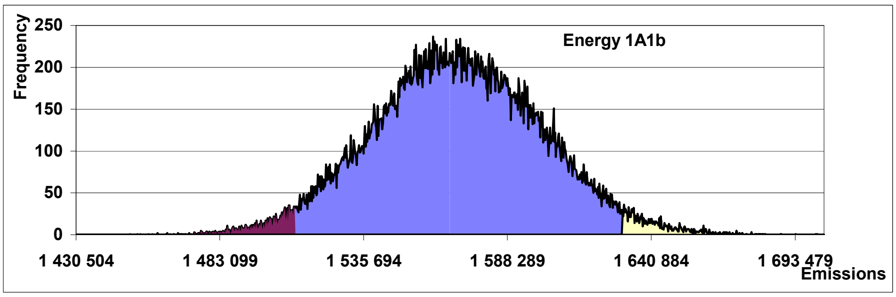


Table 3.17: Selected statistical characteristics for category 1A1C, median, mean value, standard deviation, minimum, maximum of emissions and percentiles

Median	Average	Standard dev.	2,50%	97,50%
1 334 296,84	1 334 646,00	30 047,22	1 276 319,16	1 394 351,84
Min	**Max**		**Per_2,5**	**Per_97,5**
1 213 714,51	1 461 949,35		-4,37%	4,47%

Figure 3.13: Probability density function for category 1A1C in tons of CO_2

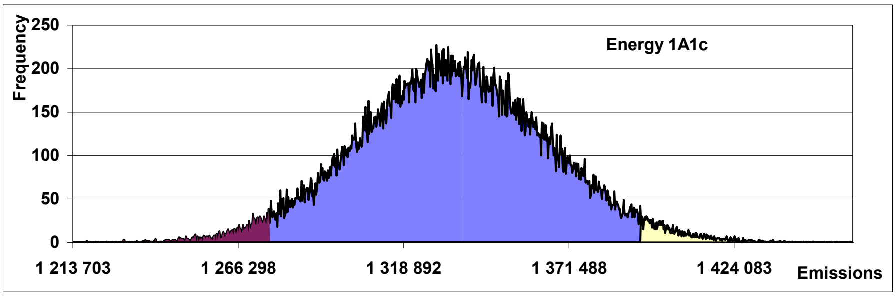


Table 3.18: Selected statistical characteristics for category 1A2A, median, mean value, standard deviation, minimum, maximum of emissions and percentiles

Median	Average	Standard dev.	2,50%	97,50%
671 236,44	671 391,57	13 416,86	645 391,82	697 993,79
Min	**Max**		**Per_2,5**	**Per_97,5**
613 700,08	730 667,05		-3,87%	3,96%

Figure 3.14: Probability density function for category 1A2A in tons of CO_2

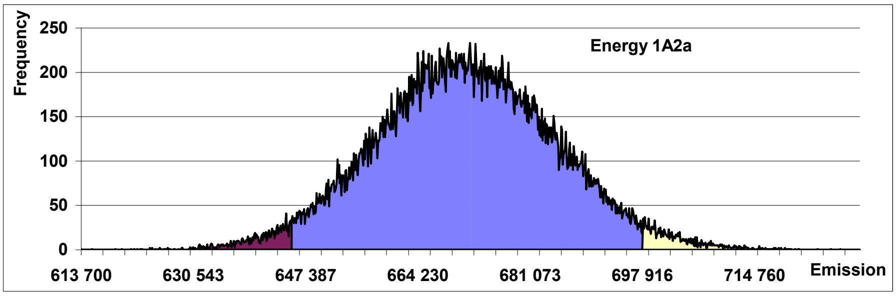


Table 3.19: Selected statistical characteristics for category 1A2B, median, mean value, standard deviation, minimum, maximum of emissions and percentiles

Median	Average	Standard dev.	2,50%	97,50%
191 704,12	192 100,15	4 415,60	184 570,83	201 860,14
Min	**Max**		**Per_2,5**	**Per_97,5**
172 655,61	212 263,17		-3,92%	5,08%

Figure 3.15: Probability density function for category 1A2B in tons of CO_2

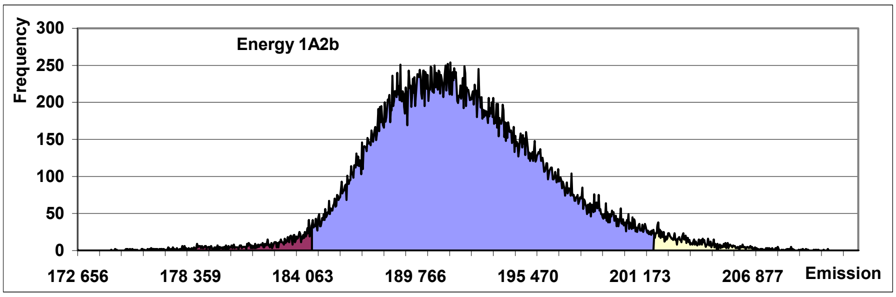


Table 3.20: Selected statistical characteristics for category 1A2C, median, mean value, standard deviation, minimum, maximum of emissions and percentiles

Median	Average	Standard dev.	2,50%	97,50%
1 515 917,13	1 516 155,42	27 524,06	1 462 767,43	1 570 941,91
Min	**Max**		**Per_2,5**	**Per_97,5**
1 401 394,98	1 649 784,49		-3,52%	3,61%

Figure 3.16: Probability density function for category 1A2C in tons of CO_2

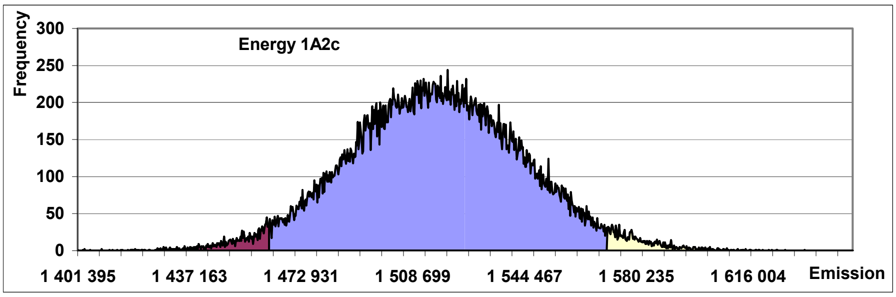


Table 3.21: Selected statistical characteristics for category 1A2D, median, mean value, standard deviation, minimum, maximum of emissions and percentiles

Median	Average	Standard dev.	2,50%	97,50%
433 264,46	433 906,28	9 303,61	417 521,48	453 173,32
Min	**Max**		**Per_2,5**	**Per_97,5**
400 647,78	473 619,32		-3,78%	4,44%

Figure 3.17: Probability density function for category 1A2D in tons of CO_2

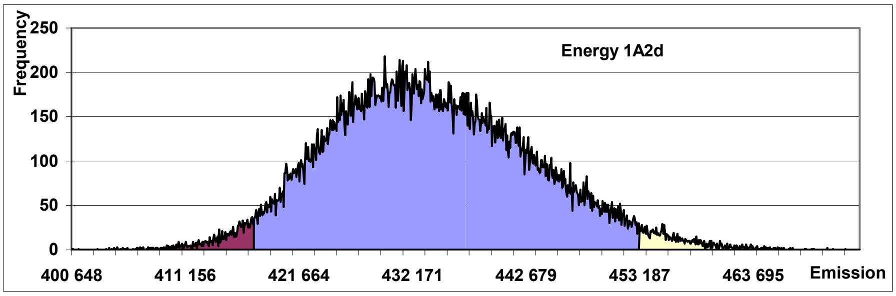


Table 3.22: Selected statistical characteristics for category 1A2E, median, mean value, standard deviation, minimum, maximum of emissions and percentiles

Median	Average	Standard dev.	2,50%	97,50%
321 005,04	321 097,89	8 597,73	304 397,60	337 972,44
Min	**Max**		**Per_2,5**	**Per_97,5**
283 228,87	362 338,51		-5,20%	5,26%

Figure 3.18: Probability density function for category 1A2E in tons of CO_2

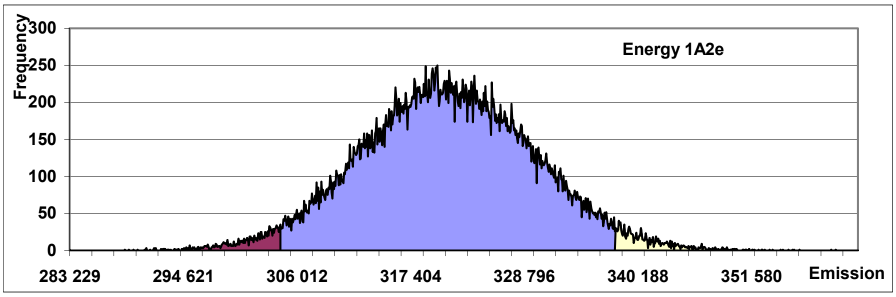


Table 3.23: Selected statistical characteristics for category 1A2F, median, mean value, standard deviation, minimum, maximum of emissions and percentiles

Median	Average	Standard dev.	2,50%	97,50%
2 262 291,04	2 267 965,46	48 997,35	2 182 768,55	2 376 917,78
Min	**Max**		**Per_2,5**	**Per_97,5**
2 039 590,13	2 491 470,52		-3,76%	4,80%

Figure 3.19: Probability density function for category 1A2F in tons of CO_2

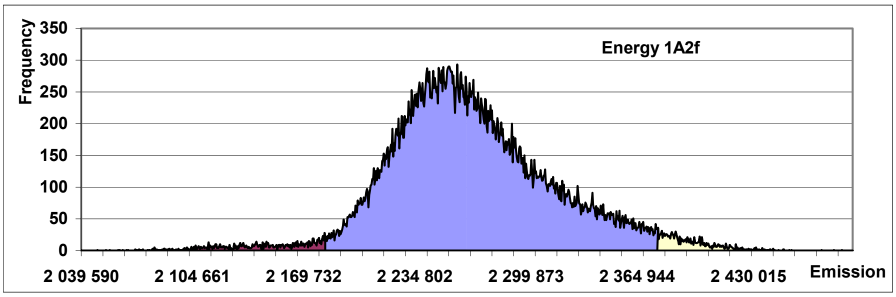


Table 3.24: Selected statistical characteristics for category 1A4A, median, mean value, standard deviation, minimum, maximum of emissions and percentiles

Median	Average	Standard dev.	2,50%	97,50%
893 515,35	895 080,76	21 870,79	855 671,67	941 516,58
Min	**Max**		**Per_2,5**	**Per_97,5**
787 651,06	982 653,07		-4,40%	5,19%

Figure 3.20: Probability density function for category 1A4A in tons of CO_2

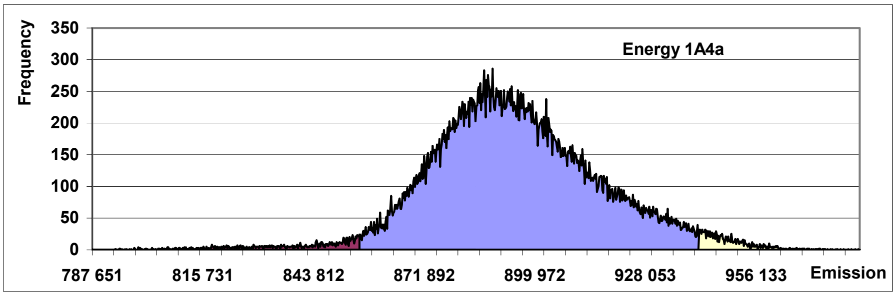


Table 3.25: Selected statistical characteristics for category 1A4C, median, mean value, standard deviation, minimum, maximum of emissions and percentiles

Median	Average	Standard dev.	2,50%	97,50%
113 843,66	114 070,16	2 996,00	108 711,40	120 409,45
Min	**Max**		**Per_2,5**	**Per_97,5**
98 663,85	126 492,91		-4,70%	5,56%

Figure 3.21: Probability density function for category 1A4C in tons of CO_2

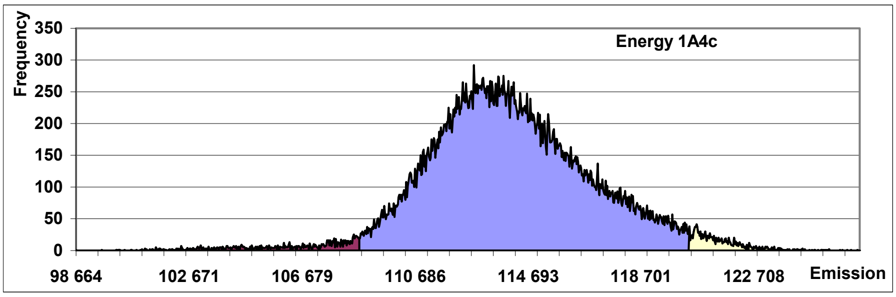
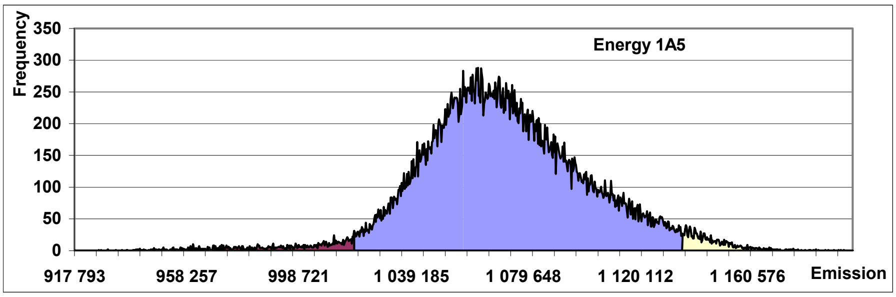


Table 3.26: Selected statistical characteristics for category 1A5A, median, mean value, standard deviation, minimum, maximum of emissions and percentiles

Median	Average	Standard dev.	2,50%	97,50%
1 070 663,16	1 072 897,04	30 279,10	1 018 713,15	1 137 051,02
Min	**Max**		**Per_2,5**	**Per_97,5**
917 792,88	1 198 792,04		-5,05%	5,98%

Figure 3.22: Probability density function for category 1A5A in tons of CO_2



Since 2007, complete time series have been evaluated 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 – 2010). 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) has 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 SHMU, the Department of Emissions and Air Quality Monitoring. 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 SHMU.

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 – 2010 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 – 2010), the difference was stabilized (97.79%, 97.84%, 99.20%). It can be explained by non-compatibility of source allocation, different definitions of technological and energy emissions according to the Act No. 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 3.23). For the comparison study, 26 biggest emitters were taken, which represent more than 90% of all allocated emissions in the Slovak Republic.

Figure 3.23: Comparison of CO_2 emissions from energy sources (in Gg) allocated in ETS and estimated by sectoral approach from the dbase NEIS for 2005 – 2010

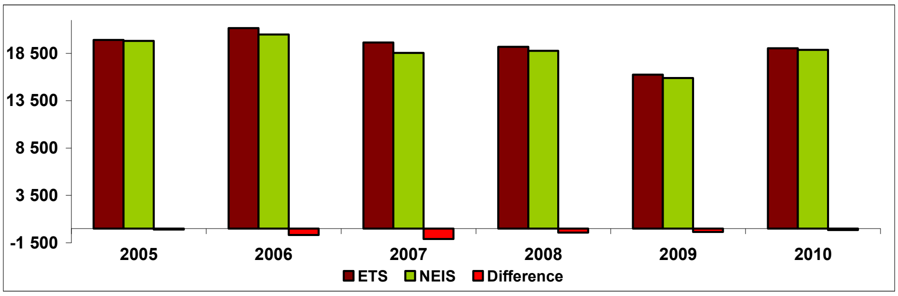


Table 3.27: Comparison of CO_2 emissions (in Gg) allocated in ETS and estimated by sectoral approach from dbase NEIS for 2005 – 2010

	Energy + Technology (CO_2 Gg)						Energy (CO_2 Gg)					
	NAP I			NAP II			NAP I			NAP II		
	2005	2006	2007	2008	2009	2010	2005	2006	2007	2008	2009	2010
ETS	21 487,27	22 684,75	21 033,72	20 567,60	17 916,09	21 698,63	19 937,20	21 166,72	19 652,88	19 197,17	16 251,32	19 029,13
NEIS	19 825,35	20 496,39	18 554,39	18 772,50	15 900,96	18 876,83	19 825,35	20 496,39	18 554,39	18 772,50	15 900,96	18 876,83
Difference	-1 661,93	-2 188,36	-2 479,33	-1 795,10	-2 015,12	-2 821,79	-111,85	-670,33	-1 098,49	-424,66	-350,35	-152,30
Difference	**92,27%**	**90,35%**	**88,21%**	**91,27%**	**88,75%**	**87,00%**	**99,44%**	**96,83%**	**94,41%**	**97,79%**	**97,84%**	**99,20%**

3.2.7 Source specific recalculations

The recalculations in these categories were based on the recommendations of the ERT provided in the SVK ARR 2011 and directly discussed during the in-country review 2011. Recalculations in the sectoral approach are connected with implementation of new methodology (described in chapter 3.2.2) fulfilling requirement for harmonization data with the reference approach. The calculations include corrected and harmonized values for NCVs, EFs and oxidation factors for each fuel category (except biomass) and carbon stored. Recalculations cover all energy combustion categories 1.A.1, 1.A.2, 1.A.4 and 1.A.5 since the base year 1990 and all gases.

Table 3.28: Impact of recalculation sectoral approach in 1990 – 2009

	CO_2/Gg								
	Submission 2011	Submission 2012	Submission 2011	Submission 2012	Submission 2011	Submission 2012	Submission 2011	Submission 2012	Difference
Year	1A1 Energy Industries		1A2 Manufacturing Industries and Construction		1A4 Other Sectors		1A5 Other		2011/2012
1990	16 107,71	16 819,21	19 712,35	18 093,02	10 908,11	10 442,83	1 872,53	2 219,78	102,16%
1991	14 609,13	15 167,46	18 339,16	16 723,76	9 654,10	9 341,97	1 823,08	1 931,68	102,92%
1992	13 505,40	13 211,30	16 885,95	15 622,08	9 235,73	8 920,19	1 772,33	1 645,13	105,08%
1993	12 725,77	12 101,97	14 989,29	14 794,51	7 703,35	7 402,49	1 722,72	1 362,43	104,15%
1994	12 213,79	11 080,10	13 407,36	14 048,16	6 919,98	6 524,30	1 674,35	859,13	105,24%
1995	11 936,81	11 601,22	12 291,59	13 572,67	6 581,31	6 686,12	1 627,27	1 366,98	97,62%
1996	11 848,42	11 486,22	11 532,85	13 071,35	6 235,35	7 034,10	1 581,57	1 539,27	94,17%
1997	11 869,91	12 019,12	10 348,27	12 659,27	5 920,22	6 720,25	1 537,32	1 434,67	90,38%
1998	12 117,68	12 011,79	9 384,69	12 009,63	6 263,19	6 174,19	1 494,61	1 443,65	92,48%
1999	12 260,87	11 728,70	8 580,30	11 363,39	6 205,26	6 216,82	1 453,49	1 399,39	92,81%
2000	12 247,10	11 489,80	8 480,39	10 991,22	5 979,30	5 921,59	1 512,33	1 552,79	94,20%
2001	13 028,26	12 883,26	8 008,57	10 982,18	6 360,54	6 623,83	1 391,71	1 417,24	90,23%
2002	12 682,02	13 521,07	7 140,73	9 910,30	5 638,91	5 406,36	1 169,35	1 185,45	88,70%
2003	13 188,27	13 714,99	8 243,49	10 717,79	5 507,04	5 387,75	1 074,78	1 091,33	90,62%
2004	12 863,61	12 638,70	7 380,21	10 050,81	4 943,08	4 932,64	1 505,98	1 529,55	91,57%
2005	11 843,14	12 063,67	7 326,10	10 358,91	4 924,13	4 660,26	1 431,42	1 427,46	89,53%
2006	11 167,00	11 250,95	8 558,13	11 229,22	4 507,11	4 301,56	1 053,48	1 049,08	90,86%
2007	10 285,65	10 468,21	7 657,43	10 087,79	3 640,77	3 602,80	1 144,00	1 137,66	89,85%
2008	10 792,06	10 898,14	7 030,54	9 995,29	3 938,73	4 124,18	1 309,68	1 302,25	87,66%
2009	9 808,34	8 615,60	6 311,26	9 519,18	3 986,66	3 879,12	984,54	977,87	91,73%

	CH_4/Gg			N_2O/Gg		
	Submission 2011	Submission 2012	Difference	Submission 2011	Submission 2012	Difference
Year	1A1+1A2+1A4+1A5		2011/2012	1A1+1A2+1A4+1A5		2011/2012
1990	20,76	3,10	669,56%	0,53	0,49	107,50%
1991	20,02	3,91	511,63%	0,48	0,45	107,59%
1992	18,30	3,34	548,19%	0,43	0,40	107,60%
1993	15,75	4,06	387,98%	0,39	0,36	107,02%
1994	13,58	4,16	326,45%	0,35	0,33	106,98%
1995	12,49	4,37	285,89%	0,33	0,32	103,85%
1996	11,45	5,32	215,11%	0,32	0,32	99,05%
1997	9,48	4,79	198,05%	0,29	0,30	98,92%
1998	9,92	4,76	208,35%	0,29	0,28	104,17%
1999	9,31	4,86	191,57%	0,29	0,27	104,48%
2000	10,48	5,23	200,62%	0,28	0,28	99,95%
2001	10,45	5,87	178,05%	0,29	0,30	97,20%
2002	8,39	5,67	148,00%	0,30	0,29	101,63%
2003	8,75	6,07	144,04%	0,33	0,33	101,01%
2004	9,53	7,34	129,86%	0,31	0,31	98,28%
2005	11,84	9,80	120,81%	0,34	0,34	99,84%
2006	11,29	9,07	124,37%	0,33	0,32	102,40%
2007	9,75	8,46	115,20%	0,29	0,29	99,61%
2008	16,58	15,30	108,33%	0,41	0,40	100,51%
2009	8,00	6,87	116,59%	0,26	0,26	97,30%

The most important result is improving estimation in energy combustion categories and harmonizing reference and sectoral approaches difference and improving emission factors for non-CO_2 gases. Despite the effort it is not possible to fully harmonize RA and SA in early 90-ties due to different methodologies for balancing the energy consumption.

3.2.8 Source specific planned improvements

Several important changes in methodology to improve harmonization of balance have been successfully implemented in this submission. However, there are ongoing negotiations with the Statistical Office of the Slovak Republic concerning contract for provision of disaggregated data according to enterprises. Enterprise split should allow better mutual comparability of data obtained from the SO SR with the data from other bottom-up sources (NEIS database, ETS reports). It is planned to control input data from the year 2001 and analyze possibilities for harmonization of data gathering.

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.

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 2010. The emissions from road and non-road transport were calculated by using models and default methods and the consistent data series from 1990 to 2010 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, PM_{10}, $PM_{2.5}$), 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 2010. 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

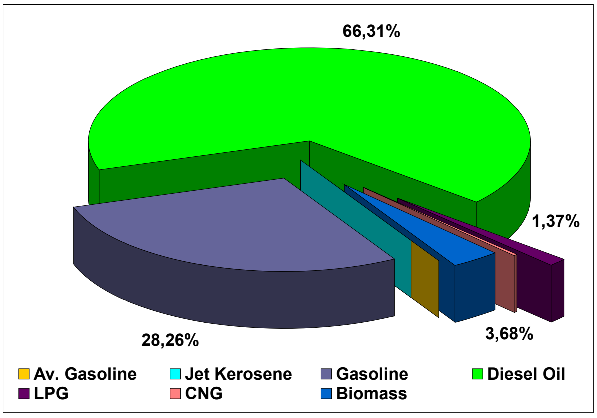
8.1. The emissions from road transport were recalculated from the base year 1990 year by using updated version COPERT IV version 8.1 to receive consistent time series. Total GHG emissions in category transport were 6 654.12 Gg of CO_2 equivalents in 2010 (with 1.60 Gg of CO_2 equivalents from military aviation). The share of road transportation was 98.39%, railways 1.50%, civil aviation represents 0.09%, other military aviation 0.02% and navigation 0.001%. Total energy consumption was 92 910 TJ of consummated fuels in category transport. According to the fuels, the most important are liquid fuels (diesel oil – 66.31%, gasoline – 28.26% and LPG - 1.37%, followed by jet kerosene - 0.10%, aviation gasoline - 0.01% and biomass - 3.68%) and gaseous fuel (CNG - 0.27%). No solid fuels are used in category transport. The complete time series of GHG emissions are presented in Table 3.29. All emissions from inland transport on Danube River are included in international bunkers.

Table 3.29: GHG emissions within category transport and subcategories in 1990 – 2010

	Civil Aviation				Road Transportation				Railways			
	Consumption	CO_2	CH_4	N_2O	Consumption	CO_2	CH_4	N_2O	Consumption	CO_2	CH_4	N_2O
Year	[TJ]	[t]	[t]	[t]	[TJ]	[Gg]	[t]	[t]	[TJ]	[t]	[t]	[t]
1990	105,83	7 736,80	1,00	0,80	61 454,90	4 503,02	1 165,44	189,15	5 022,82	376 770,60	29,50	161,91
1991	98,39	7 192,90	0,93	0,75	52 195,27	3 820,33	1 079,91	155,00	3 778,29	283 416,40	22,20	121,79
1992	90,95	6 649,10	0,86	0,69	48 477,38	3 544,54	1 076,88	137,43	3 117,25	233 830,20	18,30	100,49
1993	88,56	6 473,70	0,82	0,67	48 646,05	3 552,31	1 159,28	135,79	2 676,24	200 749,40	15,70	86,27
1994	75,17	5 495,50	0,71	0,57	52 121,92	3 804,83	1 218,39	151,11	2 526,24	189 497,90	11,30	81,40
1995	75,03	5 484,70	0,69	0,57	55 265,15	4 033,64	1 232,35	168,13	2 720,51	204 070,26	12,20	87,70
1996	87,94	6 427,90	0,79	0,67	56 058,64	4 089,46	1 180,20	177,45	2 669,71	200 259,50	11,90	86,10
1997	77,90	5 694,50	0,70	0,60	58 568,07	4 267,88	1 167,29	195,15	2 508,63	188 176,80	11,20	80,90
1998	71,60	5 233,50	0,63	0,55	62 665,18	4 562,40	1 192,33	211,87	2 301,29	172 623,70	10,30	74,20
1999	72,58	5 305,70	0,65	0,55	61 401,25	4 464,32	1 114,90	212,46	2 106,64	158 023,10	9,40	67,90
2000	75,21	5 498,50	0,73	0,57	54 920,91	3 989,01	958,55	185,23	2 076,36	155 751,50	9,30	66,90
2001	71,52	5 228,80	0,72	0,54	62 613,57	4 541,25	1 055,87	214,04	2 047,83	153 611,50	9,20	66,00
2002	74,58	5 453,20	0,76	0,56	64 530,51	4 686,24	999,67	198,87	1 902,30	142 694,80	8,50	61,30
2003	95,59	6 987,50	0,88	0,73	66 508,83	4 826,84	981,70	201,34	1 521,51	114 130,70	6,80	49,00
2004	124,11	9 069,50	0,95	0,97	70 049,83	5 090,84	950,28	193,89	1 459,14	109 452,32	6,52	47,04
2005	144,16	10 534,90	1,11	1,13	83 127,01	6 045,33	935,20	218,92	1 420,98	106 590,00	6,00	46,00
2006	160,68	11 741,71	1,20	1,26	77 455,61	5 636,49	859,18	201,07	1 509,61	113 238,58	6,75	48,66
2007	184,85	13 507,06	1,32	1,46	88 381,64	6 300,45	834,26	199,21	1 448,70	108 669,63	6,48	46,70
2008	206,50	15 087,88	1,39	1,65	91 331,87	6 499,33	826,18	216,51	1 329,78	99 749,60	5,94	42,87
2009	85,78	6 244,02	0,68	0,67	84 405,46	5 988,78	732,60	207,64	1 145,21	85 903,85	5,12	36,92
2010	80,16	5 836,28	0,67	0,62	91 638,07	6 463,41	716,28	220,56	1 170,54	87 804,08	5,23	37,73

	Navigation				Military Aviation				Transport			
	Consumption	CO_2	CH_4	N_2O	Consumption	CO_3	CH_5	N_2O	Consumption	CO_3	CH_5	N_2O
Year	[TJ]	[t]	[t]	[t]	[TJ]	[t]	[t]	[t]	[TJ]	[t]	[t]	[t]
1990	0,30	22,7507	0,0012	0,0092	95,86	7 003,06	0,56	0,78	66 679,72	4 894,56	1 196,50	352,65
1991	0,26	19,4349	0,0010	0,0079	82,07	5 995,17	0,48	0,67	56 154,29	4 116,96	1 103,52	278,21
1992	0,24	18,1287	0,0010	0,0073	69,64	5 087,23	0,40	0,57	51 755,46	3 790,12	1 096,45	239,18
1993	0,25	18,4735	0,0010	0,0075	83,68	6 112,87	0,49	0,68	51 494,77	3 765,67	1 176,29	223,42
1994	0,26	19,6198	0,0010	0,0079	84,92	6 203,38	0,49	0,69	54 808,52	4 006,04	1 230,89	233,78
1995	0,28	20,7660	0,0011	0,0084	87,76	6 411,04	0,51	0,71	58 148,73	4 249,63	1 245,75	257,12
1996	0,30	22,2078	0,0012	0,0090	76,06	5 556,21	0,44	0,62	58 892,64	4 301,73	1 193,33	264,84
1997	0,31	23,1796	0,0012	0,0094	37,12	2 711,82	0,22	0,30	61 192,03	4 464,49	1 179,41	276,95
1998	0,32	24,1978	0,0013	0,0098	27,73	2 025,59	0,16	0,23	65 066,11	4 742,30	1 203,43	286,86
1999	0,32	24,2053	0,0013	0,0098	18,19	1 328,93	0,11	0,15	63 598,99	4 629,00	1 125,06	281,07
2000	0,33	24,5339	0,0013	0,0099	23,03	1 682,50	0,13	0,19	57 095,84	4 151,97	968,72	252,90
2001	0,34	25,3686	0,0014	0,0103	35,63	2 602,85	0,21	0,29	64 768,89	4 702,72	1 066,00	280,88
2002	0,35	26,5741	0,0014	0,0108	36,20	2 644,71	0,21	0,29	66 543,95	4 837,06	1 009,14	261,04
2003	0,37	27,8323	0,0015	0,0113	21,68	1 583,52	0,13	0,18	68 147,98	4 949,57	989,50	251,25
2004	0,39	29,2670	0,0016	0,0118	21,10	1 541,08	0,12	0,17	71 654,55	5 210,93	957,88	242,08
2005	0,42	31,1828	0,0017	0,0126	25,48	1 861,61	0,15	0,21	84 718,05	6 164,35	942,46	266,27
2006	0,45	33,8322	0,0018	0,0137	25,43	1 857,88	0,15	0,21	79 151,78	5 763,36	867,28	251,22
2007	0,50	37,3585	0,0020	0,0151	32,88	2 401,75	0,19	0,27	90 048,56	6 425,06	842,25	247,65
2008	0,54	40,8758	0,0022	0,0165	28,38	2 073,04	0,16	0,23	92 897,07	6 616,28	833,67	261,28
2009	0,52	38,9212	0,0021	0,0157	21,02	1 535,46	0,12	0,17	85 657,98	6 082,50	738,52	245,40
2010	0,54	40,4876	0,0022	0,0164	21,07	1 539,53	0,12	0,17	92 910,39	6 558,63	722,31	259,10

Figure 3.24: The share of different fuels within transport category 1A3 in 2010



Fuel	Consumption (TJ)	Share (%)
Diesel Oil	61 612,97	66,31
Gasoline	26 257,45	28,26
Biomass	3 417,60	3,68
LPG	1 274,00	1,37
CNG	247,12	0,27
Jet Kerosene	95,89	0,10
Av. Gasoline	5,35	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 sale decreased by 20% in the period 1990 – 2010 and compared to the previous year decreased by 7% due to the economic crises. Total GHG emissions from domestic aviation represented 6.04 Gg of CO_2 equivalents in 2010. The increasing trend of emissions was 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 have been finished in 2012 and the increasing of LTO is expected since this year.

Since 2002, air transport in the Slovak Republic has been positively affected by the penetrating entry 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 (56 754) 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 – 2010. 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 and 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 – 2010 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 was 56 754 cycles in the inventory year 2010. Total consumption of jet kerosene was 1 727.7 t and the consumption of aviation gasoline was 125.1 t on national flights.

The overview of fuel sale according to the type (aviation gasoline and jet kerosene) during 1990 – 2010 was revaluated. For the period 1994 – 2010 the data came directly from airport statistical processing information based on annual basis. 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 (filled in) at the Slovak airports during 1990 – 2010 is shown in Table 3.32.

3.3.2.4 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 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 busiest airports. Other airports have only local character for domestic and sport flights.

In the period 1990 – 2010, the sale of aviation fuels at Slovak airports was influenced mostly by prices and other conditions on fuel market at neighboring 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 – 2010 for national flights

	Aviation Gasoline					Jet Kerosene				
	Consumption	Consumption	CO_2	CH_4	N_2O	Consumption	Consumption	CO_2	CH_4	N_2O
Year	[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
2010	5,35	125,09	394,03	0,24	0,01	74,81	1 727,70	5 442,26	0,43	0,60

3.3.2.5 Source specific QA/QC and verification

The emission inventory of civil aviation was determined by the SHMU in cooperation with external experts from the Centrum of Transport Research in Brno (the Czech Republic) and the Transport Research Institute in Žilina with the cooperation of the Ministry of Transport.

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 in the central archiving system at the SHMU. The responsibility 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 2012 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 continue 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 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)

During the review of Slovakia's 2011 annual submission, the ERT identified underestimations in some of Slovakia's emission estimates. It recommended nine adjustments in the energy sector for 2008 and 2009. The adjustments, calculated in accordance with the "Technical guidance on methodologies for adjustments under Article 5, paragraph 2, of the Kyoto Protocol" (annex to decision 20/CMP.1), relate to:

The following estimates of emissions from the consumption of fuels in the energy sector, category 1A3b – Road Transportation:

- CO_2 emissions from gasoline;
- N_2O emissions from gasoline;
- CO_2 emissions from diesel oil;
- N_2O emissions from diesel oil;
- CH_4 emissions from liquefied petroleum gas (LPG);
- N_2O emissions from LPG;
- CH_4 emissions from gaseous fuels;
- CH_4 emissions from biomass;
- N_2O emissions from biomass;

With regard to the estimates of emissions from road transportation, the ERT written in the ARR 2012 that Slovakia did not provide an explanation of the values used in the COPERT IV (COmputer Programme to calculate Emissions from Road Transport) model for setting and calculating the emission factors and the corresponding emissions as requested by the ERT. In accordance with paragraph 19 of the annex to decision 20/CMP.1, the ERT initiated an adjustment procedure on the ground that the information provided by Slovakia was not sufficiently transparent.

During the adjustment process, Slovakia prepared the written submission and expressed disagreement with the ERT's views and reasoning for the recommended adjustments. Upon the national presentation of further information on the values used for setting and calculating the emission factors and the corresponding emissions in the COPERT IV model and the justifications for their application, the experts indicated that, in view of the updated information provided by Slovakia at the hearing in the front of the Compliance Committee, the nine adjustments recommended by the ERT with respect to the emissions from road transportation were no longer necessary.

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 recent 10 years, road transport has expanded significantly in the transport of goods and persons. In 2010, the transport network included 412 km of highways, 229 km of motorways and 3 317 km of the category I roads. Total roads network included 18 040 km of roads in the Slovak Republic in 2010.

Road transportation is the most important category with the highest share of emissions and increasing trend. Total aggregated emissions from road transportation reached 6 546.83 Gg of CO_2 equivalents in 2010. The increase is by 8% compared to 2009, but the 43% 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 6 463.41 Gg in 2010. After separation of biomass content, the final CO_2 balance was 6 211.6 Gg. The biomass content represented 251.81 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 2010

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	**2 609 765**	**378,74**	**121,05**	diesel >32 t	42 385	0,83	1,19
gasoline < 1.4 l	1 074 763	236,90	59,23	diesel 14 - 20 t	223 979	20,07	5,91
gasoline 1.4 l–2.0 l	564 750	88,01	28,74	diesel 20 - 28 t	262 656	19,57	5,52
gasoline > 2.0 l	131 177	18,08	4,73	diesel 28 - 34 t	146 670	10,39	4,00
diesel < 2.0 l	590 642	12,48	20,84	diesel 34 - 40 t	147 030	3,87	4,26
diesel > 2.0 l	165 649	2,95	4,37	**Buses**	**478 981**	**92,81**	**4,95**
LPG	82 720	20,30	3,14	City buses CNG	19 820	59,22	0,02
Two stroke engine	65	0,02	0,00	City buses Midi <=15 t	26 696	2,36	0,34
Light Duty Vehicles	**640 376**	**20,20**	**19,26**	City buese Stand. 15-18 t	150 729	10,50	1,43
gasoline < 3.5 t	142 896	12,90	7,25	City buses >18 t	82 574	4,46	0,61
diesel < 3.5 t	497 481	7,30	12,01	Long - line buses	199 162	16,27	2,54
Heavy Duty Vehicles	**2 976 624**	**212,72**	**75,09**	**Motorcycles**	**9 476**	**11,81**	**0,20**
diesel <=7,5 t	602 673	47,48	21,51	< 50 cm^3 (mopeds)	1 179	2,30	0,02
diesel 7,5 - 12 t	128 878	6,41	2,39	Two stroke engine > 50 cm^3	4 219	4,58	0,10
diesel 12 - 14 t	62 869	2,82	1,72	Four stroke engine < 250 cm^3	962	1,71	0,03
diesel 14 - 20 t	445 601	39,82	10,04	Four stroke engine 250 - 750 cm^3	1 261	1,77	0,02
diesel 20 - 26 t	399 166	29,93	7,45	Four stroke engine > 750 cm^3	1 855	1,45	0,03
diesel 26 - 28 t	238 639	15,71	4,56	**Total Road Transport**	**6 715 223**	**716,28**	**220,55**
diesel 28 - 32 t	276 076	15,82	6,54	***Total Blended Emissions***	***6 463 413***	***716***	***221***

3.3.3.1 Methodological issues – methods

The calculation of GHG emissions in the annual inventory 2010 was made according to the EMEP/CORINAIR EIG methodology, with the software product COPERT IV version 8.1. 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 1990 by COPERT IV version 8.1 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 241 subcategories. Further disaggregation was applied according to the operation of road vehicles in the agglomeration, road and highway traffic mode. In COPERT IV buses were divided 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. Information about the vehicle fleet is based on database operated by the Police Presidium. The SHMU has access to the database and can download the necessary information directly from the IS EVO (Information System for Vehicle Evidence) website http://www.minv.sk/?statisticke-prehlady-agendy-vozidiel.

COPERT IV version 8.1 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. Emission factors which have been used in the version 8.0 upgrade the methodology of estimation.

COPERT IV version 8.1 software fixed some bugs in the model, determining a recalculation of emission estimates. The annual update of the model emission factors is based on the availability of new measurements and studies regarding road transport emissions.

Table 3.34: Overview of input data in COPERT IV version 8.1 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	**1 724 831**	**8,68**	**7 723,54**	diesel >32 t	1 353	30,65	62 847,02
gasoline < 1.4 l	821 966	7,21	6 834,04	diesel 14 - 20 t	12 054	21,80	34 375,41
gasoline 1.4 l–2.0 l	355 655	8,36	7 009,21	diesel 20 - 28 t	5 795	26,71	66 827,33
gasoline > 2.0 l	44 979	10,13	10 852,85	diesel 28 - 34 t	2 782	27,65	73 702,41
diesel < 2.0 l	363 993	6,19	9 579,41	diesel 34 - 40 t	2 319	30,82	80 772,70
diesel > 2.0 l	82 457	7,98	9 189,00	**Buses**	**9 275**	**32,93**	**60 098,35**
LPG	55 691	10,00	8 595,04	City buses CNG	225	49,00	62 770,04
Two stroke engine	90	10,90	2 766,31	City buses Midi <=15 t	904	21,95	51 191,75
Light Duty Vehicles	**172 990,00**	**10,79**	**13 869,65**	City buese Stand. 15-18 t	3 168	29,40	60 767,35
gasoline < 3.5 t	42 590	12,21	11 203,39	City buses >18 t	1 357	37,83	60 584,53
diesel < 3.5 t	130 400	9,36	14 740,48	Long - line buses	3 621	26,46	65 178,07
Heavy Duty Vehicles	**121 739**	**25,03**	**55 070,89**	**Motorcycles**	**81 851**	**3,93**	**2 001,48**
diesel <=7,5 t	51 787	13,23	35 384,78	< 50 cm^3 (mopeds)	26 418	2,59	844,39
diesel 7,5 - 12 t	7 592	19,05	34 699,17	Two stroke engine > 50 cm^3	40 279	3,74	1 275,35
diesel 12 - 14 t	3 339	20,54	36 184,65	Four stroke engine < 250 cm^3	5 800	3,63	2 267,57
diesel 14 - 20 t	15 390	23,72	47 230,49	Four stroke engine 250 - 750 cm^3	4 474	4,21	2 653,44
diesel 20 - 26 t	8 786	26,28	61 609,12	Four stroke engine > 750 cm^3	4 880	5,49	2 966,64
diesel 26 - 28 t	5 271	27,90	63 513,58	**Total Road Transport**	**2 110 686**	**16,27**	**138 763,91**
diesel 28 - 32 t	5 271	32,02	63 704,02				

3.3.3.2 Methodological issues – emission factors and other parameters

The EFs values for CH_4 and N_2O in COPERT IV version 8.1 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

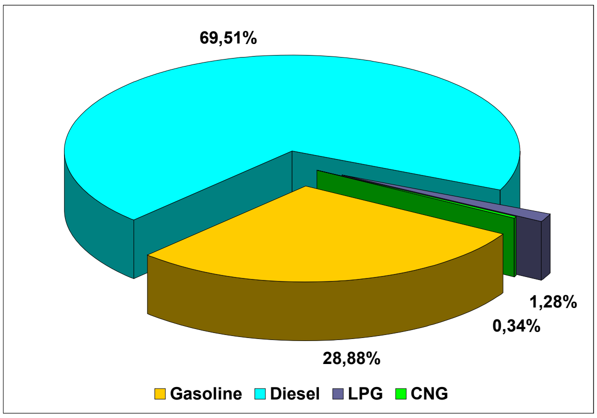
The emissions from this sector have an increasing tendency every year and they are the key source in level and trend assessment for uncertainty management. The revision of EF for CNG according to the EMEP/CORINAIR EIG 2008 and new disaggregation of buses to the EURO categories was provided in 2010. The emission inventory of road transport in 2010 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 buses have completely different combustion and after-treatment technology despite using the same fuel as passenger cars for CNG. Hence, their emission performance may vary significantly. Therefore CNG buses 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 buses 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	2 840 199	467,22	109,99
Road	2 908 126	213,37	89,88
Highway	966 898	35,69	20,63
Sum in the	**6 715 223**	**716,28**	**220,50**

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 bottom-up data from the distribution stations in the Slovak Republic are known also from the NEIS database. 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 70% share, followed by gasoline with 29% share. The minor consumptions were balanced for LPG (1.3%) and CNG (0.34%).

Figure 3.25: Fuels balance from statistics and COPERT IV model results in 2010



Fuel	**Statistical (t)**	**Calculated (t)**	**Deviation (%)**
Gasoline	618 311,00	618 311,32	-0,0001%
Diesel	1 488 124,00	1 488 123,10	0,0001%
LPG	27 360,00	27 358,87	0,0041%
CNG	7 179,30	7 179,32	-0,0003%

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 and 2006, the content of bio-component in fuel was value near 0%.
- In 2007, it was 1.53% for gasoline and 3.13% for diesel.
- In 2008, it was 0.83% for gasoline and 3.63% for diesel.
- In 2009, it was 1.71% for gasoline and 3.80% for diesel.
- In 2010, it was 2.34% for gasoline and 4.41% for diesel.

In 2010, the target of 3.79% 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			
2007	2008	2009	2010	2007	2008	2009	2010
28 879,36	29 321,86	27 950,00	26 886,60	58 321,03	60 478,51	55 086,04	63 230,35
Biomass share %				Biomass share %			
1,53%	0,83%	1,71%	2,34%	3,13%	3,63%	3,80%	4,41%
Biomass TJ				Biomass TJ			
441,85	243,37	477,95	629,15	1 825,45	2 195,37	2 093,27	2 788,46
Gasoline Fossil TJ				Diesel Oil Fossil TJ			
28 437,50	29 078,49	27 472,06	26 257,45	56 495,58	58 283,14	52 992,77	60 441,89

CO_2 Gasoline Blended Gg				CO_2 Diesel Oil Blended Gg				CO_2 Total Blended Gg			
2007	2008	2009	2010	2007	2008	2009	2010	2007	2008	2009	2010
2 065,96	2 092,16	2 000,04	1 923,13	4 321,79	4 484,51	4 085,52	4 689,56	6 387,75	6 576,67	6 085,56	6 612,68
Biomass share %				Biomass share %				Biomass share %			
1,53%	0,83%	1,71%	2,34%	3,13%	3,63%	3,80%	4,41%	2,61%	2,74%	3,11%	3,81%
Biomass CO_2 Gg				Biomass CO_2 Gg				Biomass Total CO_2 Gg			
31,61	17,36	34,20	45,00	135,27	162,79	155,25	206,81	166,88	180,15	189,45	251,81
CO_2 Gasoline Fossil Gg				CO_2 Diesel Oil Fossil Gg				CO_2 Total Fossil Gg			
2 034,35	2 074,79	1 965,83	1 878,13	4 186,52	4 321,73	3 930,27	4 482,75	6 220,87	6 396,52	5 896,11	6 360,87

CH_4 Gasoline Blended Gg				CH_4 Diesel Oil Blended Gg			
2007	2008	2009	2010	2007	2008	2009	2010
0,42	0,47	0,41	0,36	0,33	0,28	0,23	0,26
Biomass share %				Biomass share %			
1,53%	0,83%	1,71%	2,34%	3,13%	3,63%	3,80%	4,41%
Biomass CO_2 Gg				Biomass CO_2 Gg			
0,01	0,00	0,01	0,01	0,0103	0,0103	0,0088	0,0113
CO_2 Gasoline Fossil Gg				CO_2 Diesel Oil Fossil Gg			
0,41	0,46	0,40	0,35	0,32	0,27	0,22	0,25
N_2O Gasoline Blended Gg				N_2O Diesel Oil Blended Gg			
2007	2008	2009	2010	2007	2008	2009	2010
0,09	0,12	0,11	0,10	0,10	0,09	0,08	0,11
Biomass share %				Biomass share %			
1,53%	0,83%	1,71%	2,34%	3,13%	3,63%	3,80%	4,41%
Biomass CO_2 Gg				Biomass CO_2 Gg			
0,0014	0,0010	0,0020	0,0022	0,0032	0,0033	0,0032	0,0049
N_2O Gasoline Fossil Gg				N_2O Diesel Oil Fossil Gg			
0,09	0,12	0,11	0,09	0,10	0,09	0,08	0,11

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 corresponds with the consumption of the fuels. The emission factors are constant during the time series. In the period 2007 – 2008 gasoline consumption increased by 1.3% and diesel consumption also increased 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 2010, 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 passenger 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, divided 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, divided into urban, road and highway traffic.

The consistency of time series was improved by the use of most updated version of COPERT model. COPERT IV version 8.1 was used from 1990 – 2010.

3.3.3.6 Source specific QA/QC and verification

The emission inventory of Road transportation was determined by the SHMU sectoral expert for transport emission inventory and projections 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– 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 1990 have been recalculated with COPERT IV version 8.1 Emission factors are calculated automatically with COPERT IV version 8.1 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 buses were improved (instead 0.001 g/km to 0.006 g/km).

Major changes and differences occurred in CH_4 and N_2O emissions due to decreasing emission factors for several types of vehicles. It is visible, that the differences are increasing (CH_4, N_2O), which is caused by the modernization of vehicles park. Recalculated emissions are provided in Table 3.37.

Table 3.37: Recalculated GHG emissions in comparison with the previous submission

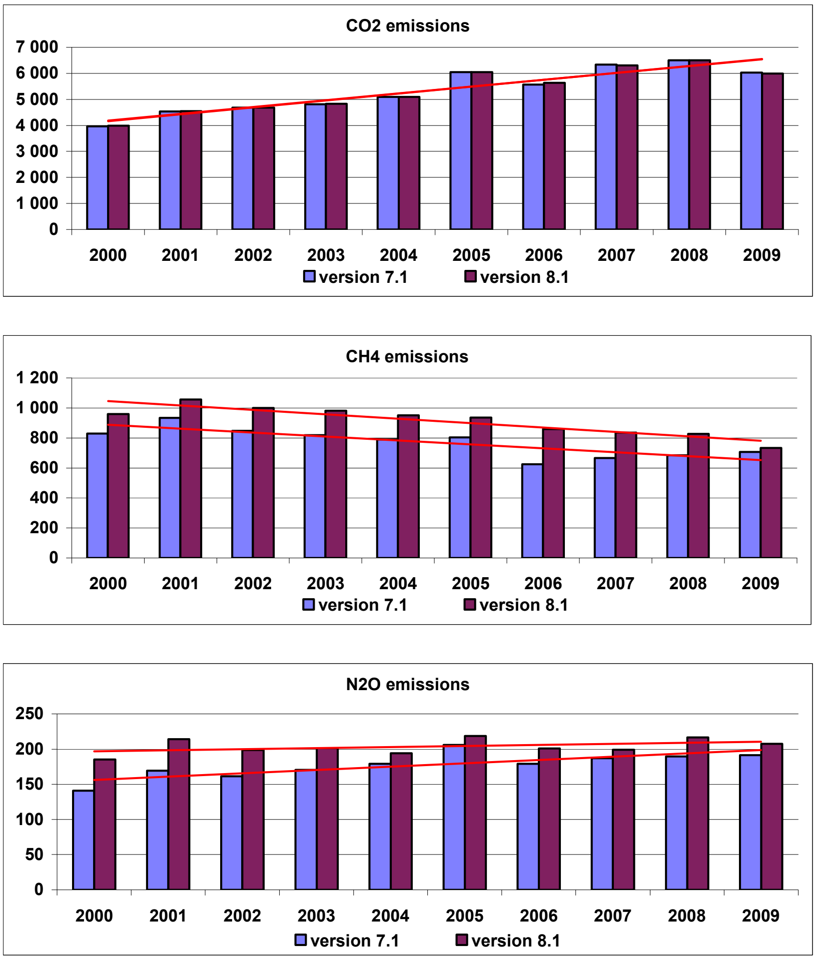
Submission	Fuel	Emissions									
		1990	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**
2011 COPERT IV	**Total**	**4 644,63**	**3 942,80**	**3 655,58**	**3 662,24**	**3 923,72**	**4 167,61**	**4 235,19**	**4 430,30**	**4 744,04**	**4 655,51**
version 7.1	CO_2 (Gg)	4 500,96	3 823,95	3 548,76	3 558,87	3 812,53	4 042,85	4 100,97	4 283,74	4 582,82	4 491,11
	CH_4 (t)	1 029,50	942,13	921,16	996,56	1 071,65	1 138,30	1 168,16	1 228,31	1 302,35	1 283,88
	N_2O (t)	393,71	319,54	282,17	265,96	286,09	325,35	353,86	389,57	431,83	443,35
2012 COPERT IV	**Total**	**4 586,13**	**3 891,06**	**3 609,76**	**3 618,75**	**3 877,26**	**4 111,64**	**4 169,25**	**4 352,89**	**4 653,12**	**4 553,59**
version 8.1	CO_2 (Gg)	4 503,02	3 820,33	3 544,54	3 552,31	3 804,83	4 033,64	4 089,46	4 267,88	4 562,40	4 464,32
	CH_4 (t)	1 165,44	1 079,91	1 076,88	1 159,28	1 218,39	1 232,35	1 180,20	1 167,29	1 192,33	1 114,90
	N_2O (t)	189,15	155,00	137,43	135,79	151,11	168,13	177,45	195,15	211,87	212,46
2012/2011	**Difference (%)**	**-1,28**	**-1,33**	**-1,27**	**-1,20**	**-1,20**	**-1,36**	**-1,58**	**-1,78**	**-1,95**	**-2,24**

Submission	Fuel	CO_2 (Gg)									
		2000	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2006**	**2008**	**2009**
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**	**6 026,09**
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	1 953,83
	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	3 979,78
	LPG	43,74	65,87	86,17	92,16	92,93	91,01	75,03	65,57	85,73	73,22
	CNG	0,63	0,63	3,65	7,08	8,85	10,85	12,80	14,93	17,13	19,26
2012 COPERT IV	**Total**	**3 989,01**	**4 541,25**	**4 686,24**	**4 826,84**	**5 090,84**	**6 045,33**	**5 636,49**	**6 300,45**	**6 499,33**	**5 988,78**
version 8.1	Gasoline	1 869,46	2 195,74	1 999,39	2 063,54	1 960,36	2 182,04	1 949,92	2 034,35	2 074,79	1 965,83
	Diesel	2 074,91	2 279,14	2 597,03	2 658,54	3 028,71	3 761,98	3 599,01	4 186,52	4 321,73	3 930,27
	LPG	43,74	65,46	86,17	92,15	92,93	90,60	74,79	64,92	85,68	73,57
	CNG	0,90	0,90	3,65	12,61	8,85	10,70	12,77	14,66	17,13	19,10
2012/2011	**Difference (%)**	**0,68**	**0,14**	**0,03**	**0,36**	**-0,17**	**-0,10**	**1,21**	**-0,57**	**-0,07**	**-0,62**

Submission	Fuel	CH_4 (t)									
		2000	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**
2011 COPERT IV	**Total**	**828,55**	**933,30**	**847,20**	**818,08**	**789,79**	**803,63**	**624,49**	**665,19**	**683,28**	**705,24**
version 7.1	Gasoline	707,93	806,07	694,17	640,35	598,39	583,67	411,02	409,37	439,57	439,57
	Diesel	104,70	105,44	118,63	115,08	140,09	164,20	162,95	172,51	165,98	165,98
	LPG	12,45	18,33	23,50	24,98	24,97	23,66	18,10	18,03	23,86	23,86
	CNG	3,46	3,46	10,91	37,67	26,34	32,10	32,42	50,36	37,71	56,98
	Biomass	0,00	0,00	0,00	0,00	0,00	0,00	0,00	14,92	16,16	18,85
2012 COPERT IV	**Total**	**958,55**	**1 055,87**	**999,67**	**981,70**	**950,28**	**935,20**	**859,18**	**834,26**	**826,18**	**732,60**
version 8.1	Gasoline	753,75	832,59	742,03	692,16	635,88	585,88	513,02	418,32	466,18	410,48
	Diesel	188,92	201,50	223,38	227,18	263,36	293,67	293,13	330,54	284,23	230,75
	LPG	12,42	18,33	23,35	24,68	24,69	23,55	20,60	17,85	23,45	18,13
	CNG	3,46	3,46	10,91	37,67	26,34	32,10	32,42	50,36	37,71	56,98
	Biomass	0,00	0,00	0,00	0,00	0,00	0,00	0,00	17,18	14,61	16,26
2012/2011	**Difference (%)**	**13,56**	**11,61**	**15,25**	**16,67**	**16,89**	**14,07**	**27,32**	**20,27**	**17,30**	**3,73**

Submission	Fuel	N_2O (t)									
		2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
2011 COPERT IV	**Total**	**140,97**	**169,34**	**161,42**	**170,44**	**179,27**	**205,92**	**179,04**	**187,25**	**189,85**	**191,56**
version 7.1	Gasoline	100,76	123,82	108,16	115,53	118,16	132,25	109,33	104,06	107,38	107,38
	Diesel	37,72	41,71	48,36	50,71	55,92	68,68	65,90	75,80	74,18	74,18
	LPG	2,49	3,80	4,90	4,20	5,19	4,99	3,80	2,78	3,49	3,49
	CNG	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
	Biomass	0,00	0,00	0,00	0,00	0,00	0,00	0,00	4,61	4,80	6,50
2012 COPERT IV	**Total**	**185,23**	**214,04**	**198,87**	**201,34**	**193,89**	**218,92**	**201,07**	**199,21**	**216,51**	**207,64**
version 8.1	Gasoline	134,55	155,58	131,23	131,48	115,03	120,26	116,85	90,43	117,06	114,66
	Diesel	48,19	54,66	62,78	64,71	73,69	93,68	81,28	101,33	91,52	84,84
	LPG	2,49	3,80	4,87	5,14	5,16	4,97	2,92	2,75	3,48	2,76
	CNG	0,00	0,00	0,00	0,02	0,01	0,01	0,02	0,02	0,02	0,02
	Biomass	0,00	0,00	0,00	0,00	0,00	0,00	0,00	4,68	4,43	5,35
2012/2011	**Difference (%)**	**23,90**	**20,89**	**18,83**	**15,35**	**7,54**	**5,94**	**10,96**	**6,00**	**12,32**	**7,74**

Figure 3.26: Comparison of CO_2, CH_4 and N_2O emissions estimated by COPERT IV version 7.1 and version 8.1



3.3.3.8 Source specific planned improvements

No specific improvements are planned for the next submission. The comparison study of carbon emission factors per fuel (diesel, gasoline) with default emission factors in the COPERT IV version 8.1 database was recommended by the previous ERT. The study being prepared in cooperation with the 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 2010, the length of managed railways was 3 622 km of which the length of electric railways was 1 578 km (http://portal.statistics.sk/showdoc.do?docid=23751).

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 was stabilized in 2003 and it occurs mostly in freight transportation. Total emissions from railways transport reached 99.61 Gg of CO_2 equivalents in 2010 and they increased by 2% compared to 2009 and decreased several times compared to the base year. Despite the fact of decreasing number of locomotives and fuel consumption, the operational kilometres are rising in 2010. The reason behind is in the increase of railways efficiency and modernization of infrastructure and decreasing of fuel consumption by technical parameters (new locomotives and wagons).

Table 3.38: Overview of GHG emission inventory in railways in 2010

	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	316 413	7 445	23 735	1,41	10,20
Žilina	122 825	2 890	9 213	0,55	3,96
Zvolen	541 920	12 751	40 650	2,42	17,47
Bratislava	189 380	4 456	14 206	0,85	6,10
Public	*561 765*	*13 218*	*42 139*	*2,51*	*18,11*
CARGO	*608 772*	*14 324*	*45 665*	*2,72*	*19,62*
Total SR	**1 170 537**	**27 542**	**87 804**	**5,23**	**37,73**

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 organizational 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 3.27 shows the information on diesel oil consumption.

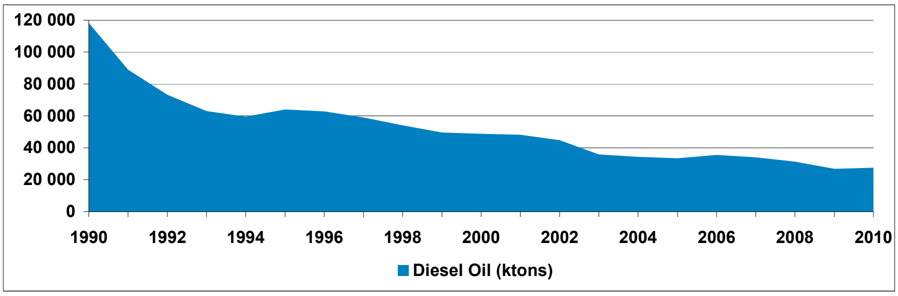
Table 3.39: Overview of activity data used in GHG inventory for railways transport in 2010

Traction 70+80, CARGO+Public 2010							
Year run	**Košice**	**Žilina**	**Zvolen**	**Bratislava**	***Total public***	***Total CARGO***	**Total SR**
Number of loco	208	100	162	149	***231***	***388***	**619**
[km per year]	5 526 482	3 560 340	8 048 913	4 447 812	***14 025 349***	***7 198 198***	**21 223 547**
Operations [hrtkm]	493 537 000	212 108 000	1 933 579 000	632 026 000	***1 105 133 000***	***2 166 117 000***	**3 271 250 000**
Consumption [l]	9 205 949	3 440 181	15 180 223	8 154 921	***15 736 355***	***20 244 919***	**35 981 274**

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

Year	Number of Loco [piece]	Annual Mileage [km]	Emissions [t] CO_2	CH_4	N_2O	Electricity Consumption [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
2010	619	21 223 547	87 804	5,23	37,73	564 500 847

Figure 3.27: Overview of diesel oil consumption for railways transport in 1990 – 2010



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. adopted a new economic and effective policy in the operation of railways transport. The extensive reconstruction of railways transport infrastructure takes place in order to fulfill international requirements and caused increase of electricity consumption in 2010. The methodology, activity data collection and used emission factors for diesel oil are consistent in time series.

3.3.4.5 Source specific QA/QC and verification

The emission inventory of railways was determined by the sectoral expert for transport emission inventory and projections Mr. Jiří Dufek from the Research Institute of Transport in Brno (the Czech Republic).

The verification process is based on cross-checking of the input data from the Railways Company Ltd. and the 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 No. 144/2001 Coll.) 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 divided according to the types of railways operations (passenger, freight and service transport).

3.3.4.6 Source specific recalculations

No recalculations in the submission 2012 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 2012 submission. This type of transport will be described more detailed in this chapter.

Total aggregated emissions from inland shipping excluding international navigation (Danube River) reached 45.61 tons of CO_2 equivalents in 2010, the slight increase was recognized compared to the previous year 2009 and compared to the base year, it is approximately a double increase.

Table 3.41: Overview of GHG emission inventory in inland shipping in 1990 – 2010

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	2010
HDP bio Euro	31,18	32,26	33,74	35,35	37,14	39,61	42,98	47,50	50,27	47,86	49,79
GDP 2008/year (%)	**60,02%**	**62,06%**	**65,01%**	**68,09%**	**71,60%**	**76,29%**	**82,77%**	**91,40%**	**100,00%**	**95,22%**	**99,05%**
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	12 700,01
Total Consumption (TJ/year)	0,33	0,34	0,35	0,37	0,39	0,42	0,45	0,50	0,54	0,52	0,54
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	40 487,63
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	2,16
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	16,38
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**	**45,61**

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 web portal www.plavba.net, where information about national tourist 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

Emission factors and other parameters are given in the Table 3.42.

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 of the Váh (Piešťany, Trenčín, Liptovská Mara dam),
- The tributary river of the Váh (Oravská priehrada dam),

- River – basin of the Bodrog (Zemplínska Šírava dam).

While the public and tourist shipping activities in the Slovak Republic are not very frequent and have expanded only in the recent 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 by the daily schedule of trips mostly in summer months (May-October).

- The duration of trips (in hours):

The duration can differ according to the type of trips (mostly short or long tours).

- The technical parameters of the most populated ships:

The technical parameters of vessels can be found on the webpage. The engines are mostly with 100 kilowatts power, 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 other years were corrected by the ratio of GDP decrease (99.05% of 2008 level in 2010).

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

No recalculations in the submission 2012 focused on the base year 1990 or the other inventory years were provided.

3.3.5.7 Source specific planned improvements

The information about 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 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 21% of the aviation category, i.e. 1.60 Gg of CO_2 equivalents in 2010.

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 – 2010

	Jet Kerosene				
	Consumption	Consumption	CO_2	CH_4	N_2O
Year	[TJ]	[t]	[t]	[t]	[t]
1990	95,86	2 223,19	7 003,06	0,5558	0,7781
1991	82,07	1 903,23	5 995,17	0,4758	0,6661
1992	69,64	1 615,00	5 087,23	0,4037	0,5652
1993	83,68	1 940,59	6 112,87	0,4851	0,6792
1994	84,92	1 969,33	6 203,38	0,4923	0,6893
1995	87,76	2 035,25	6 411,04	0,5088	0,7123
1996	76,06	1 763,88	5 556,21	0,4410	0,6174
1997	37,12	860,90	2 711,82	0,2152	0,3013
1998	27,73	643,04	2 025,59	0,1608	0,2251
1999	18,19	421,88	1 328,93	0,1055	0,1477
2000	23,03	534,13	1 682,50	0,1335	0,1869
2001	35,63	826,30	2 602,85	0,2066	0,2892
2002	36,20	839,59	2 644,71	0,2099	0,2939
2003	21,68	502,70	1 583,52	0,1257	0,1759
2004	21,10	489,23	1 541,08	0,1223	0,1712
2005	25,48	590,99	1 861,61	0,1477	0,2068
2006	25,43	589,80	1 857,88	0,1475	0,2064
2007	32,88	762,46	2 401,75	0,1906	0,2669
2008	28,38	658,11	2 073,04	0,1645	0,2303
2009	21,02	487,45	1 535,46	0,1219	0,1706
2010	21,07	488,74	1 539,53	0,1222	0,1711

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 2012 focused on the base year 1990 or the other inventory years were provided.

3.3.6.7 Source specific planned improvements

The reallocation of this category from the 1A3d to the category 1A5b – Mobile will be realized in 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.[13]

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 – 2010 are presented in Table 3.44.

Table 3.44: GHG emissions within reference approach in 1990 – 2010

	CO_2/Gg								
Year	**Fuel Combustion (RA)**	**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	-4 038,47	33 418,32	-313,86	12 362,68	-323,91	1 685,70	**-4 676,24**
1991	**49 719,54**	9 230,58	-3 502,13	28 711,40	-288,39	11 777,55	-215,01	1 381,72	**-4 005,54**
1992	**44 939,84**	7 845,45	-3 340,35	25 319,65	-266,87	11 774,73	-241,45	1 253,17	**-3 848,67**
1993	**42 859,62**	6 599,91	-2 515,24	24 768,15	-261,95	11 491,56	-180,60	720,37	**-2 957,78**
1994	**39 738,23**	6 966,86	-3 066,12	21 921,45	-271,75	10 849,91	-256,56	717,30	**-3 594,43**
1995	**40 881,10**	7 284,38	-3 553,00	21 599,21	-273,68	11 997,52	-276,51	325,72	**-4 103,20**
1996	**41 379,14**	7 348,46	-3 353,99	21 477,73	-280,93	12 552,95	-347,06	303,00	**-3 981,98**
1997	**41 478,84**	8 281,41	-3 011,58	20 411,79	-258,91	12 785,64	-272,51	348,69	**-3 543,00**
1998	**39 684,99**	8 001,86	-2 932,80	18 719,50	-230,37	12 963,62	-277,21	302,67	**-3 440,38**
1999	**38 562,21**	7 338,67	-2 544,61	18 123,30	-307,01	13 100,24	-277,21	269,48	**-3 128,83**
2000	**36 392,99**	6 279,16	-2 904,96	16 943,79	-273,43	13 170,04	-277,30	263,17	**-3 455,69**
2001	**38 645,78**	7 007,61	-2 655,86	17 492,38	-297,60	14 145,79	-198,26	1 126,72	**-3 151,71**
2002	**38 234,07**	7 634,68	-2 750,10	16 964,23	0,00	13 635,16	0,00	4 191,31	**-2 750,10**
2003	**38 882,81**	7 386,06	-2 802,14	18 274,85	0,00	13 221,90	0,00	1 474,73	**-2 802,14**
2004	**38 149,01**	7 378,39	-2 831,66	18 133,55	0,00	12 637,07	0,00	593,05	**-2 831,66**
2005	**37 644,68**	7 419,56	-3 215,92	16 937,60	-169,07	13 287,53	-294,10	1 459,56	**-3 679,10**
2006	**37 042,28**	7 283,89	-3 293,81	17 592,00	-163,86	12 166,39	-245,65	1 880,20	**-3 703,32**
2007	**35 268,77**	7 565,36	-3 283,65	16 369,87	-163,25	11 333,55	-375,44	3 360,48	**-3 822,34**
2008	**35 994,57**	8 444,72	-2 713,45	15 931,19	-163,94	11 618,66	-221,56	2 419,99	**-3 098,95**
2009	**32 437,58**	7 272,40	-3 012,93	15 182,33	-138,52	9 982,85	-224,12	3 194,62	**-3 375,57**
2010	**33 576,55**	7 948,59	-2 888,77	14 219,72	-136,06	11 408,24	-161,05	3 209,10	**-3 185,88**

The major share (39%) was represented by natural gas consumption, followed by solid fuels (28%) and liquid fuels (27%) in 2010. 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 33 576.55 Gg of CO_2 in 2010. Other emissions were not estimated. Detailed emission trend by gases and categories is presented on Figure 3.28.

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

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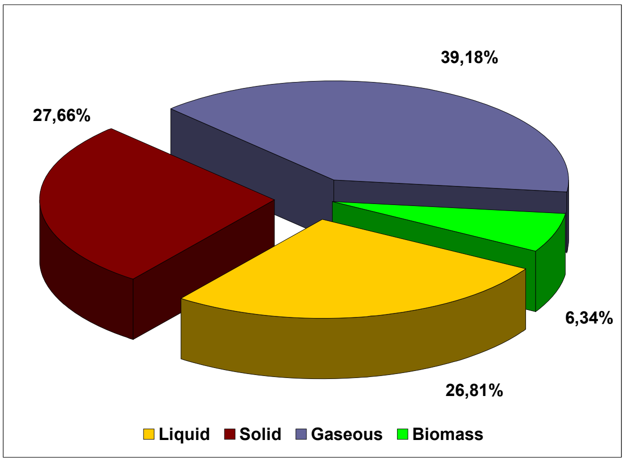
[13] *Energy 2010, http://portal.statistics.sk/files/Sekcie/sek_500/energetika/archiv2011_pdf/puben10def.pdf, December 2011,*

Figure 3.28: The share of different fuels consumption within reference approach in 2010



Reference Approach Fuels	TJ	Share (%)
Liquid	143 646,04	26,81%
Solid	148 204,19	27,66%
Gaseous	209 931,11	39,18%
Biomass	33 993,94	6,34%
Total without biomass	**501 781,34**	**100,00%**

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 the 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 for 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

The emission factors of several important fuels were used 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.

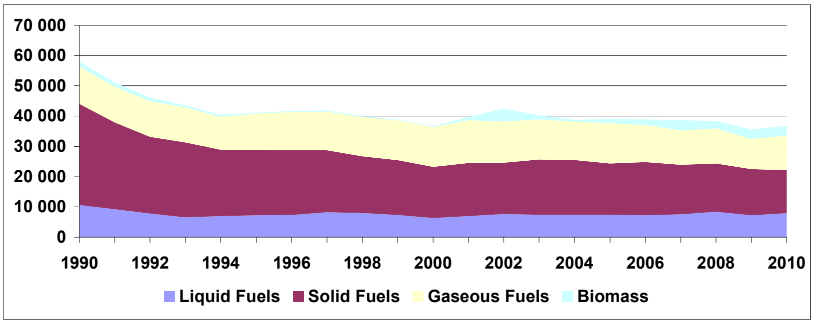
The most significant conclusion is the increasing trend of biomass share since 2006 (interannual 2006/2010 by 57%) and increasing trend of liquid and gaseous fuels and on the other hand, the decreasing trend in the share of solid fuel.

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 in 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 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 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 3.29: The share of different fuels consumption within reference approach in 1990 – 2010



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 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.

The reference approach balance is compared with the fuel balance (in metric units) published by Eurostat and by the International Energy Statistics. The results are included in Annex 2 of this report. During QA/QC procedures of the statistical information comparison, the disagreement (357 kt) between Reference approach data and IEA statistics was found in solid fuels – coking coal. Imported value of coking coal was corrected (increasing from 2 115 thousand tons to 2 472 thousand tons) by the Statistical Office of the Slovak Republic (information provided by official letter). The Statistical Office of the Slovak Republic corrected previous reported value published in December 2011[13] by increasing coking coal import. This change was not reflected in the reference approach prepared for the submission 2012, but the value 2 115 thousand tons was used for used for 2010 inventory preparation. The recalculation will be provided in the next submission.

The IEA database includes information for gaseous fuels expressed only in calorific units (TJ). The Statistical Office of the SR provides information based on gross calorific values and therefore consumptions are provided in the IEA statistics lower by the coefficient 1.11. After recalculation to natural units, no differences were found between IEA, RA and the SO SR data (Annex 2).

The differences in oil consumption between IEA, RA and the SO SR data were not found (Annex 2).

3.4.7 Source specific recalculations

No recalculations in the submission 2012 focused on the base year 1990 or the other inventory years were provided.

3.4.8 Source specific planned improvements

The official frame contract will be signed between the Statistical Office of the Slovak Republic and the Ministry of the Environment for ensuring direct responsibility for providing information about any changes, recalculations or reporting of the SO SR to the National Inventory System coordinator. This measure will avoid possible inconsistencies between the reporting of fuels.

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 9.55% in 2010. The difference in fuel consumption (in TJ) was 0.93% in 2010.

Figure 3.30: The difference between reference and sectoral approaches in 1990 – 2010

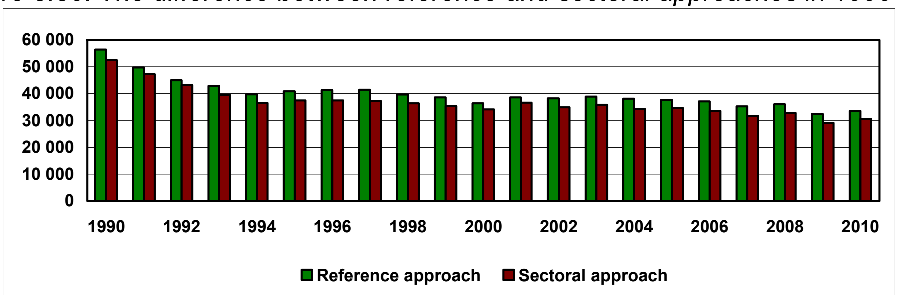
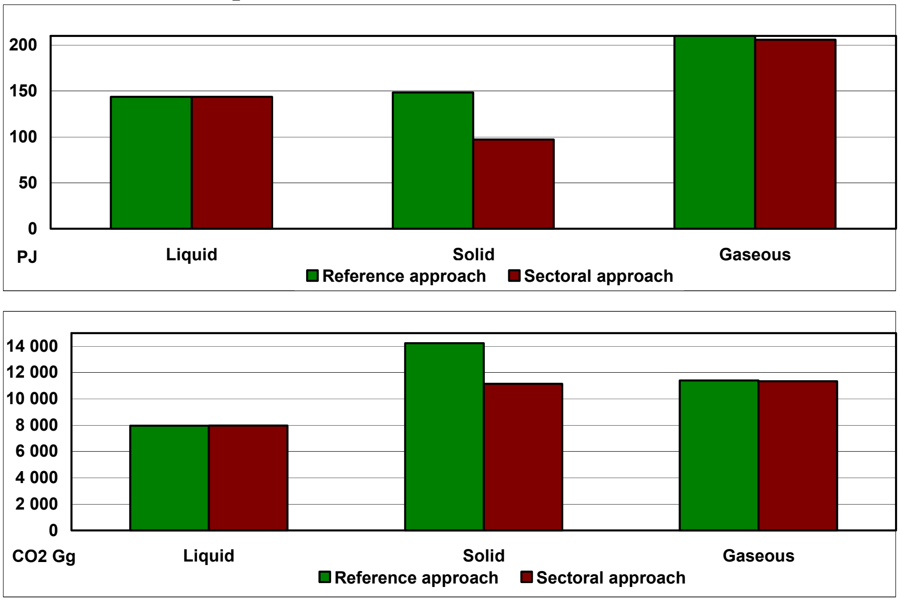


Figure 3.31: The difference between reference and sectoral approaches for fuel consumption in PJ and for CO_2 emissions in 2010



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 chapter 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 from iron and steel production and their emissions was 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).

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 shown in the following Tables 3.45 and 3.46 and Figures 3.30 and 3.31. The difference in 2010 was estimated as -2.57% 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 – 2010 for CO_2 emissions

	RA CO_2 emissions	SA CO_2 emissions	Difference CO_2 RA/SA in CRF	CO_2 from Cooking Coal in 2C1	SA CO_2 emissions	Difference CO_2 RA/SA calculated
Year	kt		%	kt		%
1990	56 377,11	52 469,39	7,45	4 095,73	56 565,12	-0,33%
1991	49 719,54	47 281,82	5,16	3 479,74	50 761,56	-2,10%
1992	44 939,84	43 188,82	4,05	3 188,59	46 377,41	-3,20%
1993	42 859,62	39 427,06	8,71	3 686,21	43 113,27	-0,59%
1994	39 738,23	36 517,73	8,82	3 663,44	40 181,17	-1,11%
1995	40 881,10	37 476,62	9,08	3 848,88	41 325,50	-1,09%
1996	41 379,14	37 432,66	10,54	3 650,00	41 082,66	0,72%
1997	41 478,84	37 297,79	11,21	3 840,38	41 138,17	0,82%
1998	39 684,99	36 381,55	9,08	3 565,00	39 946,55	-0,66%
1999	38 562,21	35 337,30	9,13	3 762,00	39 099,30	-1,39%
2000	36 392,99	34 107,37	6,70	3 414,39	37 521,76	-3,10%
2001	38 645,78	36 609,23	5,56	3 639,29	40 248,53	-4,15%
2002	38 234,07	34 860,24	9,68	3 980,10	38 840,35	-1,59%
2003	38 882,81	35 861,43	8,43	4 076,12	39 937,54	-2,71%
2004	38 149,01	34 362,63	11,02	4 067,45	38 430,08	-0,74%
2005	37 644,68	34 674,65	8,57	3 528,99	38 203,64	-1,48%
2006	37 042,28	33 594,17	10,26	4 047,71	37 641,88	-1,62%
2007	35 268,77	31 721,52	11,18	3 873,91	35 595,43	-0,93%
2008	35 994,57	32 819,84	9,67	3 788,59	36 608,42	-1,71%
2009	32 437,58	29 074,27	11,57	3 251,17	32 325,44	0,35%
2010	33 576,55	30 649,21	9,55	3 790,16	34 439,37	-2,57%

Table 3.46: The comparison of RA and SA with the inclusion of emissions from technology (reallocated into IP sector) in 1990 – 2010 for fuel consumption

	RA fuel consumption	SA fuel consumption	Difference RA/SA in CRF	Cooking Coal in 2C1	SA fuel consumption	Difference RA/SA calculated
Year	PJ		%	TJ		%
1990	763,91	708,55	-7,81%	103,11	811,66	5,88%
1991	679,15	640,05	-6,11%	91,58	731,63	7,17%
1992	625,19	600,48	-4,12%	85,47	685,95	8,86%
1993	586,82	556,97	-5,36%	92,80	649,77	9,69%
1994	561,52	521,51	-7,67%	96,42	617,93	9,13%
1995	590,98	530,51	-11,40%	92,86	623,37	5,20%
1996	599,39	533,67	-12,32%	84,54	618,20	3,04%
1997	600,08	525,62	-14,16%	88,95	614,57	2,36%
1998	582,02	517,13	-12,55%	89,75	606,88	4,10%
1999	565,85	509,67	-11,02%	99,01	608,68	7,04%
2000	545,41	505,04	-7,99%	101,91	606,94	10,14%
2001	574,89	537,44	-6,97%	108,62	646,06	11,02%
2002	562,96	510,09	-10,36%	118,79	628,89	10,48%
2003	565,57	508,29	-11,27%	126,89	635,18	10,96%
2004	553,56	496,07	-11,59%	128,00	624,07	11,30%
2005	565,00	505,23	-11,83%	122,70	627,93	10,02%
2006	549,20	482,65	-13,79%	140,02	622,67	11,80%
2007	528,99	461,44	-14,64%	138,52	599,96	11,83%
2008	531,29	469,86	-13,07%	122,44	592,30	10,30%
2009	480,51	421,77	-13,93%	105,45	527,22	8,86%
2010	501,78	448,19	-11,96%	127,43	575,62	12,83%

Considering the results of analyses, minor inconsistencies in the trend can be realized. The plant specific information before is not always possible to obtain in sufficient extent necessary for the analysis mostly for older data. 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 figures show the trend in time series of differences in fuels and emissions between sectoral and reference approach including the allocation of fuels from IP sector.

Figure 3.32: The difference between RA and SA for CO_2 emissions with the inclusion of emissions from cooking coal used in iron and steel production (IP sector) in 1990 – 2010

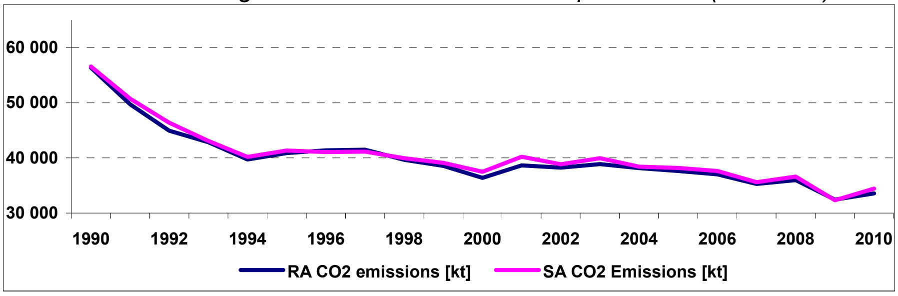
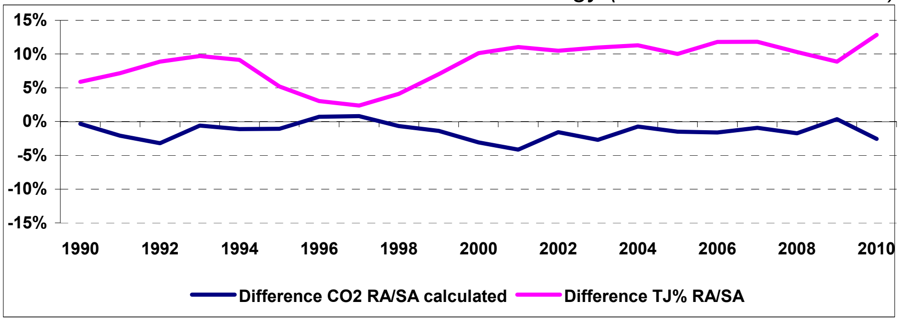


Figure 3.33: Trend in difference between RA and SA for CO_2 emissions and for fuels consumption with the inclusion of emissions from technology (reallocated in IP sector) in 1990 – 2010



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 alternative fuel type increased. After the medium increase in solid fuels in 2001, the decreasing trend in 2002 – 2007 appeared in energy balance. In the last inventory year 2010 the increasing 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 shown in Table 3.47.

Table 3.47: Comparison of fuel consumption by fuel type and CO_2 emissions within reference and sectoral approaches in 2010

	Liquid	Solid	Gaseous	Other	Total
	Fuel Consumption (PJ)				
Reference approach	143,65	148,20	209,93	NA	501,78
Sectoral approach	143,62	97,19	205,78	1,60	448,19
Difference	*0,02*	*0,00*	*2,02*	*0,00*	*0,93*
Apparent energy consumption (excluding non-energy use and feedstocks)	143,65	97,19	209,93	1,60	452,37
	CO_2 Emissions (Gg)				
Reference approach	7 948,59	14 219,72	11 408,24	NA	33 576,55
Sectoral approach	7 983,87	11 147,21	11 345,94	172,19	30 649,21
Difference	*-0,44*	*27,56*	*0,55*	*-100,00*	*9,55*

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

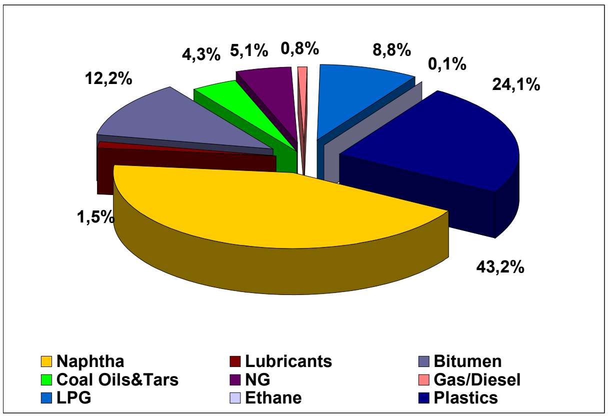
For the planned improvements see sections on sectoral and reference approaches.

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 3 185.88 Gg of CO_2 (868.88 Gg C) in 2010.

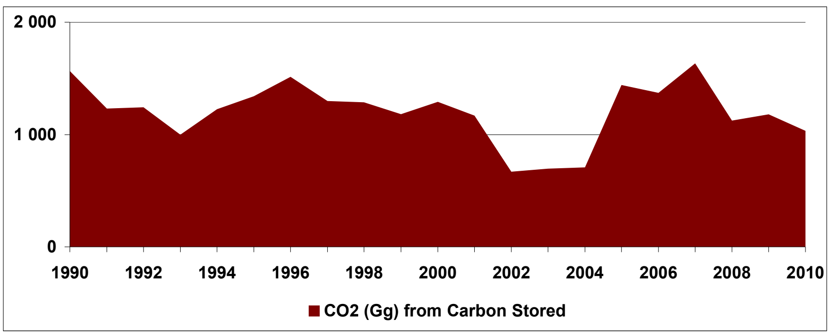
Figure 3.34: The share of different fuel type with the share of carbon stored in 2010



Fuel Type	Carbon Stored (Gg of C)	Share (%)
Naphtha	375,31	43,19%
Lubricants	12,68	1,46%
Bitumen	106,23	12,23%
Coal Oils&Ta	37,11	4,27%
NG	43,92	5,06%
Gas/Diesel	7,36	0,85%
LPG	76,25	8,78%
Ethane	0,64	0,07%
Plastics	209,38	24,10%
Total	**868,88**	**100,00%**

The major shares of carbon stored represent naphtha (43%) and plastics (24%) fuels.

Figure 3.35: Overview of CO_2 emissions from carbon stored in 1990 – 2010



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 3.48: Overview of carbon stocks in fuels in 2010

Fuel Type	Fuel quantity (TJ)	Fraction of carbon stored	EFs (tC/TJ)
Naphtha	23 456,80	0,80	20,00
Lubricants	1 267,83	0,50	20,00
Bitumen	4 866,02	1,00	21,83
Coal Oils&Tars	1 908,99	0,75	25,92
NG	8 812,01	0,33	15,10
Gas/Diesel	464,40	0,80	19,82
LPG	5 428,00	0,80	17,56
Ethane	47,40	0,80	16,80
Plastics	13 086,31	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 2010 (Table 3.49):

- Fuels used as feed stocks – 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 main types of fuels.

3.6.6 Source specific QA/QC and verification

The results of energy statistics 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.

3.6.7 Source specific recalculations

No recalculations in the submission 2012 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.

Table 3.49: Overview of quantity and CO_2 stocks in fuels in the period 1990 – 2010

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
2010	23 457	1 376	1 268	46	4 866	389	1 909	136	8 812	161

Gas/Diesel (1A1b)		LPG (1A2c)		Ethane (1A1b)		Plastics (1A2c)	
(TJ)	CO_2 (Gg)	(TJ)	CO_2 (Gg)	(TJ)	CO_2 (Gg)	(TJ)	CO_2 (Gg)
14 902	554	1 135	58	33 810	1 666	NO	NO
12 605	469	914	47	30 960	1 526	NO	NO
10 532	392	790	41	30 566	1 506	NO	NO
10 449	388	733	38	27 080	1 335	NO	NO
11 311	421	851	44	31 066	1 531	NO	NO
13 940	518	955	49	34 549	1 703	NO	NO
14 338	533	971	50	35 796	1 764	NO	NO
14 847	552	959	49	30 497	1 503	NO	NO
15 739	585	969	50	30 394	1 498	NO	NO
15 358	571	503	26	21 415	1 055	NO	NO
16 976	631	974	50	24 309	1 198	NO	NO
23 800	885	3 738	193	1 045	51	NO	NO
5 018	294	3 383	174	902	44	15 168	890
4 831	281	6 436	332	893	44	14 582	855
630	37	7 126	367	705	35	15 582	914
633	37	6 575	339	190	9	17 870	1 048
633	37	6 302	325	664	33	19 225	1 128
591	34	7 130	367	569	28	16 629	976
464	27	6 394	329	474	23	14 927	876
464	27	6 578	339	95	5	12 992	762
464	27	5 428	280	47	2	13 086	768

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 2 370 kt of brown coal from underground mines in 2010 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 780 kt of brown coal is imported (mostly from the Czech Republic). The production of brown coal (mining) slightly decreased compared to the previous year. Total methane emission from the underground coal mining in 2010 was estimated to be 15.23 Gg (13.80 Gg of CH_4 from mining activities, 1.43 Gg of CH_4 from post-mining activity and 0.09 Gg of CO_2 equivalents from methane cogeneration (category 1A1a electricity and heat production – other fuels) with recovery of 0.03 Gg of CH_4.

3.7.2.1 Methodological issues – methods

Total emissions 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 and 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 Tier 2 methodology from the IPCC 2000 GPG.

Table 3.50: Overview of fugitive emissions from mining and post-mining activities in 1990 – 2010

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**
2010	2 370,00	13,796	0,032	1,429	**15,225**

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 3.51.

Based on the judgment of sectoral expert, it was decided to calculate fugitive methane emissions in the period 1990 – 2010 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 3.51, point 2).

Table 3.51: 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 2010

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]	1 453,000	0,000	0,000	288,000	0,000	318,000	148,000	163,000
Depth of Mine [m]	200	200	500	500	500-1500	500-1500	600	400
	EF CH_4 [m³/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 2010. The amount of methane cogenerated was 48.189 kt in 2010. 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 0.09 Gg of CO_2 equivalents in 2010. 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 2010. 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 methane EF for methane from mining was 6.44 kg/t in 2010.

Table 3.52: Cogeneration of methane from Mine Handlová, the east shaft during 2007 – 2011 (*predictions)*

Methane cogenerated in Mine Handlova		2007	2008	2009	2010	2011*
Mixture Methane + Air	m³	1 022 730,00	910 560,00	925 000,00	150 590,00	150 590,00
Average Concentration of CH_4	%	33,06	30,00	17,10	32,00	32,00
Quantity of CH_4	m³	338 114,54	273 168,00	158 175,00	48 188,80	48 188,80
Density of CH_4 (20°C)	kg/m³	0,67	0,67	0,67	0,67	0,67
Quantity of Flared CH_4	t	225,86	182,00	106,00	32,19	32,19

3.7.2.3 Activity data

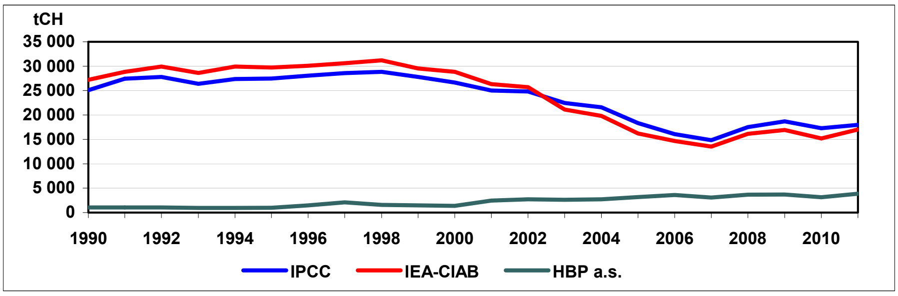
Five localities of underground mines operated by three companies are in the Slovak Republic. Data of coal production from the underground mines have been obtained from official sources (official statistical sources: the Ministry of Economy of the Slovak Republic and the Statistical Office of the Slovak 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 – 2010 (2011 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 3.36: Comparison of trends of CH_4 emissions in the Slovak Republic in years 1990 – 2011 (*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 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 $\pm$20% accuracy depending on the measurement's installation. The repeatability of the measurements increases the accuracy up to $\pm$5%. For the continual measurement the uncertainty is in the range of $\pm$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 SHMU.

3.7.2.6 Source specific recalculations

No recalculations in the submission 2012 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 728.51 Gg of CO_2 equivalents (34.68 Gg CH_4) in 2010. Total CO_2 emissions were 0.188 Gg in 2010 and the estimation was based on the composition of natural gas and carbon content. Total N_2O emissions were 4.8 kg in 2010. The time series since 1990 have been completed.

Total emission from oil activities (1B2A) were 2.17 Gg of CO_2 equivalents (0.56 t of CO_2 and 103.35 t of CH_4) in 2010. Total emissions are decreasing continuously due decreasing of production and storage (Table 3.53).

Total emissions from natural gas (1B2B) activities were 657.62 Gg of CO_2 equivalents (170 t of CO_2 and 31.31 Gg of CH_4) in 2010. 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.

Total emissions from flaring and venting activities (1B2C) were 59.62 Gg of CO_2 equivalents (15.37 t of CO_2, 2.84 Gg of CH_4 and 2.19 kg of N_2O). Emissions from the category other (1B2D) includes emissions from storage of natural gas and were 9.09 Gg of CO_2 equivalents (2.34 t of CO_2, 0.43 Gg of CH_4 and 2.6 kg of N_2O).

Table 3.53: Trend in fugitive emissions from oil activities in 1990 – 2010

	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
2010	539,50	0,11	19,50	418,13	0,29	54,41	226,30	0,16	29,45

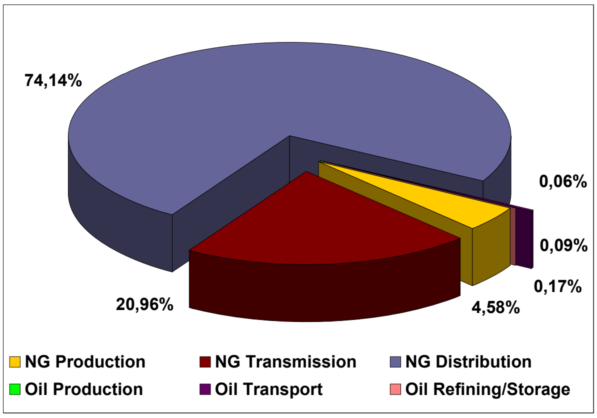
Table 3.54: Trend in fugitive emissions from NG activities in 1990 – 2010

	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
2010	3 697,20	7,79	1 437,76	2 270	35,65	6 583,00	32 798	126,12	23 286,58

Fugitive emissions from flaring and venting of oil and natural gas and from the storage of natural gas are estimated separately. Total emissions have decreased since 2003 due decreasing production and storage. The emissions in category 1B2B5 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 (74%) and NG transmission (21%). Production of natural gas is decreasing and represents 5% of the total fugitive emissions from oil and NG activities.

Figure 3.37: The share of individual activities in fugitive emissions of oil and NG in 2010



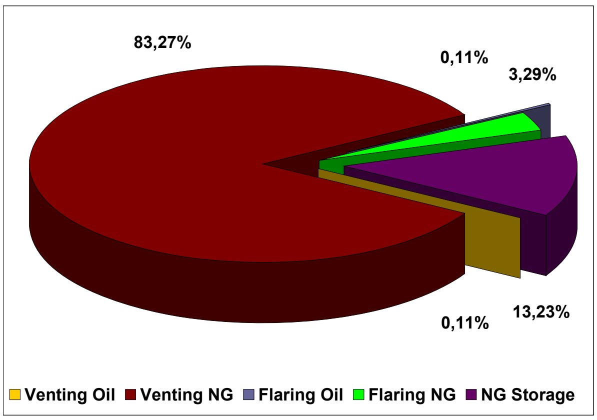
IPCC Category	GHG (CO_2 eq.)	Share (%)
NG Production	30,20	4,58%
NG Transmission	138,28	20,96%
NG Distribution	489,14	74,14%
Oil Production	0,41	0,06%
Oil Transport	1,14	0,17%
Oil Refining/Storage	0,62	0,09%

Total emissions from storage of natural gas are presented in Table 3.55 and are allocated in category 1B2D other leakages. The major share is distributed between NG storage (13%) and NG venting (83%), the venting and flaring of oil and NG flaring represented 3% from the total fugitive emissions from venting, flaring and storage of oil and NG in 2010.

Table 3.55: Trend in fugitive emissions from venting and flaring activities in 1990 – 2010

	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	0,10488	19,74699	14,45486	2 721,60000	0,10488	19,74699	0,00005	1,01409	115,51864	0,00932
1991	0,10225	19,30932	14,45486	2 721,60000	0,10255	19,30932	0,00005	0,71717	135,00000	0,00659
1992	0,08821	16,60878	14,45486	2 721,60000	0,08821	16,60878	0,00004	0,63266	119,11964	0,00582
1993	0,09536	17,95500	14,45486	2 721,60000	0,09536	17,95500	0,00004	0,58013	109,22884	0,00533
1994	0,09638	18,14670	14,45486	2 721,60000	0,09638	18,14670	0,00004	0,66007	124,28005	0,00607
1995	0,10647	20,04669	14,45486	2 721,60000	0,10647	20,04669	0,00005	0,78569	147,93197	0,00722
1996	0,10229	19,25910	14,45486	2 721,60000	0,10229	19,25910	0,00005	0,71717	135,03092	0,00659
1997	0,09178	17,28000	14,45486	2 721,60000	0,09178	17,28000	0,00004	0,66007	124,28005	0,00607
1998	0,08604	16,20000	14,45486	2 721,60000	0,08604	16,20000	0,00004	0,59384	111,80904	0,00546
1999	0,09464	17,82000	14,45486	2 721,60000	0,09464	17,82000	0,00004	0,48649	91,59741	0,00447
2000	0,08461	15,93000	14,45486	2 721,60000	0,08461	15,93000	0,00004	0,39513	74,39602	0,00363
2001	0,07887	14,85000	14,54860	2 721,60000	0,07887	14,85000	0,00004	0,44766	84,28682	0,00412
2002	0,07457	14,04000	14,54860	2 721,60000	0,07457	14,04000	0,00003	0,34425	64,81547	0,00372
2003	0,06023	11,34000	14,54860	2 721,60000	0,06023	11,34000	0,00003	0,61897	116,54200	0,00491
2004	0,05449	10,26000	14,54860	2 721,60000	0,05449	10,26000	0,00002	0,14420	25,00579	0,00347
2005	0,04445	8,37000	14,46761	2 724,00000	0,04445	8,37000	0,00002	0,01874	3,53000	0,00309
2006	0,04112	7,56000	14,81616	2 724,00000	0,04112	7,56000	0,00002	0,30172	55,47223	0,00407
2007	0,03192	7,56000	11,50118	2 724,00000	0,03192	7,56000	0,00002	0,62309	147,57644	0,00269
2008	0,02052	4,86000	11,50118	2 724,00000	0,02052	4,86000	0,00001	0,45446	107,63641	0,00214
2009	0,02585	4,05000	17,38983	2 724,00000	0,02585	4,05000	0,00001	0,68600	107,45714	0,00216
2010	0,01901	3,51000	14,75368	2 724,00000	0,01901	3,51000	0,00001	0,58208	107,47014	0,00218

Figure 3.38: The share of individual activities of venting, flaring and storage of NG in 2010



IPCC Category	GHG (CO_2 eq.)	Share (%)
Venting Oil	0,07	0,11%
Venting NG	57,22	83,27%
Flaring Oil	0,07	0,11%
Flaring NG	2,26	3,29%
NG Storage	9,09	13,23%

Table 3.56: Trend in fugitive emissions from storage of NG in 1990 – 2010

	NG Storage			
Year	Storage [TJ]	CO_2 Emissions [t]	CH_4 Emissions [t]	N_2O Emissions [t]
1990	33,5700	0,0223	4,2000	0,0111
1991	34,0500	0,0223	4,2000	0,0079
1992	34,0400	0,0223	4,2000	0,0069
1993	33,8700	0,0223	4,2000	0,0064
1994	2 390,4720	1,5927	299,8800	0,0072
1995	5 422,7872	3,5557	669,4800	0,0086
1996	5 352,1304	3,5022	659,4000	0,0079
1997	2 403,2244	1,5749	296,5200	0,0072
1998	4 799,6397	3,1453	592,2000	0,0065
1999	3 360,3885	2,1950	413,2800	0,0053
2000	17 946,7890	11,6955	2 202,0600	0,0043
2001	14 861,4640	9,6990	1 826,1600	0,0049
2002	6 203,6700	4,0487	762,3000	0,0044
2003	1 101,8721	0,7259	136,6764	0,0059
2004	13 463,0010	8,7767	1 650,6000	0,0041
2005	1 709,7000	1,1143	210,0000	0,0037
2006	377,4100	0,2513	46,2000	0,0049
2007	NO	NO	NO	NO
2008	4 558,1760	2,2344	529,2000	0,0026
2009	19 529,4456	15,2563	2 389,8000	0,0026
2010	3 539,8422	2,3430	432,6000	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 emission 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 2010 (prepared by monthly analyses) with the recalculation value of 5.095 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 3.57: Activity data, EFs and fugitive emissions from oil and NG production, transport and refining/storage in 2010

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	13 000	0,540	5,095	1,50E-03	0,00	0,106	19,50	0,00
Oil Transport	10 075 332	418,126	5,095	5,40E-06	0,00	0,295	54,41	0,00
Oil Refining/Storage	5 453 000	226,300	5,095	5,40E-06	0,00	0,159	29,45	0,00
Oil Venting	13 000	0,540	5,095	2,70E-04	0,00	0,019	3,51	0,00
Oil Flaring	13 000	0,540	5,095	2,70E-04	6,40E-07	0,019	3,51	8,32E-06
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	104 000	3,697	5,095	2,90E-03	0,00	7,79	1 437,76	0,00
NG Transmission	2 270	km	5,095	2,90E-03	0,00	35,65	6 583,00	0,00
NG Distribution	32 798	km	5,095	7,10E-04	0,00	126,12	23 286,58	0,00
NG Venting	2 270	km	5,095	1,20E-03	0,00	14,75	2 724,00	0,00
NG Flaring	104 000	3,697	5,095	1,30E-05	2,10E-08	0,58	107,47	2,18E-03
NG Storage	103 000	3,540	5,095	4,20E-03	2,50E-08	2,34	432,60	2,60E-03

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 the Economy of the Slovak Republic and the Statistical Office of the Slovak Republic.

Table 3.58: Activity data for production, export and import NG in the Slovak Republic in 2010

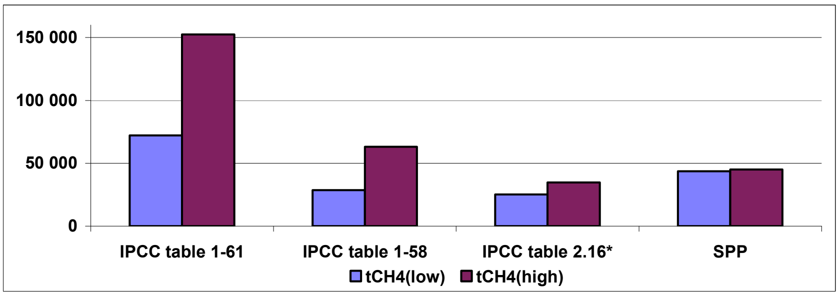
Activity	Natural Gas [m^3]	Natural Gas [PJ]	NCV [PJ/m^3]
Indigenous Production	104 000 000	3,697	35,550
Associated Gas	9 000 000	0,320	35,550
Non-associated Gas	95 000 000	3,377	35,550
Stock Changes	-103 000 000	-3,540	34,367
Gas Vented	2 000 000	0,071	35,550
Gas Flared	8 000 000	0,284	35,550
Export	0,000	0,000	35,550
Import	6 098 000 000	209,452	34,348
Inland Consumption	**6 099 000 000**	**209,607**	**34,367**

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“ has 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 realistic 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 5.095 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 – 2 mills. m^3 and flared NG – 8 mills. m^3 (the Statistical Office of the Slovak Republic, 2010).

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 0.179% mol in 2010. 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 (72 093 – 152 458 t CH_4) and are approximately 2.8-4.4 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 3.39: The comparison between the methodologies used for the calculation (national approach according to the Slovak Gas Industry, LtD. and IPCC) of fugitive methane emissions from transport and distribution of natural gas in the Slovak Republic (IPCC table 2.16 - 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) 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 SHMU.

According to the activity and input data resulted from analytical measurements performed 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 5.095 grams CO_2 per Gg of CH_4.

3.7.3.6 Source specific recalculations

No recalculations in the submission 2012 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 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 – 2010 and the expert estimation of the share in total national fuels. In 2010, the emissions from international civil aviation decreased back to the level of 2006 and represented 104.54 Gg of CO_2 equivalents. The interannual decrease of emissions is explained by recession of economy and canceling of many regular flights operated by foreign companies at Bratislava Airport in 2010. According to the recent projections the increasing trend is going to continue after 2011.

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 of 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 changed and represents 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 total LTO cycles was 56 754 cycles in 2010. Total consumption of jet kerosene was 32 826 t and the consumption of aviation gasoline by international flights was 13.90 t.

The overall view of the sale of aviation fuels according to the types (aviation gasoline and jet kerosene) during 1990 – 2010 was estimated. For the period 1994 – 2010 the data were obtained 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 (filled in) at the Slovak airports during 1990 – 2010 is shown in Table 3.59.

Table 3.59: Fuel quantities sold at the Slovak airports and GHG emissions during 1990 – 2010 for international flights

	Aviation Gasoline					Jet Kerosene				
	Consumption	Consumption	CO_2	CH_4	N_2O	Consumption	Consumption	CO_2	CH_4	N_2O
Year	[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
2010	0,59	13,90	43,79	0,03	0,001	1 421,41	32 826,22	103 402,59	1,64	3,41

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 2012 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 prepared 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 38.13 Gg of CO_2 equivalents in 2010, the increase is more than 5% compared to the previous year 2009 but compared to the base year, the decrease is significant.

Table 3.60: Overview of GHG emissions inventory in inland shipping in 2010

	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	425,34	10 542	33 607,90	2,00	14,44
State Shipping Administration	0	0	0,00	0,00	0,00
International Shipping Companies	0,00	0	0,00	0,00	0,00
Total SR	**425,34**	**10 542**	**33 607,90**	**2,00**	**14,44**

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 emissions from inland shipping on the Danube River. National shipping activities have not occurred (except of few tourist sightseeing journeys 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 – 2010.

Table 3.61 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.

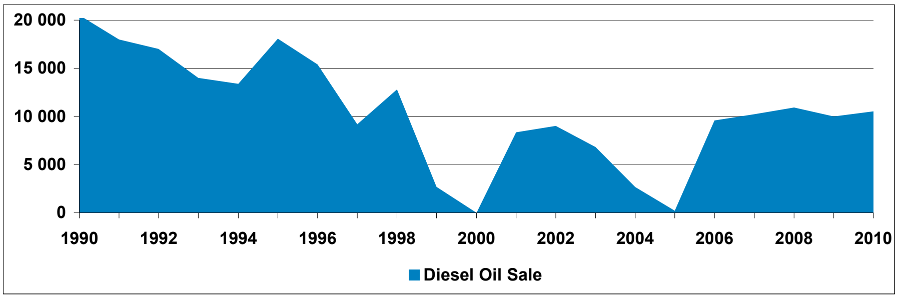
Table 3.61: Emission balance of GHGs from diesel oil sold for shipping companies in the Slovak Republic in 1990 – 2010 based on historical EFs in that time

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
2010	33 607,90	2,00	14,44	10 542

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 – 2010 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 neighbors' countries (market discrepancies).

Figure 3.40: Overview of diesel oil consumption for shipping transport in 1990 – 2010



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 2012 focused on the base year 1990 or other inventory years were provided.

3.8.3.7 Source specific planned improvements

The information about 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 estimated since the base year. Total CO_2 emissions have increasing trend and in 2010, they represented 2 820.17 Gg of CO_2 (53 059 TJ). This is the increase by 7% compared to the previous year 2009. The fluctuations in trend are expected also in the future due to the household consumption and prices policy.

Figure 3.41: Trend of CO_2 emissions from biomass in 1990 – 2010

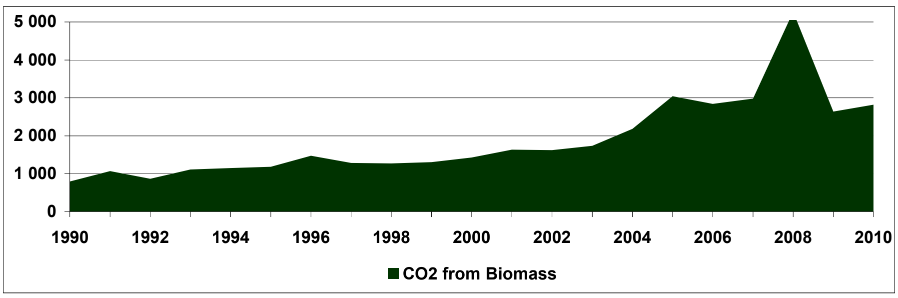


Table 3.62: Trend of CO_2 emissions from biomass in 1990 – 2010

Year	Consumption [TJ]	CO_2 [Gg]	CH_4 [t]	N_2O [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	28 315,48	2 843,16	8 037,81	113,26
2007	30 305,23	2 982,94	7 522,16	116,83
2008	53 118,09	5 266,71	14 317,75	207,14
2009	26 964,11	2 640,93	5 989,79	102,92
2010	28 953,14	2 820,17	5 680,42	109,61

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

Recalculations are connected with the corrections of biomass consumption for years 2006 – 2009. Corrections are based on the wood consumption and presented in the following Table.

Table 3.63: Recalculations of fuels and emissions from biomass in 2006 – 2009

	Consumption			CO_2			CH_4			N_2O		
	[TJ]			[Gg]			[t]			[t]		
Year	2011	2012	Difference	2011	2012	Difference	2011	2012	Difference	2011	2012	Difference
2006	29 103,39	28 315,48	97,29%	2 900,75	2 843,16	98,01%	8 043,85	8 037,81	99,93%	115,10	113,26	98,40%
2007	30 227,63	30 305,23	100,26%	2 976,46	2 982,94	100,22%	7 519,90	7 522,16	100,03%	116,76	116,83	100,06%
2008	53 013,68	53 118,09	100,20%	5 257,42	5 266,71	100,18%	14 319,31	14 317,75	99,99%	207,51	207,14	99,82%
2009	27 220,32	26 964,11	99,06%	2 660,33	2 640,93	99,27%	5 992,38	5 989,79	99,96%	104,07	102,92	98,89%

3.8.4.7 Source specific planned improvements

No further improvements are planned for the next submission.

CHAPTER 4: INDUSTRIAL PROCESSES (CRF 2)

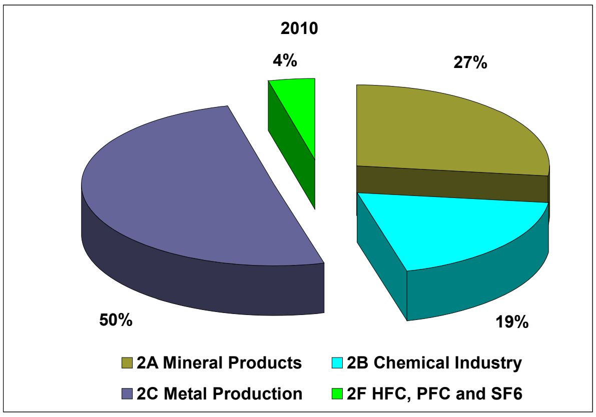
4.1 Overview of sector (CRF 2)

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 2010, total aggregated GHG emissions from industrial processes were 8 521.62 Gg of CO_2 equivalents and they increased compared to the previous year by almost 3%. Compared to the reference year 1990 the emissions decreased by 11%. CO_2 is the most important gas with the share of 85%, followed by N_2O emissions with 11%. The most important source of GHG emissions are metal production (50%), mineral products (27%), chemical industry (19%) and consumption of halocarbons and SF_6 (4%). 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.

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 (not occurring in the Slovak Republic) 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.

Figure 4.1: The share of individual categories in emissions in sector industrial processes in 2010



Category	CO_2 Eq. (Gg)	Share (%)
2A Mineral Products	2 303,17	27,03%
2B Chemical Industry	1 608,63	18,88%
2C Metal Production	4 269,30	50,10%
2F Consumption of Halocarbons and SF_6	341,00	4,00%

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 2010, 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 fibres, foodstuffs, beverages and tobacco products, coke, oil products and nuclear fuel. The industrial production and emissions were influenced by the world economic crises in 2009 and at the beginning of the year 2009 (January) also with a gas crisis. The decrease in almost all industrial categories was 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%. However, 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%. The recovery of economy is visible in 2010.

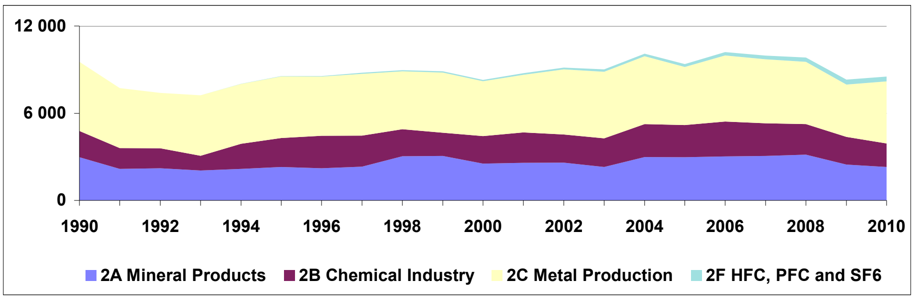
Table 4.1: GHG emissions in individual categories in IP sector in 1990 – 2010

	Sector 2. Industrial Processes CO_2 eq. (Gg)			Categories CO_2 eq. (Gg)			
Year	CO_2 emissions	CH_4 emissions	N_2O emissions	2A Mineral Products	2B Chemical Industry	2C Metal Production	2F HFC, PFC and SF_6
1990	8 082,89	1,1369	1 187,8356	2 966,48	1 805,94	4 770,81	0,03
1991	6 637,71	1,1263	831,8393	2 153,64	1 441,40	4 142,58	0,03
1992	6 405,17	1,1022	745,7125	2 215,94	1 368,35	3 816,12	0,04
1993	6 504,26	0,6593	582,5304	2 054,09	1 025,42	4 163,36	0,06
1994	6 859,98	1,1147	1 020,4314	2 157,58	1 751,39	4 104,62	12,18
1995	7 249,10	1,2283	1 166,1068	2 305,05	1 975,89	4 249,82	32,06
1996	7 121,30	1,3203	1 355,5889	2 218,56	2 223,17	4 070,99	48,34
1997	7 397,52	1,3126	1 282,1988	2 315,29	2 155,85	4 243,31	73,67
1998	7 778,25	1,3486	1 096,5781	3 032,97	1 876,52	3 989,32	55,97
1999	7 965,32	1,4467	823,3510	3 058,24	1 589,71	4 153,52	80,34
2000	7 132,15	1,4576	1 058,6106	2 523,66	1 906,56	3 773,40	94,46
2001	7 437,14	1,4334	1 200,1333	2 585,60	2 080,86	3 983,68	106,54
2002	7 926,80	1,9435	1 065,3977	2 599,01	1 927,53	4 479,01	126,13
2003	7 643,51	2,0123	1 184,5767	2 296,73	1 969,32	4 584,92	155,28
2004	8 554,78	2,0426	1 357,6737	2 978,96	2 275,82	4 679,04	176,97
2005	7 877,88	1,7184	1 284,9130	2 969,73	2 214,55	4 000,28	197,19
2006	8 365,83	1,4838	1 583,8884	3 018,57	2 404,11	4 564,34	224,46
2007	8 264,09	1,3487	1 417,9040	3 049,01	2 254,30	4 404,92	252,96
2008	8 195,92	1,2859	1 314,6218	3 144,79	2 100,16	4 303,03	291,55
2009	6 864,42	1,2728	1 091,7610	2 456,00	1 925,12	3 594,10	328,10
2010	7 254,52	1,4261	904,0095	2 303,17	1 608,63	4 269,30	341,00

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 – 2010



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. The results for industry sector and its subsectors following the mentioned assumptions it can be seen in the text below.

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

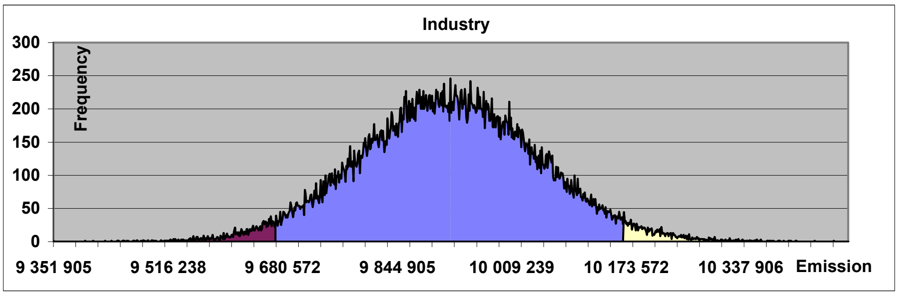


Table 4.2: Selected statistical characteristics for IP sector, median, mean value, standard deviation, minimum, maximum of emissions and percentiles

Median	Average	Standard dev,	2,50%	97,50%
9 918 571,53	9 918 852,59	122 191,29	9 681 801,37	10 158 324,73
Min	**Max**		**Per_2,5**	**Per_97,5**
9 417 685,24	10 517 153,63		-2,39%	2,41%

From the presented results of CO_2 emissions obtained by Monte Carlo simulation it seems that mean value is 9 918 571.53 ton per year excluding solvents sector. Confidence interval (95%) is represented by the relative values to the mean: (-2.39%; +2.41%). The utilizing of normal distributions almost for every subcategory has influence to the shape of total uncertainty.

Several updates and changes in methodology for emission estimation in industrial processes were taking into consideration for uncertainty analyses in comparison with the previous year. Several input data was reviewed, i.e.:

- Higher uncertainty for cement and lime production and introducing of correcting factor, with the special limiting value (less than 1). This limiting value has the influence to the uncertainty of lime production and emissions.
- The content of CaO and MgO replaced the content of $CaCO_3$ and $MgCO_3$ in limestone and dolomite use category for all operators.
- The emissions from limestone and dolomite consumption in the iron and steel production is reported in the category 2A3 – Limestone and dolomite use and the limestone consumption in the calcium carbide production is also reallocated from 2A3 into 2B4 (Carbide production).
- The uncertainty of activity data has been increased for producer "Vetropack" in the glass production.
- The uncertainty of carbon content in the fuel in ammonia production is increased against the previous year.

- The uncertainty of EF has been increased for producer “Hnojivá Stážske” in the nitric acid.
- The uncertainty value for the carbon content in anodes was better specified in the aluminum sector.

According to the ERT recommendation, the using of limestone was moved into category 2B4 Carbide Production from the category 2A3 Limestone and Dolomite Use. These changes cause slight decrease of uncertainty for carbide production. Uncertainty was changed against the previous year from ±8% to ±6% approximately.

The emissions released from limestone use in the category 2C Iron and Steel were reallocated into category 2A3 Limestone and Dolomite use. This reallocation decreases uncertainty for significant key category Iron and Steel.

4.3 Mineral products (CRF 2.A)

4.3.1 Source category description

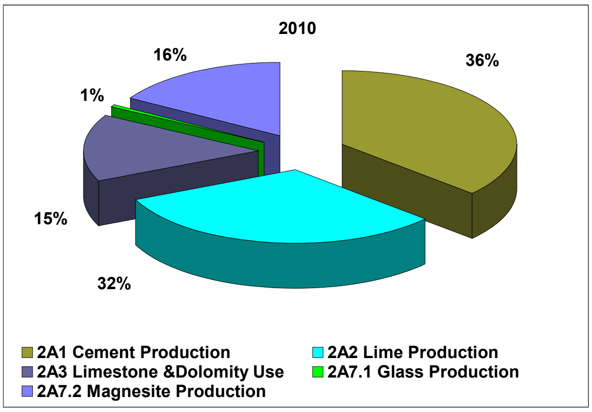
The major share of CO_2 pollution comes from the production and transformation of mineral products. Total emissions were 2 303.17 Gg of CO_2 equivalents in 2010, approximately lower by 6% compared to the previous year. The emissions are on the year 2001 level. The decrease is visible in cement production category, compared to 1990, the decrease is more than 22%.

The major share (36.7%) of emissions belongs to cement production, 31.6% belongs to lime production and 16.3% to magnesite production. The limestone and dolomite use shared 14.8% and grass production is only 0.6%. The production of magnesite and lime 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 – 2010

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	318,23	7,88	431,94
1991	1 019,27	586,40	280,78	9,95	257,24
1992	1 283,22	441,06	260,13	12,03	219,50
1993	1 010,14	520,53	283,09	14,65	225,67
1994	1 094,96	547,74	294,27	16,31	204,31
1995	1 133,75	574,95	284,31	18,01	294,03
1996	1 080,50	547,02	269,85	20,06	301,12
1997	1 192,70	490,46	301,97	19,92	310,25
1998	1 789,44	532,65	315,39	18,99	376,51
1999	1 794,34	543,75	306,16	19,15	394,85
2000	1 168,88	539,57	382,56	22,82	409,82
2001	1 187,43	584,22	359,24	23,08	431,63
2002	1 144,19	657,99	336,89	21,42	438,52
2003	904,99	573,17	346,18	22,44	449,95
2004	1 194,84	672,16	587,92	24,37	499,67
2005	1 233,51	785,83	441,37	33,04	476,00
2006	1 363,98	854,02	427,90	32,06	340,62
2007	1 458,01	897,06	348,76	41,18	304,00
2008	1 581,87	860,18	302,09	23,44	377,22
2009	1 198,66	689,43	289,03	13,19	265,69
2010	844,58	728,80	340,31	13,15	376,34

Figure 4.4: The share of individual categories in emissions from category 2A mineral products in 2010



Category	CO_2 Eq. (Gg)	Share (%)
2A1 Cement Production	844,58	36,67%
2A2 Lime Production	728,80	31,64%
2A3 Limestone&Dolomity Use	340,31	14,78%
2A7.1 Glass Production	13,15	0,57%
2A7.2 Magnesite Production	376,34	16,34%

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 clinker from cement. However, in the Slovak Statistical Yearbook only Portland cement clinker is published. The cement plants in the Slovak Republic (4 plants), where cement clinker 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 clinker is based on milling the clinker with solid additives. Therefore it is meaningful to balance only clinker production. Total CO_2 emissions from cement production were 884.58 Gg in 2010 and decreased comparably to the previous year by 30%.

Table 4.4: Activity data and CO_2 emissions in subcategory 2A1 cement production in 1990 – 2010

Category 2A1 Cement Production			
Year	Cement Clink Production (kt)	CO_2 emissions (Gg)	CaO Content
1990	2 835,75	1 438,01	64,60%
1991	2 010,00	1 019,27	64,60%
1992	2 530,50	1 283,22	64,60%
1993	1 992,00	1 010,14	64,60%
1994	2 159,25	1 094,96	64,60%
1995	2 235,75	1 133,75	64,60%
1996	2 130,75	1 080,50	64,60%
1997	2 352,00	1 192,70	64,60%
1998	3 528,77	1 789,44	64,60%
1999	3 538,43	1 794,34	64,60%
2000	2 313,71	1 168,88	64,36%
2001	2 367,29	1 187,43	63,90%
2002	2 259,79	1 144,19	64,50%
2003	1 754,73	904,99	65,70%
2004	2 271,13	1 194,84	67,02%
2005	2 352,68	1 233,51	66,78%
2006	2 589,08	1 363,98	67,11%
2007	2 825,32	1 458,01	65,74%
2008	3 045,25	1 581,87	65,74%
2009	2 348,07	1 198,66	65,87%
2010	1 635,59	844,58	66,07%

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 2 methodology according to the IPCC 2000 Good Practice Guidance 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 clinker 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 2010

Plant	Cement clink [kt]	Content of CaO	Content of MgO	Correction Factor	CO_2 Emissions [t]
VSH	C	0,6429	0,0412	0,6956	137 131
Holcim – Portland	C	0,6600	0,0255	1,0000	412 768
Holcim – white	C	0,6845	0,0223	1,0000	57 483
Považská cementáreň	C	0,6710	0,0152	1,0000	237 198
Total	**1 653,59**	**0.6607***	**00260***	**0,9340***	**844 580**

C = Confidential, *weighted average

4.3.2.2 Methodological issues – emission factors and other parameters

The content of CaO in cement clinker varies from 64.29% to 68.45% according to the plant specifications with the value of weighted average 66.07% in 2010. The content of MgO in cement clinker varies from 1.52% to 4.12% with the weighted average of 2.60% in 2010. On the basis of data supplied by plants and ETS reports, total CO_2 emissions from cement production were 844 580 t and IEF was 0.516 t/t of clinker. Total production of cement clinker decreased interannually (2009/2010) by 30% and was 1 653 592 t in 2010. 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 SHMU 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

In the period 1990 – 2000 the average CaO content in the cement clinker was very close to the default content. In 2003, one plant with the lowest CaO content was closed for reconstruction. It was reopened in 2004 and the cement clinker with higher content of CaO is produced there since that. This is the reason of higher CaO content and IEF since 2002. 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 aggregated CO_2 emissions is in interval (-3.56%; +3.62%). 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:

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

where cor_f represent the correction factor. 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 was not estimated.

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

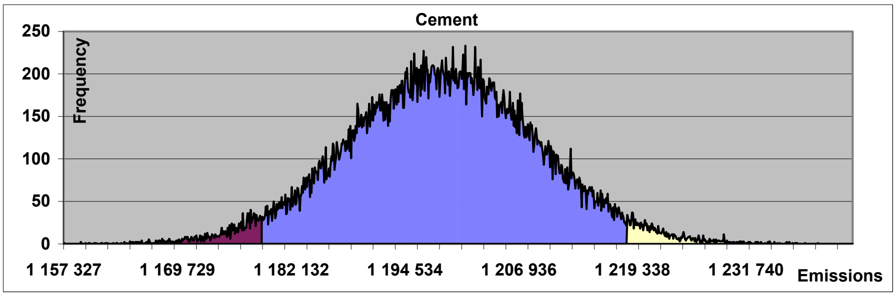


Table 4.6: Selected statistical characteristics for category 2A1, median, mean value, standard deviation, minimum, maximum of emissions and percentiles

Median	Average	Standard dev,	2,50%	97,50%
844 546,39	844 601,12	15 613,33	814 540,58	875 184,72
Min	**Max**		**Per_2,5**	**Per_97,5**
784 142,24	904 981,91		-3,56%	3,62%

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 is verified by Mr. Vladimir Danielik – the sectoral expert for IP sector in the cooperation with the Slovak Technical University in Bratislava, the Faculty of Chemical and Food Technology. The data is compared with the information from Statistical Office of the Slovak Republic (Portland cement clinker production) and with the ETS reports.

4.3.2.6 Source specific recalculations

No recalculations in the submission 2012 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 as shown above in the case of cement production. Total CO_2 emissions from lime production were 728.80 Gg in 2010 and increased compared to the previous year by 6%.

Table 4.7: Activity data and CO_2 emissions in subcategory 2A2 lime production in 1990 – 2010

Category 2A2 Lime Production				
Year	**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%

Category 2A2 Lime Production						
Year	Lime Production (kt)	CO_2 emissions (Gg)	EF (t/t)	CaO Content	MgO Content	"Hypothetic" CaO Content
2001	815,96	584,22	0,716	90,56%	0,47%	91,20%
2002	918,99	657,99	0,716	90,28%	0,66%	91,20%
2003	781,69	573,17	0,733	20,21%	2,30%	93,41%
2004	908,94	672,16	0,740	90,47%	2,69%	94,21%
2005	1 041,71	785,83	0,754	89,91%	4,45%	96,10%
2006	1 131,24	854,02	0,755	89,61%	4,72%	96,17%
2007	1 158,07	897,06	0,775	89,44%	6,64%	98,68%
2008	1 120,33	860,18	0,768	88,50%	6,48%	97,51%
2009	916,77	689,43	0,752	92,50%	2,37%	95,80%
2010	952,60	728,80	0,765	87,71%	7,01%	97,46%

"Hyp othetic" CaO content = CaO Content + 1.092/0.785×MgO content

4.3.3.1 Methodological issues – methods

In Table 4.7 the "hypothetic" CaO content is presented. It includes data on the CaO and MgO contents on the basis of stoichiometry. This approach is used because no distinguished data are available for the period 1900 – 2000. In that period the same content of CaO in the lime is assumed (91.2%). This value is based on the 2001 and 2002 data and applied on all the data available in the period 1990 – 2000. The average content of CaO in the lime is (91.2 ± 0.2)% in the period 1990 – 2002. Tier 2 according to the IPCC 2000 GPG has been applied since 2001 with the combination of plant specific activity data and emission factors estimated for each plant. The calculations are based on the data provided by the lime producers in questionnaires and in the ETS reports (produced lime and CaO and MgO contents). 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 implied emission factor of CO_2 using the data on the purity of lime is 0.765 t CO_2/t of lime. Total CO_2 emissions increased and were 728.80 Gg in 2010. 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 952 604.7 t. 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 2010

Plant	Lime Production [t]	CaO Content	MgO Content	Correction Factor	CO_2 Emissions [t]
Calmit	C	95,60%	0,80%	0,98	110 176,3
Dolvap Varín	C	87,62%	9,61%	1,00	98 120,3
Mondi SCP Ružomberok	C	92,50%	1,20%	1,00	96 279,9
Carmeuse Slavec	C	92,83%	1,30%	1,00	141 968,3
Carmeuse Košice	C	80,83%	13,81%	1,00	282 258,4
Total	**952 604,7**	**87.71%***	**7.01%***	**1.00***	**728 803,2**

C = Confidential, *weighted average

4.3.3.4 Uncertainties and time-series consistency

Time series consistency is assured by using the "hypothetic" CaO content in the lime in the period 1990 – 2000 as it is explained in details in the text above. The content is compared with the data presented in 2001 and 2002. Dolomitic lime production started in one plant in 2003 and the CaO content is not comparable since that. Because of the dolomitic lime production the IEF increased since that, as well.

The same algorithm for selected lime producers as in the cement uncertainty estimation was applied. The uncertainties in mass of lime (2.5% or 5.0%) 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 aggregated CO_2 emissions is in interval (-2.38%; +2.30%). Formula can be written in the form:

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

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

where cor_f represent the correction factor. 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 and the content of MgO is inspected again. 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.

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

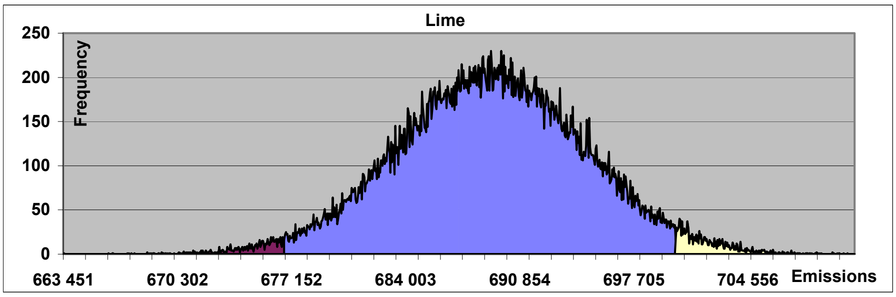


Table 4.9: Selected statistical characteristics for category 2A2, median, mean value, standard deviation, minimum, maximum of emissions and percentiles

Median	Average	Standard dev,	2,50%	97,50%
714 041,59	713 950,05	8 581,06	696 943,08	730 397,30
Min	**Max**		**Per_2,5**	**Per_97,5**
676 944,27	748 556,41		-2,38%	2,30%

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 are verified by Mr. Vladimir Danielik – the sectoral expert for IP sector in the cooperation with 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 2012 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 and is based on the stoichiometry. 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 (iron and steel 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 2 method according to the IPCC 2000 GPG and the plant specific emission factors since 2004. The amounts of consumed limestone according to the sources and emissions of CO_2 in the period 1990 – 2010 are summarized in Table 4.10.

4.3.4.2 Methodological issues – emission factors and other parameters

Implied emission factor is based on the stoichiometry of limestone and dolomite in mixtures and it was 0.441 t per ton of used carbonate mixture in 2010.

Table 4.10: Total carbonates used and emission of CO_2 in 1990 – 2010

	$CaCO_3$ from Iron and Steel Production	Desulphu-risation ($CaCO_3$)	Desulphu-risation ($MgCO_3$)	Ceramics ($CaCO_3$)	Ceramics ($MgCO_3$)	Total Carbonates	CO_2 emissions
Year	[kt]	[kt]	[kt]	[kt]	[kt]	**[kt]**	**[kt]**
1990	689,64	0,00	0,00	25,41	6,92	**721,97**	**318,23**
1991	612,55	0,00	0,00	18,35	6,10	**637,00**	**280,78**
1992	571,69	0,00	0,00	12,12	6,24	**590,05**	**260,13**
1993	620,68	0,00	0,00	14,98	6,52	**642,18**	**283,09**
1994	644,89	0,00	0,00	16,66	6,11	**667,66**	**294,27**
1995	621,07	0,00	0,00	17,19	6,66	**644,92**	**284,31**
1996	565,42	23,48	0,44	15,69	6,90	**611,93**	**269,85**
1997	594,91	68,54	1,20	13,56	6,62	**684,83**	**301,97**
1998	600,27	91,26	1,69	15,08	6,89	**715,19**	**315,39**
1999	578,39	91,71	1,67	16,38	6,20	**694,35**	**306,16**
2000	755,18	88,86	1,58	15,79	6,54	**867,95**	**382,56**
2001	697,98	91,00	1,66	18,38	6,00	**815,02**	**359,24**
2002	642,12	92,89	1,63	21,51	6,08	**764,23**	**336,89**
2003	669,71	91,66	1,69	16,09	6,16	**785,31**	**346,18**
2004	1 228,71	92,49	1,73	6,55	5,37	**1 334,85**	**587,92**
2005	876,85	94,52	1,73	21,80	6,64	**1 001,54**	**441,37**
2006	840,71	92,84	1,75	30,65	5,25	**971,20**	**427,90**
2007	674,12	72,59	1,24	36,31	6,87	**791,12**	**348,76**
2008	522,00	69,75	1,02	72,47	17,82	**683,05**	**302,09**
2009	543,56	85,82	0,00	19,01	7,16	**655,55**	**289,03**
2010	682,78	60,49	0,99	18,95	8,46	**771,67**	**340,31**

4.3.4.3 Activity data

Total amount of used limestone and dolomite in industry was 771.67 kt, the activity data are summarized in Table 4.10. The CO_2 emissions increased in comparison with the year 2009 by 18%. It is caused by the increased production of iron and steel.

4.3.4.4 Uncertainties and time-series consistency

The same Tier approach is used for the whole time period 1990 – 2010. The presented data are obtained directly from producers. The missing data for some ceramics producers was interpolated / extrapolated in the periods 1990 – 1991 and 1993 – 1995 on the level of individual producers with the limit to economic aspects of the building industry in Slovakia (they served as the boundary conditions of interpolation / extrapolation).

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 aggregated 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 2010. 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

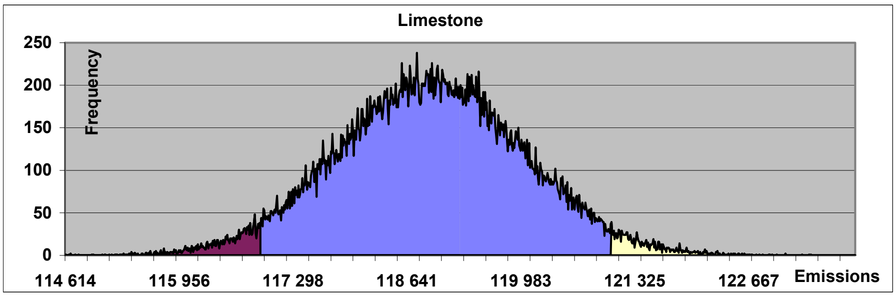


Table 4.11: Selected statistical characteristics for category 2A3, median, mean value, standard deviation, minimum, maximum of emissions and percentiles

Median	Average	Standard dev,	2,50%	97,50%
340 322,32	340 339,05	2 804,05	334 851,04	345 825,41
Min	**Max**		**Per_2,5**	**Per_97,5**
329 005,23	352 631,58		-1,61%	1,61%

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 ceramics 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 are verified by Mr. Vladimir Danielik – the sectoral expert for IP sector in the cooperation with the Slovak Technical University in Bratislava, the Faculty of Chemical and Food Technology. The data are compared with the available ETS reports.

4.3.4.6 Source specific recalculations

According to the recommendations of the ERT during the in-country review in 2011, the limestone used for calcium carbide production was moved into category carbide production (CRF 2.B.4). On the other hand the limestone used for iron and steel production was moved from Iron and steel production (CRF 2.C.1) category into this category. Revision of activity data from desulphurization and ceramics production was made, as well. It was assured that the most important coal power plant in Slovakia started using the limestone for desulphurization in 1996 and the activity data were obtained from the operator. The power plant was the first that used limestone for desulphurization. Moreover, huge amount of archive data about ceramics production was collected and the missing data from some ceramics producers were extrapolated and interpolated in the periods 1990 – 1991 and 1993 – 1995, respectively. The recalculation was made on the individual producers' level with the limit to economic aspects of the building industry in Slovakia (they served as the boundary conditions of interpolation/extrapolation). The CO_2 emissions were recalculated (Table 4.12) using the plant specific EFs. The recalculated emissions are higher by hundreds per cents. It is caused by moving the limestone and dolomite used for iron and steel production from iron and steel production (CRF 2.C.1) category into this category. The recalculations increased transparency, completeness and accuracy of the inventory in category limestone and dolomite use.

Table 4.12: The recalculations changes and comparison of the submissions 2011 and 2012

	Submission 2011	Submission 2012	2011/2012
Year	Total CO_2 [kt]	Total CO_2 [kt]	Changes
1990	41,83	318,23	760,71%
1991	41,83	280,78	671,18%
1992	48,70	260,13	534,11%
1993	76,18	283,09	371,59%
1994	92,33	294,27	318,72%
1995	99,75	284,31	285,03%
1996	103,67	269,85	260,31%
1997	108,20	301,97	279,08%
1998	102,70	315,39	307,09%
1999	97,39	306,16	314,37%
2000	102,86	382,56	371,94%
2001	110,30	359,24	325,70%
2002	110,62	336,89	304,54%
2003	110,84	346,18	312,34%
2004	115,98	587,92	506,89%
2005	122,21	441,37	361,15%
2006	124,80	427,90	342,86%
2007	121,68	348,76	286,61%
2008	148,56	302,09	203,34%
2009	118,92	289,03	243,04%

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 the category 1.A.3 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. Emissions of CO and NMVOC from this category are included in category in energy sector category 1A2f.

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, 25.257 kt of asphalt were used in the production of asphalt roofing in 2010. It follows that the emissions of CO and NMVOC were 0.240 t and 3.763 t, respectively. 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 was 102.4 kt in 2010. The emission factor for NMVOC was estimated at 0.00647 kg/t and total emissions of NMVOC included in this category were 0.674 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. The emissions from carbonates used are at the same level as in 2009 and were 13.145 kt in 2010.

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 CO_2 emissions from the used carbonates were calculated in the basis of stoichiometry. The same approach is used for the calculation of default factors in IPCC 2000 GPG.

4.3.8.2 Methodological issues – emission factors and other parameters

The implied emission factor is based on carbonate and CO_2 stoichiometry and it was 0.417 t per ton of used carbonates in 2010.

Table 4.13: Total amounts of carbonates used in glass production in 1990 – 2010

	Used Carbonates [t]								
Year	$CaCO_3$	K_2CO_3	Na_2CO_3	$BaCO_3$	$MgCO_3$	$SrCO_3$	Li2CO3	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**
2010	15,89	0,48	13,62	1,52	0,01	0,00	0,00	31,52	**13,145**

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

4.3.8.3 Activity data

In 2010 the glass production in the Slovak Republic was as follows: 66 200 tons of white glass, 77 000 tons of green glass, 118 526 tons of crystal glass and 1 159 tons of leaded glass. Total amount of produced glass was 262 885 t. $SrCO_3$ and Li_2CO_3 were not used for glass production. Total amounts of used carbonates are summarized in Table 4.13 and were 31.52 kt in 2010.

4.3.8.4 Uncertainties and time-series consistency

The carbonates are included in the form of calcium carbonate on the basis of stoichiometry in the period 1990 – 2003. The reason of that is caused by the data supplied by producers. They supplied the carbonate origin CO_2 emissions, only. Thus, only one carbonate could be calculated from that data. New production of white glass started in 2005 and the emission increased in that year adequately. In 2007, consumption of $MgCO_3$ (very high EF) increased significantly. Moreover, the plant using K_2CO_3 (much lower EF in comparison with $MgCO_3$) was closed up in 2007. In 2008, the consumption of $CaCO_3$ decreased very much in one plant (the decrease in consumption was ca 40 000 tons). Instead of $CaCO_3$ calumite slag and colemanite is used since 2008 in that plant. Since 2009 the consumptions of $CaCO_3$ and other carbonates are quasi constant.

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 aggregated CO_2 emissions is in interval (-2.83%; +2.85%).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

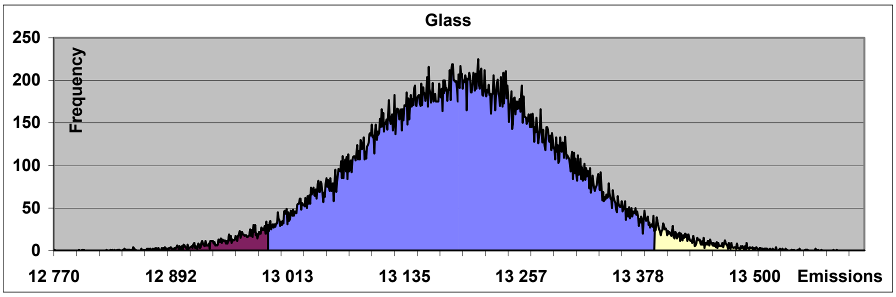


Table 4.14: Selected statistical characteristics for category 2A71, median, mean value, standard deviation, minimum, maximum of emissions and percentiles

Median	Average	Standard dev,	2,50%	97,50%
13 145,28	13 145,35	191,44	12 772,76	13 520,16
Min	**Max**		**Per_2,5**	**Per_97,5**
12 361,28	13 888,79		-2,83%	2,85%

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 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 are verified by Mr. Vladimir Danielik – the sectoral expert for IP sector in the cooperation with 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 (glass production) 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.

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 increased interannually (2009/2010) by 42% and were 376.34 Gg in 2010. They are approximately at the same level as in 2008. The driver for increasing was recovery of industry and increasing of production.

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 2 method according to the IPCC 2000 GPG and the plant specific emission factors. The amounts of magnesite clinker and emissions of CO_2 in the period of 1990 – 2010 are summarized in Table 4.15.

4.3.9.2 Methodological issues – emission factors and other parameters

Implied 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). Implied emission factor was 0.9424 t per 1 ton of magnesite clinker in 2010.

4.3.9.3 Activity data

Total amount of magnesite clinker produced in the Slovak Republic was 399.34 kt in 2010. The purity of magnesite in the Slovak Republic varies mainly from 82% to 87%. 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 for the purity presented above.

Table 4.15: Total magnesite clinker production and CO_2 emissions in 2000 – 2010

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
2010	399,34	376,34	0,942

4.3.9.4 Uncertainties and time-series consistency

The same Tier 2 is used for the whole time period 1990 – 2010. New production of high purity magnesite clinker (for refractory materials) started in Slovakia in 2004 and ended in 2007.

The uncertainties in mass of produced magnesite clink (2.5%) and the content of MgO and CaO (2.0%) 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 aggregated CO_2 emissions is in interval (-2.88%; +2.95%). Formula can be written in the following form:

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

Three producers have contributed to the emissions computations from magnesite consumption. During the uncertainty computation the relation between the content of CaO and MgO is inspected. It means that the sum of CaO 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

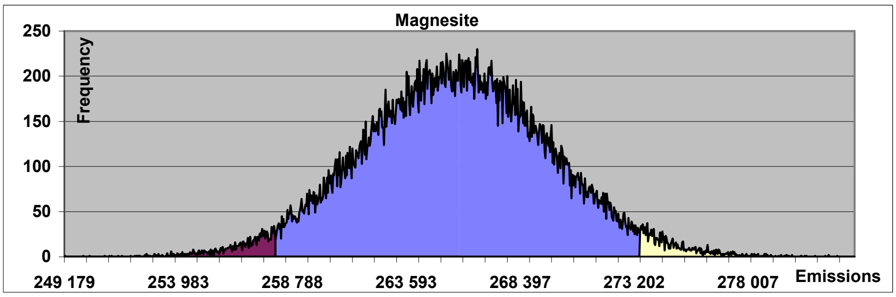


Table 4.16: Selected statistical characteristics for category 2A72, median, mean value, standard deviation, minimum, maximum of emissions and percentiles

Median	Average	Standard dev,	2,50%	97,50%
376 376,77	376 376,91	5 605,21	365 543,82	387 463,84
Min	**Max**		**Per_2,5**	**Per_97,5**
352 750,66	400 568,95		-2,88%	2,95%

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 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 are verified by Mr. Vladimir Danielik – the sectoral expert for IP sector in the cooperation with the Slovak Technical University in Bratislava, the Faculty of Chemical and Food Technology. The data are compared with the information from the 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)

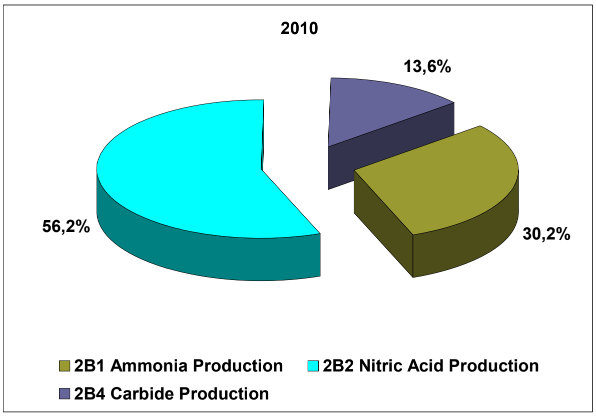
4.4.1 Source category description

The major share of emissions comes from N_2O pollution in nitric acid production Total emissions were 1 608.63 Gg of CO_2 equivalents in 2010, i.e. the decrease by more than 16% compared to the previous year. The continual increasing trend since base year was interrupted in 2006 and the decrease reached 11% in 2010 comparable to the base year. The overall increasing trend is still visible in nitric acid production and carbide production. The major share (56%) in emissions belongs to nitric acid production, 30% belongs to ammonia production and 14% to carbide production.

Table 4.17: GHG emissions in individual subcategories in the 2B category in 1990 – 2010

Category 2B - CO_2 emissions equivalents (Gg)				
Year	2B1 Ammonia Production	2B2 Nitric Acid Production	2B4 Carbide Production	2B Total
1990	618,44	1 187,50	NO	**1 805,94**
1991	609,89	831,51	NO	**1 441,40**
1992	594,19	745,39	28,77	**1 368,35**
1993	354,23	582,34	88,85	**1 025,42**
1994	596,60	1 020,10	134,68	**1 751,39**
1995	655,73	1 165,74	154,42	**1 975,89**
1996	702,54	1 355,20	165,43	**2 223,17**
1997	697,06	1 281,81	176,97	**2 155,85**
1998	617,89	1 096,23	162,39	**1 876,52**
1999	618,56	823,01	148,15	**1 589,71**
2000	685,53	1 058,23	162,81	**1 906,56**
2001	698,56	1 199,74	182,57	**2 080,86**
2002	679,08	1 065,02	183,44	**1 927,53**
2003	600,97	1 184,24	184,11	**1 969,32**
2004	692,44	1 357,29	226,10	**2 275,82**
2005	723,17	1 284,51	206,87	**2 214,55**
2006	604,14	1 583,55	216,42	**2 404,11**
2007	616,03	1 417,56	220,71	**2 254,30**
2008	557,94	1 314,31	227,91	**2 100,16**
2009	619,93	1 091,41	213,78	**1 925,12**
2010	485,78	903,75	219,10	**1 608,63**

Figure 4.10: The share of individual categories on emissions in category 2B chemical industry in 2010



Category	CO_2 Eq. (Gg)	Share (%)
2B1 Ammonia Production	485,78	30,20%
2B2 Nitric Acid Production	903,75	56,18%
2B4 Carbide Production	219,10	13,62%

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 4.18.

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 and natural gas consumption for its production was provided directly by the company. The measured values of natural gas consumption from the plant were used for CO_2 emissions estimation and calculated according to the relation:

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

where: FR – fuel requirement (natural gas) in Nm^3; CF – conversion factor in TJ / m^3 (36.31 at 0°C); CCF – content of carbon in the fuel in t / TJ (15.10); OF – oxidation factor of the fuel (1).

4.4.2.2 Methodological issues – emission factors and other parameters

The emission factor is 2.075 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 high emission factor is caused by breakdown in the plant. The emission factor for methane and N_2O are IPCC default: CH_4 was 5 kg/TJ of natural gas and 0.1 kg N_2O /TJ of natural gas. The consumption of natural gas in TJ was calculated based on consumption in mil m^3 and annual specific net calorific vales used in energy sector (Table 4.18).

4.4.2.3 Activity data

The produced amount of ammonia was 233.56 ktons in 2010. Based on data supplied by the plant 241 076 515 Nm^3 of natural gas was consumed for ammonia production. The presented data are based on the measurements in the plants. It should be noted, that IEF of CO_2 for ammonia production was changed because of the malfunction in the plant in 2009 and 2010. For repairs, the plant did not produce ammonia for 3.5 months in 2010. Ending and starting of production is always characterized with non-stable emissions.

Table 4.18: Ammonia production and GHG emissions in 1990 – 2010

Category 2B1 Ammonia Production							
Year	Ammonia Production (kt)	CO_2 emissions (Gg)	CH_4 emissions (t)	N_2O emissions (t)	NG Consump. (m^3)	NG Consump. (TJ)	EF CO_2 (t/t NH_3)
1990	360,00	616,97	54,14	1,08	322 544 714,00	10 827,83	1,7138
1991	351,60	608,44	53,63	1,07	315 018 671,00	10 726,39	1,7305
1992	344,20	592,76	52,49	1,05	308 388 585,00	10 497,55	1,7221
1993	206,90	353,38	31,39	0,63	185 373 615,00	6 278,60	1,7080
1994	353,90	595,16	53,08	1,06	317 079 373,00	10 615,82	1,6817
1995	383,80	654,14	58,49	1,17	343 868 503,00	11 698,41	1,7044
1996	411,70	700,83	62,87	1,26	368 865 719,00	12 574,63	1,7023
1997	409,90	695,36	62,51	1,25	367 252 995,00	12 501,29	1,6964
1998	364,30	616,38	55,55	1,11	326 397 331,00	11 110,57	1,6919
1999	364,00	617,04	55,69	1,11	326 128 544,00	11 137,29	1,6952
2000	403,00	683,85	61,80	1,24	361 070 888,00	12 359,46	1,6969
2001	411,80	696,84	63,05	1,26	368 958 002,00	12 610,98	1,6922
2002	400,00	677,41	61,34	1,23	358 383 015,00	12 267,45	1,6935
2003	353,68	599,49	54,28	1,09	316 882 262,00	10 856,39	1,6950
2004	407,90	690,73	62,59	1,25	365 461 976,00	12 517,07	1,6934
2005	426,35	721,40	65,32	1,31	381 988 809,00	13 064,02	1,6920
2006	354,56	602,65	54,50	1,09	317 668 913,00	10 899,22	1,6997
2007	362,44	614,52	55,64	1,11	324 730 850,00	11 128,53	1,6955
2008	328,20	556,57	50,40	1,01	293 937 581,00	10 079,12	1,6958
2009	344,40	618,40	55,97	1,12	308 455 000,00	11 194,45	1,7956
2010	233,56	484,65	41,49	0,83	241 076 515,00	8 297,99	2,0751

4.4.2.4 Uncertainties and time-series consistency

The same Tier is used for the whole time period 1990 – 2010. Increased emission factors in 2009 and 2010 are caused by the malfunction in the plant in the end of 2009. The ammonia was not produced for 3.5 months in 2010. The emissions were higher as usual at the new start of the production. 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 aggregated CO_2 emissions (in equivalents) is in interval (-6.16%; +6.93%).

In the formula subscript *I* represent CH_4 and N_2O contribution to the total emission. Formula can be written in the following form, where CF is a conversion factor for CO_2 equivalent:

$$Emissions = (gas \pm \Delta gas) * (caloric \pm \Delta caloric) * (oxid.fact \pm \Delta oxid.fact) * \frac{44}{12} / 1000 +$$

$$+ \sum_{i} (gas \pm \Delta gas) * (g\_density \pm \Delta g\_density) * (EF_i \pm \Delta EF_i) * CF_i$$

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

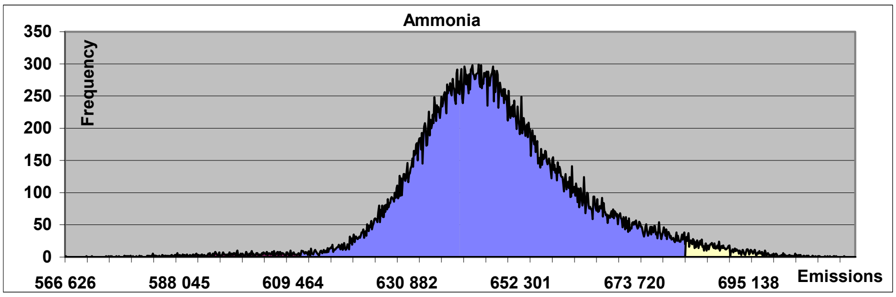


Table 4.19: Selected statistical characteristics for category 2B1, median, mean value, standard deviation, minimum, maximum of emissions and percentiles

Median	Average	Standard dev,	2,50%	97,50%
507 064,98	507 655,39	16 706,86	476 377,10	542 827,99
Min	**Max**		**Per_2,5**	**Per_97,5**
430 207,60	585 311,79		-6,16%	6,93%

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 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 are verified by Mr. Vladimir Danielik – the sectoral expert for IP sector in the cooperation with 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 report.

4.4.2.6 Source specific recalculations

The recalculation was provided in methane and N_2O emissions back to base year. The systematic error occurred in calculation, where the used default emission factors for natural gas (5 t/TJ for CH_4 and 0.1 t/TJ for N_2O) was multiplied with natural gas consumption in tons instead of TJ. The correction was made back to base year and for calculation of natural gas in TJ, the net calorific values specific for each year were used in line with the NCVs used in energy sector.

The improvement of emission estimation was result of QA/QC procedures used in line with the uncertainty calculation in this category.

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 increased interannually (2009/2010) by 22%. However, N_2O emissions decreased by 17% in 2010 in comparison with 2009. The reason of that is the start of using the technology with the second YARA catalyst. This is in contrast with the increase of NO_x emissions (25%) compared to 2009 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.

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) in 2006 and 2007. The same value was used in the previous submissions. However, after thorough survey of published data supplied by plant in 2010, the above presented emission factors are correct for medium pressure plant in 2006 and 2007, only. There was a malfunction at the cooling of the reactor. After that, the measured emission factors were 7.3; 7.6 and 7.5 kg/t in 2005, 2008 and 2009, respectively. The average value of this emission factor (7.5 kg / 1 t of HNO_3) is used for medium pressure plant for the period 1990 – 2004, as well. The same value was also measured before technological change in 2010. According to the ERT recommendation, the same EF should be used also for the other producer in the Slovak Republic. The used technologies are very similar. The new information on emission factors led to the recalculation of nitric acid production category (2:B.2).

In September 2010, one of the producers with medium pressure and high pressure plant introduced the technology with secondary YARA catalyst. It resulted in significant decrease of N_2O emissions. The weighted EF was 5.706 kg N_2O/t of HNO_3 and the N_2O emissions were 2 915.33 tons. The detailed information about decreasing of the emissions is in Tables 4.20 and 4.21.

4.4.3.3 Activity data

Total production of nitric acid was 510.97 ktons and the emissions of NO_x were 331 tons in 2010. Activity data and emissions are presented in Table 4.20.

Table 4.20: Estimated N_2O emissions and weighted EFs in 1990 – 2010

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)	Total NO_x emissions (t)
1990	400,54	0,00956	1 953,77	1 876,88	0,00	3 830,65	4 310,94
1991	301,83	0,00889	989,37	1 692,92	0,00	2 682,28	3 216,50
1992	278,44	0,00864	747,36	1 657,12	0,00	2 404,47	2 927,93
1993	233,62	0,00804	298,74	1 579,76	0,00	1 878,50	2 457,62
1994	360,82	0,00912	1 381,64	1 909,01	0,00	3 290,65	3 870,12
1995	398,80	0,00943	1 818,70	1 941,77	0,00	3 760,47	4 250,00
1996	446,78	0,00978	2 412,67	1 958,94	0,00	4 371,61	236,80
1997	421,33	0,00981	2 304,38	1 830,50	0,00	4 134,88	229,67
1998	377,35	0,00937	1 668,94	1 867,30	0,00	3 536,24	208,88
1999	306,51	0,00866	554,58	1 371,88	728,40	2 654,86	185,26
2000	407,22	0,00838	0,00	1 256,58	2 157,06	3 413,64	202,78
2001	464,35	0,00833	0,00	1 545,02	2 325,11	3 870,14	202,04
2002	403,84	0,00851	0,00	995,28	2 440,26	3 435,54	189,15
2003	454,64	0,00840	0,00	1 357,93	2 462,20	3 820,13	193,76
2004	524,82	0,00834	0,00	1 725,29	2 653,06	4 378,34	230,38
2005	497,68	0,00833	0,00	1 584,29	2 559,28	4 143,57	265,15
2006	564,00	0,00906	0,00	2 470,33	2 637,90	5 108,23	252,46
2007	489,22	0,00935	0,00	1 934,70	2 638,07	4 572,77	228,32
2008	509,26	0,00833	0,00	1 845,09	2 394,62	4 239,71	215,00
2009	418,62	0,00841	0,00	1 259,34	2 261,35	3 520,69	287,14
2010	510,97	0,00571	0,00	1 393,18	1 522,15	2 915,33	331,26

Table 4.21: Detailed information about N_2O concentrations in 2010

	medium pressure plant		high pressure plant	
Year 2010	**N_2O concentration [ppm]**	**EF [kg / t]**	**N_2O concentration [ppm]**	**EF [kg / t]**
January - August	1 327,6	7,50	1097,5	6,92
September	248,4	1,50	362,1	2,26
October	219,9	1,27	414,1	2,61
November	188,7	1,12	328,7	2,08
December	240,3	1,38	345,6	2,16
Weighted average in 2010		**5,84**		**5,23**

4.4.3.4 Uncertainties and time-series consistency

The plant specific factors are used for the whole time period except of atmospheric plant. The atmospheric plant ended in 1999 and default EF for atmospheric plant (4.5 kg / 1 t of HNO_3) is used. The emission factor for medium pressure plant is based on the measured data in 2005, 2008, 2009 and 2010. The average value is used for the rest of the time series except of 2006 and 2007. According to the measured N_2O emissions the EF was 10.332 kg / 1 t of HNO_3 (malfunction in the plant) in 2006 - 2007. The emissions factor for high pressure plant was measured to be 9.02 kg / 1 t of HNO_3 which is in good agreement with the default EF for that type of plant (9 kg / 1 t of HNO_3). The same value is used for the whole time period when the high pressure plant produces nitric acid (1999 – 2010). In September 2010, the technology was changed in medium pressure and high pressure plant. The secondary YARA catalyst is used which results in significant decrease of N_2O emissions. The uncertainties in mass of produced nitric acid (2.5%) and used EF (2% or 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 aggregated CO_2 emissions (in equivalents) is in interval (-2.62%; +2.63%). 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.

Figure 4.12: Probability density function for category 2B2 in tons of CO_2

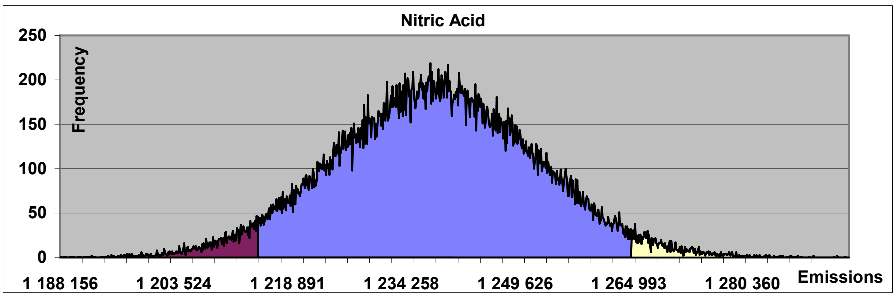


Table 4.22: Selected statistical characteristics for category 2B2, median, mean value, standard deviation, minimum, maximum of emissions and percentiles

Median	Average	Standard dev,	2,50%	97,50%
903 824,29	903 812,31	12 111,52	880 107,64	927 555,48
Min	**Max**		**Per_2,5**	**Per_97,5**
854 286,66	957 027,25		-2,62%	2,63%

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 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 are verified by Mr. Vladimir Danielik – the sectoral expert for IP sector in the cooperation of the Slovak Technical University with 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).

4.4.3.6 Source specific recalculations

The recalculation of N_2O emissions is made in this submission. It is caused by new available data about measured concentrations of N_2O in output gas. The high EF used in previous inventory are valid only for 2006 and 2007 when a malfunction in the plant existed. After that the N_2O emissions decreased to the values that were measured in 2005. Thus the measured values in 2005 and in the period 2008 – 2010 (non confidential only since 2010) served for the calculation of the EF for the time period 1990 – 2004 and recalculation was made. No activity data were changed only the N_2O emissions. The recalculated emissions are higher in the beginning of the time series (by 3%) and lower in the end of the time series (12%). It is caused by using the default emission factors in the beginning of the time series and wrong values of emission factors in the end of time series in previous submissions.

4.4.3.7 Source specific planned improvements

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

Table 4.23: The recalculations changes and comparison of the submissions 2011 and 2012

	Submission 2011		Submission 2012		2011/2012
Year	Total N_2O [t]	EF (N_2O) [t/t]	Total N_2O [t]	EF (N_2O) [t/t]	Changes
1990	3 705,52	0,00925	3 830,65	0,00956	103,38%
1991	2 569,42	0,00851	2 682,28	0,00889	104,39%
1992	2 294,00	0,00824	2 404,47	0,00864	104,82%
1993	1 773,19	0,00759	1 878,50	0,00804	105,94%
1994	3 163,39	0,00877	3 290,65	0,00912	104,02%
1995	3 631,01	0,00910	3 760,47	0,00943	103,57%
1996	4 241,01	0,00949	4 371,61	0,00978	103,08%
1997	4 012,84	0,00952	4 134,88	0,00981	103,04%
1998	3 411,75	0,00904	3 536,24	0,00937	103,65%
1999	2 563,40	0,00836	2 654,86	0,00866	103,57%
2000	3 329,87	0,00818	3 413,64	0,00838	102,52%
2001	3 767,14	0,00811	3 870,14	0,00833	102,73%
2002	3 369,19	0,00834	3 435,54	0,00851	101,97%
2003	3 729,60	0,00820	3 820,13	0,00840	102,43%
2004	4 263,32	0,00812	4 378,34	0,00834	102,70%
2005	4 132,82	0,00830	4 143,57	0,00833	100,26%
2006	5 443,58	0,00965	5 108,23	0,00906	93,84%
2007	4 670,95	0,00955	4 572,77	0,00935	97,90%
2008	4 913,36	0,00965	4 239,71	0,00833	86,29%
2009	3 996,20	0,00955	3 520,69	0,00841	88,10%

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). The final CO_2 emissions are influenced by export of carbide and limestone use. The production is stable since 2004 and emissions reached 219.10 Gg of CO_2 in 2010.

4.4.5.3 Methodological issues – methods

The main component of released emissions is CO_2. The Tier 2 methodology according to the IPCC 2000 GPG was applied to this category in combination with the plant specific emission factors. The plant specific factors are the same as default factors. The CO_2 emissions are calculated from the consumption of coke (reduction step), limestone use and using of the products and they are summarized in Table 4.24. CO_2 emissions from reduction step and limestone consumption are calculated using the total production of calcium carbide. On the other hand, CO_2 emissions from using the products were calculated only from non-exported production.

4.4.5.4 Methodological issues – emission factors and other parameters

Emission factors for CO_2 (0.44 t CO_2/t of $CaCO_3$ 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 used and compared with the IPCC 2000 GPG. Implied emission factor for the category 2B4.2 was 2.230 t CO_2 for 1 t of produced CaC_2. The CO_2 emissions at the decomposition of limestone are included in this category, as well, based on the ERT recommendation.

4.4.5.5 Activity data

Total production of CaC_2 (calcium carbide) was 98 262 tons in 2010. According to the data supplied by the producer, 59 720 tons of produced calcium carbide was exported from the Slovak Republic. The rest was used for acetylene production.

Table 4.24: Estimated CO_2 emissions and carbide production and export in 1990 – 2010

Category 2B4.2 Calcium Carbide Production								
	Carbide Production	Carbide Export	$CaCO_3$ consumption	CO_2 Emissions (reduction step)	CO_2 Emissions (using of the product)	CO_2 Emissions (using of the $CaCO_3$)	IEF CO_2	CO_2 Emissions Total
Year	[kt]						[t/t]	[Gg]
1990	NO	NO	NO	NO	NO	NO	NO	NO
1991	NO	NO	NO	NO	NO	NO	NO	NO
1992	10,00	NO	15,61	10,90	11,00	6,87	2,88	28,77
1993	50,00	50,00	78,07	54,50	0,00	34,35	1,78	88,85
1994	73,50	69,80	114,76	80,12	4,07	50,50	1,83	134,68
1995	84,30	80,10	131,63	91,89	4,62	57,92	1,83	154,42
1996	90,00	85,00	140,53	98,10	5,50	61,83	1,84	165,43
1997	96,60	91,77	150,83	105,29	5,31	66,37	1,83	176,97
1998	88,60	84,10	138,34	96,57	4,95	60,87	1,83	162,39
1999	80,87	76,82	126,26	88,14	4,45	55,56	1,83	148,15
2000	88,82	84,30	138,68	96,81	4,97	61,02	1,83	162,81
2001	99,65	94,67	155,60	108,62	5,48	68,46	1,83	182,57
2002	100,13	95,12	156,34	109,14	5,51	68,79	1,83	183,44
2003	100,44	95,32	156,82	109,48	5,63	69,00	1,83	184,11
2004	100,00	56,00	156,14	109,00	48,40	68,70	2,26	226,10
2005	97,03	65,71	151,50	105,76	34,45	66,66	2,13	206,87
2006	97,26	57,62	151,86	106,01	43,60	66,82	2,23	216,42
2007	101,22	64,08	158,04	110,32	40,85	69,54	2,18	220,71
2008	107,52	74,04	167,90	117,20	36,83	73,88	2,12	227,91
2009	97,50	62,56	156,95	106,28	38,44	69,06	2,19	213,78
2010	98,26	59,72	158,17	107,11	42,40	69,60	2,23	219,10

4.4.5.6 Uncertainties and time-series consistency

The same Tier is used for the whole time series. Outliers in emissions and emission factors are caused by different amounts of exported calcium carbide.

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 2010. The emission factors and uncertainty for both AD and EF (in formula represent by symbol Δ) were used for uncertainty estimation. The uncertainty of aggregated CO_2 emissions (in equivalents) is in interval (-6.08%; +6.15%). Formula can be written in the following form:

Emission = (carbide production ± Δ(carbide production)))*(EFcarb ± ΔEFcarb)+((carbide production ± ± Δ(carbide production))-(exported carbide ± Δ(exported carbide))*(EFcarb ± ΔEFcarb)

The accumulated uncertainty and statistical characteristics for carbide production are presented in the following figure.

Figure 4.13: Probability density function for category 2B4 in tons of CO_2

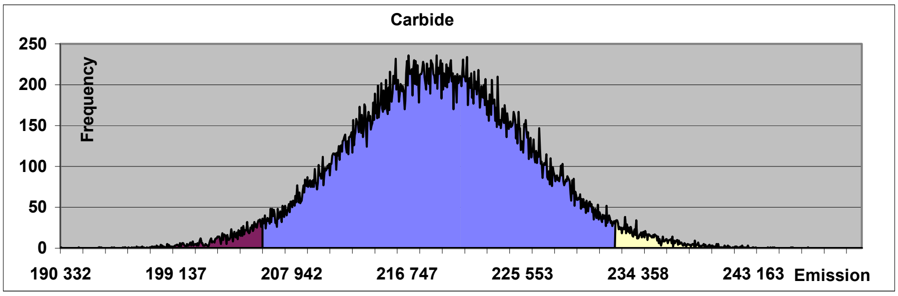


Table 4.25: Selected statistical characteristics for category 2B4, median, mean value, standard deviation, minimum, maximum of emissions and percentiles

Median	Average	Standard dev,	2,50%	97,50%
219 046,64	219 106,41	6 807,55	205 778,49	232 591,07
Min	**Max**		**Per_2,5**	**Per_97,5**
190 331,76	251 479,25		-6,08%	6,15%

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 producer 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 are verified by Mr. Vladimir Danielik – the sectoral expert for IP sector in the cooperation with 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).

4.4.5.8 Source specific recalculations

In the previous emission inventory, the CO_2 emissions from limestone consumption were included in the category 2.A.3 limestone and dolomite use. According to the ERT recommendation, the CO_2 emissions should be allocated into this category. Therefore CO_2 emissions have been recalculated since 1992 (beginning of the production). The changes in the CO_2 emissions are in tenths per cent and they are caused by reallocating the CO_2 emissions between categories 2.A.3 and 2.B.4.2.

Table 4.26: The recalculations changes and comparison of the submissions 2011 and 2012

	Submission 2011	Submission 2012	2011/2012
Year	Total CO_2 [kt]	Total CO_2 [kt]	Changes
1992	21,90	28,77	131,37%
1993	54,50	88,85	163,03%
1994	84,19	134,68	159,98%
1995	96,51	154,42	160,01%
1996	103,60	165,43	159,68%
1997	110,61	176,97	160,00%
1998	101,52	162,39	159,96%
1999	92,59	148,15	160,00%
2000	101,79	162,81	159,95%
2001	114,10	182,57	160,00%
2002	114,65	183,44	160,00%
2003	115,11	184,11	159,94%
2004	157,40	226,10	143,65%
2005	140,21	206,87	147,54%
2006	149,61	216,42	144,66%
2007	151,17	220,71	146,00%
2008	154,04	227,91	147,96%
2009	144,72	213,78	147,72%

4.4.5.9 Source specific planned improvements

Thorough survey of using of acetylene produced from calcium carbide is planned in next submissions. There is a possibility that not total amount of acetylene is burned to CO_2.

4.5 Metal production (CRF 2.C)

4.5.1 Source category description

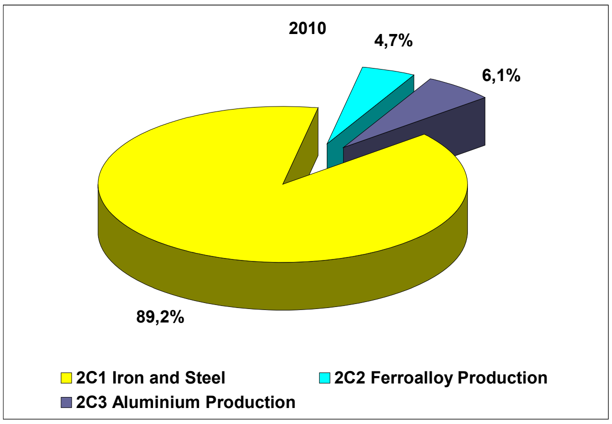
Total emissions were 4 268.84 Gg of CO_2 equivalents in 2010, the decrease is 16% compared with the previous year. Comparing with the base year, the increase is more than 18%. The increase is caused by the increase in CO_2 emissions from iron and steel production and ferroalloy production. Total NMVOC emissions from this category are 362 tons. The emissions of other basic pollutants are included in the energy sector, category iron and steel.

Table 4.27: GHG emissions in individual subcategories in the 2C category in 1990 – 2010

Category 2C - CO_2 emissions equivalents (Gg)				
Year	2C1 Iron and Steel	2C2 Ferroalloy Production	2C3 Aluminium Production	2C Total
1990	4 113,88	264,24	392,69	**4 770,81**
1991	3 498,40	257,89	386,28	**4 142,58**
1992	3 206,40	250,24	359,48	**3 816,12**
1993	3 703,91	234,55	224,90	**4 163,36**
1994	3 681,89	231,63	191,10	**4 104,62**
1995	3 867,09	209,72	173,00	**4 249,82**
1996	3 668,12	201,26	201,61	**4 070,99**
1997	3 858,65	185,95	198,71	**4 243,31**
1998	3 583,22	221,47	184,64	**3 989,32**
1999	3 780,40	197,97	175,14	**4 153,52**
2000	3 432,88	164,39	176,13	**3 773,40**
2001	3 657,82	149,34	176,53	**3 983,68**
2002	3 998,08	304,80	176,13	**4 479,01**
2003	4 094,73	301,67	188,30	**4 584,70**
2004	4 085,13	339,39	254,67	**4 679,19**
2005	3 542,45	207,47	250,75	**4 000,66**
2006	4 061,46	250,11	252,78	**4 564,35**
2007	3 894,46	272,02	238,60	**4 405,08**
2008	3 809,42	237,85	255,71	**4 302,99**
2009	3 268,82	104,64	220,77	**3 594,23**
2010	3 807,76	201,01	260,53	**4 269,30**

The major share (89%) of emissions belongs to the iron and steel production, 5% belongs to the ferroalloy production and 6% to the aluminium production.

Figure 4.14: The share of individual categories in emissions in category 2C metal production in 2010

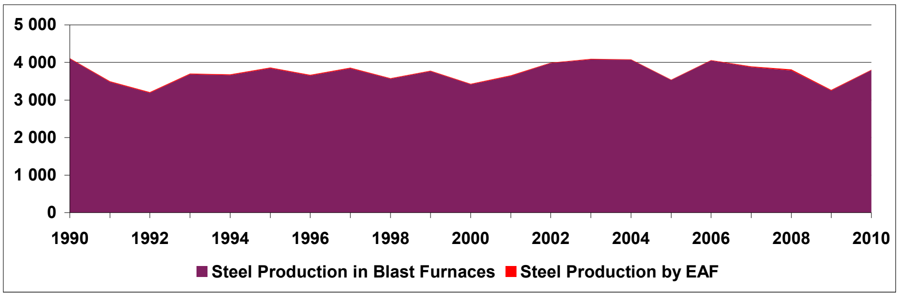


Category	CO_2 Eq. (Gg)	Share (%)
2C1 Iron and Steel	3 807,76	89,19%
2C2 Ferroalloy Production	201,01	4,71%
2C3 Aluminium Production	260,53	6,10%

4.5.2 Source category description – Iron and steel production (CRF 2.C.1)

Total emissions were 3 807.76 Gg of CO_2 in 2010, that is increase by 16% in comparison with 2009. Comparing with the base year, the decrease is approximately 7%. 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) and steel production in electric arc furnaces (2C15-other). The emissions from coke production and sinter are included in energy sector, category iron and steel production (1.A.2.a) according to the methodology in the IPCC 2000 GPG. Major share of technological CO_2 emissions represents pig iron and steel production in blast furnaces. CO_2 emissions from pig iron production are included directly in steel production. The emissions from other sources are almost stable (Figure 4.15).

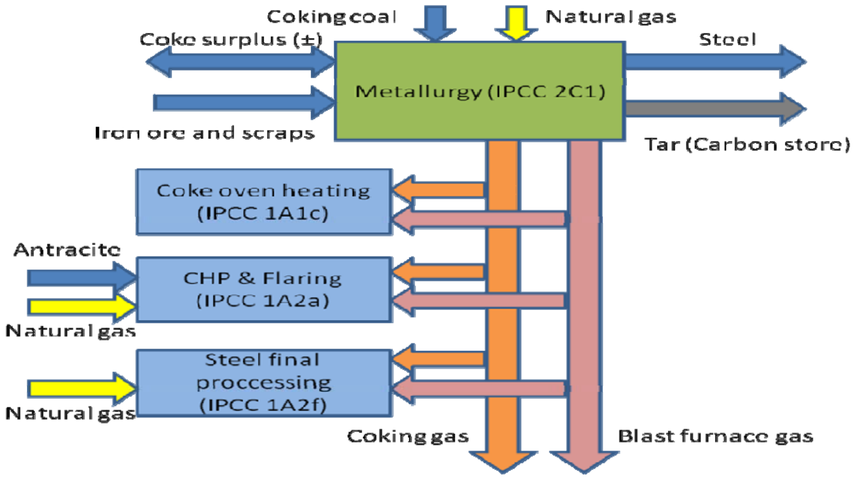
Figure 4.15: The trend of individual categories in emissions in category 2C1 iron and steel production in 2010



4.5.2.1 Methodological issues – methods

The national methodology was revised in this submission. In the Slovak Republic, pig iron and steel are produced mainly in blast furnaces and by the EAF processes. The plant with blast furnaces is a complex one with many energy-related installations (coke ovens, heating plant, manufacturing of steel products, etc.). In order to balance the carbon in the plant the simplified scheme of the plant was proposed after discussion with the plant operators (Figure 4.16).

Figure 4.16: The simplified calculation and distribution scheme of the plant for pig iron and steel production



All the streams are recalculated on the basis of conversion unit and carbon EF from energy sector (or on the basis of content of carbon in material - iron ore, steel) to mass of carbon.

Thus the CO_2 emissions can be calculated:

$$E(\text{steel BF}) = \left(\sum\left(\text{mass of C in input stream}_i\right) - \sum\left(\text{mass of C in output stream}_i\right)\right) \cdot \frac{44}{12}$$

$$E(\text{steel EAF}) = EF(\text{steel in EAF}) \cdot \text{mass of Steel produced in EAF}$$

$$\text{Total Emissions} = \sum_i E(i)$$

Carbon balance of the iron and steel production is described in more details in energy chapter.

However, the data necessary for this new approach are available only for the time period 2005 - 2010. Thus, the older data had to be recalculated by using alternative recalculation techniques (overlap method) described in the Chapter 7.3.2.2 of GPG 2000.

The technological emissions from iron (2C1.1) and steel (2C1.2) production 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 included in energy sector, category 1A2a in line with the IPCC 2006 GL. The CO_2 emissions from limestone consumption were moved into limestone and dolomite use category (2.A.3) as it is *good practice* described in IPCC 2000 GPG.

4.5.2.2 Methodological issues – emission factors and other parameters

It should be noted that the EFs differ and are estimated annually on plant level. Differences between annual emission factors are caused by the different amounts of iron scrap added to the charge in steel making process. EU ETS data were used for an inventory preparation (mass of inputs and outputs of raw materials and products and contents of carbon in all inputs and outputs) and verification purposes. Other data were taken from NEIS database. The result of the calculation based on the Fig. 4.16 was then compared with EU ETS data from the plant. The reason for this approach is the distribution of emissions among several categories in CRF (2A3, 2C1, 1A2a, 1A2f, 1A1c). The content of carbon in iron ore was 0.216 kg/t, 40 kg/t in pig iron and 0.770 kg/t in steel (based on ETS data). Emission factors and other parameters are summarized in Tables 4.28 - 4.30.

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 manufacturers of iron and steel in blast furnaces produced totally 3 648 842 tons of pig iron and subsequently 4 401 784 tons of steel from 2 606 316 tons of iron ore in 2010. Total production of steel produced by EAF was 331 248 tons in 2010. The plant UNEX, Prakovce did not produced steel in 2010.

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, Zlieváreň, 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 44 433 tons in 2010.

Table 4.28: Activity data, emission factors and CO_2 emissions in iron and steel production (blast furnaces) in the 2C1 category in 2005 – 2010

	Coking coal consumption	Coke saldo	Natural gas consumption	Cokin gas output	BFG output	Steel production	Tar output	CO_2 Emissions	IEF (CO_2)
Year	[kt]	[kt]	[millions m^3]	[kt]	[kt]	[kt]	[kt]	[kt]	[t/t]
2005	2 594,52	-20,00	30,67	626,30	3 622,84	4 238,12	71,00	**3 528,99**	0,83
2006	2 853,64	179,00	37,68	670,28	4 665,12	4 836,49	69,00	**4 047,71**	0,84
2007	2 960,17	-147,00	26,31	682,77	3 838,94	4 784,81	69,00	**3 873,91**	0,81
2008	2 867,21	-152,00	22,11	668,56	3 693,60	4 229,40	62,00	**3 788,59**	0,90
2009	2 455,88	-85,00	20,27	592,13	3 378,26	3 642,28	58,00	**3 251,17**	0,89
2010	2 516,80	327,63	36,14	657,13	4 227,88	4 401,78	57,00	**3 790,16**	0,86

BFG – blast furnace gas

Table 4.29: Activity data, emission factors and CO_2 emissions in individual plants for EAF steel production in the category 2C1.5 in 1990 – 2010

	Železiarne Podbrezová			Metalurg Steel		UNEX, Prakovce		Total		
	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*
Year	[t]									*[t/t]*
1990	C	3 810,00	13 970,00	C	4 021,00	C	162,00	310 729,00	**18 153,00**	*0,0584*
1991	C	3 928,00	14 403,00	C	4 097,00	C	162,00	319 963,00	**18 662,00**	*0,0583*
1992	C	3 735,00	13 695,00	C	3 947,00	C	161,00	304 644,00	**17 803,00**	*0,0584*
1993	C	3 729,00	13 673,00	C	3 863,00	C	166,00	303 750,00	**17 702,00**	*0,0583*
1994	C	3 884,00	14 241,00	C	4 042,00	C	166,00	316 433,00	**18 449,00**	*0,0583*
1995	C	3 878,00	14 219,00	C	3 829,00	C	164,00	314 641,00	**18 212,00**	*0,0579*
1996	C	3 797,00	13 922,00	C	4 041,00	C	160,00	309 851,00	**18 123,00**	*0,0585*
1997	C	3 841,00	14 084,00	C	4 025,00	C	167,00	313 155,00	**18 276,00**	*0,0584*
1998	C	3 876,00	14 212,00	C	3 842,00	C	166,00	314 601,00	**18 220,00**	*0,0579*
1999	C	3 952,00	14 491,00	C	3 750,00	C	159,00	319 660,00	**18 400,00**	*0,0576*
2000	C	3 879,00	14 223,00	C	4 096,00	C	167,00	316 358,00	**18 486,00**	*0,0584*
2001	C	3 900,00	14 300,00	C	4 055,00	C	166,00	317 710,00	**18 521,00**	*0,0583*
2002	C	3 765,00	13 805,00	C	4 002,00	C	171,00	307 356,00	**17 978,00**	*0,0585*
2003	C	3 953,00	14 494,00	C	3 991,00	C	134,00	320 863,00	**18 619,00**	*0,0580*
2004	C	4 583,00	16 804,00	C	829,00	C	46,00	347 605,00	**17 679,00**	*0,0509*
2005	C	3 409,00	12 490,00	C	888,00	C	83,00	356 900,00	**13 461,00**	*0,0377*
2006	C	3 232,00	11 843,00	C	1 815,00	C	94,00	376 581,00	**13 752,00**	*0,0365*
2007	C	4 982,00	18 254,00	C	2 218,00	C	69,00	389 435,00	**20 541,00**	*0,0527*
2008	C	4 986,00	18 269,00	C	2 508,00	C	62,00	382 609,00	**20 839,00**	*0,0545*
2009	C	4 597,00	16 856,00	C	776,00	C	23,00	348 065,00	**17 655,00**	*0,0507*
2010	C	4 465,00	16 372,00	C	1 229,00	0,00	0,00	331 248,00	**17 601,00**	*0,0531*

Table 4.30: Recalculated data for iron and steel production (blast furnaces) in the 2C1 category in 1990 – 2004

Year	Steel production [kt]	CO_2 Emissions [kt]	IEF (CO_2) [t/t]
1990	3 561,50	**4 095,73**	1,150
1991	3 163,40	**3 479,74**	1,100
1992	2 952,40	**3 188,59**	1,080
1993	3 205,40	**3 686,21**	1,150
1994	3 330,40	**3 663,44**	1,100
1995	3 207,40	**3 848,88**	1,200
1996	2 920,00	**3 650,00**	1,250
1997	3 072,30	**3 840,38**	1,250
1998	3 100,00	**3 565,00**	1,150
1999	3 420,00	**3 762,00**	1,100
2000	3 519,99	**3 414,39**	0,970
2001	3 751,85	**3 639,29**	0,970
2002	4 103,20	**3 980,10**	0,970
2003	4 382,92	**4 076,12**	0,930
2004	4 421,14	**4 067,45**	0,920

4.5.2.4 Uncertainties and time-series consistency

The time series consistency was respected in the highest degree. However, some notes should be mentioned:

1. Iron and steel production in blast furnaces: Natural gas has also been used for heating of blast furnaces since 2001. Therefore the IEF CO_2 decreased from that year. The necessary data for the new methodology described above are available for the time period 2005 - 2010. Thus, the overlap recalculation method was used for the years 1990 - 2004. EU ETS reports are available since 2005, but no detail data fuel consumption or CO_2 emissions are presented in the reports. The methodology used by plant operator in EU ETS report based on mass balance.

2. The emission calculation for EAF steel production is based on the available data and assumptions:

- Železiarne Podbrezová: EU ETS reports are available since 2005. 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 t of steel.
- Metalurg Steel: EU ETS reports are available since 2007. According to the questionnaires concerning the period 2000 – 2006; the emission factor of CO_2 was 0.165 t per 1 t 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.

The uncertainties in mass of used coke (2.5%), mass of used iron ore (5%), mass of produced pig iron (2.5%), mass of produced steel (2%), contents of carbon in iron ore (10%), in pig iron (10%), in steel (5%) and used EF from coke (3%) were estimated according to IPCC 2000 GPG for each plant. The emission factors and uncertainty for both AD and EF (in formula represent by symbol Δ) were used for uncertainty estimation. The uncertainty of aggregate CO_2 emissions (in equivalents) is in interval (-3.85%; +3.91%). Formula can be written in the following form:

$$\begin{aligned}
\text{Emissions} = {} & (\text{amount of Coke} \pm \Delta\text{Coke}) * (\text{EFCoke} \pm \Delta\text{EFCoke}) + \\
& + ((\text{amount of Ore} \pm \Delta\text{Ore}) * (\text{content of C_Ore} \pm \Delta\text{C_Ore}) - \\
& - (\text{amount of Iron} \pm \Delta\text{Iron}) * (\text{content of C_I} \pm \Delta\text{C_I})) * \frac{44}{12} + \\
& + (\text{amount of Iron} \pm \Delta\text{Iron}) * ((\text{content C_I} \pm \Delta\text{C_I}) - (\text{content C_Steel} \pm \Delta\text{C_Steel})) * \frac{44}{12}.
\end{aligned}$$

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 and 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 4.17: Probability density function for category 2C1 in tons of CO_2

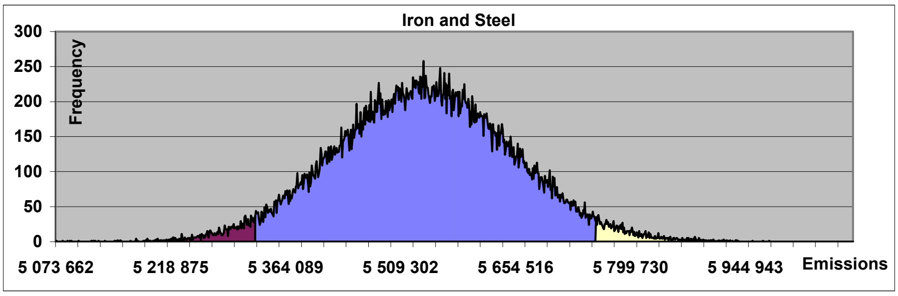


Table 4.31: Selected statistical characteristics for category 2C1, median, mean value, standard deviation, minimum, maximum of emissions and percentiles

Median	Average	Standard dev,	2,50%	97,50%
5 538 470,75	5 539 140,11	110 076,26	5 325 820,01	5 755 588,45
Min	**Max**		**Per_2,5**	**Per_97,5**
5 073 661,76	6 082 089,30		-3,85%	3,91%

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 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 are verified by Mr. Vladimir Danielik – the sectoral expert for IP sector in the cooperation with 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

Recalculation was made for the whole time series. It is caused by introducing new approach to the calculation of CO_2 emissions. This approach allows more precise differentiation between technological and energy emissions. The other reason for recalculation was the moving the CO_2 emissions from limestone consumption into the category limestone and dolomite use (2.A.3). The decrease in emissions is mainly up to 30%. However, this decrease is compensated by the same increase in emissions in energy sectors as it can be seen in Figure 4.16.

Table 4.32: The recalculations changes and comparison of the submissions 2011 and 2012

	Submission 2011		Submission 2012		2011/2012
Year	Total CO_2 [kt]	EF (CO_2) [t/t]	Total CO_2 [kt]	EF (CO_2) [t/t]	Changes
1990	5 380,51	1,390	4 095,73	13,181	76,12%
1991	4 781,62	1,373	3 479,74	10,875	72,77%
1992	4 463,07	1,370	3 188,59	10,467	71,44%
1993	4 843,89	1,380	3 686,21	12,136	76,10%
1994	5 032,85	1,380	3 663,44	11,577	72,79%
1995	4 847,42	1,376	3 848,88	12,233	79,40%
1996	4 414,60	1,367	3 650,00	11,780	82,68%
1997	4 644,07	1,372	3 840,38	12,263	82,69%
1998	4 685,72	1,372	3 565,00	11,332	76,08%
1999	5 131,92	1,372	3 762,00	11,769	73,31%
2000	5 349,74	1,394	3 414,39	10,793	63,82%
2001	5 306,38	1,304	3 639,29	11,455	68,58%
2002	5 626,19	1,276	3 980,10	12,949	70,74%
2003	5 870,76	1,248	4 076,12	12,704	69,43%
2004	6 021,93	1,263	4 067,45	11,701	67,54%
2005	5 750,65	1,251	3 528,99	9,888	61,37%
2006	5 755,24	1,104	4 047,71	10,749	70,33%
2007	5 667,85	1,095	3 873,91	9,948	68,35%
2008	5 173,17	1,122	3 788,59	9,902	73,24%
2009	4 447,08	1,114	3 251,17	9,341	73,11%

4.5.2.7 Source specific planned improvements

No improvements of the used approach are planned for this category for the next submission. However, the recalculation in the time period 1990 – 2004 will be checked and verified in 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 submissions and according to the inventory in 2010 were 200.451 Gg of CO_2 and 26.419 t of CH_4.

4.5.3.1 Methodological issues – methods

The CO_2 emission estimation for the period 1990 – 2010 was based on tier 2 approach by using the plant specific data. Since 2002, more detailed information about ferroalloys production is known. Before that, the simple aggregation of data into the ferroalloys based on Cr, Mn and Si was used. The production of FeSi started in 1998. The estimation is provided in Table 4.33 and table 4.34.

4.5.3.2 Methodological issues – emission factors and other parameters

In the previous inventory submission (2011) the thorough survey of CO_2 emissions was done in the cooperation with the producers according to the recommendations of the ERT during the centralized review 2010. 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 4.33. Methane emission factor was not changed and the default value 1 kg CH_4/1 tone of FeSi ferroalloys was used

Table 4.33: Plant specific emission factors of CO_2 at ferroalloys production in tones of CO_2 per 1 tone of ferroalloy in 2010

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 directly from the producers of ferroalloys in the Slovak Republic based on questionnaires and are summarized in Table 4.34 and Table 4.35.

Table 4.34: 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	264 244,00	1,564	0,00
1991	52 000	113 000	0	165 000	257 892,00	1,563	0,00
1992	50 000	110 000	0	160 000	250 240,00	1,564	0,00
1993	47 000	103 000	0	150 000	234 552,00	1,564	0,00
1994	34 000	111 300	0	145 300	231 629,20	1,594	0,00
1995	45 000	89 800	0	134 800	209 723,20	1,556	0,00
1996	46 000	84 000	0	130 000	201 256,00	1,548	0,00
1997	42 000	78 000	0	120 000	185 952,00	1,550	0,00
1998	44 000	81 000	8 666	133 666	221 283,20	1,655	8,67
1999	46 700	56 300	13 205	116 205	197 695,97	1,701	13,21
2000	17 658	69 458	7 611	94 727	164 232,21	1,734	7,61
2001	12 140	69 380	5 200	86 720	149 226,72	1,721	5,20

Table 4.35: Activity data, emission factors and CO_2 for ferroalloys production in 2002 – 2010

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	0	0	62 084	56 297	3 521	364	153 474	304 147,20	1,982	31,21
2003	41 539	0	0	52 773	43 434	1 654	1 155	140 555	301 012,10	2,142	41,54
2004	34 684	0	0	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	0	0	134 674	249 765,40	1,855	16,16
2007	8 417	112	0	71 587	74 065	0	0	154 181	271 678,70	1,762	8,58
2008	9 510	941	393	59 940	61 194	0	0	131 978	237 667,10	1,801	10,84
2009	4 241	118	278	32 102	20 976	0	0	57 715	104 415,00	1,809	4,64
2010	16 274	9 519	626	34 960	35 449	0	0	96 828	200 451,00	2,070	26,42

4.5.3.4 Uncertainties and time-series consistency

In 2010 submission, the thorough survey of CO_2 emissions was done in the cooperation with the producers. The detailed data about the individual ferroalloys were obtained and the respective EFs are summarized in Table 4.33. However, before 2002 the different aggregation of production data is available only. The emission factors for CO_2 were assumed: 1.734 t/t of ferroalloys based on Mn, 1.3 t/t of ferroalloys based on Cr and 3.155 t/t of ferroalloys based on Si in the time period 1990 – 2001. According to the ERT recommendation (in-country review in 2011) the recalculation methods described in IPCC 2000 GPG was made. The Overlap method described in Chapter 7 of 2000 GPG was adopted and new EFs were calculated for the period 1990 – 2001 (1.684 t / t of ferroalloys based on Mn, 1.3 t / t of ferroalloys based on Cr and 3.194 t / t of ferroalloys based on Si). The verification calculation of emissions was made with the same aggregation of production data for the period 2002 – 2010 and the difference in the emissions did not exceed 0.6%. Significant increase in emissions since 2002 is caused by change of the owner of the plant and new market situation.

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 aggregated CO_2 emissions (in equivalents) is in interval
(-5.28%; +5.27%). 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 4.18: Probability density function for category 2C2 in tons of CO_2

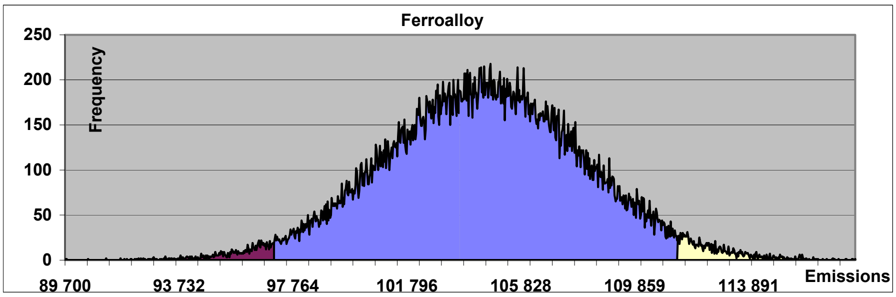


Table 4.36: Selected statistical characteristics for category 2C2, median, mean value, standard deviation, minimum, maximum of emissions and percentiles

Median	Average	Standard dev,	2,50%	97,50%
201 033,89	201 034,26	5 392,86	190 419,94	211 632,51
Min	**Max**		**Per_2,5**	**Per_97,5**
178 664,61	223 026,88		-5,28%	5,27%

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 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 are verified by Mr. Vladimir Danielik – the sectoral expert for IP sector in the cooperation with 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).

4.5.3.6 Source specific recalculations

According to the recommendations of the ERT during the in-country review in 2011, the revision of emission factors for CO_2 emissions was made since 1990 in ferroalloys production according to the type of alloys. The Overlap method described in Chapter 7 of 2000 GPG was adopted and new EFs were calculated for the period 1990 – 2001. The verification of emissions calculation was made with the same aggregation of production data for the period 2002 – 2010 and the difference in the emissions did not exceed 0.6%. The production activity data were not changed, but the CO_2 emissions were recalculated (Table 4.37) using the new country specific EFs. The recalculated emissions are lower down to 2.5% in several years (mostly in 90-ties).

4.5.3.7 Source specific planned improvements

The verifying of $FeSi_x$ alloys content is planned. Based on this specific information, the recalculation of methane emissions will be providing.

Table 4.37: The recalculations changes and comparison of the submissions 2011 and 2012

	Submission 2011		Submission 2012		2011/2012
Year	**Total CO_2 [t]**	**EF (CO_2) [t/t]**	**Total CO_2 [t]**	**EF (CO_2) [t/t]**	**Changes**
1990	270 044,00	1,598	264 244,00	1,564	97,85%
1991	263 542,00	1,597	257 892,00	1,563	97,86%
1992	255 740,00	1,598	250 240,00	1,564	97,85%
1993	239 702,00	1,598	234 552,00	1,564	97,85%
1994	237 194,20	1,632	231 629,20	1,594	97,65%
1995	214 213,20	1,589	209 723,20	1,556	97,90%
1996	205 456,00	1,580	201 256,00	1,548	97,96%
1997	189 852,00	1,582	185 952,00	1,550	97,95%
1998	224 995,20	1,683	221 283,20	1,655	98,35%
1999	199 996,00	1,721	197 695,97	1,701	98,85%
2000	167 408,30	1,767	164 232,21	1,734	98,10%
2001	152 492,90	1,758	149 226,72	1,721	97,86%

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. 69 452 tons of graphite anodes was used in 2010 with the carbon content of 94%. In previous submissions the used carbon content (85%) was not correct and the CO_2 emissions were recalculated in this submission. 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 (239 378 t CO_2 in 2010). The total PFC emission was 3.136 t in 2010 and it was calculated according to the Slope method.

4.5.4.2 Methodological issues – emission factors and other parameters

The emission factors of PFCs (CF_4, C_2F_6) were calculated according to the Tabereaux's equation (version of the Slope method):

$$EF(PFC) = const \cdot \frac{x}{\eta} \cdot AE \cdot AED$$

Where *const* is a constant for emission factor of CF_4 = 1.698, for emission factor of C_2F_6 = 0.1698 and it equals to:

- *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 92.94% in 2010, the number of anode effects per pot day equals to 0.088 and their average duration was 1.36 min. It follows that the emission factors were 0.0175 kg CF_4/t of aluminium and 0.00175 kg C_2F_6/t of aluminium, respectively. 162 997 t of aluminium were produced in 2010. SF_6 is not used in aluminium castings in the Slovak Republic since 2004.

Table 4.38: The overview of emissions and EFs in aluminium production in 1990 – 2010

Year	Aluminium Production	*EF per Aluminium*	CO_2 (Aluminium)	CF_4	*EF per Aluminium*	C_2F_6	*EF per Aluminium*	Total PFC Emissions
	[kt]	*[t/t]*	**[kt]**	[t]	[t/t]	[t]	[t/t]	**[Gg CO_2 eq.]**
1990	67,40	*1,8000*	**121,32**	36,60	*0,5430*	3,64	*0,0540*	**271,37**
1991	66,30	*1,8000*	**119,34**	36,00	*0,5430*	3,58	*0,0540*	**266,94**
1992	61,70	*1,8000*	**111,06**	33,50	*0,5430*	3,33	*0,0540*	**248,42**
1993	38,60	*1,8000*	**69,48**	20,96	*0,5430*	2,08	*0,0540*	**155,42**
1994	32,80	*1,8000*	**59,04**	17,81	*0,5430*	1,77	*0,0540*	**132,06**
1995	32,60	*1,8000*	**58,68**	15,42	*0,4730*	1,53	*0,0470*	**114,32**
1996	111,40	*1,5000*	**167,10**	4,68	*0,0420*	0,45	*0,0040*	**34,51**
1997	110,19	*1,5000*	**165,29**	4,52	*0,0410*	0,44	*0,0040*	**33,42**
1998	108,00	*1,5000*	**162,00**	3,02	*0,0280*	0,32	*0,0030*	**22,64**
1999	109,20	*1,5000*	**163,80**	1,53	*0,0140*	0,15	*0,0014*	**11,34**
2000	109,81	*1,5000*	**164,72**	1,54	*0,0140*	0,15	*0,0014*	**11,41**
2001	110,06	*1,5000*	**165,09**	1,54	*0,0140*	0,15	*0,0014*	**11,43**
2002	109,81	*1,5000*	**164,72**	1,54	*0,0140*	0,15	*0,0014*	**11,41**
2003	111,62	*1,5000*	**167,43**	2,81	*0,0252*	0,28	*0,0025*	**20,87**
2004	156,89	*1,5000*	**235,34**	2,60	*0,0166*	0,26	*0,0017*	**19,32**
2005	159,20	*1,4490*	**230,69**	2,70	*0,0170*	0,27	*0,0017*	**20,06**
2006	158,29	*1,3706*	**216,95**	4,83	*0,0305*	0,48	*0,0031*	**35,82**
2007	160,46	*1,3319*	**213,72**	3,35	*0,0209*	0,34	*0,0021*	**24,88**
2008	163,00	*1,3470*	**219,55**	4,87	*0,0299*	0,49	*0,0030*	**36,16**
2009	149,60	*1,3570*	**203,01**	2,39	*0,0160*	0,24	*0,0016*	**17,76**
2010	163,00	*1,4686*	**239,38**	2,85	*0,0175*	0,29	*0,0018*	**21,15**

4.5.4.4 Uncertainties and time-series consistency

In 1996 the technology was changed from Søderberg to prebaked technology. It results in significant decrease of CO_2 and PFC emissions. The CO_2 emissions are calculated only by using the Tier 1 method in the period 1990 - 1995 and cannot be changed. The data are not available because of the change of the plant owner. Since that the same Tier is used for both of them, CO_2 and PFC emissions. According to the questionnaire, the significant progress in control of the electrolysis was achieved in 2009. The progress results in decrease of PFC emissions since 2009.

The uncertainties in the mass of produced aluminium (2.5%), 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. The uncertainty of CO_2 emissions (in equivalents) is in interval (-3.69%; +3.75%). To compute the uncertainties of aggregated 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:

$$\text{Emission} = (\text{amount of Anodes} \pm \Delta\text{Anode}) * (\text{content of C} \pm \Delta\_\text{content of C}) * \frac{44}{12} +$$

$$+ \sum_{I} \Big(\text{constant} * (\text{PFCcontent} \pm \Delta\text{PFCcontent}) * (\text{anode effects} \pm \Delta\text{anode effects})\Big) *$$

$$* \frac{(\text{duration of Anodes} \pm \Delta\text{duration of Anode})}{(\text{current eff} \pm \Delta\_\text{current eff})} / 1000$$

The accumulated uncertainty and statistical characteristics for subsector aluminum are presented on the following figure.

Figure 4.19: Probability density function for category 2C3 in tons of CO_2

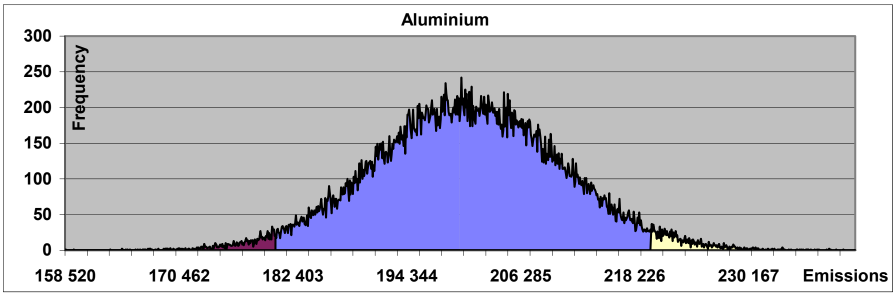


Table 4.39: Selected statistical characteristics for category 2C3, median, mean value, standard deviation, minimum, maximum of emissions and percentiles

Median	Average	Standard dev,	2,50%	97,50%
259 648,93	259 691,64	4 953,18	250 104,12	269 427,48
Min	**Max**		**Per_2,5**	**Per_97,5**
239 426,89	279 467,90		-3,69%	3,75%

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 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 are verified by Mr. Vladimir Danielik – the sectoral expert for IP sector in the cooperation with 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).

4.5.4.6 Source specific recalculations

The carbon content in prebaked anodes, presented since 2006 – 2009, was not correct because of the confusion in the supplied data (carbon content in anodes before prebaking was presented). This is a reason of the CO_2 emissions recalculation in this submission (Table 4.40). The production activity data and PFC emissions were not changed. The CO_2 emissions are higher up to 11% in the period 2006 – 2009.

Table 4.40: The recalculations changes and comparison of the submissions 2011 and 2012

	Submission 2011		Submission 2012		2011/2012
Year	Total CO_2 [kt]	EF (CO_2) [t/t]	Total CO_2 [kt]	EF (CO_2) [t/t]	Changes
2006	196,44	1,241	216,95	1,371	110,44%
2007	192,22	1,198	213,72	1,332	111,18%
2008	198,53	1,218	219,55	1,347	110,59%
2009	183,57	1,227	203,01	1,357	110,59%

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 2010 and NMVOC emissions from food industry were 301 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 – 2010.

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, 365mfc).
- 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 more than 15 different 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.

According to the latest inventory data, the actual HFCs emissions in category 2.F Consumption of halocarbons were 321.06 Gg of CO_2 equivalents in 2010 and have increased by 4% compared to the previous year and 14 times compared to the year 1995. The potential emissions of HFCs represented 484.84 Gg of CO_2 equivalents in 2010. The emissions have decreased by 30% compared to the previous year. The ratio of potential/actual HFCs emissions in 2010 was 1.51 and the trend of ratio starting to decrease.

Table 4.41: The overview of actual and potential HFCs and SF_6 emissions in 1990 – 2010

Category 2F Consumption of HFCs and SF_6									
Year	Actual HFCs (Gg CO_2 eq.)	Potential HFCs (Gg CO_2 eq.)	Ratio A/P	Potential PFCs (kt)	Potential PFCs (Gg CO_2 eq.)	Ratio A/P	Actual SF_6 (kt)	Potential SF_6 (kt)	Ratio A/P
1990	NO	NO	NO	NO	NO	NO	0,0013	NO	NO
1991	NO	NO	NO	NO	NO	NO	0,0014	0,0100	7,26
1992	NO	NO	NO	NO	NO	NO	0,0016	0,0220	13,76
1993	NO	NO	NO	NO	NO	NO	0,0027	0,1130	41,57
1994	2,9091	NO	NO	NO	NO	NO	0,3878	38,5060	99,30
1995	22,1532	119,8636	5,41	NO	NO	NO	0,4146	3,0800	7,43
1996	37,5808	166,5176	4,43	NO	NO	NO	0,4502	3,9800	8,84
1997	61,1335	208,5057	3,41	1,20	1,20	1,00	0,4745	2,8800	6,07
1998	40,9561	120,6116	2,94	2,77	2,81	1,01	0,5122	4,3400	8,47
1999	65,3922	151,0394	2,31	2,26	2,28	1,01	0,5309	2,5620	4,83
2000	80,9708	221,2709	2,73	0,24	0,24	1,00	0,5546	2,9130	5,25
2001	88,5391	236,7941	2,67	4,16	4,16	1,00	0,5792	3,0080	5,19
2002	109,0106	325,6102	2,99	2,34	2,34	1,00	0,6184	4,5899	7,42
2003	139,1123	328,7744	2,36	0,78	0,78	1,00	0,6439	3,1530	4,90
2004	160,4984	363,5260	2,26	0,59	0,59	1,00	0,6648	3,6090	5,43
2005	180,3818	368,8989	2,05	0,20	0,20	1,00	0,6951	3,8600	5,55
2006	207,3094	476,8527	2,30	NO	NO	NO	0,7177	2,9390	4,10
2007	235,5177	543,0532	2,31	NO	NO	NO	0,7296	3,3233	4,56
2008	273,0410	584,8550	2,14	NO	NO	NO	0,7745	5,2570	6,79
2009	308,7168	688,3377	2,23	NO	NO	NO	0,8112	4,4850	5,53
2010	321,0628	484,8406	1,51	NO	0,04	NA	0,8327	2,9600	3,55

The actual emissions of PFCs in the category 2.F did not occur in 2010, however the potential emissions of CF_4 in bulk was 0.039 Gg of CO_2 equivalents.

Actual emissions of SF_6 reached 0.83 tons in 2010 and increased by 2% compared to the previous inventory year. The potential emissions of SF_6 reached 2.96 tons and decreased by 34% compared to the previous year. The ratio of potential/actual emissions of SF_6 was 3.55 in 2010.

4.8.1 Methodological issues – methods

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 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: 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 and started its operation 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 to legal status in the 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 has to fill in the table which will be shown after entering its account. 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 is applied on the following sources:

- SF_6 emissions from electrical equipment and other sources.[14]
- Fluorinated carbon emissions[15] from semiconductor manufacturing.
- HFCs emissions from refrigeration and air conditioning.

The system is gathering data from year 2009. 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 is 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, because contractors can buy refrigerant abroad and use them in the country.

The new internet reporting system needs time for running in. Problem was usually to get data from importers of F-gases in products. These importers were used to get a questionnaire. It was for the first time they had to send data in paper form only according to the Act No 286/2009 Coll. and its amendment No 314/2009 Coll. Lot of the importers had 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 then be expected that the next year the reported data will be more complex and precise. 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

[14] *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.*

[15] *Including CF_4, C_2F_6, C_3F_8, C_4F_8, CHF_3, NF_3, SF_6*

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4.8.2 Activity Data

The following substances belong to this group:

- 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 AC cars, 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 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. 80 kg of imported SF_6 is filled into windows, annually.10 kg is stored in windows in the Slovak Republic and the rest (70 kg) is exported in products, annually. 1% of this domestic amount of SF_6 in windows is reported as emissions. While this is very small amount, the emissions are reported in the category electrical equipment (CRF 2.F.8).
- 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.

4.8.3 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 310.15 Gg of CO_2 equivalents and they increased from the previous year by 5%, the potential emissions of HFCs were 469.54 Gg of CO_2 equivalents in 2010, they decreased by 28% 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 and 23.44 tons of new fillings were used in 2010.

4.8.3.1 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.

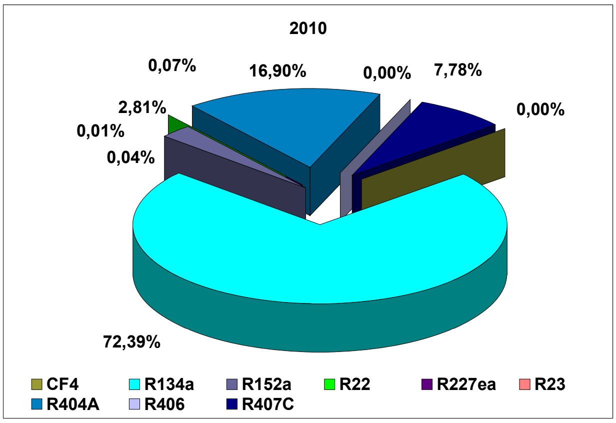
4.8.3.2 Methodological issues – emission factors and other parameters

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.

4.8.4 Activity data

Situation in import of new F-gases in refrigeration in 2010 can be seen in the following Figure 4.20. The major share of imported gases belongs to R134a with 72% and R404A with the share of 17%. The category of refrigerants is the most important for emission inventory in the category 2.F. The overview of emissions is presented in Table 4.41.

Figure 4.20: Results from data reported by importers of refrigerants in 2010



Refrigerant	kg of new (imported)	Share (%)
CF4	6,00	0,001%
R134a	353 352,99	72,390%
R152a	13 713,45	2,809%
R22	350,00	0,072%
R227ea	196,00	0,040%
R23	27,30	0,006%
R404A	82 492,30	16,900%
R406	0,00	0,000%
R407C	37 985,30	7,782%

4.8.5 Source category description – Foam blowing (CRF 2.F.2)

This category was estimated according to the new information first time in this submission. The emissions are produced from hard (CRF 2.F.2.1) and soft foams (2.F.2.2) categories. The following gases are occurred since 1999: HFC134a, HFC245fa for hard foam and HFC365mfc for soft foam (Table 4.42). The product life factor is 0.5% for all gases in this category.

According to the recommendations of the ERT during the in-country review 2011, the review of national circumstances was performed. The average values 0.435 Gg of CO_2 per inhabitant x 10^{-6} was used based on average values from neighbouring countries. After carefully verifying data in country, it is supposed that our consumption is very low, the production of foams changed from blowing agent R141b directly to cyclopentane and in 2002 to HFC245fa and HFC365mfc. Import to building industry was based on values of big importers (BASF, etc.) and estimation of parts imported by small companies.

Table 4.42: Overview of HFCs emissions in category 2.F.2 Foam Blowing

	2.F.2.1 Hard Foam				2.F.2.2 Soft Foam
	HFC134a			HFC245fa	HFC365mfc
Year	new products [t]	in operation [t]	Actual emissions from stock [t]	Actual emissions from stock [Gg of CO_2 eq.]	Actual emissions from stock [Gg of CO_2 eq.]
1999	41,200	41,200	0,206	NO	NO
2000	41,200	82,400	0,412	NO	NO
2001	37,500	119,900	0,600	NO	NO
2002	37,500	157,400	0,787	0,034	0,026
2003	31,200	188,600	0,943	0,068	0,052
2004	24,900	213,500	1,068	0,099	0,076
2005	18,700	232,200	1,161	0,130	0,100
2006	13,700	245,900	1,230	0,156	0,120
2007	12,500	258,400	1,292	0,176	0,136
2008	NO	258,400	1,292	0,192	0,148
2009	NO	258,400	1,292	0,203	0,156
2010	NO	258,400	1,292	0,213	0,164

4.8.6 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 2010, total actual emissions of HFC227ea and HFC236fa were 1.77 Gg of CO_2 equivalents and they decreased by 67% compared to the previous year. The potential emissions of HFCs were 13.78 Gg of CO_2 equivalents and they decreased by 58% compared to the previous inventory year. The emissions of PFCs and SF_6 are not occurring in this category. PFC extinguishing media import is not occurred in the Slovak Republic and SF_6 is used and reported as isolation gas.

4.8.7 Source category description – Aerosols/metered dose inhalers (CRF 2.F.4)

This category was estimated according to the new information first time in this submission. The emissions are produced in the category 2.F.1 – Metered Dose Inhalers. The following gases are occurred HFC134a (since 2000) and HFC227ea (in 2010) (Table 4.43). The product life factor is 100% for all gases in this category. According to the recommendation of the ERT during the in-country review 2011, the following approach for emission estimation in this category was chosen. Number of containers is based on reporting of the ŠÚKL institute[16]. Original charge of container was set on the base of expert estimation with the average value of 1.36 Gg CO_2 on inhabitants x 10^{-6}.

[16] *ŠÚKL – State Institute for Drug Control*

Table 4.43: Overview of HFCs emissions in category 2.F.4.1 Metered Dose Inhalers

	2.F.4.1 Metered Dose Inhalers		
	HFC134a		HFC227ea
Year	in operation [t]	Actual emissions from stock [t]	Actual emissions from stock [t]
2000	3,730	3,730	NO
2001	4,100	4,100	NO
2002	4,290	4,290	NO
2003	4,470	4,470	NO
2004	4,660	4,660	NO
2005	4,850	4,850	NO
2006	5,030	5,030	NO
2007	5,030	5,030	NO
2008	5,070	5,070	NO
2009	5,440	5,440	NO
2010	4,838	4,838	0,274

4.8.8 Source category description – Solvents (CRF 2.F.5)

No emissions of F gases were included in this category. There is no import of F-solvents to the Slovak Republic. According to the information from industry, solvents L113, S316 are used, but these are not included in the IPCC GPG 2000.

4.8.9 Source category description – Other applications using ODS substitutes (CRF 2.F.6)

No emissions of F gases were included in this category.

4.8.10 Source category description – Semiconductor manufacture (CRF 2.F.7)

No emissions of F gases were included in this category.

4.8.11 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 2010, total actual emissions of SF_6 were 0.83 Gg of CO_2 equivalents and they increased by 2% compared to the previous year. The potential emissions of SF_6 were 0.00296 Gg of CO_2 equivalents and they decreased by 34% compared to the previous inventory year. The emissions of HFCs and PFCs are not occurring in this category.

The emissions from windows isolation are reported in this category in the total volume 80 kg/per year.

4.8.12 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 2010, the potential emissions of HFCs from the consumption were 484.84 Gg of CO_2 equivalents and 0.039 Gg of CO_2 equivalents of PFCs. Total potential emissions of SF_6 were 2.96 Gg of CO_2 equivalents.

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 t of it were purchased in years 1993 and 1995. This amount had been consumed gradually. 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 4.44: 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**	**2010**
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	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	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	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	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	0,00
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	0,00
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	0,00
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**	**0,00**

Type of equipment	**R407C (t)**												
	1998	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**
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	6,78
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	0,00
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	0,66
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	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	7,50
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	30,97
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**	**38,47**
% in bulks									95,00	89,00	89,00	91,00	80,00

Type of equipment	R134a (t)												
	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
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	2,56
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	0,50
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	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	50,60
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	53,66
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	150,90
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	3,99
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**	**208,50**

Type of equipment	R404A (t)												
	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
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	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	2,38
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	0,96
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	0,10
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	2,57
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	51,60
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**	**54,10**

Type of equipment	R410A (t)												
	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
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	15,20
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	0,46
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	0,20
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	0,60
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	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	16,50
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	12,40
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**	**28,90**
% 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	2010
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	24,60
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	3,80
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	0,96
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	50,60
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	0,00
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	85,27
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	269,10
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**	**354,00**
% 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	69,00

Refrigerant/import 2010	AC	CC	DC	CAR AC	Bulks	Store	Total
R22	0,000	0,000	0,000	0,000	0,000	0,000	**0,000**
R134a	1,251	0,001	0,000	58,410	150,900	69,800	**208,000**
R404A	0,000	2,370	0,960	0,100	51,600	0,000	**54,100**
R407C	6,780	0,000	0,660	0,000	30,970	0,000	**38,470**
R410A	15,200	0,460	0,200	0,600	12,400	0,000	**40,290**
HCFC, HFC mixtures	0,000	0,000	0,000	0,000	0,000	0,230	**0,000**
Total	**23,231**	**2,831**	**1,820**	**59,110**	**245,870**	**29,337**	**340,860**
TOTAL	**341 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 decreased in accordance with the impacts of economic recession and colder summer in 2009, but also as an effect of implementation of Regulation No. 842/2006/EC.

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 2010 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 4.21: Development of refrigerant import in products and bulks in the Slovak Republic

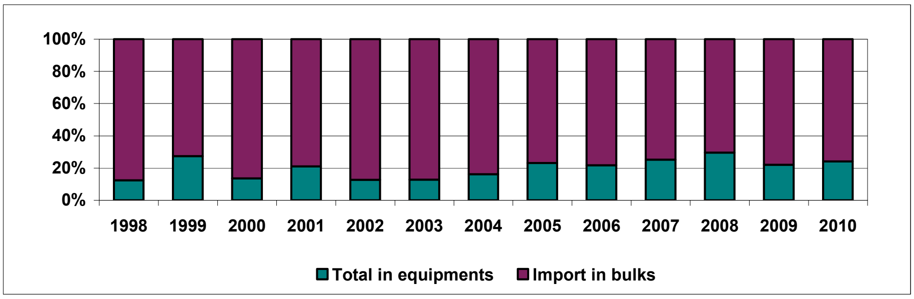
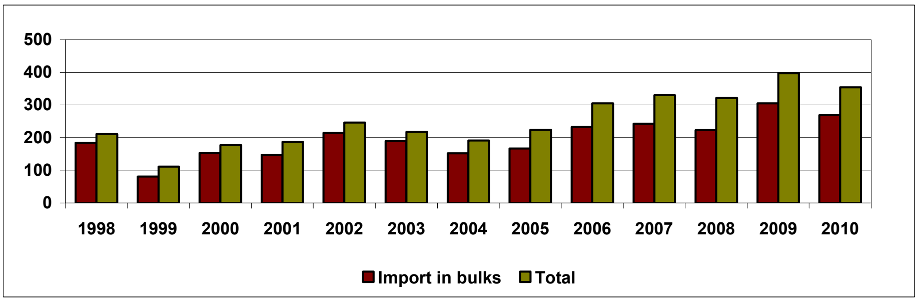
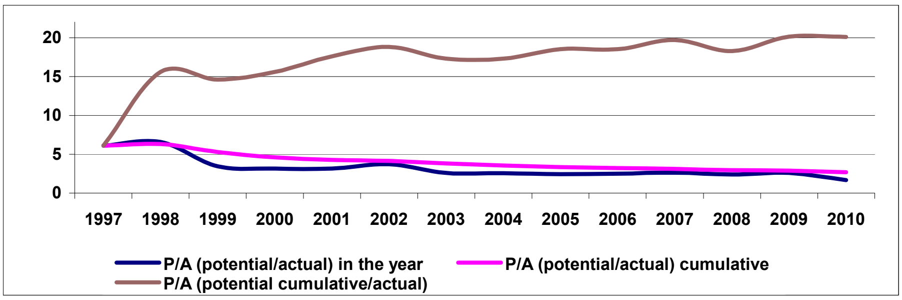


Figure 4.22: Development of refrigerant consumption in the Slovak Republic



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 potential emissions will mainly 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 4.23: The development of ratio of potential and actual emissions

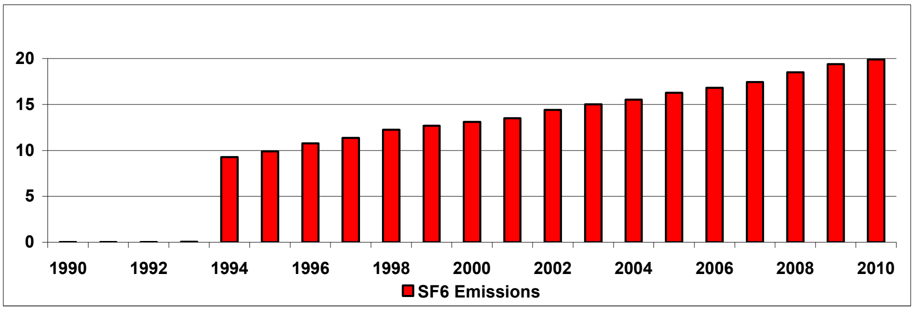


- Potential and actual emissions of PFC14 and PFC116 - C_2F_6 perfluorethane originates as a by-product during the aluminium production in Žiar nad Hronom. Since 2000 PFC 14 and PFC116 have been originated as a by-product during the aluminium production and they have not been included in this part of inventory.
- Less than 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 2010 was reached faster application of HFCs because the HCFCs applications have been completely abandoned in new installations by Act No. 76/1998 Coll. in version No. 408/2000 Coll. 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 4.24: The development of SF_6 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 than 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 comes out from the assessment of emission factor, which was gradually decreasing during 1994 – 2010 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 more than 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 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.

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 on 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%.

Inventory of F gases is complicated due to high number of substances HFCs, PFCs a SF_6. They are components of different mixtures used in more than 15 different applications. Each application has its own development of consumption and trend of emission development. According to GPG it is no sense to deal with uncertainties, which do not have fundamental influence to the total emissions. This should be taken into account in all numerous applications of different F-gases. That is why in the coincidence with GPG the first step is the quantifying of uncertainties and it is done by expert judgment due to this 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 SR. It means that we have lot of different data sources on the base of yearly internet reporting.

Two systems of data reporting are recognized:

- Up to the year 2008
- Since the year 2009

Up to the year 2008 due to the links, relations in the questionnaire to other potential importers, producers, and that the most of the companies are presented in Catalogue of RAC companies and are the members or are trained by SZ CHKT which is authorized by the Ministry for training and certification of personnel, or they are on the internet, participate on the exhibitions and so on, we can assume, that more than 90% of potential companies were addressed. 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 were confronted during the next two years. It should be enough for checking and correcting the wrong data. The data processed in this way we could consider as representative.

Since the year 2009 refrigerant movement reporting is required according to legal status in the EU and the SR. 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 and thus a proper table shall fill in 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. This system started to work in the year 2010 and needs time for running in. Additional data are received from the Ministry of Environment, where the importers should report F-gases in imported products. This system is not sufficient and needs a new solution for:

- comfort of data sending with self-control of their reliability,
- history of sent data,
- possibility of mass communication,
- automatic data processing.

During an inventory in both systems we can assume a nonsymmetrical error distribution in reported data in the range from -5% to +15%, which will be narrower in the system since the year 2009. It means that we suppose data sooner underestimated as overestimated. Similarly, uncertainness come out from the assessing of emission factor, which is gradually decreasing during the years 1994 – 2010 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 on the place of application for example commercial, agricultural, industrial, transport refrigeration and so on. Given range of emission factors is overcome only in car air conditioning, where emission factor is expected over 20%. From this assessment comes out that emission factor in all applications is in the range from 8 to 25%. The emission factor is starting to be influenced by amortization and equipment's end of life. Refrigerant recovery from eliminated equipment is important, but these are eliminated often, because the refrigerant has leaked. Due to this fact the decreasing of emission factor can be slower. Assessment of uncertainties by expert judgment is considered for the development of potential and actual emissions. Potential emissions depended on preciseness and completeness of reported data is evaluated in the range from - 5 to +15% and actual emissions in the range from 8 to17%. Both distributions are nonsymmetrical. In the case of potential emissions we suppose that reported data are likely to be underestimated and in the case of emission factor we suppose in more applications that trend to be towards the lower emission factor.

Potential emissions have correlation to economic development in the SR. Uncertainties in the relation of potential emissions are dependent on time (years). Trend of development of potential emissions can have fluctuating and mainly increasing tendency, which in the future will be decreasing due to implementation of alternative natural refrigerants. Nowadays, the development is given mainly by the fact that HFCs substances are substituting CFCs and HCFCs substances excluded from usage by Montreal Protocol.

Emission factors depend on time (years) and correlate with the technical and technological development and to the implementation of legal acts, technical standards and so on. Trend of the development of emission factor should have decreasing tendency.

If these assessments should be exactly statistically analyzed, it would be necessary to buy software for statistical analysis by the method of Monte Carlo and analyze probability distribution of inputs it means emission factors and the movement of substances in every application. Such work would be quite extensive and it would require higher financial costs. It is therefore necessary to consider whether such work in comparison with expert judgment, which is acceptable by GPG, will be adequate to the significance and the ratio of emissions in all or only chosen applications. Method Monte Carlo requires sequence of steps during several years. It is a method which only on the basement of gradually acquired experiences improves quality of inventory by gradual decreasing of uncertainties.

4.9.6 Source specific recalculations

During the review of Slovakia's 2011 annual submission, ERT identified underestimations in some of Slovakia's emission estimates. ERT recommended five adjustments in the industrial processes sector for 2008 and 2009. The adjustments, calculated in accordance with the "Technical guidance on methodologies for adjustments under Article 5, paragraph 2, of the Kyoto Protocol" (annex to decision 20/CMP.1), relate to:

The following estimates of emissions from the consumption of halocarbons and sulphur hexafluoride (SF_6) in the industrial processes sector:

- Hydroflurocarbon (HFC) emissions from foam blowing
- Perfluorocarbon (PFC) emissions from fire extinguishers
- SF_6 emissions from fire extinguishers
- HFC emissions from aerosols/metered dose inhalers
- HFC emissions from solvents.

With regard to the estimates of emissions from the consumption of halocarbons and SF_6, Slovakia pointed out that the adjustments proposed by the ERT do not take into account its national circumstances. Expert advice indicated that national circumstances could be taken into account provided that they are adequately explained. At the hearing, after consideration of the expert advice, Slovakia accepted the five adjustments recommended by the ERT with respect to the emissions from the consumption of halocarbons and SF_6, calculated in the FCCC/ARR/2011/SVK.

Reflecting further deep examination of the HFCs and SF_6 emission sources in the country, several recalculations and corrections of proposed adjustments took place:

- 2.F.2 – Foam Blowing: completed in the emission inventory submission 2012
- 2.F.3 – PFCs emissions from Fire Extinguishers: status "NO" is used

PFCs as extinguishing media are not used in Slovakia. Usage does not depend on GDP. Slovakia is conservative and switched directly from ODS to HFCs as extinguishing media. PFCs were never used as extinguishing media.

- 2.F.3 – SF_6 emissions from Fire Extinguishers: status "NO" is used

SF_6 is used especially as isolating gas in high voltage switchgears, in high voltage switchers with supposed release 1% of filling per year. Filling is dimensioned for 30 years without refilling. SF_6 as isolation gas in HV circuit breakers has been reported by SVK since 1990. Consumption of SF_6 for anti-noise and thermal isolation into exported windows was phased out in the year 2002.

- 2.F.4 – Aerosols: completed in the emission inventory submission 2012
- 2.F.5 – Solvents: status "NO" is used

There is no import of F solvents to SVK because they are very expensive. SP-255, which contains distilled oil and methyl-acetate, is used as a flushing material. SVK uses solvents L113 and S316 which are not included in the inventory. HFCs as solvents are not used in cleaning machines for flushing refrigeration circuits, which were originally projected for use of F gas solvents Genesolv SF – HFC245fa.

After thorough evaluation of the adjustments recommended by the ERT in the SVK ARR 2011, Slovakia decided upon the conclusion of the national experts not to follow in proposed estimates given in adjustments for categories 2.F.3 (PFCs and SF_6 emissions from Fire Extinguishers) and 2.F.5 (Solvents) and keep the status "Not Occurring" (NO) in the recalculated inventory submission 2012.

On the other hand, estimations in categories 2.F.2 (Foam Blowing) and 2.F.4 (Aerosols) were completed and recalculated in line with the proposed adjustments by ERT and with the help of more sophisticated methodology and collection of national data. The results and description of methodology is given in the chapters 4.8.5 and 4.8.7 of this report and estimation since 1999 is in the Table 4.45.

Table 4.45: The recalculations changes and comparison of the submissions 2011 and 2012

	Submission 2011			Submission 2012			2011/2012 Changes		
Year	Actual HFCs (Gg CO_2 eq.)	Potential HFCs (Gg CO_2 eq.)	Ratio A/P	Actual HFCs (Gg CO_2 eq.)	Potential HFCs (Gg CO_2 eq.)	Ratio A/P	Actual HFCs in %	Potential HFCs in %	Ratio A/P in %
1999	65,12	151,04	2,32	65,39	151,04	2,31	100,41	100,00	99,59
2000	75,59	221,27	2,93	80,97	221,27	2,73	107,12	100,00	93,35
2001	82,43	236,79	2,87	88,54	236,79	2,67	107,41	100,00	93,10
2002	102,35	316,56	3,09	109,01	325,61	2,99	106,51	102,86	96,57
2003	131,96	319,73	2,42	139,11	328,77	2,36	105,42	102,83	97,54
2004	152,88	355,30	2,32	160,50	363,53	2,26	104,98	102,31	97,46
2005	172,34	360,67	2,09	180,38	368,90	2,05	104,67	102,28	97,72
2006	198,90	470,00	2,36	207,31	476,85	2,30	104,23	101,46	97,34
2007	226,99	537,57	2,37	235,52	543,05	2,31	103,76	101,02	97,36
2008	264,43	580,74	2,20	273,04	584,86	2,14	103,26	100,71	97,53
2009	299,61	685,32	2,29	308,72	688,34	2,23	103,04	100,44	97,48

4.9.7 Source specific planned improvements

The improvements regarding the detailed information fill into the sectoral tables are planned 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 2010.

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 NMVOC (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 2012 submission, the primary attention regarding the solvent use sector inventory was put on CO_2 emission calculation of categories 3A and 3B and N_2O emissions in 3D category. It should be noted that CO_2 emissions represent only potential emissions which originate from NMVOC oxidation. The most important issue was collection of 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.

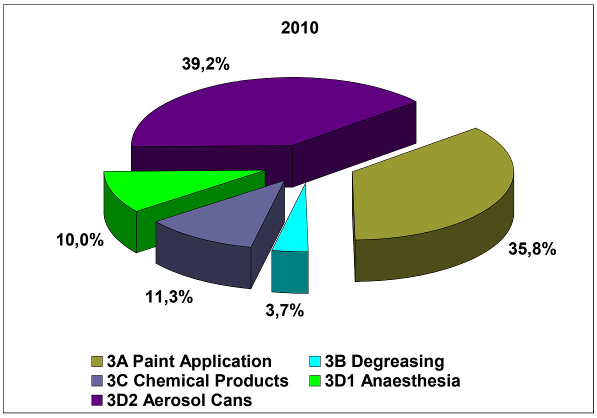
In the frame of the National Program for Emission Reduction of Non-Methane Volatile Organic Compounds, total NMVOC emissions from solvent and other products use were estimated in the cooperation with the Ministry of Environment, the team of experts established in compliance with the Directive 1999/13/EC 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 – 2010

	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
Year	[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
2010	**83,5619**	**0,2606**	**31,8599**	58,8830	6,1446	18,5343	0,0528	0,2078

The major share (39%) 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 calculated based on national methodology used NMVOC emission inventory of different type of solvents and represent the potential CO_2 emissions. Their shares are presented on the Figure 5.1.

Figure 5.1: The share of individual categories in emissions in sector solvent use in 2010



Category	CO_2 Eq. (Gg)	Share (%)
3A Paint Application	58,88	35,83%
3B Degreasing	6,14	3,74%
3C Chemical Products	18,53	11,28%
3D1 Anaesthesia	16,37	9,96%
3D2 Aerosol Cans	64,42	39,20%

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 164 310 ton per year. Confidence interval (95%) is represented by the relative values to the mean: (-19.54%; +20.00%). The normal distribution of all sub-categories has influence to the total uncertainties. The symmetry of aggregate uncertainty is not surprising in this case.

Figure 5.2: Probability density function for sector Solvent use in tons of CO_2

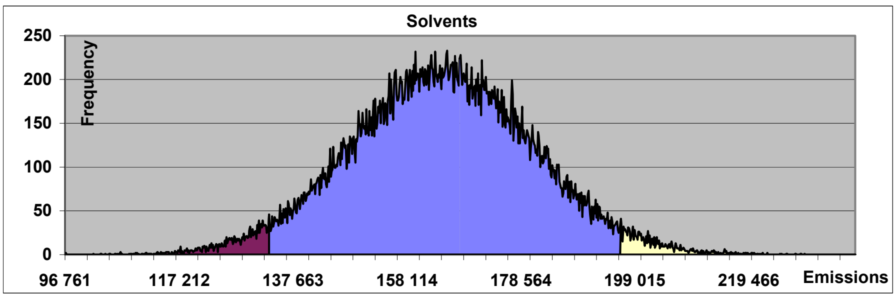


Table 5.2: Selected statistical characteristics for sector Solvent use, median, mean value, standard deviation, minimum, maximum of emissions and percentiles

Median	Average	Standard dev,	2,50%	97,50%
164 193,48	164 310,09	16 494,95	132 208,93	197 174,89
Min	**Max**		**Per_2,5**	**Per_97,5**
96 638,33	234 067,52		-19,54%	20,00%

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

No recalculation was made in 2012 submission.

5.5 Source specific planned improvements

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

5.6 Paint application (CRF 3.A)

The calculation of the CO_2 emissions is based on the NMVOC emissions. In previous submission 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 (potential) CO_2 emissions from paint application have been calculated 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 5.3. In the later period (2006 – 2010) more detailed information are available and the appropriate carbon contents are listed in Table 5.4. The carbon contents were verified by using the Overlap method described in Chapter 7 in IPCC 2000 GPG. The NMVOC and CO_2 emissions are summarized in Table 5.5 and Table 5.6. CO_2 emissions from paint application were 58.88 Gg and NMVOC emissions from paint application were 20.28 ktons. The increasing trend continues also in 2010 due to the increase of used painting and glues.

Table 5.3: The carbon contents in solvent classes for 3A category ("Paint") in 1990 – 2005

Solvent	Solvent naphta	Aromates	Ester	Alcohols	Acetone	Dichlor-methane	Cyklo-hexane	Others
Carbon Content	0,86	0,91	0,59	0,59	0,62	0,14	0,28	0,6

Table 5.4: The carbon contents in solvent classes for 3A category ("Paint") in 2006 – 2010

Solvent	Solvent Naphta	Xylene	Toluene	Styrene	Ethyl-acetate	Buthyl-acetate	Methyl-acetate	Metoxy-propyl-acetate
Carbon Content	0,860	0,905	0,913	0,923	0,545	0,620	0,486	0,545
Solvent	Ethyl-alcohol	Buthyl-alcohol	Iso-propanol	Iso-buthanol	Acetone	Dichlor-methane	Cyklo-hexane	Others
Carbon Content	0,521	0,648	0,600	0,648	0,620	0,141	0,273	0,600

Table 5.5: 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 5.6: The NMVOC and CO_2 emissions in solvent classes for 3A category in 2005 – 2010

	Year	2006	2007	2008	2009	2010
	Activity data [t]	35 562	36 405	36 690	36 805	36 830
NMVOC emissions [t]	**Total**	**19 522**	**20 003**	**20 205**	**20 367**	**20 279**
	Solvent Naphta	7 223	7 232	7 183	7 386	7 383
	Xylene	2 310	2 774	2 889	2 817	2 840
	Toluene	2 789	2 725	2 987	3 035	3 028
	Styrene	872	849	825	816	810
	Ethylacetate	1 110	1 131	1 122	1 144	1 131
	Buthylacetate	2 135	2 155	2 185	2 110	2 100
	Methylacetate	262	243	230	236	237
	Metoxypropylacetate	192	201	168	121	104
	Ethylalcohol	696	917	919	929	928
	Buthylalcohol	310	232	250	307	262
	Isopropanol	193	185	148	154	148
	Isobuthanol	426	410	388	394	407
	Acetone	702	741	760	763	769
	Dichlormethane	39	39	31	34	22
	Cyklohexane	164	42	45	46	45
	Others	99	127	75	75	65
	CO_2 emissions [t]	**56 153,1**	**57 709,8**	**58 534,4**	**59 047,4**	**58 883,0**

5.6.1 Uncertainties and time-series consistency

The time series is divided into two periods with different aggregation of the data. The same aggregation of data is not available for the whole time period since 1990. The time series consistency was verified by using the Overlap recalculation method described in Chapter 7 of 2000 GPG.

The accumulated uncertainty and statistical characteristics for subsector solvent are presented. Confidence interval (95%) is represented by the relative values to the mean: (-50.56%; +52.10%).

Median	Average	Standard dev,	2,50%	97,50%
58 681,81	58 815,90	15 347,07	29 081,03	89 461,55
Min	**Max**		**Per_2,5**	**Per_97,5**
1 464,70	128 135,85		-50,56%	52,10%

5.7 Degreasing and Dry Cleaning (CRF 3.B)

The indirect (potential) 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 5.7. NMVOC and CO_2 emissions are listed in Table 5.8. NMVOC emissions from degreasing and dry cleaning use in industry and services were 3.00 ktons and CO_2 emissions were estimated to be 6.14 Gg in 2010. The decreasing trend in emissions is visible since 2006.

Table 5.7: Carbon contents in solvent classes for 3B category – Degreasing since 1990

Solvent	Trichlorethylene	Tetrachlorethylen	Acetone	Isopropanol
Carbon Content	0,183	0,145	0,620	0,600

Table 5.8: 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**
2010	168,00	200,70	1721,30	914,60	**3 004,51**	**6 144,60**

5.7.1 Uncertainties and time-series consistency

The same approach is used for the whole time series.

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%
6 136,44	6 137,78	1 568,90	3 052,78	9 217,19
Min	**Max**		**Per_2,5**	**Per_97,5**
156,40	13 027,45		-50,26%	50,17%

5.8 Chemical Products, Manufactured and Processing (CRF 3.C)

The indirect (potential) 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 8.42 kt and CO_2 emissions were estimated to 18.53 Gg in 2010. 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 same approach is used for the whole time series.

The accumulated uncertainty and statistical characteristics for subsector solvent are presented. Confidence interval (95%) is represented by the relative values to the mean: (-50.56%; +52.10%).

Median	Average	Standard dev,	2,50%	97,50%
18 471,08	18 513,29	4 830,75	9 153,74	28 159,52
Min	**Max**		**Per_2,5**	**Per_97,5**
461,04	40 332,91		-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 0.208 Gg and total N_2O emissions from anesthesia were 0.0528 Gg in 2010.

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 N_2O emissions was based on the questionnaires from importers, producers and sellers. The estimation of NMVOC emissions was processed based on IPCC methodology (IPCC, 1996) using 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 152 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 four major distributors of N_2O liquid gas – Messer-Tatragas, Linde, Air Products and SIAD companies.

5.9.4 Uncertainties and time-series consistency

The same approach is used for the whole time series.

The accumulated uncertainty and statistical characteristics for subsector solvent are presented. Confidence interval (95%) is represented by the relative values to the mean: (-8.20%; +8.26%).

Median	Average	Standard dev,	2,50%	97,50%
80 797,20	80 792,81	3 404,54	74 169,21	87 462,90
Min	**Max**		**Per_2,5**	**Per_97,5**
66 290,07	94 531,43		-8,20%	8,26%

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 law 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 62% of total nitrous oxide emissions in the Slovak Republic.

By the end of 2010, the primary soil fund (arable land) of the Slovak Republic was 1 359 958 ha from the total agricultural land 1 945 386 ha. The importance of agriculture in economy shows a long-lasting decrease, as regards either the share in GDP or employment. In 2010, the area of seeded soil slightly decreased by 1.3%. The areas of following plants increased: sugar-beet (11.1%), maize (29%), soya been (52%), oilseed rape (3.1%) cultivated flax (48%) and sunflower (5.4%). The area of N-fixing crops has increased after three-years decreasing in total by 32%. This was reaction on the price situation on EU agricultural commodity market. The decreasing of soil seeded with potatoes (5.4%), crops (7%) and other crops (16.4%) was reaction on situation low prices and demand on the market. However, Act No. 77/2009 Coll. changing and amending Act No. 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 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.[17]

[17] http://www.mpsr.sk/index.php?navID=78&id=5214

Table 6.1: GHG emissions in individual categories in the agriculture sector in 1990 – 2010

	Sector 4 Agriculture		Categories (t)			
Year	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	113,46	15,18	95 901,46	17 555,08	3 465,54	11 712,93
1991	104,22	12,29	87 893,20	16 324,44	3 144,52	9 148,70
1992	92,31	9,87	77 493,54	14 816,71	2 704,39	7 170,19
1993	80,49	8,37	66 869,22	13 617,34	2 343,28	6 026,20
1994	76,05	8,16	63 140,71	12 905,62	2 188,72	5 973,58
1995	80,96	8,37	67 708,71	13 253,17	2 306,57	6 063,45
1996	76,06	8,21	63 464,46	12 597,28	2 127,34	6 082,35
1997	68,44	8,22	56 883,36	11 559,48	1 948,65	6 273,85
1998	63,74	7,54	53 529,47	10 210,04	1 717,66	5 826,99
1999	61,29	6,88	51 421,00	9 869,61	1 636,33	5 244,04
2000	60,34	7,06	50 819,56	9 519,76	1 601,25	5 456,97
2001	61,67	6,99	52 039,26	9 634,41	1 548,33	5 445,63
2002	60,12	7,34	50 378,48	9 742,34	1 531,67	5 813,31
2003	57,52	7,06	48 259,54	9 262,14	1 487,71	5 576,90
2004	52,87	6,82	45 023,89	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	41 202,04	5 943,25	1 216,14	5 327,54
2010	46,48	6,74	40 813,39	5 667,45	1 207,88	5 531,59

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 6.7% (without LULUCF) with 3 065.33 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 40.81 Gg (88%) of methane within sector in 2010, 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 5.5 Gg N_2O (82%) within sector in 2010.

The major emission source in the sector agriculture is category 4.D – Agricultural Soils with the share 56%, followed by the category 4.A – Enteric Fermentation with the share 28%. The category 4.B – Manure Management represents 16% from the total sector emissions.

Figure 6.1: Trend in aggregated emissions (Gg) by categories within agriculture sector in 1990 – 2010

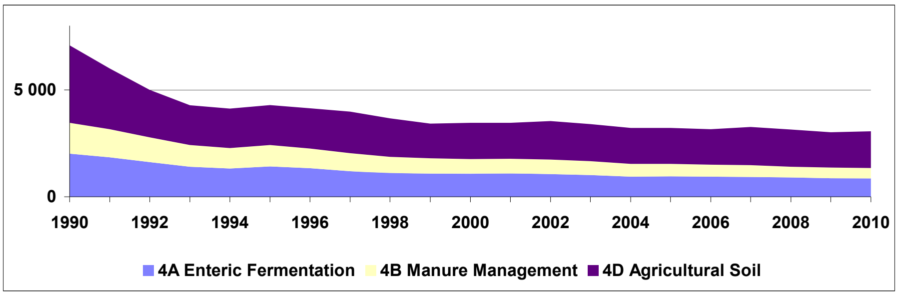
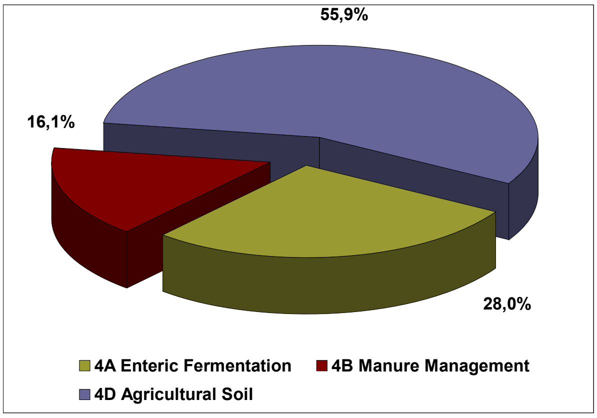


Figure 6.2: The share of aggregated emissions by categories within agriculture sector in 2010



Category	CO_2 Eq. (Gg)	Share (%)
4A Enteric Fermentation	857 081,14	27,96%
4B Manure Management	493 460,67	16,10%
4D Agricultural Soil	1 714 792,83	55,94%

6.2 Enteric fermentation (CRF 4.A)

6.2.1 Source category description

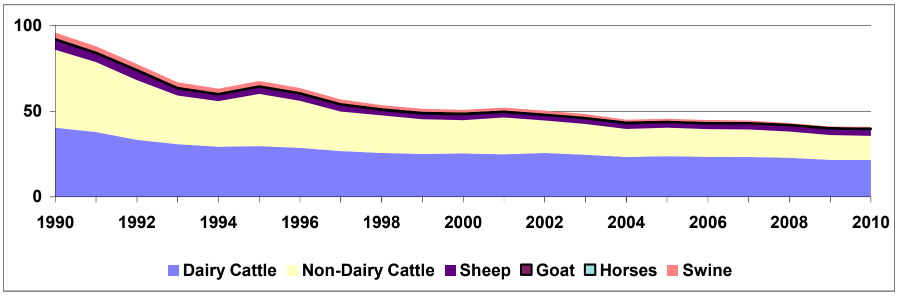
Among all domestic livestock the cattle is the most important producer of methane due to its digestive tract, weight and a relatively high number compared with other population of livestock in the Slovak Republic. Therefore, the trends in total CH_4 emissions reflect a number of animals in this category. 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. 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 2010. Total methane emissions from enteric fermentation decreased from 95.9 Gg in 1990 to 40.81 Gg in 2010, what is the decrease by more than 57% and by 1% 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 – 2010

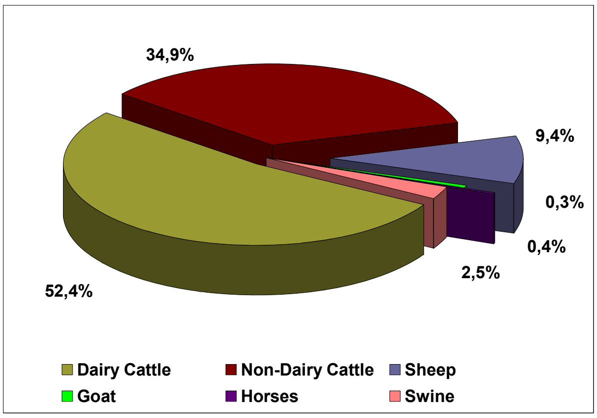
	Category 4A Enteric Fermentation - CH_4 (Gg)					
	Dairy Cattle	Non-Dairy Cattle	Sheep	Goat	Horses	Swine
1990	40,368	45,443	5,932	0,1250	0,2520	3,7815
1991	37,832	40,811	5,250	0,1250	0,2340	3,6420
1992	33,245	34,849	5,655	0,1250	0,2160	3,4035
1993	30,678	28,537	4,063	0,1250	0,1980	3,2685
1994	29,243	26,594	3,925	0,1250	0,1980	3,0555
1995	29,638	30,420	4,230	0,1250	0,1820	3,1146
1996	28,650	27,390	4,141	0,1305	0,1750	2,9778
1997	26,746	22,991	4,126	0,1339	0,1716	2,7148
1998	25,648	21,842	3,225	0,2545	0,1719	2,3889
1999	25,041	20,248	3,365	0,2554	0,1682	2,3432
2000	25,343	19,375	3,440	0,2571	0,1713	2,2327
2001	24,883	21,409	3,127	0,2019	0,1419	2,2759
2002	25,613	18,963	3,124	0,2010	0,1462	2,3308
2003	24,529	18,005	3,218	0,1961	0,1461	2,1645
2004	23,216	16,368	3,374	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	0,1784	0,1296	1,1113
2010	21,406	14,224	3,848	0,1765	0,1280	1,0309

Figure 6.3: Trend in methane emissions (Gg) by categories within enteric fermentation in 1990 – 2010



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 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 2010



Category	CO_2 eq. (Gg)	Share (%)
Dairy Cattle	449,54	52,45%
Non-Dairy Cattle	298,69	34,85%
Sheep	80,81	9,43%
Goat	3,71	0,43%
Horses	2,69	0,31%
Swine	21,65	2,53%

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. 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 (sheep since 2004). The time series 1990 – 1996 was evaluated with the extrapolation methodology for dairy and non-dairy cattle and for sheep (1990 – 2004). The complete time series is consistent with the recommendations of the IPCC 2000 GPG. Tier 1 methodology is used for goats, 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 basis 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 the year 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 – 2010. Average weight was 550 kg for cattle (dairy and non-dairy) and 54.2 kg for sheep in 2010. 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 2010 (Table 6.4).

Table 6.3: Activity data and methane emissions for dairy cattle in 1990 – 2010

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
2010	204,386	15,671	304,374	104,735	21,4064

Table 6.4: The overview of used country specific parameters for dairy cattle in 2010

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	6 480	19,419	19,04	334,64	131,69	768,02
Trnava	31 238	19,77	19,38	338,05	133,03	3 740,08
Trencin	18 768	17,27	16,93	313,50	123,37	2 083,89
Nitra	25 907	18,67	18,30	327,24	128,78	3 002,68
Zilina	30 901	13,49	13,22	276,31	108,74	3 024,03
Banska Bystrica	32 197	13,01	12,76	271,61	106,89	3 097,25
Presov	38 681	13,15	12,89	272,93	107,40	3 739,07
Kosice	20 214	13,11	12,85	272,57	107,26	1 951,41
Weighted Average (SR)	**204 386**	**15,98**	**15,67**	**304,37**	**104,74**	**21 406,44**

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). Time series back to the base year was completed based on extrapolation method using tier 2 methodology.

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 – 2010

	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	AGEI in MJ/head/day	EF in kg/head/year	CH_4 Emissions in Gg
1990	1 014,000	122,035	44,816	45,443	600,000	21,533	9,886	5,932
1991	896,000	123,049	45,548	40,811	531,000	21,533	9,886	5,250
1992	753,000	124,063	46,280	34,849	572,000	21,533	9,886	5,655
1993	607,000	125,077	47,013	28,537	411,000	21,533	9,886	4,063
1994	557,000	126,092	47,745	26,594	397,000	21,533	9,886	3,925
1995	627,500	127,106	48,478	30,420	427,844	21,533	9,886	4,230
1996	556,600	128,120	49,210	27,390	418,823	21,533	9,886	4,141
1997	493,656	131,395	46,573	22,991	417,337	21,533	9,886	4,126
1998	420,627	130,198	51,927	21,842	326,199	21,533	9,886	3,225
1999	390,990	130,198	51,787	20,248	340,346	21,533	9,886	3,365
2000	374,964	131,387	51,672	19,375	347,983	21,533	9,886	3,440
2001	365,921	133,647	58,507	21,409	316,302	21,533	9,886	3,127
2002	347,944	130,906	54,501	18,963	316,028	21,533	9,886	3,124
2003	347,380	135,861	51,831	18,005	325,521	21,533	9,886	3,218
2004	308,272	134,317	53,095	16,368	321,227	22,876	10,503	3,374
2005	298,282	140,808	55,953	16,690	320,487	21,667	9,948	3,188
2006	289,167	140,808	56,095	16,221	332,571	21,266	9,764	3,247
2007	286,158	141,266	56,416	16,144	347,179	21,162	9,716	3,373
2008	277,252	139,326	55,091	15,274	361,634	21,302	9,780	3,537
2009	267,834	139,143	54,272	14,536	376,978	21,359	9,807	3,697
2010	262,739	139,992	54,136	14,224	394,175	21,263	9,762	3,848

Table 6.6: Activity data and methane emissions for other animal in 1990 – 2010

	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
2010	35,292	0,176	7,111	0,128	687	1,031	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 – 2011, the Ministry of Agriculture of the Slovak Republic.
- Statistical Yearbook 1990 – 2011, 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 2010

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	6 697	13	1 073	5 624	140,08	58,34	402,46
Trnava	47 389	27	4 506	42 894	160,29	64,60	3 114,37
Trencin	24 467	53	2 645	21 805	147,26	60,41	1 497,71
Nitra	40 283	41	4 043	36 199	126,68	53,74	2 084,29
Zilina	35 275	105	5 820	29 314	111,07	48,64	1 639,10
Banska Bystrica	41 539	198	7 488	33 853	120,05	51,58	2 113,76
Presov	42 475	275	6 620	35 580	127,50	54,01	2 219,62
Kosice	24 614	156	3 812	20 595	113,38	49,40	1 152,25
Weighted Average (SR)	**262 739**	***868***	***36 007***	***225 864***	**139,99**	**54,14**	**14 223,56**

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 2010

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	457	0,122	0,120	23,14	13,72	6,27
Trnava	2 666	0,122	0,120	23,14	11,75	31,34
Trencin	32 916	0,122	0,120	23,14	9,73	320,40
Nitra	10 041	0,122	0,120	23,14	8,87	89,03
Zilina	85 137	0,122	0,120	23,14	9,85	839,01
Banska Bystrica	133 604	0,122	0,120	23,14	9,71	1 297,88
Presov	81 961	0,122	0,120	23,14	9,84	806,41
Kosice	47 393	0,122	0,120	23,14	9,66	457,70
Weighted Average (SR)	**394 175**	**0,122**	**0,120**	**23,14**	**9,76**	**3 848,03**

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 SHMU 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 2010 on preparing report evaluating GHG emissions from agriculture sector in 2010.

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

Reflecting the ERT recommendations, the consistency in sheep methane emissions estimation was improved. The time series was recalculated for 1990 – 2004 using tier 2 methodology and extrapolation method with average values. New estimation led to increasing of methane emissions as it is shown in Tables 6.8 and 6.9.

Table 6.9: The recalculation of sheep emissions in 1990 – 2004

	Submission 2012	Submission 2011	Difference
Year	Total CH_4 (Gg)	Total CH_4 (Gg)	2012/2011
1990	5,9319	4,8000	123,58%
1991	5,2497	4,2480	123,58%
1992	5,6550	4,5760	123,58%
1993	4,0633	3,2880	123,58%
1994	3,9249	3,1760	123,58%
1995	4,2299	3,4228	123,58%
1996	4,1407	3,3506	123,58%
1997	4,1260	3,3387	123,58%
1998	3,2249	2,6096	123,58%
1999	3,3648	2,7228	123,58%
2000	3,4403	2,7839	123,58%
2001	3,1271	2,5304	123,58%
2002	3,1244	2,5282	123,58%
2003	3,2182	2,6042	123,58%
2004	3,3737	3,1961	105,56%

6.2.8 Source specific planned improvements

Several important methodological changes 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.

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 2010.

Methane emissions from this source decreased from 17.56 Gg in 1990 to 5.67 Gg in 2010. CH_4 emissions 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 67% 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 6.10: Methane emissions from manure management according to the animals in 1990 – 2010

	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
2010	0,818	0,998	0,075	0,0042	0,0100	2,7490	1,0134

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 – 2010

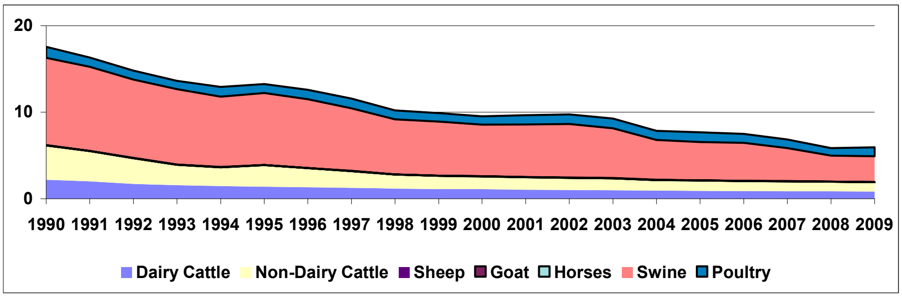
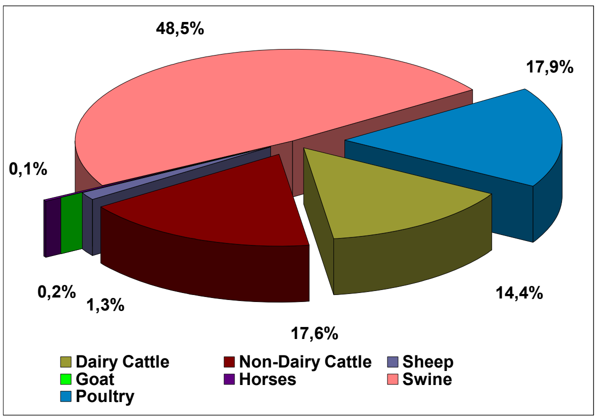


Figure 6.6 shows the share of individual categories in the production of manure methane emissions. The share of swine category is 50% which is in compliance with the methodology.

Figure 6.6: The share of aggregated emissions by categories within manure management in 2010



Category	CH_4 (Gg)	Share (%)
Dairy Cattle	0,8175	14,43%
Non-Dairy Cattle	0,9984	17,62%
Sheep	0,0749	1,32%
Goat	0,0042	0,07%
Horses	0,0100	0,18%
Swine	2,7490	48,51%
Poultry	1,0134	17,88%

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 6.11 shows emission factors for different animal categories.

Table 6.11: EF for methane emissions in manure management in 2010

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 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 2012 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 1.208 Gg of N_2O in 2010 and total decrease was about 65% compared to the base year.

Table 6.12: N_2O and N emissions in manure management according to the animal categories and AWMS in 1990 – 2010

Category 4B Manure Management										
	N_2O (Gg)			N - Excretion (kt)						
Year	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
2010	0,026	1,182	**1,2079**	20,439	15,764	6,307	0,565	0,178	10,898	9,507

Figure 6.7: Trend in nitrogen excretion (kt) by categories within manure management in 1990 – 2010

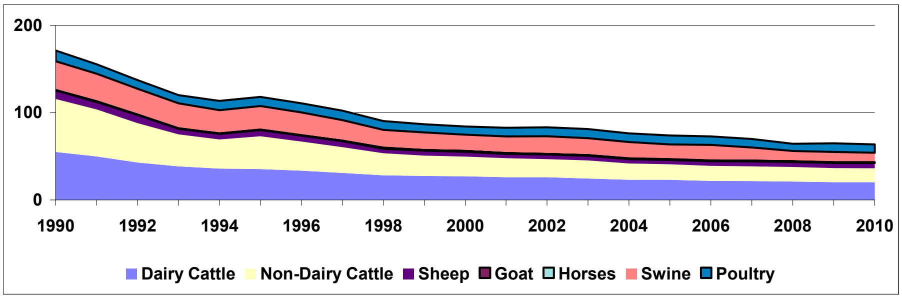
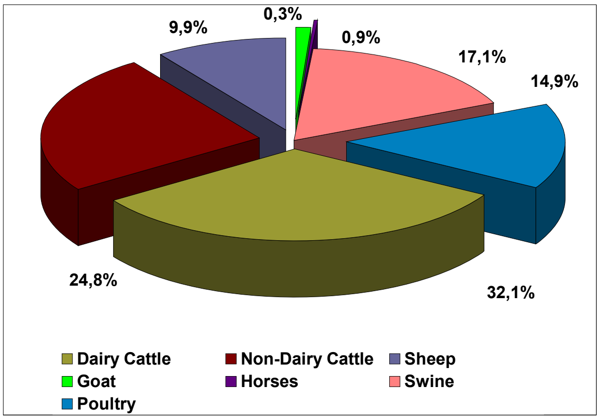


Figure 6.8: The share of aggregated emissions by categories within manure management in 2010



Category	N (kt per year)	Share (%)
Dairy Cattle	20,439	32,11%
Non-Dairy Cattle	15,764	24,76%
Sheep	6,307	9,91%
Goat	0,565	0,89%
Horses	0,178	0,28%
Swine	10,898	17,12%
Poultry	9,507	14,93%

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 by 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 6.13: N production (kg/head/year) for different domestic livestock and share in AWMS in 2010

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 conditions 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

No recalculations in the submission 2012 focused on the base year 1990 or the other inventory years were provided.

6.4.8 Source specific planned improvements

Tier 2 methodology and national N-excretion values are planned to be improved in the next submission.

6.5 Rice Cultivation (CRF 4.C)

No emissions from rise cultivation were estimated in this category because no rice was cultivated in the Slovak Republic in 1990 – 2010.

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 conditions 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 applied 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 5.53 Gg of N_2O. The emissions have been increasing by 3.8% in comparison with 2009 and by 53% 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.

Table 6.14: N_2O emissions from agricultural soils according to the subcategories in 1990 – 2010

Category 4D N_2O (Gg) from Agricultural Soils								
	4D1 Direct Emissions					4D2	4D3 Indirect Emissions	
Year	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
2010	1,536	0,744	0,383	1,324	NO	0,300	0,337	0,908

Figure 6.9: Trend in nitrogen excretion (kt) by categories within agricultural soils in 1990 – 2010

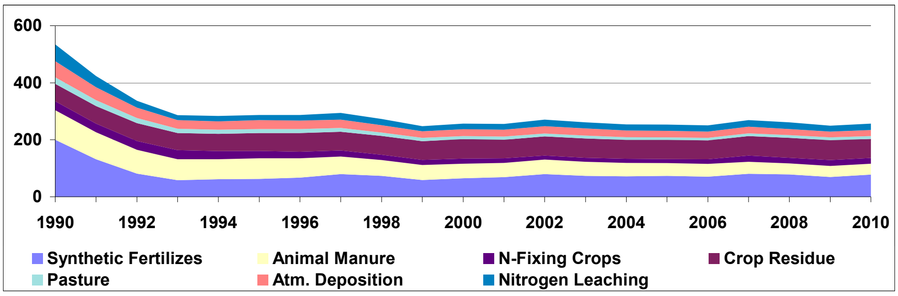
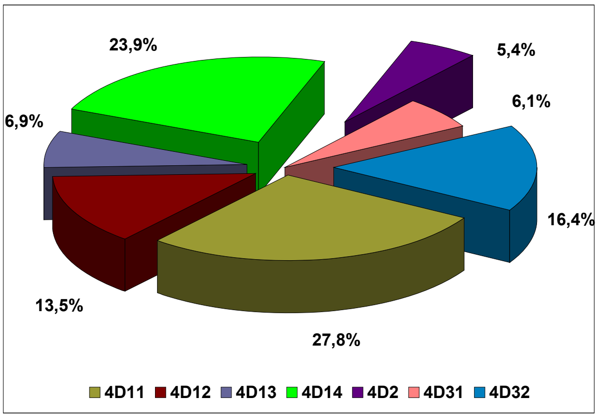


Figure 6.10: The share of aggregated emissions by categories within agricultural soils in 2010



Category	N_2O (Gg)	Share (%)
Synthetic Fertilizes	1,536	27,76%
Animal Manure	0,744	13,45%
N-Fixing Crops	0,383	6,93%
Crop Residue	1,324	23,94%
Pasture	0,300	5,42%
At.Deposition	0,337	6,08%
N Leaching & Run-off	0,908	16,41%

The major share belongs to synthetic fertilizers use (28%) and crop residue (24%). Animal manure use (13%) and nitrogen leaching and run-off (16%) 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 20th century, from 222 kt in 1990 to 78 kt in 2010. The synthetic fertilizers were applied on 60.7% of area of arable soils and only on 62.3% of sowing area of cereals in 2010. 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 in 2006 – 2010 by about 20% 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, 2010).

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, that means that only 90% of total applied synthetic fertilizers remain for the conversion of N to N_2O (78 kt in 2010). 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 1.54 Gg in 2010. 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 – 2010

Category 4D11 Synthetic Fertilisers				
Year	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
2010	86 873 000	78 185 700	0,0125	1,536

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 2012 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 DNDC model are known. The direct measurements of N_2O soil 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)[18] 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).[19]

Total nitrogen excretion per liquid (16 509 t/N/year) and solid system (37 607 t/N/year) in manure management in 2010 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 input from animal waste applied to soils was 37 881.04 t/N/year (liquid and solid systems) and default EF was 0.0125 kg N_2O-N/kgN. Total amount of N_2O emissions from animal excreta applied to soils was 0.74 Gg in 2010.

Table 6.16: Input parameters and EF in category 4D12 Animal manure applied to soils in 1990 – 2010

Category 4D12 Animal Manure Applied to Soils					
Year	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
2010	16 508 501	37 607 276	37 881 044	0,0125	0,744

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.

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[18] 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.

[19] 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.

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

No recalculations in the submission 2012 focused on the base year 1990 or the other inventory years were provided.

6.6.3.7 Source specific planned improvements

Further research and development of national emission factors are included in 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) slightly increased and were 89 716 ha in 2009 due to increasing of area of peas, been, soya and lens. On the other hand, the area of fodder N-fixing crops decreased. The direct inputs of nitrogen from N-fixing crops (lower than in previous year) were 19 508.5 t N in 2010. 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 0.38 Gg including biologic fixation in 2010.

6.6.4.3 Activity data

Total N_2O emissions from N–fixing crops (residuals + biologic fixation) were 0.38 Gg in 2010. 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 6.17: Crops characteristics in category 4D13 N-Fixing crops in 2010

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	6 393,90	6,51	1,66	0,11	690,96
Lens	764,04	7,00	2,42	0,17	129,43
Beans	321,94	7,00	2,96	0,21	66,71
Mix of fodder beans and cereals	5 328,42	10,94	2,96	0,32	1 725,47
Soybeans	14 745,07	3,44	4,19	0,14	2 125,30
Alfalfa	54 794,60	7,00	2,42	0,17	9 282,21
Clover	7 368,15	6,00	1,97	0,12	870,92
Other Fodder Crops*	39 065,24	6,00	1,97	0,12	4 617,51
Total	89 716,12				19 508,50

permanent (not including in total harvested area)

Table 6.18: Input parameters and EF in category 4D13 N-Fixing crops in 1990 – 2010

Category 4D13 N-Fixing Crops				
Year	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
2010	89 716	19 508 495	0,0125	0,383

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

No recalculations in the submission 2012 focused on the base year 1990 or the other inventory years were provided.

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 6.17 and 6.18 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 decreased again in comparison with the previous year and was 1 086 340 ha in 2009 and the direct inputs of nitrogen from crop residuals were 67 416 t in 2010. The crops residuals from previous year (2009) 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 1.324 Gg in 2010.

Table 6.19: Growing areas and total nitrogen amount of crops and leguminous in 2010

Crop		Average nitrient potential of crop residuals (kg N/ha)	Area of Crops (ha)	Nitrogen Fixed Total (kg)
Cereals	Wheat	52,50	349 678,99	18 358 146,98
	Ray	45,00	29 369,77	1 321 639,65
	Barley	44,00	138 929,99	6 112 919,56
	Oat	55,00	17 240,49	948 226,95
	Maize	39,00	178 862,65	6 975 643,35
Potato		59,00	11 517,10	679 508,90
Sugar beet		20,00	17 715,81	354 316,20
Oil plants		107,00	265 280,65	28 385 029,55
Tobacco		45,00	14,57	655,65
Fodder crops		59,00	1 085,31	64 033,29
Maize for silage		55,00	76 644,82	4 215 465,10
Total			1 086 340,15	67 415 585,18

Table 6.20: Input parameters and EF in category 4D14 Crop residue in 1990 – 2010

Category 4D14 Crop Residue				
Year	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
2010	1 086 340	67 415 585	0,0125	1,324

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 Agricultural 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 6.21: 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

No recalculations in the submission 2012 focused on the base year 1990 or the other inventory years were provided.

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 occurred in the Slovak Republic in 2010. 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 9 541 t in 2010. Total emissions of N_2O from pasture of animals were 0.30 Gg of N_2O in 2010. 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 6.22 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 2012 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 6.22: Input parameters and EF in category 4D2 Pasture, range and paddock in 1990 – 2010

Category 4D2 Pasture, Range and Paddock Manure			
Year	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
2010	9 541 240	0,020	0,300

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 0.337 Gg in 2010 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 21 419 t N in 2010. 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 6.23 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 6.23: Input parameters and EF in category 4D31 Atmospheric deposition in 1990 – 2010

Category 4D31 Atmospheric Deposition					
Year	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
2010	8 687 300	12 731 403	21 418 703	0,010	0,337

6.6.8.6 Source specific recalculations

No recalculations in the submission 2012 focused on the base year 1990 or the other inventory years were provided.

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 0.908 Gg in 2010 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 23 108 t N in 2010. 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 6.24 shows time series of parameters and emissions.

Table 6.24: Input parameters and EF in category 4D32 Nitrogen leaching and Run-off in 1990 – 2010

Category 4D32 Nitrogen Leaching and Run-off					
Year	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
2010	12 162 220	8 911 982	21 074 202	0,025	0,908

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

No recalculations in the submission 2012 focused on the base year 1990 or the other inventory years were provided.

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.

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)

The 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 (NOx 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 Marrakesh 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 harvested 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.

The LULUCF sector represents net removals of CO_2 -6 115.98 Gg due to the following categories: Forest Land removals were -5 332.61 Gg CO_2, Cropland removals were -714.79 Gg CO_2, Grassland removals were -325.94 Gg CO_2, Settlements emissions were 119.44 Gg CO_2 and Other Land emissions were 137.92 Gg CO_2. Total amount of methane emissions from LULUCF sector represented 1.09 Gg of CH_4 and total amount of N_2O was 0.015 Gg in 2010. The emissions of other pollutant originated from forest fires and controlled burning of forest. The estimated amount of NO_x emissions was 0.54 Gg and the estimated amount of CO emissions was 9.55 Gg in 2010. Total removals from the LULUCF sector fluctuated between 1990 and 2010.

Table 7.1: Summary of GHG emissions and removals (Gg of CO_2 equivalents) according to the categories in 1990 – 2010

	Emissions of CO_2						CH_4 Emissions	N_2O Emissions
Year	Forest land	Cropland	Grassland	Settlements	Other land	LULUCF	LULUCF	LULUCF
1990	-10 335,39	-180,41	-327,72	121,44	400,52	**-10 321,57**	**14,0910**	**12,0900**
1991	-11 144,02	-157,86	-255,72	129,32	261,17	**-11 167,11**	**8,9670**	**6,0140**
1992	-11 987,56	-153,69	-1 388,25	129,00	236,49	**-13 164,01**	**8,0220**	**26,1640**
1993	-12 071,05	-89,06	-582,85	128,69	230,26	**-12 384,01**	**8,1060**	**31,1240**
1994	-11 221,26	-178,61	-359,00	98,36	219,91	**-11 440,60**	**8,5260**	**3,1930**
1995	-10 388,63	-338,30	-534,41	97,67	176,32	**-10 987,35**	**9,5550**	**3,5030**
1996	-10 405,92	-363,18	-366,58	104,49	177,83	**-10 853,36**	**10,2270**	**9,3930**
1997	-10 571,41	-430,68	-414,72	116,17	188,65	**-11 111,98**	**11,2770**	**3,1930**
1998	-12 663,37	-398,42	-376,57	73,64	182,27	**-13 182,45**	**11,2770**	**1,0230**
1999	-9 707,04	-360,80	-665,24	96,05	217,17	**-10 419,85**	**12,8037**	**3,1930**
2000	-9 230,22	-520,40	-829,09	88,44	159,38	**-10 331,89**	**11,7537**	**37,2930**
2001	-9 046,87	-349,16	-825,02	102,48	177,70	**-9 940,88**	**14,2737**	**3,1930**
2002	-9 188,70	-576,66	-744,20	73,15	136,30	**-10 300,11**	**14,0427**	**1,3330**
2003	-8 750,22	-659,98	-491,19	97,48	128,34	**-9 675,55**	**15,1137**	**6,2930**
2004	-8 027,80	-624,14	-482,48	75,84	87,87	**-8 970,71**	**17,1990**	**4,4020**
2005	-4 678,09	-653,19	-319,33	84,20	256,97	**-5 309,44**	**22,4383**	**5,3401**
2006	-7 060,19	-736,56	-380,55	79,39	159,39	**-7 938,52**	**18,9000**	**3,1725**
2007	-7 073,56	-658,09	-355,72	87,98	192,46	**-7 806,93**	**18,7356**	**8,1710**
2008	-6 355,03	-723,13	-363,41	98,94	220,91	**-7 121,73**	**21,0525**	**1,8438**
2009	-6 607,43	-702,50	-409,52	212,11	251,00	**-7 256,34**	**20,7648**	**7,0370**
2010	-5 332,61	-714,79	-325,94	119,44	137,92	**-6 115,98**	**22,9127**	**4,6531**

Table 7.2: Summary of total emissions and removals according to the categories in 2010

	Net CO_2		CH_4	N_2O	NO_x	CO
	Emissions/Removals		Emissions			
	(Gg)					
5. LULUCF		**-6 115,98**	**1,09**	**0,02**	**0,54**	**9,55**
A. Forest Land		-5 332,61	1,09	0,02	0,54	9,55
B. Cropland		-714,79	0,00	0,00	0,00	0,00
C. Grassland		-325,94	0,00	0,00	0,00	0,00
D. Wetlands		NO	0,00	0,00	0,00	0,00
E. Settlements	119,44		0,00	0,00	0,00	0,00
F. Other Land	137,92		0,00	0,00	0,00	0,00
G. Other		NO	0,00	0,00	0,00	0,00

Figure 7.1: CO_2 removal balance (in Gg) according to the Forest Land category in 1990 – 2010

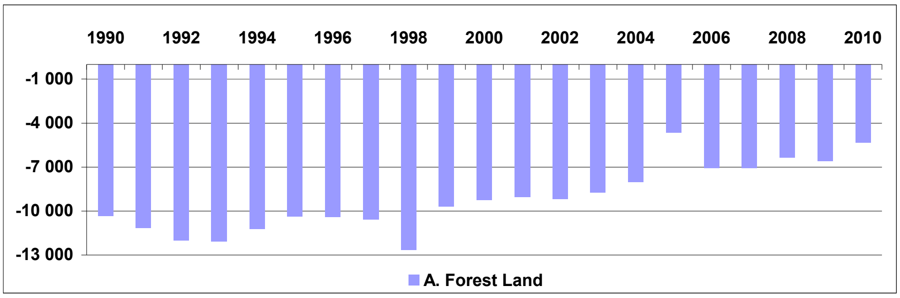
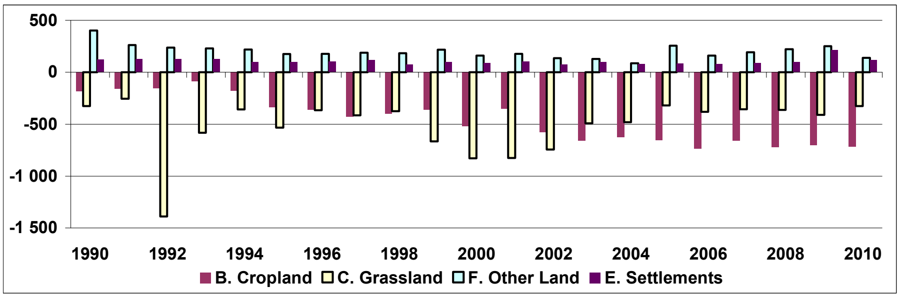


Figure 7.2: CO_2 emission and removal balance (in Gg) according to the LULUCF land use categories except Forest Land in 1990 – 2010



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 LULUCF sector have remained at the level of 8-10% of total GHG emissions. Historically stable trend was disrupted in 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 of total sinks to the half of previous 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 annually issues 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, grasslands) 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 fodder lasting more years, as well as hotbeds and greenhouses if they are built up on arable land. This category includes also fallow land which is arable land left for regeneration for one growing season. During this time there were not sown 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 grasslands 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

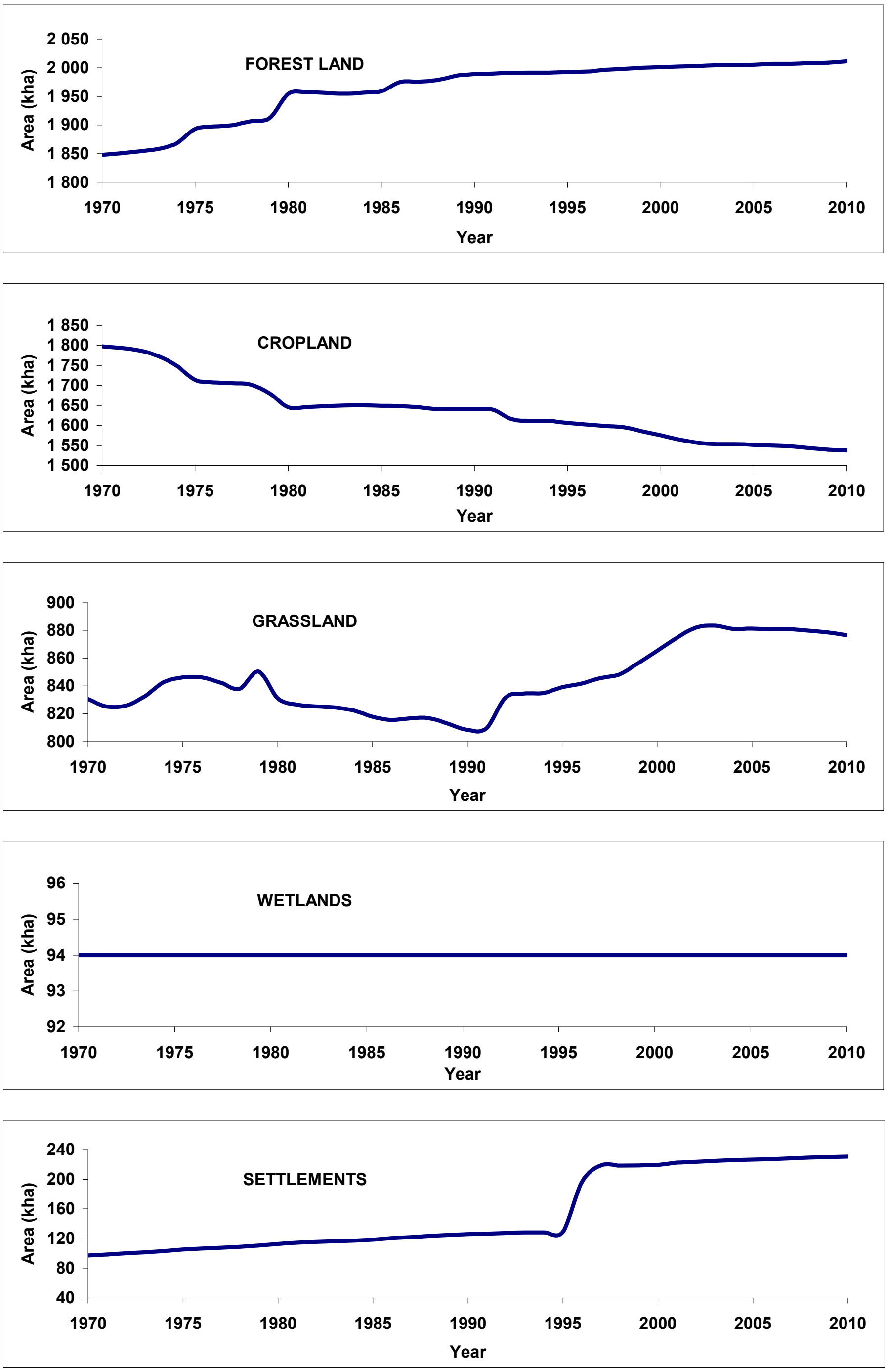
This category represents the last of land use categories in the Slovak Republic. Other land is represented by bare soil, rock and all unmanaged land areas that do not fall into any of the other categories. Each of these categories is divided into lands remaining in the given category during the inventory 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.

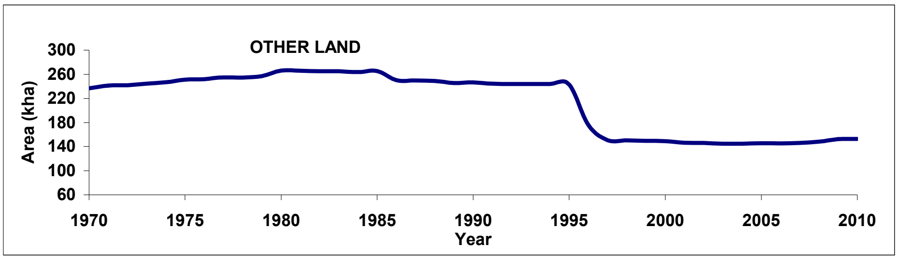
Table 7.3: The areas (kha) of land-use categories remaining into category since 1990

	Area [kha]				
	5A1 FL remaining FL	5B1 CL remaining CL	5C1 GL remaining GL	5E1 S remaining S	5F1 OL remaining OL
1990	1 809,15	1 492,51	685,50	97,22	193,37
1991	1 813,81	1 500,65	688,06	96,71	194,58
1992	1 817,65	1 481,64	692,80	98,39	195,17
1993	1 822,29	1 480,78	702,77	99,63	197,86
1994	1 833,68	1 486,74	718,89	101,37	200,63
1995	1 861,77	1 502,51	741,05	103,38	205,87
1996	1 868,44	1 506,22	746,36	104,93	139,54
1997	1 873,39	1 512,60	750,97	105,77	116,56
1998	1 881,17	1 517,93	754,52	106,80	117,90
1999	1 887,29	1 512,52	769,80	108,30	121,67
2000	1 929,76	1 517,74	767,08	110,44	131,29
2001	1 935,71	1 513,56	765,63	112,12	129,81
2002	1 938,38	1 508,66	765,14	113,18	130,33
2003	1 939,25	1 509,67	765,75	114,59	129,83
2004	1 942,12	1 511,55	762,70	115,40	129,82
2005	1 945,27	1 514,54	762,73	118,02	131,41
2006	1 962,09	1 517,88	763,27	119,96	130,47
2007	1 964,04	1 518,45	765,98	121,45	131,80
2008	1 968,41	1 517,92	767,70	123,01	132,87
2009	1 978,59	1 514,12	768,26	124,44	133,84
2010	1 982,03	1 512,31	766,66	123,58	132,94

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 land-use categories from 1970 – 2010 (based on information from the Geodesy, Cartography and Cadastre Authority of the SR).





The areas of land-use change among the major land use categories from 1990 to 2010 for individual years show 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 to in the CRF Tables. These areas account for the progressing for 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 matrices identified annual land-use conversions among the categories for the period 1990 – 2010 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 1991		**Initial (1990)**						Area
	Category	Forest Land	Grassland	Cropland	Wetland	Settlements	Other Land	(kha)
Final (1991)	Forest Land	**1 988,00**	0,33	0,01	0,00	0,00	1,63	1 989,96
	Grassland	0,68	**806,58**	2,22	0,00	0,00	0,00	809,48
	Cropland	0,05	0,94	**1 637,98**	0,00	0,00	0,17	1 639,14
	Wetland	0,00	0,00	0,00	**94,00**	0,00	0,00	94,00
	Settlements	0,08	0,36	0,13	0,00	**126,03**	0,00	126,59
	Other Land	0,19	0,09	0,00	0,00	0,00	**244,23**	244,51
	Area (kha)	1 988,99	808,29	1 640,34	94,00	126,03	246,24	**4 903,70**

Year 1992		**Initial (1991)**						Area
	Category	Forest Land	Grassland	Cropland	Wetland	Settlements	Other Land	(kha)
Final (1992)	Forest Land	**1 989,64**	0,20	0,20	0,00	0,00	1,07	1 991,11
	Grassland	0,15	**808,49**	22,78	0,00	0,00	0,00	831,41
	Cropland	0,00	0,79	**1 614,94**	0,00	0,00	0,00	1 615,74
	Wetland	0,00	0,00	0,00	**94,00**	0,00	0,00	94,00
	Settlements	0,06	0,00	0,83	0,00	**126,59**	0,00	127,49
	Other Land	0,11	0,00	0,38	0,00	0,00	**243,31**	243,80
	Area (kha)	1 989,96	809,48	1 639,14	94,00	126,59	244,51	**4 903,50**

Year 1993		**Initial (1992)**						Area
	Category	Forest Land	Grassland	Cropland	Wetland	Settlements	Other Land	(kha)
Final (1993)	Forest Land	**1 990,74**	0,14	0,22	0,00	0,00	0,37	1 991,46
	Grassland	0,18	**829,86**	4,60	0,00	0,00	0,00	834,63
	Cropland	0,00	0,98	**1 610,38**	0,00	0,00	0,00	1 611,36
	Wetland	0,00	0,00	0,00	**94,00**	0,00	0,00	94,00
	Settlements	0,07	0,27	0,29	0,00	**127,49**	0,16	128,27
	Other Land	0,12	0,17	0,26	0,00	0,00	**243,52**	244,07
	Area (kha)	1 991,11	831,41	1 615,74	94,00	127,49	243,80	**4 903,80**

Year 1994		Initial (1993)						Area
	Category	Forest Land	Grassland	Cropland	Wetland	Settlements	Other Land	(kha)
Final (1994)	Forest Land	**1 991,11**	0,31	0,02	0,00	0,00	0,23	1 991,67
	Grassland	0,19	**833,77**	0,87	0,00	0,00	0,00	834,83
	Cropland	0,01	0,55	**1 610,34**	0,00	0,00	0,29	1 611,20
	Wetland	0,00	0,00	0,00	**94,00**	0,00	0,00	94,00
	Settlements	0,03	0,00	0,13	0,00	**128,27**	0,04	128,46
	Other Land	0,13	0,00	0,00	0,00	0,00	**243,79**	243,91
	Area (kha)	1 991,46	834,63	1 611,36	94,00	128,27	244,07	**4 903,80**

Year 1995		Initial (1994)						Area
	Category	Forest Land	Grassland	Cropland	Wetland	Settlements	Other Land	(kha)
Final (1995)	Forest Land	**1 991,54**	0,56	0,03	0,00	0,00	0,14	1 992,26
	Grassland	0,06	**833,33**	5,39	0,00	0,00	0,24	839,03
	Cropland	0,00	0,73	**1 605,79**	0,00	0,00	0,10	1 606,62
	Wetland	0,00	0,00	0,00	**94,00**	0,00	0,00	94,00
	Settlements	0,02	0,21	0,00	0,00	**128,46**	0,29	128,99
	Other Land	0,05	0,00	0,00	0,00	0,00	**243,00**	243,04
	Area (kha)	1 991,67	834,83	1 611,20	94,00	128,46	243,91	**4 904,00**

Year 1996		Initial (1995)						Area
	Category	Forest Land	Grassland	Cropland	Wetland	Settlements	Other Land	(kha)
Final (1996)	Forest Land	**1 991,79**	1,11	0,11	0,00	0,00	0,36	1 993,37
	Grassland	0,28	**837,30**	4,02	0,00	0,00	0,12	841,71
	Cropland	0,10	0,61	**1 602,02**	0,00	0,00	0,00	1 602,73
	Wetland	0,00	0,00	0,00	**94,00**	0,00	0,00	94,00
	Settlements	0,03	0,00	0,47	0,00	**128,99**	66,65	196,14
	Other Land	0,06	0,00	0,00	0,00	0,00	**176,00**	176,05
	Area (kha)	1 992,26	839,03	1 606,62	94,00	128,99	243,04	**4 904,00**

Year 1997		Initial (1996)						Area
	Category	Forest Land	Grassland	Cropland	Wetland	Settlements	Other Land	(kha)
Final (1997)	Forest Land	**1 992,98**	0,31	0,13	0,00	0,00	2,95	1 996,37
	Grassland	0,20	**840,19**	4,63	0,00	0,00	0,57	845,59
	Cropland	0,03	1,21	**1 597,80**	0,00	0,00	0,00	1 599,04
	Wetland	0,00	0,00	0,00	**94,00**	0,00	0,00	94,00
	Settlements	0,07	0,00	0,16	0,00	**196,14**	22,21	218,58
	Other Land	0,09	0,00	0,00	0,00	0,00	**150,46**	150,55
	Area (kha)	1 993,37	841,71	1 602,73	94,00	196,14	176,05	**4 904,10**

Year 1998		Initial (1997)						Area
	Category	Forest Land	Grassland	Cropland	Wetland	Settlements	Other Land	(kha)
Final (1998)	Forest Land	**1 996,00**	0,85	0,07	0,00	0,00	1,38	1 998,28
	Grassland	0,29	**843,17**	4,72	0,00	0,00	0,00	848,19
	Cropland	0,00	1,58	**1 593,84**	0,00	0,00	0,00	1 595,41
	Wetland	0,00	0,00	0,00	**94,00**	0,00	0,00	94,00
	Settlements	0,00	0,00	0,00	0,00	**218,08**	0,00	218,08
	Other Land	0,08	0,00	0,42	0,00	0,50	**149,29**	150,29
	Area (kha)	1 996,37	845,59	1 599,04	94,00	218,58	150,55	**4 904,20**

Year 1999		Initial (1998)						Area
	Category	Forest Land	Grassland	Cropland	Wetland	Settlements	Other Land	(kha)
Final (1999)	Forest Land	**1 997,99**	0,83	0,07	0,00	0,00	1,20	2 000,09
	Grassland	0,09	**846,28**	10,06	0,00	0,00	0,00	856,43
	Cropland	0,01	0,87	**1 584,93**	0,00	0,00	0,00	1 585,81
	Wetland	0,00	0,00	0,00	**94,00**	0,00	0,00	94,00
	Settlements	0,03	0,00	0,36	0,00	**218,04**	0,00	218,43
	Other Land	0,17	0,21	0,00	0,00	0,05	**149,20**	149,63
	Area (kha)	1 998,28	848,19	1 595,41	94,00	218,08	150,29	**4 904,30**

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	**144,40**	144,82
	Area (kha)	2 004,10	883,51	1 553,37	94,00	224,67	144,84	**4 904,00**

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	**4 904,00**

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	**4 904,00**

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**

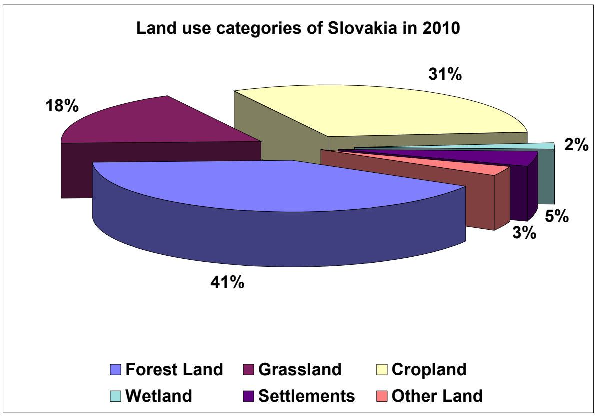
Year 2008		Initial (2007)						Area
	Category	Forest Land	Grassland	Cropland	Wetland	Settlements	Other Land	(kha)
Final (2008)	Forest Land	**2 006,82**	0,85	0,08	0,00	0,00	0,51	2 008,26
	Grassland	0,12	**878,49**	1,25	0,00	0,00	0,00	879,85
	Cropland	0,01	0,77	**1 542,84**	0,00	0,00	0,00	1 543,63
	Wetland	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**

Year 2010		Initial (2009)						Area
	Category	Forest Land	Grassland	Cropland	Wetland	Settlements	Other Land	(kha)
Final (2010)	Forest Land	**2 008,52**	1,22	0,04	0,00	0,00	1,48	2 011,25
	Grassland	0,16	**875,77**	0,56	0,00	0,00	0,00	876,48
	Cropland	0,02	0,78	**1 536,59**	0,00	0,00	0,42	1 537,81
	Wetland	0,00	0,00	0,00	**94,00**	0,00	0,00	94,00
	Settlements	0,07	0,52	1,32	0,00	**228,17**	0,50	230,59
	Other Land	0,08	0,18	0,96	0,00	1,77	**149,76**	152,75
	Area (kha)	2 008,84	878,47	1 539,47	94,00	229,94	152,36	**4 903,00**

The distribution of the IPCC land-use categories in Slovakia in 2010 are shown in Figure 7.4. Forest Land represents the dominant land-use category, accounting for 41% of the total Slovak area in 2010, followed by the Cropland with 31%, Grassland with 18%, Settlements with 5%, Other Land with 3% and Wetlands category with 2% of the total country area.

Figure 7.4: Distribution of IPCC land-use categories in Slovakia in 2010



Category	Area (kha)	Share (%)
Forest Land	2 011,25	41,02%
Grassland	876,48	17,88%
Cropland	1 537,81	31,37%
Wetland	94,00	1,92%
Settlements	230,59	4,70%
Other Land	152,75	3,12%

7.3 Methodological issues – methods

The methodology of GHG inventory is built up on the principles from the Revised IPCC 1996 Guidelines (IPCC 1996), Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories 2000 (IPCC 2000), Good Practice Guidance for Land Use, Land-Use Change and Forestry 2003 (IPCC 2003) and partially IPCC Guidelines for National greenhouse gas inventories – Volume IV Agriculture, Forestry and Other Land Use 2006 (IPCC 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

7.4 Completeness

The completeness of inventory is determined by several factors, especially by importance of the processes and data availability.

Slovak inventory submission in 2012 reports carbon stock changes, as well as greenhouse gas emissions and removals from Forest Land (CRF 5.A), Cropland (CRF 5.B), Grassland (CRF 5.C), Settlements (CRF 5E) and Other Land (CRF 5F). In category 5.A Forest Land carbon stock change in living biomass, dead organic matter and mineral soils is reported. In category 5.B Cropland carbon stock change in living biomass is reported. The carbon stock changes in living biomass, dead organic matter and mineral soils are reported for Cropland, Grassland, Settlements and Other Land related to conversion from Forest Land category. Direct N_2O emissions from N fertilization of Forest Land and Others (CRF 5(I)) as well as non-CO_2 emissions from drainage of soils and wetlands (CRF 5(II)) and N_2O emission from soil disturbance associated with land-use conversion to cropland (CRF 5(III)) are not reported. In addition, CO_2 emission from liming is reported in CRF table 5(IV) and CH_4 and N_2O emissions from biomass burning are reported in CRF table 5(V).

The summary of all categories and subcategories in the Slovak National Inventory for LULUCF is described in the Table 7.5.

Table 7.5: Completeness of LULUCF sector in the Slovak Republic

5	LULUCF		Carbon pools			Note
5A	**Forest Land**					
5A1	Forest Land Remaining Forest Land	*Y*	Living biomass	DOM	Soil C	
5A2	Land Converted to Forest Land	*Y*	Living biomass		Soil C	
5A2.1	Cropland Converted to Forest Land	*Y*	Living biomass		Soil C	
5A2.2	Grassland Converted to Forest Land	*Y*	Living biomass		Soil C	
5A2.3	Wetlands Converted to Forest Land	*NO*				
5A2.4	Settlements Converted to Forest Land	*NO*				
5A2.5	Other Land Converted to Forest Land	*Y*	Living biomass		Soil C	
5B	**Cropland**					
5B1	Cropland remaining Cropland	*Y*	Living biomass			
5B2	Land Converted to Cropland	*Y*			Soil C	
5B2.1	Forest Land Converted to Cropland	*Y*	Living biomass	DOM	Soil C	
5B2.2	Grassland Converted to Cropland	*Y*			Soil C	
5B2.3	Wetlands Converted to Cropland	*NO*				
5B2.4	Settlements Converted to Cropland	*NO*				
5B2.5	Other Land Converted to Cropland	*Y*			Soil C	
5C	**Grassland**					
5C1	Grassland Remaining Grassland	*NE*				2
5C2	Land Converted to Grassland	*Y*			Soil C	
5C2.1	Forestland Converted to Grassland	*Y*	Living biomass	DOM	Soil C	
5C2.2	Cropland Converted to Grassland	*Y*			Soil C	
5C2.3	Wetlands Converted to Grassland	*NO*				
5C2.4	Settlements Converted to Grassland	*NO*				
5C2.5	Other Land Converted to Grassland	*Y*			Soil C	
5D	**Wetlands**					
5D1	Wetlands Remaining Wetlands	*Y*				1
5D1	CO_2 emissions from peat lands remaining peat lands	*NE*				1
5D1	CO_2 emissions from flooded land remaining flooded land	*NE*				1
5D2	Land Converted to Wetlands	*NE*				1
5D2	CO_2 emissions from land being converted for peat extraction	*NE*				1
5D2	CO_2 emissions from land converted to flooded land	*NE*				1
5E	**Settlements**					
5E1	Settlements Remaining Settlements	*Y*				
5E2	Land Converted to Settlements	*Y*			Soil C	
5E2.1	Forest Land Converted to Settlements	*Y*	Living biomass	DOM	Soil C	
5E2.2	Cropland Converted to Settlements	*Y*			Soil C	
5E2.3	Grassland Converted to Settlements	*Y*			Soil C	
5E2.4	Wetlands Converted to Settlements	*Y*				
5E2.5	Other Land Converted to Settlements	*Y*			Soil C	
5F	**Other Land**					
5F1	Other Land Remaining Other Land	*Y*				
5F2	Land Converted to Other Land	*Y*			Soil C	
5F2.1	Forest Land Converted to Other Land	*Y*	Living biomass	DOM	Soil C	
5F2.2	Cropland Converted to Other Land	*Y*			Soil C	
5F2.3	Grassland Converted to Other Land	*Y*			Soil C	
5F2.4	Wetlands Converted to Other Land	*Y*				
5F2.5	Settlements Converted to Other Land	*Y*			Soil C	
5(I)	***N fertilization of Forest land and Other***		*NE*			**1**
5(II)	***Drainage of soil and wetland***		*NE*			**1**
5(III)	***Disturbance associated with land use conversion to cropland***		*NE*			**1**
5(IV)	***Liming of Agricultural soils***		***Y***			
5(V)	***GHG emission from biomass burning***		***Y***			
5(V)	*Emissions from biomass burning in forest lands*		*Y*			
5(V)	*Emissions from biomass burning in croplands*		*NE*			1
5(V)	*Emissions from biomass burning in grasslands*		*NE*			1
5(V)	*Emissions from biomass burning in other lands*		*NE*			1

<u>Explanations:</u> NE – not estimated, NO – not occurred, 1 – no important in Slovakia, 2 – lack of activity data

7.5 Forest land (CRF 5.A)

7.5.1 Source category description

Forests currently cover 42% of the Slovak republic area. All forests can be considered to be temperate-zone managed forests. Slovak forests are known for their richly diverse species composition with European beech being the dominant forest cover (31.8%) followed by Norway spruce (25.3%) and oaks (10.7%). 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 reads 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. The estimated growing stock was 461.95 million m^3 in 2010 (merchantable volume, define as tree stem and branch volume under bark with minimum diameter threshold of 7 cm). Average hectare growing stock was 239 m^3.

The total volume of timber felled in 2010 reached 9 859.7 thousand m^3 which represented increase by 611.6 thousand m^3 (6.2%) compared to 2009. The volume of incidental felling represents 62.5% of the total felling volume. Similarly as in 2009, the volume of the felling has exceeded 20% of planned felling, mainly due to the high volume of incidental felling in the year 2010. Volume of 2010 harvested timber represents the second largest volume ever recorded in Slovakia.

A general description of the Slovak forests and forestry in English can be found in the Green Report on the web: http://www.mpsr.sk/en/index.php?navID=17&id=26.

All actually available information of Slovak forests is based on two sources. The first one is the Forest Management Plans (FMP), which are usually updated on a cyclic 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, the Aggregated Forest Management Plan (AFMP), and the Permanent Forest Inventory (PFI). Aggregated data refer to 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 the 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 the inventory of forest condition. It has two levels – national and regional, and provides data for all forests regardless of land category (forest, non-forest). The 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 by 23% higher than that entered in AFMP. This source of data is not usable for detection of carbon stock changes in Slovak forests, because only one inventory cycle was performed. But it is usable for estimation of carbon pools for example dead organic matter – dead wood.

7.5.2 Methodological issues – methods

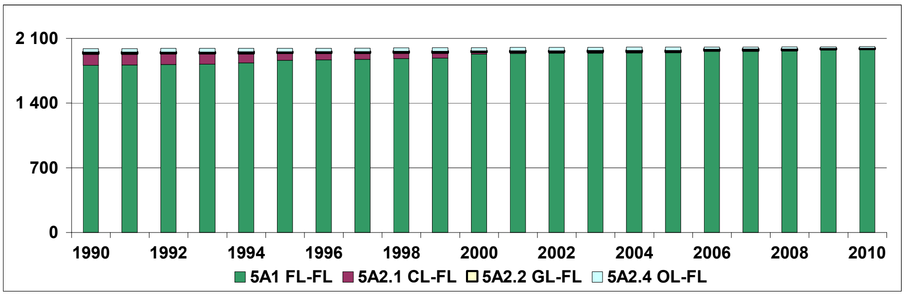
This category (5A) includes emissions and removals of CO_2 (Gg) associated with forests. Category consists from two parts 5.A.1 Forest Land remaining Forest Land and 5.A.2 Land converted to Forest Land.

7.5.2.1 Forest land remaining forest land (CRF 5.A.1)

Calculations are based on the principles defined in GPG for LULUCF (IPCC 2003), GPG for AFOLU (IPCC 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 GPG for LULUCF (IPCC 2003) and national data on area of forested land and land converted to the forest during the inventory year 2010. This category should include the stock carbon changes in following carbon pools: living biomass – above and below ground, dead organic matter – deadwood 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.

The total area of Forest Land remaining Forest Land category represents 1 982.03 kha, the changes in the Forest Land were following: Grassland converted to FL 11.98 kha, Cropland converted to FL 1.40 kha and Other Land converted to FL 15.84 kha in 2010. Total forest area in 2010 was 2011.25 kha.

Figure 7.5: Development of activity data in kha for category 5A Forest Land in the period 1990 – 2010



The carbon stock change in living biomass was estimated using a default method according to Eq. 3.2.2 of the GPG for LULUCF (IPCC 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 carried out as follows the equations 3.2.4-3.2.6 (IPCC 2003).

According to present knowledge, about 55-90% (depending on tree species) of the total tree's biomass can be assumed stored in the stems (Šebík et al. 1989). The density of wood (at dry weight) varies depending on tree species from 350 to 800 kg/m^3 in the Slovak conditions (Požgaj et al. 1993). The biomass conversion/expansion factors, shown in Table 7.7 were deduced using mentioned and another experimental data source by Minďáš et al. (1996) 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 aboveground biomass of forest trees varies from 133.9 million tons (1990) to 170.8 million tons (2007). The average stock of carbon varies from 47.9 (Poplars) to 108.8 (Beech) tons of carbon per hectare.

The equation for estimating the annual carbon loss due to commercial felling is provided in equation 3.2.7 (IPCC LULUCF 2003). It used the annual amount of total harvest removals and fuel wood removals published in the Green Report 2010. The annual harvest volume data are collected and calculated by the National Forest Centre on the basis of about 9 000 forest owner respondents. It represents 90-95% of annual harvest data. Relevant forest companies and forest owners are obligated by the Ministerial Regulation (the latest is no. 297/2011) provide data from forest management (harvest, silviculture) to the Forest's Register every year.

The current age structure of Slovak forests and its foreseen development suggest a gradual increase in the volume of mature felling. The prediction is based on the currently abnormal percentage of premature forests (both in terms of area and growing stock volume) coming to rotation in next few decades. In 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 by using the equation 3.2.8 GPG for LULUCF (IPCC 2003).

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/m³		kt C
Picea abies	Spruce	501,06	4,96	2 486,25	0,60	0,50	**1 243,12**
Abies alba	Fir	79,48	4,24	337,15	0,60	0,50	**168,58**
Pinus sp.	Pine	138,74	4,94	685,94	0,80	0,50	**342,97**
Larix decidua	Larch	47,37	4,49	212,60	0,80	0,50	**106,30**
Other coniferous		21,80	1,46	31,92	0,60	0,50	**15,96**
Quecus robur, petr.	Oak	212,47	5,97	1 267,83	1,30	0,49	**621,24**
Fagus sylvatica	Beech	630,09	6,71	4 227,89	1,20	0,49	**2 071,67**
Carpinus betulus	Hornbeam	114,76	6,40	734,69	1,10	0,49	**360,00**
Acer sp.	Maple	43,01	4,98	214,19	1,10	0,49	**104,95**
Fraxinus excelsior	Ash	30,13	6,40	192,81	1,00	0,49	**94,48**
Ulmus sp.	Elm	0,59	7,77	4,62	1,00	0,49	**2,27**
Quercus cerris	Pubescent oak	49,95	5,72	285,90	1,30	0,49	**140,09**
Robinia pseudoac.	Robinia	34,29	3,20	109,86	1,20	0,49	**53,83**
Betulus sp.	Birch	28,74	2,16	62,08	0,80	0,49	**30,42**
Alnus sp.	Alder	14,87	2,46	36,52	0,90	0,49	**17,90**
Tilia sp.	Linden	7,73	5,55	42,92	0,80	0,49	**21,03**
Breeding poplars		9,51	0,66	6,28	0,60	0,49	**3,08**
Populus sp.	Poplar	7,73	1,66	12,80	0,60	0,49	**6,27**
Salix sp.	Willow	1,98	3,21	6,36	1,00	0,49	**3,12**
Other broadleaves		7,73	2,00	15,48	1,10	0,49	**7,58**
Total		**1 982,03**	**4,25**	**10 974,09**			**5 414,84**

The annual tree biomass increment per hectare (resulting from application of annual wood volume increment data and biomass conversion/expansion factor) varies from 0.64 to 8.20 t dm/ha. The total annual carbon increment in tree biomass was 5 414.84 kt C. The total annual carbon release from forest harvest in the Slovak forests was 4 086.12 kt C in the reporting year.

The assessment of the net carbon stock change in DOM includes the deadwood and the litter pools. The deadwood carbon pool contains from standing dead trees, stumps, coarse laying deadwood and small-sized laying deadwood not included in the litter or soil carbon pools in Slovak conditions. The information about deadwood stocks were obtained from the first National Forest Inventory realized in 2005 – 2006. Until then, no reliable data about deadwood, except for standing dead trees, had been available in Slovakia. Quantification of deadwood was, unlike abroad, performed in such a way that all its components were determined in the same volume units (m^3 outside bark) in order to enable their aggregation. The volume of standing dead trees was determined from the volume equations of living trees (HSK). In order to determine the stump volume, new regression equations were derived, while the diameter at the top of the cut area D and the stump height H represent input variables. The volume of the lying deadwood with the top diameter of 7 cm was calculated from the measured diameters d1 and d2 (cm) outside bark at both ends and the length of each piece inside the IP or a sub-plot using the Smalian equation (Šmelko 2000). The volume of small-sized lying deadwood (having diameter from 1 to 7 cm) was estimated by the original method, where the volume of small-sized lying deadwood (in m^3) densely arranged in 1 m^2 is calculated from the biometrical model as a function of the middle diameter of small-sized lying deadwood multiplied by the area of IP, estimated coverage of small-sized lying deadwood, and tree species proportion (Šmelko et al. 2008).

Table 7.7: Total biomass consumption from stocks for individual forest tree species in the Slovak Republic

Tree Species		Commer. Harvest	Total Biomass Removed in Harvest	Total Traditional Fuelwood Consumed	Total Other Wood Used	Total Biomass Consumption
		1 000 m^3	kt dm	kt dm	kt dm	kt dm
Picea abies	Spruce	2 434,54	1 460,72	60,46	887,30	2 408,48
Abies alba	Fir	685,73	411,44	5,37	200,61	617,42
Pinus sp.	Pine	595,03	476,02	36,12	301,77	813,91
Larix decidua	Larch	82,24	65,79	7,10	66,87	139,77
Other coniferous		0,00	0,00	0,00	0,00	0,00
Quecus robur, petr.	Oak	275,00	357,50	23,24	163,78	544,51
Fagus sylvatica	Beech	1 506,92	1 808,30	122,49	984,96	2 915,75
Carpinus betulus	Hornbeam	66,74	73,42	13,07	157,05	243,54
Acer sp.	Maple	44,49	48,94	2,81	27,93	79,68
Fraxinus excelsior	Ash	25,74	25,74	12,76	16,92	55,43
Ulmus sp.	Elm	18,39	18,39	0,00	0,00	18,39
Quercus cerris	Pubescent oak	71,71	93,22	7,80	53,51	154,53
Robinia pseudoac.	Robinia	57,37	68,84	7,78	66,32	142,94
Betulus sp.	Birch	16,18	12,94	1,40	17,50	31,85
Alnus sp.	Alder	6,62	5,96	0,97	4,15	11,08
Tilia sp.	Linden	0,45	0,36	0,00	0,00	0,36
Breeding poplars		51,85	31,11	0,65	15,20	46,96
Populus sp.	Poplar	11,03	6,62	0,16	4,15	10,93
Salix sp.	Willow	5,52	5,52	0,40	3,45	9,37
Other broadleaves		6,07	6,67	0,35	5,91	12,93
Total		**5 961,60**	**4 977,50**	**302,93**	**2 977,37**	**8 257,80**

Estimation followed the Tier 1 – default GPG of LULUCF (IPCC 2003) assumption of zero change in this carbon pool. This is a safe assumption, if the country did not experience significant changes in forest types, disturbance or management regimes within the reporting year.

The definition of the litter pool used for Slovak reporting/accounting system is following:

Litter includes all non-living biomass with a size less than the minimum diameter chosen for dead wood (e.g., 0 cm). This includes the surface organic layer (horizons L, F, H) as usually defined in soil typologies. Live fine roots above the mineral or organic soil (of less than the minimum diameter limit chosen for below-ground biomass) are included in litter because they cannot be distinguished from it empirically. The small-sized lying deadwood (diameter between 0 and 7 cm), in various states of decomposition above the mineral soil are not a part of litter, because they are included to deadwood in Slovak conditions. This definition is similar to the definition of surface soil organic layer in forests comprises all humus sublayers or subhorizons (L, F, H – if present) included all non-living parts of biomass (foliage, seeds, buds, flowers). All existing national databases on carbon stocks in forest soil organic layer are based on the same approach and soil data were obtained by standard sampling procedure including these humus layers.

The total carbon stock in litter represents 16.66 Mt (mean value per area unit is 8.3 t/ha). These values are derived from similar datasets of the Forest Monitoring System (FMS) and the National Forest Inventory (NFI) as a part of soil inventory.

As changes of forests management that would dramatically change litter properties and litter carbon changes do not occur, we assume no significant changes of carbon stocks in litter in forests remaining forests (Tier 1).

Table 7.8: The results of net annual carbon uptake or release for individual forest tree species

Tree Species		Total Biomass Con. 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	2 408,48	0,50	1 204,24	38,88	**142,57**
Abies alba	Fir	617,42	0,50	308,71	-140,13	**-513,83**
Pinus sp.	Pine	813,91	0,50	406,95	-63,98	**-234,60**
Larix decidua	Larch	139,77	0,50	69,88	36,42	**133,53**
Other coniferous		0,00	0,50	0,00	15,96	**58,52**
Quecus robur, petr.	Oak	544,51	0,49	266,81	354,43	**1 299,56**
Fagus sylvatica	Beech	2 915,75	0,49	1 428,72	642,95	**2 357,49**
Carpinus betulus	Hornbeam	243,54	0,49	119,33	240,66	**882,44**
Acer sp.	Maple	79,68	0,49	39,04	65,91	**241,68**
Fraxinus excelsior	Ash	55,43	0,49	27,16	67,32	**246,84**
Ulmus sp.	Elm	18,39	0,49	9,01	-6,74	**-24,73**
Quercus cerris	Pubescent oak	154,53	0,49	75,72	64,37	**236,03**
Robinia pseudoac.	Robinia	142,94	0,49	70,04	-16,21	**-59,43**
Betulus sp.	Birch	31,85	0,49	15,61	14,81	**54,31**
Alnus sp.	Alder	11,08	0,49	5,43	12,47	**45,72**
Tilia sp.	Linden	0,36	0,49	0,18	20,85	**76,46**
Breeding poplars		46,96	0,49	23,01	-19,93	**-73,08**
Populus sp.	Poplar	10,93	0,49	5,35	0,92	**3,37**
Salix sp.	Willow	9,37	0,49	4,59	-1,48	**-5,41**
Other broadleaves		12,93	0,49	6,34	1,25	**4,57**
Total		**8 257,80**		**4 086,12**	**1 328,73**	**4 872,00**

Information on soil carbon stocks in forest soils in Slovakia is based on databases from soil survey on permanent monitoring plots (16x16 km grid of large-scale forest monitoring), soil survey on the NFI plots and sets of research plots.

The most detailed information source with respect to soil depth (0-10 cm, 10-20 cm, 20-40 cm, 40-80 cm) and sampling design is the set of 112 plots of large-scale 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.

The calculated soil carbon stocks for the depth 0-20 cm range from 13.7 to 486.8 t/ha (for both the FMS and the NFI datasets).

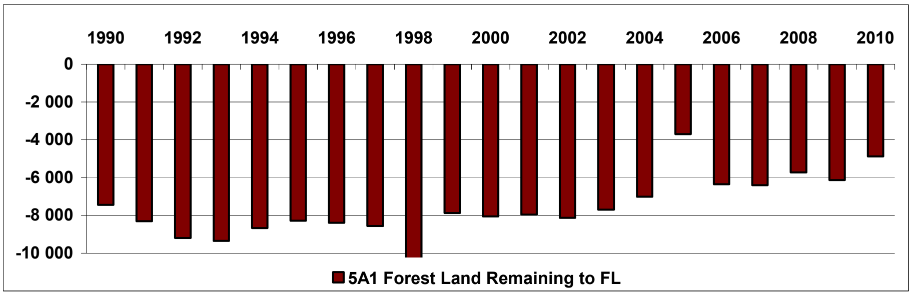
Supplementary information about carbon content and carbon stock in forest soils comes also from other research plots with detailed soil profile description and classification. It is used mainly for derivation of indices for recalculation of carbon stocks for different depths and respective soil types 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 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 based on measured data. Though increase of soil carbon stocks seems to be possible, the preliminary results do not show significant changes.

For estimation of carbon stock change for mineral soils carbon pool the Tier 1 default GPG for LULUCF (IPCC 2003) approach was used and assumed that soil carbon stocks change in category 5.A.1 (FL remaining FL) is considered to equal zero and mean the facts that it did not change.

The net CO_2 removals in the FL remaining FL represents 4 872.00 Gg of CO_2 in 2010. It is necessary to mention that almost every forest in the Slovak Republic is managed, it means that total annual uptake on woody areas for last 100 years and the harvest from deforestation are included in this category. Uptake of carbon into the biomass of forest trees has slightly increased since 1990. Despite release of carbon in this category, its high fluctuation persists between the years. The main reason is fluctuation of timber harvesting. It is a determining factor of final balance differences.

Figure 7.6: Summary results of CO_2 removals (Gg) from 5A1 in 1990 – 2010



7.5.2.2 Land converted to forest land (CRF 5.A.2)

This category includes all process connected with conversion of lands into forest land. This activity is closely connected with artificial or natural regeneration. The Green Report 2010 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 39% in 2010.

This category included the calculation net carbon stock change in living biomass, DOM and in the mineral soil. The Tier 1 method (IPCC 2003) was used for calculation of carbon stocks change in the 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 (IPCC 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. These data were published by Priwitzer et al. (2008), Priwitzer et al. (2009) and Pajtík et al. (article under review process). 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 activity data comes from representative experimental plots. 7 plots per each tree species were established. Then, whole-tree samples including foliages, branches, stem and coarse roots were taken, oven-dried and weighed. We constructed allometic relationships for all tree compartments using tree height and/or diameter on stem base as independent variables. The tree biomass at the sites was measured and calculated by different compartment (stem, branches, roots and foliage) from the measured data using allometric functions. Moreover, soil cores for fine roots (diameter up to 2 mm) estimation were taken. Biomass for all tree compartments was calculated on a hectare base. Biomass allocation into the tree compartments changed with stand size, also, some inter-specific differences were found. Most probably, carbon accumulated in the soil prevailed over carbon fixed in the dendromass.

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 ratio of main tree species from total natural regeneration areas for different years was selected from database of Slovak Statistical Office (www.statistics.sk) and represented 35% for spruce, 15% for pine, 46% for beech and 4% for oak in 2010.

The carbon loss connected with living biomass due to 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 deadwood was assumed to be insignificant (zero), in accordance with the assumptions of Tier 1 method (IPCC LULUCF 2003). Methods to quantify emissions and removals of carbon in deadwood 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 so that corresponding carbon pools prior to conversion can be taken as zero amount.

The net carbon stock change in litter was estimated using the country specific Tier 2 method. It was based on existing data sets from soil inventories and published information (Šály 1998, Kobza et al. 1997, 2002, Pavlenda 2008) with the default assumption of 20 years period for carbon stock equilibrium in „new land-use" conditions. The mean value of 8.3 Mg C ha^{-1} for C stocks in litter (representing surface organic layer) as well as 0.415 Mg C ha^{-1} yr^{-1} as a net annual accumulation of litter over length of transition period were used for calculation of net carbon stock change in litter. For calculation was used following equation:

Annual changes in litter C stocks for Land converted to FL = net annual accumulation of litter over length of transition period (Mg C ha^{-1} yr^{-1}) x converted area (kha).

The change in litter carbon stock in each year was calculated as the sum of annual changes in C stocks for each category of land use associated with land converted to forest.

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 (Šály 1998, Kobza et al. 1997, 2002, Pavlenda 2008) with the default assumption of 20 years period for carbon stock equilibrium in „new land-use" conditions. The mean value of 166.1 Mg C ha^{-1} for organic carbon stocks in forest soils (including surface organic layer) was used in previous GHG inventory reports. On the recommendation of the review team this value was reduced to 157.8 Mg C ha^{-1}. The difference is the amount of carbon accumulated in surface organic layer which is now calculated separately. For respective land use categories following values (calculated as weighted average) were used for calculations of stock carbon changes in mineral soils (0-100 cm, without any surface organic layer) as a result of land use change:

- Forest Land 157.8 Mg C ha^{-1}
- Grassland 129.7 Mg C ha^{-1}
- Cropland 108.6 Mg C ha^{-1}
- Settlements 97.3 Mg C ha^{-1}
- Other Land 97.3 Mg C ha^{-1}

The average annual C stock change in mineral soil for different conversion of land to FL category was calculated as:

Annual changes in mineral soil C stocks for Land converted to FL = average annual change of SOC over length of transition period (Mg C ha^{-1} yr^{-1}) x converted area (kha)

Average annual change of SOC over length of transition period = (mean SOC stock of FL - mean SOC stock of land converted to FL)/20.

The following values were calculated for different type of conversion:

CL converted to FL – 2.44 Mg C ha^{-1} yr^{-1}, GL converted to FL – 1.40 Mg C ha^{-1} yr^{-1}, S converted to FL – 3.02 Mg C ha^{-1} yr^{-1}, OL converted to FL – 3.02 Mg C ha^{-1} yr^{-1}.

The change in soil carbon stock in each year was calculated as the sum of annual changes in C stocks for each category of land use associated with land converted to forest.

As mentioned in the category 5.A.1, the same values as in previous reports were used 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. The only difference in procedures and values used for calculation is the separation of mean carbon stocks in surface organic layer from stocks in mineral soils for forest land.

Table 7.9: The land use matrix since 1989 to 2010

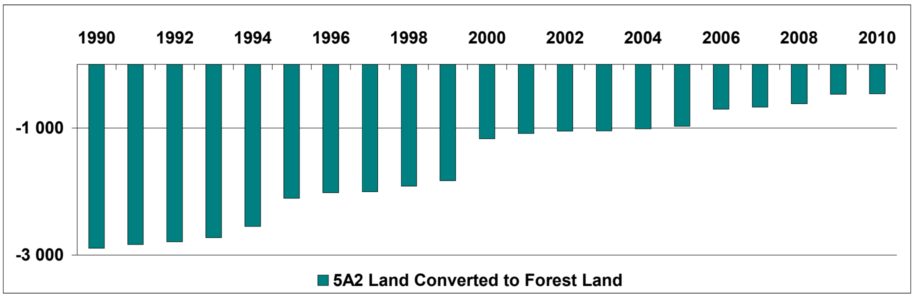
Year 2010		Initial (1990)						Area
	Category	Forest Land	Grassland	Cropland	Wetland	Settlements	Other Land	(kha)
Final (2010)	Forest Land	**1 982,03**	11,98	1,40	0,00	0,00	15,84	2 011,25
	Grassland	3,30	**766,66**	105,60	0,00	0,00	0,93	876,48
	Cropland	0,40	24,12	**1 512,31**	0,00	0,00	0,98	1 537,81
	Wetland	0,00	0,00	0,00	**94,00**	0,00	0,00	94,00
	Settlements	1,01	2,59	8,87	0,00	**123,58**	94,54	230,59
	Other Land	2,25	2,94	12,17	0,00	2,46	**132,94**	152,75
	Area (kha)	1 988,99	808,29	1 640,34	94,00	126,03	246,24	**4 902,88**

Table 7.10: Results from the category 5A2 Land converted to Forest 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 FL	**45,36**	**NA,NO**	**45,36**	**12,13**	**68,14**	**-460,61**
CF	18,60	NO	18,60	4,97	16,82	-148,11
GF	2,17	NO	2,17	0,58	3,42	-22,65
WF	NA	NA	NA	NA	NA	NA
SF	NO	NO	NO	NO	NO	NO
OF	24,59	NO	24,59	6,57	47,89	-289,85

Removals from this category were 460.61 Gg CO_2 in 2010. The net carbon stock change in living biomass, DOM and soil from Land converted to Forest Land represented gains of 45.36, 12.13 and 68.14 Gg C in the reporting year.

Figure 7.7: Summary results of CO_2 removals (Gg) from 5A2 in 1990 – 2010



7.5.3 Methodological issues – emission factors and parameters

Information about emission factors and other parameters are described in the sections 7.5.2.1 and 7.5.2.2.

7.5.4 Activity data

Information about activity data are described in the sections 7.5.2.1 and 7.5.2.2.

7.5.5 Uncertainties and time consistency

Information on uncertainties should include information on completeness and accuracy. Concerning completeness, some emissions and removals could not be estimated, because the input data sets are still missing. With respect to accuracy, the reported estimated values are generally accurate as far as practicable. According to the expert estimation and based on statistical approach for the estimation of wood stocks in the Slovak forest published by Šmelko et al. (2003) the uncertainty represented 15-20%. In Slovakia, the uncertainty of current annual increment (CAI) can fluctuate from ± 30 up to 60% (Šmelko et al. 2003) for individual forest stand. The accuracy of tree biomass annual increment on new afforested areas represented by standard deviation was following: spruce ±1.56 t dm /ha/y, pine

±1.61 t dm/ha/y, beech ±2.04 t dm/ha/y, oak ±1.05 t dm/ha/y. The Šmelko et al. (2008) published following accuracy of dead wood volume for different parts of DW and tree species: standing dead trees – coniferous ±0.03 m^3/ha, broadleaves ±0.02 m^3/ha, stumps – coniferous ±0.01 m^3/ha, broadleaves ±0.01 m^3/ha, coarse laying deadwood – coniferous ±0.07 m^3/ha, broadleaves ±0.04 m^3/ha and small-sized laying deadwood – coniferous ±0.02 m^3/ha, broadleaves ±0.03 m^3/ha.

The time series are consistent with the consistent methodology, activity data collection and using emission factors and other parameters.

7.5.6 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. 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 and references

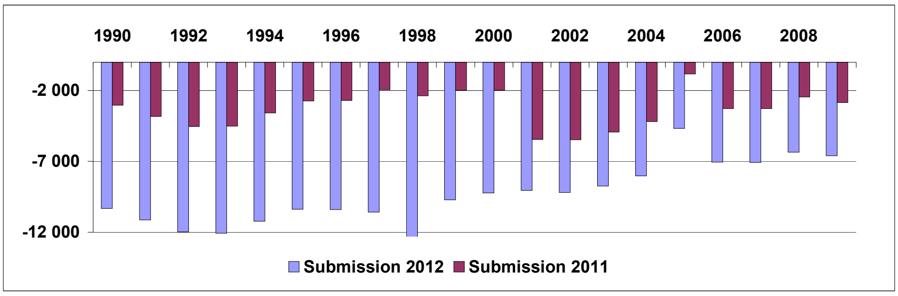
Input Activity Data	Area of forest land remaining forest land by tree species.	The Statistical Yearbook of the Soil Resources in the SR
	Average annual increment rate in total biomass by forest tree	The Permanent Forest Inventory (National Forest Centre)
	Carbon fraction of dry matter.	Pozgaj et al. 1993
	Biomass conversion/expansion factors for conversion of annual net increment (including bark) to aboveground tree biomass increment.	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

7.5.7 Source specific recalculations

The category Forest Land was recalculated for whole time period since 1990. The main reason was recalculation of land areas due to incorrect determination of the length of the transition period. In previous GHG inventory was used the 21 year transition period instead of 20 year period. 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.

Also recalculation of the current annual biomass increments was done for all tree species and all reported years. The current annual increment (CAI) is calculated by the National Forest Centre every year. CAI is determined based on the average stocks in the different age levels for individual tree species as the sum of the average increment in the different age levels, expressed per unit of actual area of occurrence the tree species. In previous GHGs inventories was the CAI calculated by different way for different years. By the year 1992 CAI was counted using old growth tables (CAI was underestimated). In the period 1993 to 2002 were used combined calculations, based on the old and new growth tables. From the year 2003 were CAI calculated according to only new growth tables. Due to the unification of the calculation and the inputs, values of CAI have been recalculated for the whole reporting period (1990 – 2010) with the use of new growth tables. This recalculation has caused an increase of net annual C uptake of Living Biomass in the FL remaining FL category.

Figure 7.8: Comparison of the 2011 and 2012 submissions for category 5A Forest Land



7.5.8 Source specific planned improvements

Following improvements are planned for this category for the next submission:

- estimation more accurate soil carbon stocks data for forest soils
- improve the estimation of DOM carbon pools

Slovakia has applied for the research project: Assessment and modeling of carbon stocks in forest ecosystems for greenhouse gas inventory in landscape of Slovakia. The project application is currently under consideration.

7.6 Cropland (CRF 5.B)

7.6.1 Source category description

The emissions and removals of GHGs in this category were obtained by using the GPG LULUCF methodology (IPCC 2003) and national data on area of cropland and land converted to the cropland during the inventory year 2010. Total removals from the category 5B Cropland were -714.79 Gg of CO_2. The total area of cropland represented 1 537.81 kha in 2010, this is approx. 31% of the total area of the country. This land use category has constantly decreased during whole reporting period, even since 1970. The total area of Cropland remaining Cropland represents 1 512.31 kha, the changes in the Cropland were following: Cropland converted to FL 0.40 kha, Cropland converted to the GL 24.12 kha and Other Land converted to the Cropland 0.98 kha per 2010.

Figure 7.9: CO_2 balance (Gg) for category 5B Cropland in 1990 – 2010

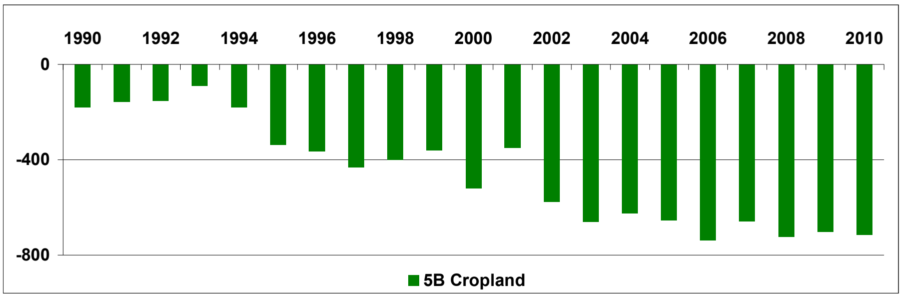
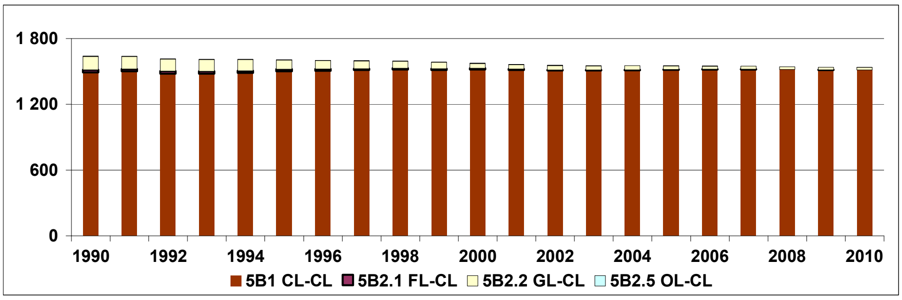


Figure 7.10: Development of activity data in kha for category 5B Cropland in the period 1990 – 2010



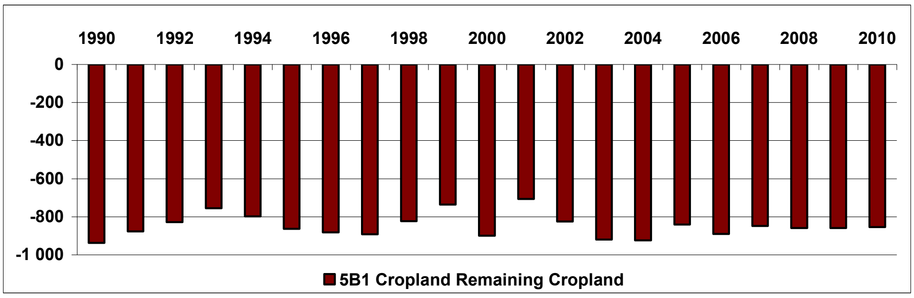
7.6.2 Cropland remaining cropland (CRF 5.B.1)

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 include vineyards, orchards and gardens and represented 120.65 kha in 2010.

For calculation the change in biomass carbon stocks of Cropland remaining Cropland was used Tier 1 method of GPG for LULUCF (IPCC 2003). The annual change of carbon stocks in biomass was calculated using Equation 2.7 from GPG for 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. The 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 for AFOLU (IPCC 2006).

The total area of Cropland remaining Cropland category (5B1) represents 1 512.31 kha, the changes in the Cropland were following: Forest Land converted to CL 0.40 kha, Grassland converted to CL 24.12 kha, and Other Land converted to CL 0.98 kha in 2010.

Figure 7.11: Summary results of CO_2 removals (Gg) from 5B1 in 1990 – 2010



7.6.3 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.

7.6.3.1 Methodological issues – methods, activity data, emission factors and parameters

For calculation of carbon stock changes in biomass was used Tier 1 method GPG for AFOLU (IPCC 2006). Tier 1 method follows the approach 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 to 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. A default value 6.5 t/ha for biomass carbon stock on grassland prior to conversion and for above and below ground biomass were used (Table 6.4, IPCC 2006). Land conversion to cropland was assumed to be 0 t/ha of biomass.

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 (NFI) realised in 2005 – 2006. The NFI provides data, published on the mean deadwood biomass stocks (m^3/ha) separately for coniferous and broadleaves trees in the following categories: standing dead trees, stumps, coarse laying deadwood and small-sized laying deadwood. Each of the 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.

The calculation of stock carbon change in litter was separated from calculations of changes in soil. The information about carbon stocks in surface organic layer of forest soils (based on the data from the soil inventory) was used for calculation of carbon stock change in dead organic matter (for the case of land use change forests to cropland) with the default assumption of 20 years period for carbon stock equilibrium in „new land use“ conditions.

The net carbon stock change in litter was estimated by using the country specific Tier 2 method. It was based on existing data sets from soil inventories and published information (Šály 1998, Kobza et al. 1997, 2002, Pavlenda 2008) with the default assumption of 20 years period for carbon stock equilibrium in „new land-use“ conditions. The mean value of 8.3 Mg C ha^{-1} for C stocks in litter (representing surface organic layer) as well as 0.415 Mg C ha^{-1} yr^{-1} as a net annual accumulation of litter over length of transition period were used for calculation of net carbon stock change in litter. The following equation was used:

Annual changes in litter C stocks for Forest Land converted to CL = net annual accumulation of litter over length of transition period (Mg C ha^{-1} yr^{-1}) x converted area (kha).

The change in litter carbon stock in each year was calculated as the sum of annual changes in C stocks for each category of land use associated with FL converted to CL.

The calculation of carbon stock 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 carbon stock changes in mineral soils as a result of Forest land and Grassland conversion to Cropland carried out followed the GPG LULUCF (IPCC 2003). The net carbon stock change in mineral soils was estimated by 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 stocks per hectare noted above (category 5.A.2. Land Converted to Forest land).

The average annual C stock change in mineral soil for different conversion of land to CL category was calculated as follow:

Annual changes in mineral soil C stocks for Land converted to CL = average annual change of SOC over length of transition period (Mg C ha^{-1} yr^{-1}) x converted area (kha).

Average annual change of SOC over length of transition period = (mean SOC stock of CL – mean SOC stock of land converted to CL)/20.

The following values were calculated for different type of conversion:

FL converted to CL – 2.44 Mg C ha^{-1} yr^{-1}, GL converted to CL – 1.40 Mg C ha^{-1} yr^{-1}, S converted to CL – 0.58 Mg C ha^{-1} yr^{-1} and OL converted to CL – 0.58 Mg C ha^{-1} yr^{-1}.

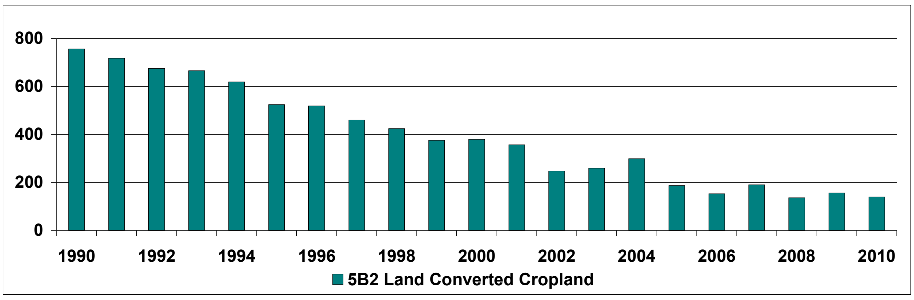
The change in soil carbon stock in each year was calculated as the sum of annual changes in C stocks for each category of land use associated with Land converted to Cropland. The land use matrix is shown in Table7.9.

Table 7.12: Results from the category 5A2 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 CO_2 emission/ removals (Gg CO_2)
	gains	losses	net change			
Land converted to CL	**NO**	**12,09**	**-12,09**	**-0,27**	**-25,52**	**138,90**
FC	NO	3,14	3,14	-0,27	-0,97	16,06
GC	NO	8,95	8,95	NA	-25,12	124,92
WC	NA	NA	NA	NA	NA	NA
SC	NA	NA	NA	NA	NA	NA
OC	NO	NO	NO	NO	NO	-2,08

Emissions from this category were estimated at 138.90 Gg CO_2 in 2010. The net carbon stock change in living biomass, DOM and soil from Land converted to Cropland represented losses of -12.09, -0.27 and -25.52 Gg C in the reporting year.

Figure 7.12: Summary CO_2 emissions (in Gg) from 5B2 in 1990 – 2010



7.6.3.2 Uncertainties and time consistency

The default uncertainty level for biomass accumulation rate and biomass C loss ±75% was used, according Tier 1 method published by GPG for AFOLU (IPCC, 2006) for Cropland. This error range represents a nominal estimate of error, equivalent to two times standard deviation, as a percentage of the mean. No uncertainty analysis has been made for vineyards, orchards and gardens area data source.

According to the expert estimation and based on statistical approach for the estimation of wood stocks in the Slovak forests published by Šmelko et al. (2003) the uncertainty represented 15-20%. The accuracy of dead wood volume for different parts of DW and tree species was published by Šmelko et al. (2008), see chapter Forest Land.

The time series is consistent with the consistent methodology, activity data collection and using emission factors and other parameters.

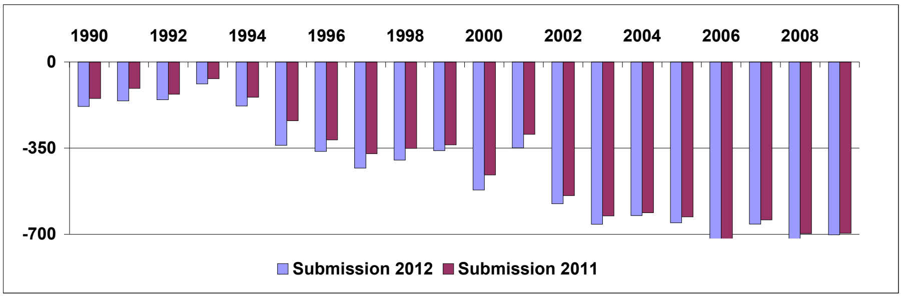
7.6.3.3 Source specific QA/QC and verification

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.

7.6.3.4 Source specific recalculations

The category Cropland was recalculated for whole time period since 1990. The main reason was recalculation of land areas due to incorrect determination of the length of the transition period. In previous GHG inventory was used the 21 year transition period instead of 20 year period. 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.

Figure 7.13: Comparison of the 2011 and 2012 submissions for category 5B Cropland



7.6.3.5 Source specific planned improvements

Following improvements are planned for this category for the next submission:

- Estimation of more accurate soil carbon stocks data for soils representing cropland,
- estimation of cropland areas for using the respective relative stock change factors FLU, FMG and FI and estimation of changes in carbon stocks in soils for cropland remaining cropland if available and applicable.

7.7 Grassland (CRF 5.C)

7.7.1 Source category description

The emissions and removals of GHGs in this category were obtained by using the GPG for LULUCF methodology (IPCC, 2003) and national data on area of grassland and land converted to the grassland during the inventory year 2010. Total removals from the category 5C Grassland were -325.94 Gg of CO_2 in 2010. The total area of grassland represented 876.48 kha in 2010, this is approx. 18% of the total area of the country. Grassland areas decreased from 1980 to beginning of 1990 and since this year started increasing up to 2005. Since 2005 it shows moderately downward trend.

Figure 7.14: CO_2 balance (Gg) for category 5C Grassland in 1990 – 2010

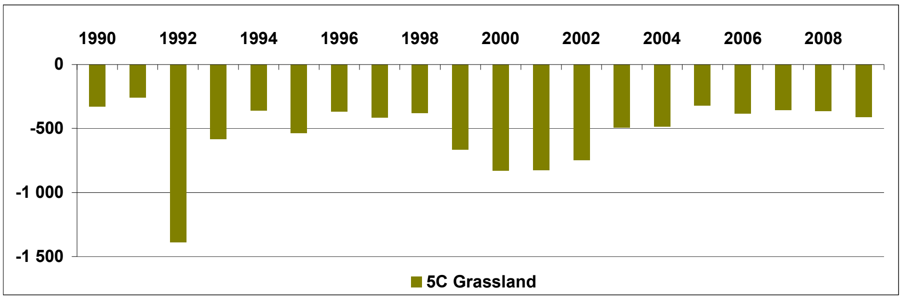
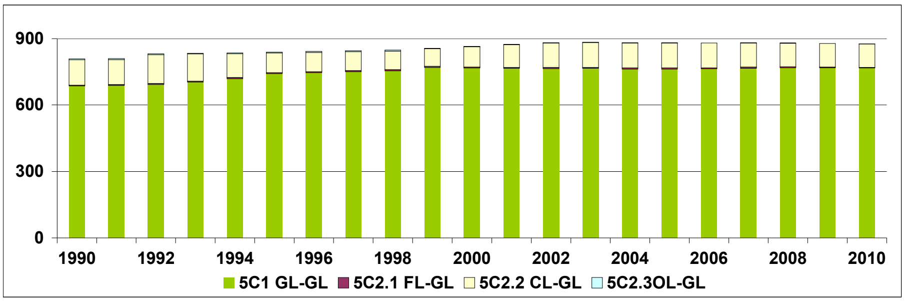


Figure 7.15: Development of activity data in kha for category 5C Grassland in 1990 – 2010



The total area of Grassland remaining Grassland was 766.66 kha in 2010, the changes in the Grassland were following: Forest land converted to Grassland 3.30 kha, Cropland converted to the Grassland 105.60 kha, Other Land converted to Grassland 0.93 kha per 2010.

7.7.2 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). For this category the emissions of CO_2 can be considered insignificant as no change in DOM (deadwood 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. In CRF table 5.C.1 NO is reported.

7.7.3 Land converted to Grassland (CRF 5.C.2)

This category includes all processes connected with conversion of lands into Grassland. For calculation of carbon stock changes in biomass was used Tier 1 method GPG for 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.

7.7.3.1 Methodological issues – methods, activity data, 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 LULUCF 2003).

Estimation of DOM emissions includes the emissions due to changes in deadwood in forest land. The calculation procedure is identical with the estimation described in land converted to cropland category.

The calculation of carbon stock change in litter was separated from calculations of changes in soil. The information about carbon stocks in surface organic layer of forest soils (based on the data from the soil inventory) was used for calculation of carbon stock change in dead organic matter (for the case of land use change forests to grassland) with the default assumption of 20 years period for carbon stock equilibrium in „new land-use“ conditions.

The net carbon stock change in litter was estimated using the country specific Tier 2 method. It was based on existing data sets from soil inventories and published information (Šály 1998, Kobza et al. 1997, 2002, Pavlenda 2008) with the default assumption of 20 years period for carbon stock equilibrium in „new land-use“ conditions. The mean value of 8.3 Mg C ha^{-1} for C stocks in litter (representing surface organic layer) as well as 0.415 Mg C ha^{-1} yr^{-1} as a net annual accumulation of litter over length of transition period were used for calculation of net carbon stock change in litter. Following equation was used:

Annual changes in litter C stocks for Forest Land converted to GL = net annual accumulation of litter over length of transition period (Mg C ha^{-1} yr^{-1}) x converted area (kha).

The change in litter carbon stock in each year was calculated as the sum of annual changes in C stocks for each category of land use associated with FL converted to GL.

The calculation of carbon stock 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 carbon stock changes in mineral soils as a result of Forest land, Cropland conversion to Grassland carried out as follows GPG for LULUCF (IPCC 2003) using Tier 2 method described in detail in section 7.2. Net carbon stock change in mineral soil was used for estimation of the average carbon stock per hectare noted above (category 5.A.2. Land converted to Forest land).

The average annual C stock change in mineral soil for different conversion of land to GL category was calculated as:

Annual changes in mineral soil C stocks for Land converted to GL = average annual change of SOC over length of transition period (Mg C ha^{-1} yr^{-1}) x converted area (kha).

Average annual change of SOC over length of transition period = (mean SOC stock of GL - mean SOC stock of land converted to GL)/20.

The following values were calculated for different types of conversion:

FL converted to GL – 1.40 Mg C ha^{-1} yr^{-1}, CL converted to GL – 1.04 Mg C ha^{-1} yr^{-1}, S converted to GL – 1.62 Mg C ha^{-1} yr^{-1} and OL converted to GL – 1.62 Mg C ha^{-1} yr^{-1}.

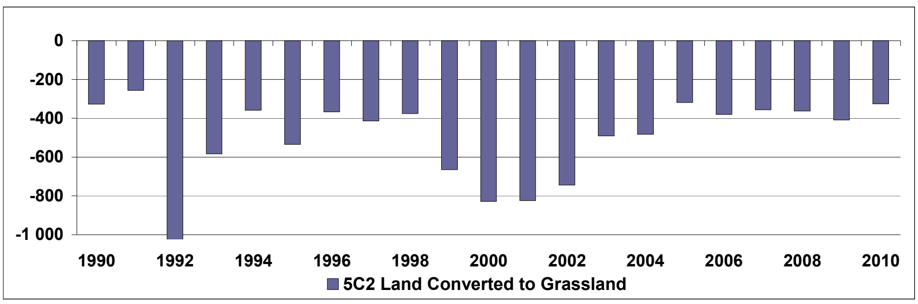
The change in soil carbon stock in each year was calculated as the sum of annual changes in C stocks for each category of land use associated with land converted to Grassland. The land use matrix is shown in Table7.9.

Table 7.13: Results from the category 5C2 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 CO_2 emission/ removals (Gg CO_2)
	gains	losses	net change			
Land converted to GL	**6,46**	**22,28**	**-15,81**	**-2,13**	**106,84**	**-325,94**
FG	NO	22,28	-22,28	-2,13	-4,63	106,49
CG	6,46	NO	6,46	NO	109,97	-426,93
WG	NA	NA	NA	NA	NA	NA
SG	NA	NA	NA	NA	NA	NA
OG	NO	NO	NO	NO	1,50	-5,49

Removals from this category were estimated at 325.94 Gg CO_2 in 2010. The net carbon stock change in living biomass and DOM from Land converted to Grassland represented the losses of 15.81 and 2.13 Gg C, but the net carbon stock change in soil for this category represented gains of 106.84 Gg C in the reporting year.

Figure 7.16: Summary CO_2 removals (in Gg) from 5C2 in 1990 – 2010



7.7.3.2 Uncertainties and time consistency

The default uncertainty level for biomass accumulation rate and biomass C loss ±75% was used, according to Tier 1 method published by GPG for AFOLU (IPCC, 2006) for Grassland. This error represents a nominal estimate of error, equivalent to two times standard deviation, as a percentage of the mean. According to the expert estimation and based on statistical approach for the estimation of wood stocks in the Slovak forest published by Šmelko et al. (2003) the uncertainty represented 15-20%. The accuracy of dead wood volume for different parts of DW and tree species was published by Šmelko et al. (2008), see chapter Forest Land.

The time series is consistent with the consistent methodology, activity data collection and using emission factors and other parameters.

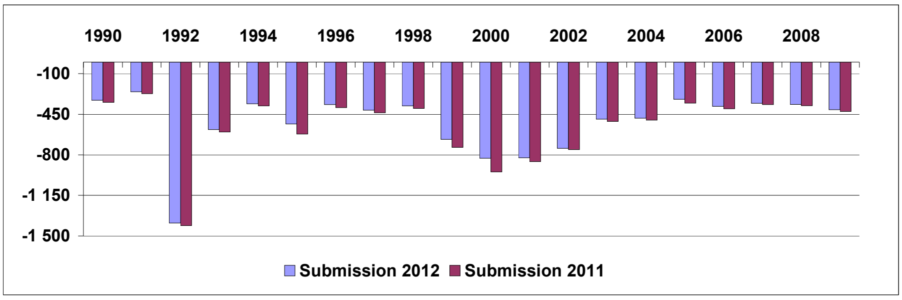
7.7.3.3 Source specific QA/QC and verification

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 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.

7.7.3.4 Source specific recalculations

The category Grassland was recalculated for whole time period since 1990. The main reason was recalculation of land areas due to incorrect determination of the length of the transition period. In previous GHG inventory was used the 21 year transition period instead of 20 year period. It affected the estimation of emissions/removals of GHGs for the categories 5.C.1 Grassland remaining Grassland as well as for 5.C.2 Land converted to Grassland.

Figure 7.17: Comparison of the 2011 and 2012 submissions for category 5C Grassland



7.7.3.5 Source specific planned improvements

Following improvements are planned for this category for the next submission:

- estimation of more accurate soil carbon stocks data for soils representing grassland,
- estimation of grassland areas for using of respective relative stock change factors FLU, FMG and FI and estimation of changes in carbon stocks in soils for grassland remaining grassland if available and applicable.

7.8 Wetlands (CRF 5.D)

Based on the cadastral data for this category the area represents 1.9% (94.00 kha) of the whole Slovak territory. The share of this land use category has been unchanged since 1990.

7.9 Settlements (CRF 5.E)

7.9.1 Source category description

The category Settlements was reported as a separate category, for the first time in the reporting year 2009. This category represented about 5% of the Slovak area in reporting year. Total emissions from the category 5E Settlements were 119.44 Gg CO_2 in 2010. Total settlements area represented 230.59 kha in 2010. The share of settlements area is increasing for whole reporting period, especially in the most recent years. This increase is mostly caused by development of transport infrastructure, industrial areas, municipal development and raising the standards and infrastructure and is connected with the decreasing of cropland and other land-use categories.

Figure 7.18: CO_2 balance (Gg) for category 5E Settlements in 1990 – 2010

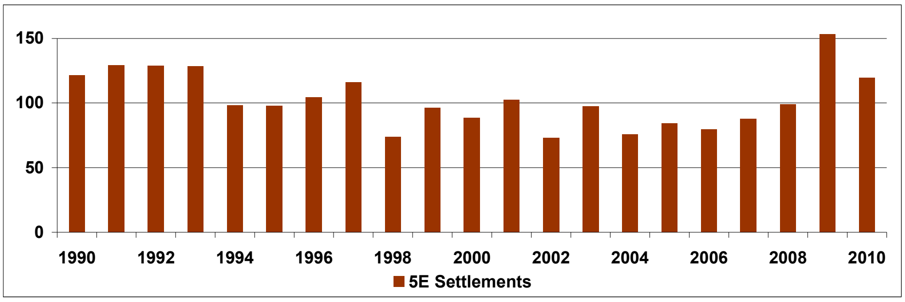
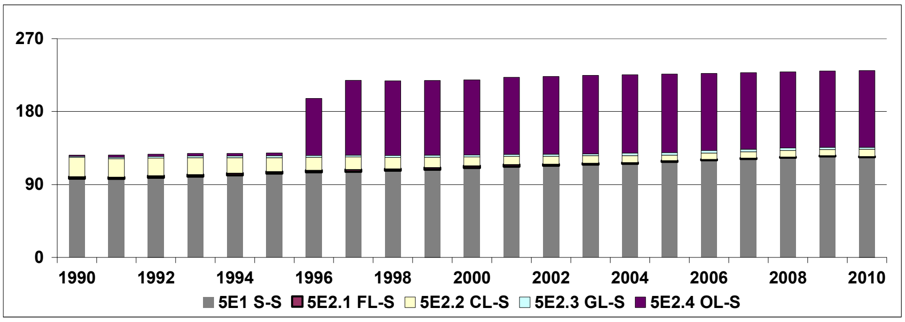


Figure 7.19: Development of activity data in kha for category 5E Settlements in 1990 – 2010



The total area of settlements remaining settlements represents 123.58 kha, the changes in the settlements were following: forest land converted to settlements 1.01 kha, cropland converted to settlements 2.59 kha, grassland converted to settlements 8.87 kha, other land converted to settlements 94.54 kha in 2010.

7.9.2 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 (deadwood 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.

7.9.3 Land converted to settlements (CRF 5.E.2)

This category includes all processes connected with conversion of lands into settlements.

7.9.3.1 Methodological issues – methods, activity data, emission factors and parameters

Tier 1 method GPG for AFOLU (IPCC 2006) was used for carbon stock changes in biomass calculation. Tier 1 method requires estimation 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.

Estimation of DOM includes the emission changes in deadwood in forest land. The calculation procedure is identical as described in detail in section Land Converted to Cropland.

The net carbon stock change in litter was estimated using the country specific Tier 2 method. It was based on existing data sets from soil inventories and published information (Šály 1998, Kobza et al. 1997, 2002, Pavlenda 2008) with the default assumption of 20 years period for carbon stock equilibrium in „new land-use" conditions. The mean value of 8.3 Mg C ha^{-1} for C stocks in litter (representing surface organic layer) as well as 0.415 Mg C ha^{-1} yr^{-1} as a net annual accumulation of litter over length of transition period were used net carbon stock change in litter calculation expressed by following equation:

Annual changes in litter C stocks for Forest Land converted to S = net annual accumulation of litter over length of transition period (Mg C ha^{-1} yr^{-1}) x converted area (kha).

The change in litter carbon stock in each year was calculated as the sum of annual changes in C stocks for each category of land use associated with FL converted to S.

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 for LULUCF (IPCC 2003) using 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).

The average annual C stock change in mineral soil for different conversion of land to S category was calculated as:

Annual changes in mineral soil C stocks for Land converted to S = average annual change of SOC over length of transition period (Mg C ha^{-1} yr^{-1}) x converted area (kha).

Average annual change of SOC over length of transition period = (mean SOC stock of S – mean SOC stock of land converted to S)/20.

The following values were calculated for different type of conversion:

FL converted to S – 3.02 Mg C ha^{-1} yr^{-1}, CL converted to S – 0.58 Mg C ha^{-1} yr^{-1}, GL converted to S – 1.62 Mg C ha^{-1} yr^{-1} and OL converted to S – 0.58 Mg C ha^{-1} yr^{-1}.

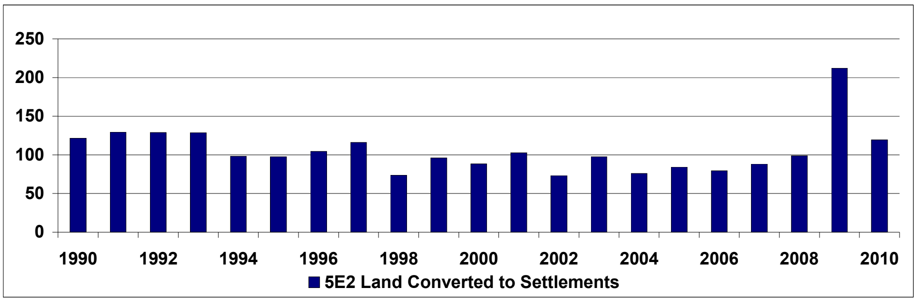
The change in soil carbon stock in each year was calculated as the sum of annual changes in C stocks for each category of land use associated with Land Converted to Settlements. The land use matrix is shown in Table7.9.

Table 7.14: Results from the category 5E2 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**	**19,45**	**-19,45**	**-0,74**	**-12,38**	**119,44**
FS	NA,NO	9,42	-9,42	-0,74	-3,06	48,50
CS	NA	3,41	-3,41	NA	-4,19	27,85
GS	NA	6,62	-6,62	NA	-5,13	43,08
WS	NA	NA	NA	NA	NA	NA
OS	NO	NO	NO	NO	NO	NO

Emissions from this category were estimated at 119.44 Gg CO_2 in 2010. The net carbon stock change in living biomass, DOM and soil from land converted to Settlements represented losses of -19.45, -0.74.and -12.38 Gg C in the reporting year.

Figure 7.20: Summary of CO_2 emissions (Gg) from 5E2 Land Converted to Settlements in 1990 – 2010



7.9.3.2 Uncertainties and time consistency

The default uncertainty level ±75% for biomass accumulation rate was used, according to Tier 1 method published by GPG for AFOLU (IPCC, 2006) for Cropland and Grassland. This error range represents a nominal estimate of error, equivalent to two times standard deviation, as a percentage of the mean. According to the expert estimation and based on statistical approach for the estimation of wood stocks in the Slovak forests published by Šmelko et al. (2003) the uncertainty represented 15-20%. The accuracy of dead wood volume for different parts of DW and tree species was published by Šmelko et al. (2008).

The time series are consistent with the consistent methodology, activity data collection and using emission factors and other parameters.

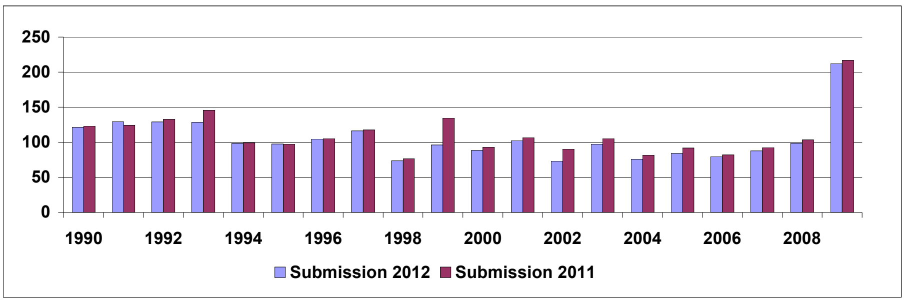
7.9.3.3 Source specific QA/QC and verification

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.

7.9.3.4 Source specific recalculations

The Settlements category was recalculated for whole time period since 1990. The main reason was recalculation of land areas due to incorrect determination of the length of the transition period. In previous GHG inventory was used the 21 year transition period instead of 20 year period. It affected the estimation of emissions/removals of GHGs for the categories 5E1 Settlements Remaining Settlements as well as for 5E2 Land Converted to Settlements.

Figure 7.21: Comparison of the 2011 and 2012 submissions for category 5E Settlements



7.9.3.5 *Source specific planned improvements*

There are no short term plans concerning improvements in this land use category.

7.10 Other land (CRF 5.F)

7.10.1 Source category description

The emissions and removals of GHGs in this category were obtained by using the GPG for LULUCF methodology (IPCC 2003) and national data on other land and land converted to the other land area during the inventory year 2010. Total CO_2 emissions in this land-use category were 137.92 Gg. The total area of other land represented 152.75 kha in 2010, this is approximately 18% of the total area of the country. Other land areas decreased sharply between 1995 and 1997. Since this year well balanced trend is shown.

Figure 7.22: CO_2 balance (Gg) for category 5F Other Land in 1990 – 2010

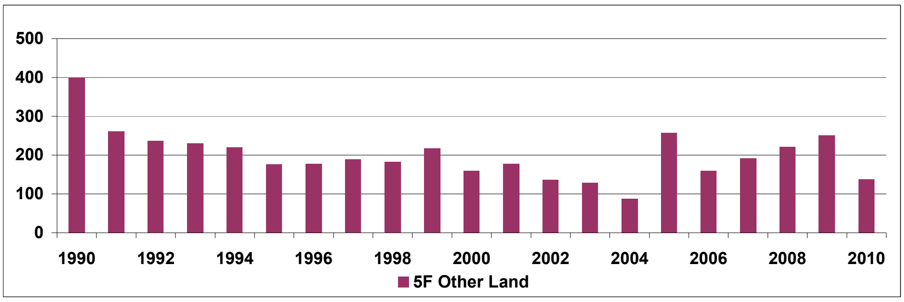
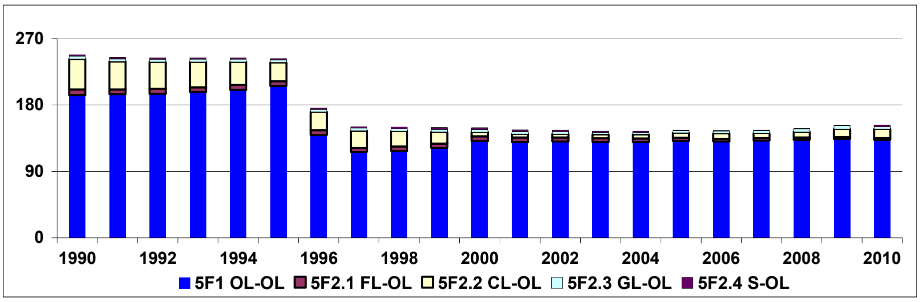


Figure 7.23: Development of activity data in kha for category 5F Other Land in 1990 – 2010



The total area of Other Land Remaining Other Land was 132.94 kha, the changes in Other Land were following: Forest Land converted to OL 2.25 kha, Cropland converted to OL 12.17 kha, Grassland converted to OL 2.94 kha, Settlements converted to OL 2.46 kha per 2010.

7.10.2 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 has not experienced significant changes in land-use types, disturbance or management regimes within the reporting year.

7.10.3 Land converted to other land (CRF 5.F.2)

This category includes all processes connected with conversion of lands into other lands. Tier 1 method GPG AFOLU (IPCC 2006) was used for carbon stock changes in biomass calculation. 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.

7.10.3.1 Methodological issues

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.

Estimation of DOM includes the emissions changes in deadwood in forest land. The calculation procedure is identical as described in detail in section Land converted to Cropland.

The net carbon stock change in litter was estimated using the country specific Tier 2 method. It was based on existing data sets from soil inventories and published information (Šály 1998, Kobza et al. 1997, 2002, Pavlenda 2008) with the default assumption of 20 years period for carbon stock equilibrium in „new land-use“ conditions. The mean value of 8.3 Mg C ha^{-1} for C stocks in litter (representing surface organic layer) as well as 0.415 Mg C ha^{-1} yr^{-1} as a net annual accumulation of litter over length of transition period were used for calculation of net carbon stock change in litter with the following equation:

Annual changes in litter C stocks for Forest Land converted to S = net annual accumulation of litter over length of transition period (Mg C ha^{-1} yr^{-1}) x converted area (kha).

The change in litter carbon stock in each year was calculated as the sum of annual changes in C stocks for each category of land-use associated with FL converted to S.

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 Settlements conversion to Other land carried out as follows the GPG LULUCF (IPCC LULUCF 2003) using 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).

The average annual C stock change in mineral soil for different conversion of land to OL category was calculated as:

Annual changes in mineral soil C stocks for Land converted to OL = average annual change of SOC over length of transition period (Mg C ha^{-1} yr^{-1}) x converted area (kha).

Average annual change of SOC over length of transition period = (mean SOC stock of OL - mean SOC stock of land converted to OL)/20.

The following values were calculated for different type of conversion:

FL converted to OL – 3.02 Mg C ha^{-1} yr^{-1}, CL converted to OL – 0.58 Mg C ha^{-1} yr^{-1}, GL converted to OL – 1.62 Mg C ha^{-1} yr^{-1} and S converted to OL – 0.58 Mg C ha^{-1} yr^{-1}.

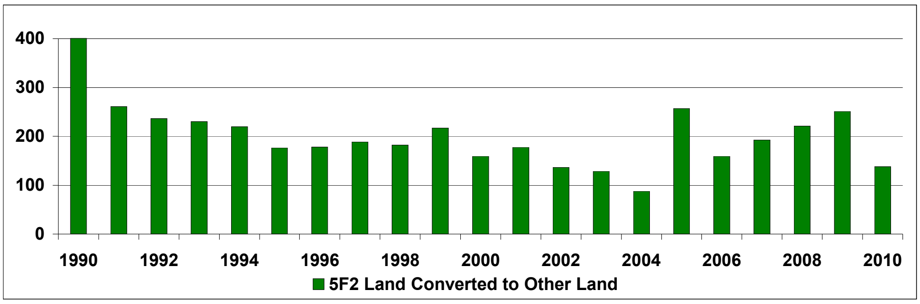
The change in soil carbon stock in each year was calculated as the sum of annual changes in C stocks for each category of land-use associated with Land converted to Other Land. The land use matrix is shown in Table 7.9.

Table 7.15: Results from the category 5F2 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	**NO**	**17,68**	**-17,68**	**-1,33**	**-18,60**	**137,92**
FO	NA,NO	11,71	-11,71	-1,33	-6,80	72,76
CO	NA	1,20	-1,20	NA	-4,76	21,84
GO	NA	4,78	-4,78	NA	-7,04	43,33
SO	NA	NA	NA	NA	NA	NA
WO	NO	NO	NO	NO	NO	NO

Emissions from this category were estimated at 137.92 Gg CO_2 in 2010. The net carbon stock change in living biomass, DOM and soil from land converted to other land represented losses of -17.68, -1.33, -18.60 Gg C in the reporting year.

Figure 7.24: Summary of CO_2 emissions (Gg) from 5F2 Land Converted to Other Land in 1990 – 2010



7.10.3.2 Uncertainties and time consistency

The default uncertainty level ±75% for living biomass was used, according to Tier 1 method published by the GPG for AFOLU (IPCC, 2006) for Cropland and Grassland. This error range represents a nominal estimate of error, equivalent to two times standard deviation, as a percentage of the mean. According to the expert estimation and based on statistical approach for the estimation of wood stocks in the Slovak forests published by Šmelko et al. (2003) the uncertainty represented 15-20%. The accuracy of dead wood volume for different parts of DW and tree species was published by Šmelko et al. (2008) (see chapter Forest Land).

The time series are consistent with the consistent methodology, activity data collection and using emission factors and other parameters.

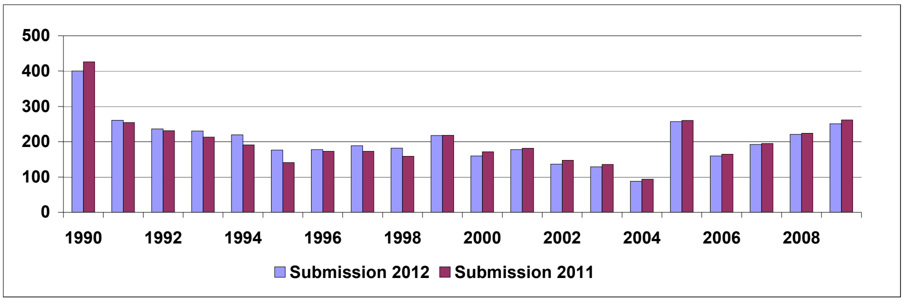
7.10.3.3 Source specific QA/QC and verification

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.

7.10.3.4 Source specific recalculations

The category Other Land was recalculated for whole time period since 1990. The main reason was recalculation of land areas due to incorrect determination of the length of the transition period. In previous GHG inventory the 21 year transition period instead of 20 year period was used. It affected the estimation of emissions/removals of GHGs for the categories 5F1 Other Land Remaining Other Land as well as for 5F2 Land Converted to Other Land.

Figure 7.25: Comparison of the 2011 and 2012 submissions for category 5F Other Land



7.10.3.5 Source specific planned improvements

Re-evaluation of the soil carbon stocks for OL category is planned for the next submission. This category is overestimated in this inventory.

7.11 Direct N_2O emissions from N fertilization of forest land and other (CRF 5(I))

Not estimated. Not important source in the Slovak Republic.

7.12 Non CO_2 emissions from drainage of soils and wetlands (CRF 5(II))

Not estimated. Not important source in the Slovak Republic.

7.13 N_2O emissions from disturbance associated with land use conversion to cropland (CRF 5(III))

Not estimated. Not important source in the Slovak Republic.

7.14 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 emissions from liming = Total amount of limestone (dolomite) x EF.

Table 7.16: The results in emission inventory for fertilizers in LULUCF in 1990 – 2010

Year	$CaCO_3$ (Mg/year)	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
2010	34 988,01	0,12	4,20

Data source of agricultural soils (cropland) liming is the Central Controlling and Testing Institute in Agriculture (ÚKSÚP). For the period 1998 – 2010 the data are based on summarization of recordings that have to be submitted by land owners/users to ÚKSÚP in accordance to the national legislation. For the period 1992 and 1994 – 1997 the data are based on statistics of ÚKSÚP according to the former legislation, for years 1990, 1991 and 1993 only expert estimation was used.

The amount of applied limestone has been registered since 1998. For previous years the 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.

7.14.1 Uncertainties and time consistency

No uncertainty analysis has been made for this source. Uncertainties in the net amount of C added to soils from liming that is emitted as CO_2 are dependent on the Tier. Using the Tier 1 method, it is assumed all C in the lime is emitted as CO_2 to the atmosphere. This is a conservative approach, and the default emission factors are considered certain given this assumption. In practice, however, some of the C in lime is likely to be retained in the soil as inorganic C and not emitted as CO_2, at least in the year of application. Consequently, default emission factors can lead to systematic biases in the emission estimates (IPCC 2006).

The time series are consistent with the consistent methodology, activity data collection and using emission factors and other parameters.

7.14.2 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.

7.14.3 Source specific recalculations

No recalculation was provided in this category.

7.14.4 Source specific planned improvements

There are no short term plans concerning improvements in this land-use category.

7.15 Biomass Burning (CRF 5(V))

7.15.1 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 127 forest fires were reported in the Slovak Republic in 2010. This number decreased in comparison with 2009. The total burnt area was 191.96 ha and total burnt biomass was 151 539.34 kg of dm. The average burnt forest area per fire was 1.51 ha. The largest forest area damaged by fire was 50 ha. The forest fires occurred mostly in spring and early summer.

Emissions from biomass burning for Cropland, Grassland, Settlements and Other land were not calculated because biomass burning of these categories is strictly prohibited by law in the Slovak Republic.

Table 7.17: Biomass burned in forests, CH_4 and N_2O emissions from wildfires and controlled burning of the Slovak forests in 1990 – 2010

	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
2010	150 340,39	1 198,95	IE	IE	1 082,45	8,63	14,90	0,11

Table 7.18: Activity data from forest fires and controlled burning of the forest in 1990 – 2010

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	2 084,85	0,03	62,55	0,90	56,29	0,50	28,15
Broadleaves	1 755,90	0,05	87,79	0,90	79,02	0,50	39,51
Forest Fires	1,20	1,00	1,20	0,90	1,08	0,50	0,54

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							
67,65	0,02	1,35	**CH_4**	0,012	0,812	16/12	1,082
			CO	0,060	4,059	28/12	9,471
					kt N		
			N_2O	0,007	0,009	44/28	0,015
			NOx	0,121	0,164	46/14	0,538
Wildfires							
1,40	0,02	0,03	**CH_4**	0,012	0,006	16/12	0,009
			CO	0,060	0,032	28/12	0,076
					kt N		
			N_2O	0,007	0,000	44/28	0,000
			NOx	0,121	0,001	46/14	0,004

7.15.2 Controlled Burning

Total methane emissions from controlled burning were 1 082.45 tons in 2010 and total emissions of N_2O were 14.90 tons in 2010. CO_2 emissions are included in category 5A changes in living biomass.

7.15.3 Forest Fires

Total methane emissions from forest fires were 8.63 tons in 2009 and total emissions of N_2O were 0.11 tons in 2009. CO_2 emissions are included in category 5A1(V) changes in living biomass.

7.15.4 Uncertainties and time consistency

No uncertainty analysis has been made for this source.

The time series is consistent with the consistent methodology, activity data collection and using emission factors and other parameters.

Table 7.19: The sources of activity data, methodology, uncertainty, references and planned improvements

Input data	area burnt, ha	Forest Protection Service – Forest Fire Statistics (NFC Zvolen)
		Forest Protection Service – Forest Fire Statistics (NFC Zvolen)
	mass of 'available' fuel	IPCC default value
		IPCC default value
	combustion efficiency	
	emission factor	
Uncertainty estimates	100%	Based on the expert judgement.
Changes in methods	No	
Problems	No exact data about „mass of available fuel“.	

7.15.5 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.

7.15.6 Source specific recalculations

No recalculations were provided in this category.

7.15.7 Source specific planned improvements

There are no short term plans concerning improvements in this land-use category.

CHAPTER 8: WASTE (CRF 6)

8.1 Overview of sector (CRF 6)

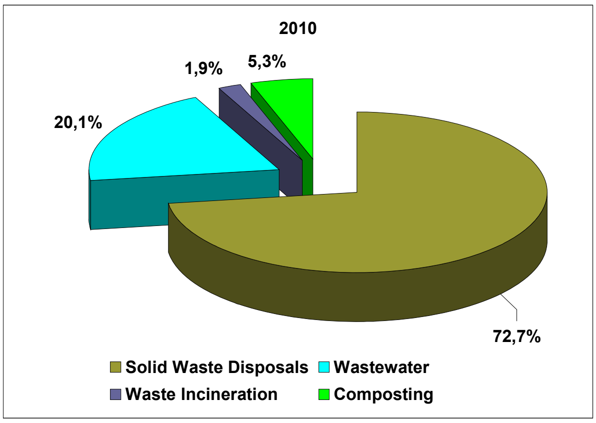
Inventory of emissions from waste management includes direct (CO_2, CH_4, N_2O) and indirect (NMVOCs) greenhouse gas emissions. The production of CH_4 and N_2O emissions are important for waste disposal and wastewater treatment. Disposal of wastes and handling of wastewater results in production of greenhouse gases emissions. An estimation of the following emissions in 2010 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 2010, total aggregated GHG emissions from waste were 2 222.15 Gg of CO_2 equivalents and they increased compared to the previous year by almost 3% mostly caused by increase in the SWDS category (industrial). Compared to the reference year 1990 the emissions increased two times. 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 this category were 175.40 Gg in 2010. These emissions are accounting in energy sector.

The most important gas is CH_4, with the 91% share, N_2O emissions with 7% and CO_2 emissions with 2% (without waste incineration with energy use). The most important source of GHG emissions are solid waste disposal on land (73%), wastewaters (20%), composting (5%) and waste incineration without energy use (2%).

Figure 8.1: The share of individual categories in emissions in sector waste in 2010



Category	GHG (Gg CO_2 eq.)	Share (%)
Solid Waste Disposals	1 615,26	72,69%
Wastewater	446,59	20,10%
Waste Incineration	41,84	1,88%
Composting	118,46	5,33%

Waste sector contributed by 4.8% 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 – 2010

	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	62,459	0,411	1 484,450	919,800	509,957	47,842	6,851
1998	91,100	76,773	0,405	1 828,832	1 218,000	509,565	94,541	6,726
1999	63,200	90,957	0,385	2 092,741	1 515,780	504,233	65,773	6,955
2000	62,800	76,424	0,353	1 777,040	1 207,710	497,254	65,652	6,424
2001	52,200	78,675	0,343	1 810,848	1 258,740	489,992	54,401	7,715
2002	24,709	111,160	0,727	2 584,457	1 845,900	501,381	29,576	207,600
2003	26,418	107,903	0,676	2 501,900	1 776,390	483,016	30,572	211,921
2004	28,000	109,464	0,453	2 467,293	1 875,720	478,133	33,332	80,108
2005	21,856	103,147	0,510	2 346,127	1 736,070	476,628	27,281	106,148
2006	48,488	109,709	0,581	2 532,596	1 853,460	474,739	53,541	150,856
2007	7,520	104,832	0,495	2 362,594	1 773,450	470,562	11,674	106,908
2008	5,713	105,297	0,494	2 369,992	1 780,800	462,231	9,557	117,403
2009	5,039	95,538	0,493	2 164,064	1 584,450	451,306	7,705	120,604
2010	37,092	96,714	0,497	2 222,154	1 615,264	446,592	41,838	118,460

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]

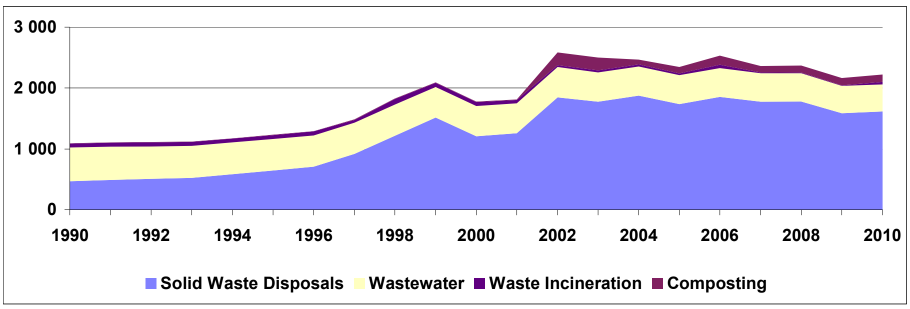
The disaggregation of emissions from waste incineration into two groups, i.e. waste incineration for and without energy utilisation, was another important change with respect to the quality improvement of the emission inventory. The emissions from waste incineration with energy utilisation were reported 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.

The temporally decrease in emissions during 1999 – 2002 was caused by the decrease of methane emissions in SWDS category due to the changes in waste catalogue and other legislative changes in waste categorization.

Figure 8.2: Emission trends of individual categories in sector waste in 1990 – 2010



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 emission source in waste sector. The methane emissions are estimated separately for subcategories:

- 6A1 Managed waste disposal on land in 2001 – 2010.
- 6A3 Other:
  - Uncategorised municipal solid waste in 1990 – 2000.
  - Agricultural and industrial solid waste in 1997 – 2010.

Total methane emissions in category 6A were 76.92 Gg (1 615.26 Gg of CO_2 eq.) in 2010 and they increased by 2% compared to the previous year. This increase was caused by increasing of industrial waste disposal. The emissions of NMVOC were estimated to be 2.32 tons in 2010. 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 – 2010

Solid Waste Disposal on Land (CRF 6A)					
Year	Total 6A CH_4 (Gg)	Managed MSW CH_4 (Gg)	CH_4 Recovery (Gg)	Uncategorised MSW CH_4 (Gg)	Agricultural & Industrial SW CH_4 (Gg)
1990	22,37	IE	NO	22,37	NE
1991	23,45	IE	NO	23,45	NE
1992	24,16	IE	NO	24,16	NE
1993	24,89	IE	NO	24,89	NE
1994	27,75	IE	NO	27,75	NE
1995	30,85	IE	NO	30,85	NE
1996	33,81	IE	NO	33,81	NE
1997	43,80	IE	NO	36,70	7,10
1998	58,00	IE	NO	39,40	18,60
1999	72,18	IE	NO	42,18	30,00
2000	57,51	IE	NO	42,51	15,00
2001	59,94	44,94	NO	NO	15,00
2002	87,90	45,54	NO	NO	42,36
2003	84,59	46,27	NO	NO	38,32
2004	89,32	46,63	0,17	NO	42,69
2005	82,67	47,04	0,34	NO	35,63
2006	88,26	47,65	0,37	NO	40,61
2007	84,45	48,22	0,50	NO	36,23
2008	84,80	47,96	1,68	NO	36,84
2009	75,45	48,89	1,68	NO	26,56
2010	76,92	46,86	2,00	NO	30,06

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 No. 223/2001 Coll. and Decree of the Ministry of Environment No. 283/2001 Coll. 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 odours 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 a cumulative diagram, which shows the contribution of emissions from MSW disposed each year and covers the entire period 1960 – 2010 and as a bar chart showing total emissions for the period 1990 – 2010.

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 46.86 Gg in 2010, but this number was reduced with the methane recovery value (2.00 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 a 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 modelling 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 does not depend on the year when MSW was disposed, but on the year when the estimation of methane emission was done. The MCF depends on the year when MSW was disposed following 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 No. 283/2001 Coll.) was in accordance with this directive, a later amendment (Ordinance No. 509/2002 Coll.) 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 kt 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 2.00 Gg in 2010.

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 Ministry of Environment. Thus, the following hypothesis is proposed:

- Before 1992 all MSW were disposed of in SWDSs on which very little or no data exist = IPCC category uncategorized sites (6A3).
- Period 1993 – 1999 is a period of transition when managed sites were gradually developed = linear growth of MCF (6A3).
- Since 2000 all MSW has been disposed of in managed landfills = IPCC category managed sites (6A1).

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 – 2010 (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 – 2010) 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 Ministry of the Environment.

Table 8.3: Activity data and input parameters for municipal solid waste disposal in 1990 – 2010

Municipal Solid Waste Disposal on Land (CRF 6A1)									
	Annual MSW at the SWD (kt)	MCF	DOC_F (%)	EF CH_4 (t/t)	Waste Generation Rate (kg/person/day)	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	219,337	0,120	0,900	0,000	0,000
1991	1 182,000	0,600	60,000	0,020	223,719	0,120	0,900	0,000	0,000
1992	1 210,000	0,600	60,000	0,020	228,021	0,120	0,900	0,000	0,000
1993	1 238,000	0,600	60,000	0,020	232,504	0,120	0,900	0,000	0,000
1994	1 266,000	0,650	60,000	0,022	236,755	0,120	0,900	0,000	0,000
1995	1 347,000	0,700	60,000	0,023	251,134	0,120	0,858	0,000	0,000
1996	1 249,000	0,750	60,000	0,027	232,424	0,120	0,856	0,000	0,000
1997	1 206,000	0,800	60,000	0,030	224,029	0,120	0,831	0,000	0,000
1998	1 113,000	0,850	60,000	0,035	206,460	0,120	0,815	0,000	0,000
1999	1 134,000	0,900	60,000	0,037	210,182	0,120	0,822	0,000	0,000
2000	1 056,000	0,950	60,000	0,040	195,531	0,120	0,788	0,000	0,000
2001	1 049,000	1,000	60,000	0,043	194,989	0,120	0,834	0,000	0,000
2002	1 192,000	1,000	60,000	0,038	221,610	0,120	0,782	0,000	0,000
2003	1 256,000	1,000	60,000	0,037	233,503	0,120	0,785	0,000	0,000
2004	1 195,000	1,000	60,000	0,039	222,013	0,120	0,810	0,170	0,000
2005	1 227,000	1,000	60,000	0,039	227,759	0,120	0,788	0,340	0,050
2006	1 260,000	1,000	60,000	0,038	233,925	0,120	0,776	0,370	0,050
2007	1 295,000	1,000	60,000	0,038	240,277	0,120	0,776	0,500	0,050
2008	1 369,000	1,000	60,000	0,036	253,192	0,120	0,765	1,680	0,050
2009	1 411,000	1,000	60,000	0,036	260,410	0,120	0,808	1,680	0,050
2010	1 412,000	1,000	60,000	0,035	259,988	0,120	0,781	2,000	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

Other parameters:

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 as time-variable, although this is not stated in the IPCC documents. Currently, the fraction with the value of 0.05 is used since 2005.

The methane generation potential is also a time-variable, as its value depends on time-variable parameters (Table 8.3).

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)	0,600	IPCC default value, no national data available
Fraction of methane in landfill gas (F)	0,500	IPCC default value, no national data available
Methane recovery (R)	2,000	Plant specific data
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)	0,60-1,00	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)	0,00-0,05	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 has been publishing 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 50 years. Analysis of MSW generation data shows a huge difference in MSW generation in years 1992 – 1994, compared to data 1995 – 2010. 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 replaced 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 the 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 – 2010 (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 – 2010: 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 such as 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 greenhouse 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 limitations an approximate results with Tier 1 method could be obtained in the cases, which exceed mentioned circumstances. Unlike 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 than 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 varied during the analyzed period 1960 – 2010 significantly, the mean value and 95% confidence interval 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 2010. 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 features 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 the 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.

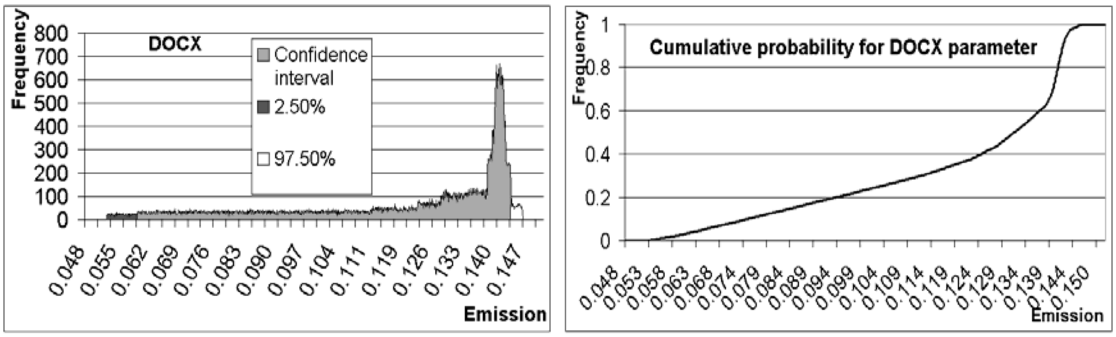
In some cases an empirical distribution is constructed, which supplies analytical properties of PDF or CDF. There are many references, which prefer to use analytical distribution instead of empirical distribution. They say that empirical probability distributions are unwieldy and they offer the replacement 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.

Several recommendations on the PDF or CDF construction 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. Firstly, 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 differs 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 influence to the total uncertainty should be investigated. 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 2010

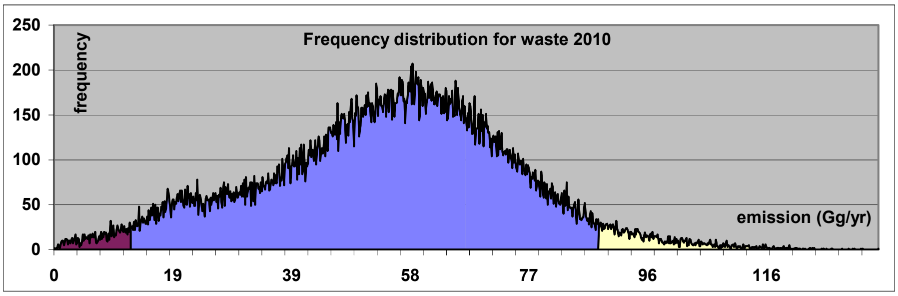


Table 8.9: Uncertainty and mean value estimation

Median	Average	Standard dev,	2,50%	97,50%
52,52	51,37	19,26	12,51	88,37
Min	**Max**		**Per_2,5**	**Per_97,5**
1,00	130,41		-75,65%	72,03%

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 – 2010

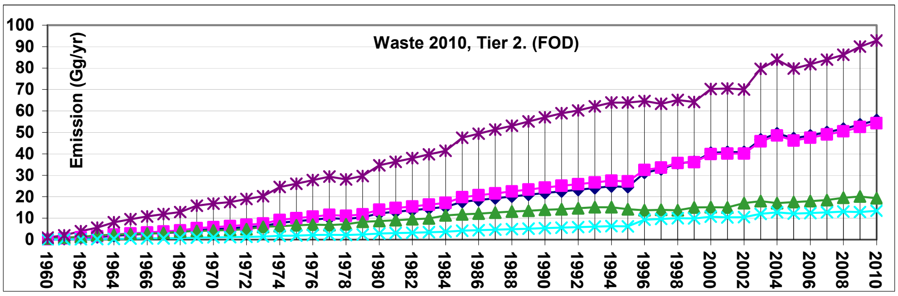
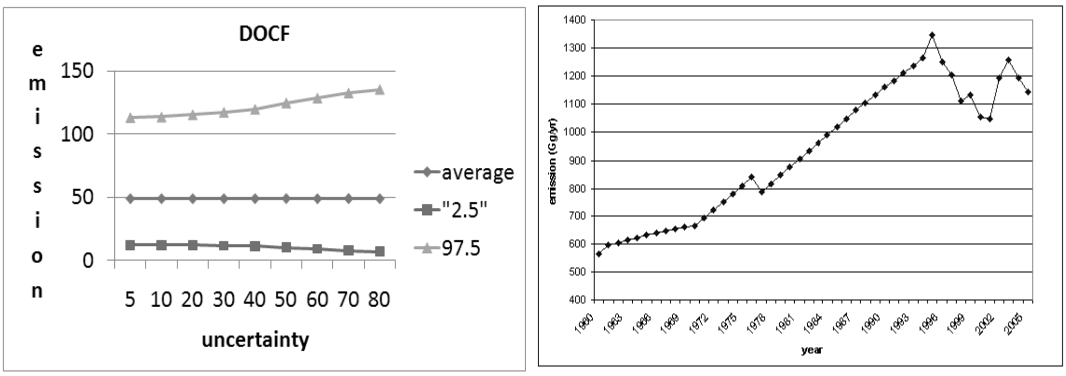


Figure 8.6: On the left, DOCF parameter sensitivity to the normal PDF uncertainty variation, on the right, municipal solid waste landfill (MSWL) mean value variation during the period 1960 – 2005



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 statistics is available for total methane emissions for chosen years (1960 – 2010). The result is from 60 000 trials. A number of trials has the influence on the accuracy of result.

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 -75.65%; +72.03% in 2010. 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 – 2010

Year	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Median	40,83	40,83	46,69	49,50	47,21	48,58	50,11	51,62	53,72	55,66	52,52
Average	40,16	40,12	45,83	48,54	46,24	47,53	49,00	50,45	52,44	54,30	51,37
St.dev	15,08	14,97	17,02	17,93	17,06	17,51	17,98	18,47	19,52	20,12	19,26
0,025	10,38	10,42	11,98	12,76	12,09	12,37	12,78	13,13	12,90	13,46	12,51
0,975	70,46	70,01	79,60	83,90	79,73	81,75	83,95	86,19	90,05	92,90	88,37
Min	0,93	0,94	1,10	1,18	0,99	0,88	0,91	0,85	-0,20	0,00	1,00
Max	101,43	100,76	114,50	120,65	114,62	117,53	120,67	123,89	129,84	133,88	130,41
Per_2.5	**-74,16**	**-74,03**	**-73,87**	**-73,72**	**-73,85**	**-73,97**	**-73,91**	**-73,97**	**-75,40**	**-75,21**	**-75,65**
Per_97.5	**75,44**	**74,50**	**73,69**	**72,87**	**72,45**	**71,99**	**71,34**	**70,85**	**71,70**	**71,08**	**72,03**

8.2.2.6 Source specific recalculations

No recalculations in the submission 2012 focused on the base year 1990 or the other inventory years were provided. However, several reporting improvements in the CRF Tables were included. The waste generation rate in kg/person/day was reported since 1990, fractions of MSW disposed to the SWDS since 1990 and fraction of DOC in MSW was corrected to 0.60.

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 have been collected according to the European Waste Classification (EWC) since 2002 and only now discrepancies in data become visible.

The national census in 2011 will published 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 do not occur from this category, the unmanaged waste disposal sites do not occur 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 30.06 Gg in 2010. The interpolation method was used for methane emission estimation in the period 1990 – 1996, the estimate is not included in the emission inventory submission 2012, 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 – 2010 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	NE	NE	***15.0****
1991	NE	NE	***15.0****
1992	NE	NE	***15.0****
1993	NE	NE	***15.0****
1994	NE	NE	***15.0****
1995	NE	NE	***15.0****
1996	NE	NE	***15.0****
1997	3 085,00	115,00	**7,10**
1998	2 861,00	372,00	**18,60**
1999	2 642,00	525,00	**30,00**
2000	2 313,00	222,00	**15,00**
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**
2010	2 397,24	465,51	**30,06**

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 because of the following reasons:

- The system of waste classification changed in 2002; this is splitting the available data to two non-compatible sets.
- ISW data have been 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 difficult.
- 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 – 2010 (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) for the years 1997 – 2000. The results of recalculation are summarised in the following table. The changes in volume of ISW disposal did not occur. Recalculation led to decrease in methane emissions in comparison with previous submission.

Table 8.12: The comparison of 2011 and 2012 submissions of methane emissions estimation in category 6A3 in 1997 – 2000

	CH_4 emissions (Gg/yr)		Changes in %
Year	Submission 2010	Submission 2011	2012/2011
1997	7,40	7,10	95,98%
1998	18,61	18,60	99,96%
1999	30,06	30,00	99,81%
2000	14,96	15,00	100,29%

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 2010, the total methane emissions from wastewater treatment were 17.12 Gg. This is a slight decrease compared to the previous year but the trend is almost stable. In 2010, the total N_2O emissions from wastewater treatment were 0.28 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 emission 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 emission 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.

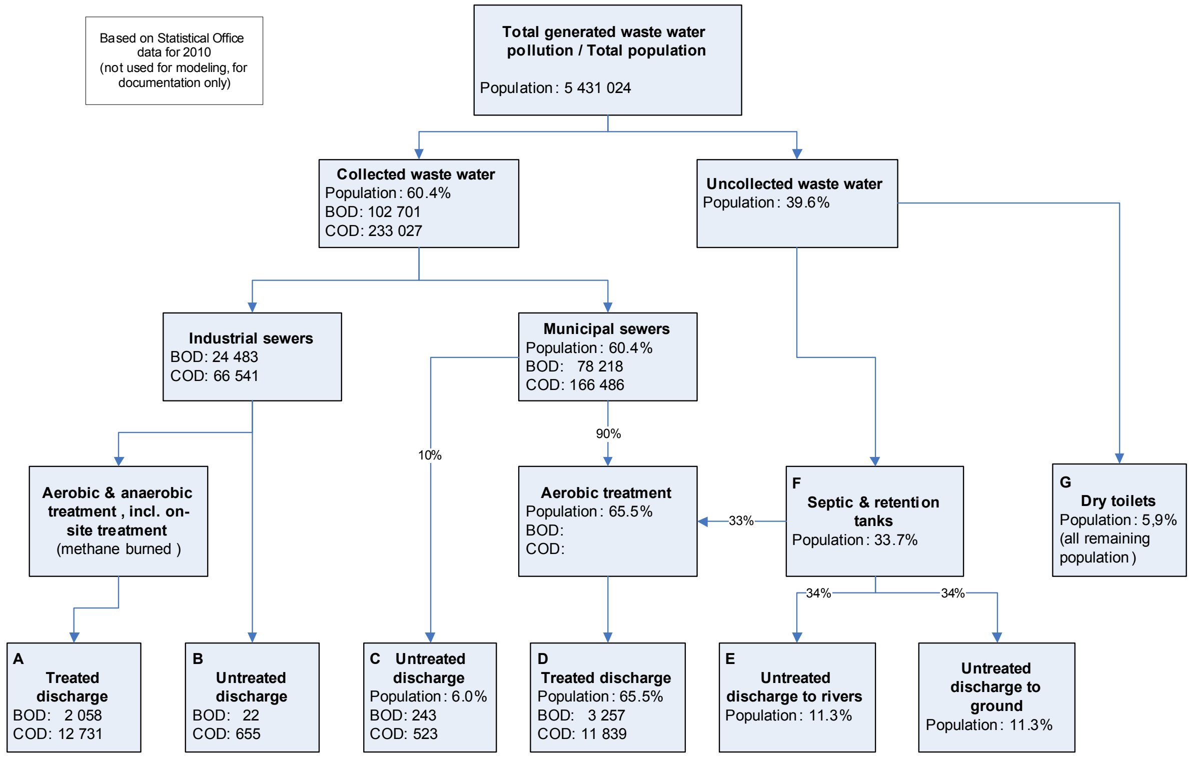
Table 8.13: GHG emissions in individual categories in wastewater handling in 1990 – 2010

	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	0,330
2000	30 295,000	0,726	0,030	5 400,680	18,043	0,302
2001	12 623,000	0,681	0,030	5 379,780	17,880	0,293
2002	34 578,000	0,637	0,072	5 378,810	17,932	0,288
2003	37 763,300	0,664	0,031	5 378,950	17,860	0,273
2004	34 296,750	0,551	0,039	5 382,574	17,783	0,262
2005	31 631,640	0,422	0,043	5 387,285	17,656	0,270
2006	32 865,403	0,324	0,040	5 393,640	17,716	0,269
2007	32 424,285	0,315	0,040	5 400,998	17,651	0,260
2008	28 601,759	0,324	0,033	5 412,254	17,520	0,249
2009	28 111,451	0,342	0,029	5 418,374	17,020	0,251
2010	28 515,780	0,300	0,029	5 435,273	16,820	0,252

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 – 2010 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 (data have only documenting character)



8.3.2 Source category description – Industrial Wastewater (CRF 6.B.1)

Total methane emissions were 0.30 Gg and total N_2O emissions were 0.03 Gg from industrial wastewater treatment in 2010. 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 – 2010

	Generated IWW (m^3/y)	Treated Discharged IWW (%)	CH_4 (Gg)	EF (CH_4) (kg/kg DC)	N_2O (Gg)	EF (N_2O) (kg/kg DC)
1990	72 351,800	70,000	1,250	0,025	0,065	0,0013
1991	73 589,300	70,000	1,250	0,025	0,065	0,0013
1992	55 180,700	70,000	1,250	0,025	0,050	0,0010
1993	42 559,300	71,200	1,019	0,025	0,040	0,0010
1994	43 256,000	96,400	1,211	0,025	0,041	0,0008
1995	38 782,100	90,700	0,845	0,025	0,039	0,0011
1996	43 440,600	88,900	0,701	0,025	0,042	0,0015
1997	41 474,100	91,100	0,662	0,025	0,040	0,0015
1998	44 166,600	74,000	0,669	0,025	0,041	0,0015
1999	36 705,300	73,000	0,631	0,025	0,036	0,0014
2000	30 295,000	76,600	0,726	0,025	0,030	0,0010
2001	12 623,000	75,700	0,681	0,025	0,030	0,0011
2002	34 578,000	74,700	0,637	0,025	0,072	0,0028
2003	37 763,300	71,900	0,664	0,025	0,031	0,0012
2004	34 296,750	75,000	0,551	0,025	0,039	0,0018
2005	31 631,640	97,700	0,422	0,025	0,043	0,0026
2006	32 865,403	97,600	0,324	0,025	0,040	0,0031
2007	32 424,285	98,200	0,315	0,025	0,040	0,0032
2008	28 601,759	98,000	0,324	0,025	0,033	0,0026
2009	28 111,451	98,800	0,342	0,025	0,029	0,0021
2010	28 515,780	99,000	0,300	0,025	0,029	0,0024

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. For N_2O calculation only data for treatment plant where biological nitrification and denitrification is was used. Numbers of this type of treatment for industrial wastewater have increased, therefore the N_2O emissions in the future will increase. Emission factor for N_2O estimation is dynamic and changing from year to year. It is depending on direct measurement of industrial wastewater treatment operators. The list of emission factors for N_2O emission from industrial wastewater treatment is shown in Table 8.14.

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, 99% of industrial wastewaters are treated, of which 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 changes 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 – 2010

	Fertilisers		Food and Beverages		Organic Chemicals		Other Streams	
	WW output (m^3/y)	COD (kg/m^3)	WW output (m^3/y)	COD (kg/m^3)	WW output (m^3/y)	COD (kg/m^3)	WW output (m^3/y)	COD (kg/m^3)
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
2010	15 633,70	0,40	4 897,40	0,04	6 335,10	0,17	1 649,58	0,03

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 - year 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 corrections in reporting of treated and untreated discharge of IWW in 1990 – 2009 were taking place. These changes did not influence total emissions in this category.

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 16.82 Gg and total N_2O emissions were 0.25 Gg from domestic wastewater treatment in 2010. 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 – 2010

Year	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	13,576	1,570	18,456
1991	144,633	0,790	1,370	0,920	13,775	1,510	18,365
1992	145,267	0,830	1,350	0,930	13,804	1,520	18,434
1993	145,762	1,000	1,330	0,940	13,784	1,450	18,504
1994	146,383	1,010	0,880	0,960	13,791	1,480	18,121
1995	146,831	0,770	0,810	0,970	13,955	1,320	17,825
1996	147,108	0,580	0,810	0,980	14,260	1,260	17,890
1997	147,366	0,390	0,700	0,990	14,582	1,180	17,842
1998	147,575	0,480	0,700	1,000	14,632	1,140	17,952
1999	147,697	0,460	0,670	1,010	14,799	1,050	17,989
2000	147,844	0,440	0,630	1,020	14,923	1,030	18,043
2001	147,271	0,330	0,550	1,030	14,990	0,980	17,880
2002	147,245	0,310	0,560	1,030	15,072	0,960	17,932
2003	147,249	0,400	0,550	1,030	14,950	0,930	17,860
2004	147,348	0,240	0,570	1,030	15,103	0,840	17,783
2005	147,477	0,450	0,440	1,040	14,906	0,820	17,656
2006	147,451	0,370	0,450	1,040	15,056	0,800	17,716
2007	147,541	0,210	0,480	1,050	15,291	0,620	17,651
2008	148,016	0,200	0,300	1,050	15,450	0,520	17,520
2009	148,328	0,187	0,305	0,999	15,129	0,400	17,020
2010	148,674	0,178	0,310	0,989	14,986	0,357	16,820

8.3.3.1 Methodological issues – methods

The IPCC 2006 GL (Volume 5, Chapter 6, page 6.11) recommends 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, initial and final data indicate deficiencies in reporting. The initial 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: Using the default parameters, these emissions were estimated, summarising sources of nitrous oxide emission for domestic wastewater

Total N_2O emissions (Gg) in 6.B.2.2				
Year	Treated effluent (Gg)	Other effluents (Gg)	Direct from WWT (Gg)	Total N_2O (Gg)
1990	0,198	0,185	NO	0,383
1991	0,203	0,160	NO	0,362
1992	0,186	0,152	NO	0,338
1993	0,182	0,156	NO	0,338
1994	0,181	0,157	NO	0,338
1995	0,204	0,148	NO	0,352
1996	0,213	0,138	NO	0,352
1997	0,224	0,128	NO	0,352
1998	0,214	0,127	0,000	0,341
1999	0,205	0,123	0,002	0,330
2000	0,184	0,115	0,004	0,302
2001	0,179	0,109	0,005	0,293
2002	0,173	0,108	0,007	0,288
2003	0,155	0,109	0,009	0,273
2004	0,152	0,100	0,011	0,262
2005	0,145	0,113	0,012	0,270
2006	0,145	0,111	0,013	0,269
2007	0,150	0,097	0,013	0,260
2008	0,144	0,091	0,014	0,249
2009	0,143	0,093	0,015	0,251
2010	0,144	0,092	0,015	0,252

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 estimation, 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	1990	2000	2010
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	12,98%	4,93%	2,00%
D – Collected WW treated	0.6	0.1	0.06	48,12%	60,88%	69,49%
E – Untreated discharge from septic tanks	0.6	0.1	0.06	10,60%	11,50%	11,09%
F – Emissions from septic & retention tanks	0.6	0.5	0.30	31,20%	33,66%	33,60%
G – Dry toilets	0.6	0.1	0.06	18,00%	11,64%	4,00%

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 2010 include protein consumption data of 2009). 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 plants 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 activity data and parameters used for N_2O emission estimation for domestic and commercial wastewater

Year	Total Population (1 000 persons)	Protein Consumption (kg/person/year)	Nitrogen Fraction (kg N/kg protein)	EF N_2O (kg N_2O-N/kg N)
1990	5 297,770	38,325	0,160	0,0075
1991	5 283,400	36,099	0,160	0,0076
1992	5 306,540	33,653	0,160	0,0075
1993	5 324,630	33,617	0,160	0,0075
1994	5 347,310	33,544	0,160	0,0075
1995	5 363,680	34,420	0,160	0,0076
1996	5 373,790	34,128	0,160	0,0076
1997	5 383,230	33,872	0,160	0,0077
1998	5 390,870	32,960	0,160	0,0076
1999	5 395,320	32,777	0,160	0,0074
2000	5 400,680	30,806	0,160	0,0072
2001	5 379,780	30,660	0,160	0,0071
2002	5 378,810	30,879	0,160	0,0069
2003	5 378,950	30,295	0,160	0,0067
2004	5 382,574	29,930	0,160	0,0065
2005	5 387,285	31,755	0,160	0,0063
2006	5 393,640	32,120	0,160	0,0062
2007	5 400,998	31,317	0,160	0,0061
2008	5 412,254	30,478	0,160	0,0060
2009	5 418,374	31,025	0,160	0,0059
2010	5 435,273	31,335	0,160	0,0059

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[20] 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 the review on the annual emission inventory in 2011, the N_2O emissions from domestic and commercial wastewater treatment were recalculated based on corrections in protein consumption values. The emission estimations are compared in the following table, but the changes are significant since 1998.

Table 8.20: The comparison of submissions 2011 and 2012 for N_2O emissions in domestic and commercial wastewater

Total N_2O emissions (Gg) in 6.B.2.2			
Year	Submission 2011	Submission 2012	Changes 2012/2011 in %
1990	0,383	0,383	100,00%
1991	0,362	0,362	100,00%
1992	0,338	0,338	100,00%
1993	0,338	0,338	100,00%
1994	0,338	0,338	100,00%
1995	0,352	0,352	100,00%
1996	0,352	0,352	100,00%
1997	0,352	0,352	100,00%
1998	0,341	0,341	100,06%
1999	0,328	0,330	100,59%
2000	0,299	0,302	101,23%
2001	0,288	0,293	101,87%
2002	0,281	0,288	102,53%
2003	0,264	0,273	103,34%
2004	0,251	0,262	104,20%
2005	0,257	0,270	104,77%
2006	0,256	0,269	105,13%
2007	0,247	0,260	105,42%
2008	0,235	0,249	105,99%
2009	0,236	0,251	106,24%

[20] 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.

8.3.3.7 Source specific planned improvements

The wastewater activity data will be reviewed in 2013, after the publication of national census results in 2011.

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 2010, 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 every four/five years, when a new National Waste Management Plan is published.

In 2010, the total CO_2 emissions reported in category 6.C from waste incineration were 37.09 Gg. This is an increase compared to the previous year caused by the increasing volume of industrial waste. In 2010, the total N_2O emissions reported in category 6.C from waste incineration were 0.015 Gg. The trend in N_2O emissions is almost stable with the slight increase 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. For reasons of completeness, first all emissions are estimated and then those without energy recovery are included into results.

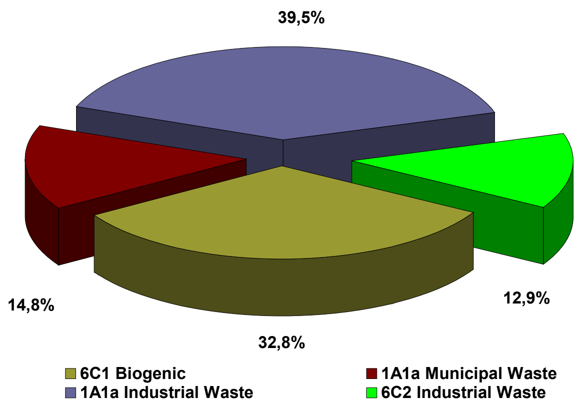
Five waste streams are defined, which differ in their content of fossil fuel carbon, thus have different emission potential. These are:

- 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 2010



Category	GHG (Gg CO_2 eq.)	Share (%)
6C1 Biogenic	106,00	32,79%
1A1a Municipal Waste	47,84	14,80%
1A1a Industrial Waste	127,56	39,46%
6C2 Industrial Waste	41,84	12,94%

Table 8.21: Activity data and emissions from waste incineration in 1990 – 2010

Waste Incineration (CRF 1A1a and 6C)											
	Municipal Waste Incineration*			Industrial Waste Incineration*			Industrial Waste Incineration			Biogenic Waste	
Year	Quantity (TJ)	CO_2 (Gg)	N_2O (Gg)	Quantity (TJ)	CO_2 (Gg)	N_2O (Gg)	Quantity (Gg)	CO_2 (Gg)	N_2O (Gg)	Quantity (Gg)	CO_2 (Gg)
1990	1 307,045	43,000	0,005	IE	127,300	0,011	40,000	62,700	0,009	125,000	110,000
1991	1 307,045	43,000	0,005	IE	127,300	0,011	40,000	62,700	0,009	125,000	110,000
1992	1 503,093	44,357	0,004	IE	127,300	0,011	40,000	62,700	0,009	125,000	110,000
1993	1 614,280	47,639	0,005	IE	127,300	0,011	40,000	62,700	0,009	125,000	110,000
1994	1 409,033	41,582	0,003	IE	127,300	0,011	40,000	62,700	0,009	125,000	110,000
1995	1 314,201	38,783	0,003	IE	127,300	0,011	40,000	62,700	0,009	125,000	110,000
1996	1 289,151	38,044	0,003	IE	127,300	0,011	40,000	62,700	0,009	125,000	110,000
1997	1 404,659	41,453	0,003	IE	91,700	0,010	31,000	45,300	0,008	107,500	93,000
1998	1 567,065	46,245	0,004	IE	184,900	0,010	62,000	91,100	0,011	195,400	166,000
1999	1 520,477	44,870	0,004	IE	128,800	0,011	43,000	63,200	0,008	130,300	116,000
2000	1 816,223	53,598	0,004	IE	127,200	0,010	42,667	62,800	0,009	129,900	116,000
2001	1 142,095	33,704	0,003	IE	105,800	0,011	35,333	52,200	0,007	99,600	93,000
2002	1 363,659	40,243	0,003	IE	566,872	0,038	77,324	24,709	0,016	73,000	84,000
2003	1 416,038	41,788	0,003	IE	843,325	0,057	70,087	26,418	0,013	70,000	78,000
2004	1 604,256	47,343	0,003	IE	338,279	0,023	56,171	28,000	0,017	73,000	81,000
2005	1 593,283	47,019	0,002	IE	451,445	0,030	28,527	21,856	0,018	103,000	131,000
2006	1 655,518	48,856	0,002	IE	394,046	0,027	54,950	48,488	0,016	99,000	98,000
2007	1 570,341	46,342	0,002	IE	240,202	0,016	22,630	7,520	0,013	85,000	118,000
2008	1 370,620	40,448	0,002	IE	637,166	0,043	22,864	5,713	0,012	66,000	92,000
2009	1 548,816	45,707	0,002	IE	251,843	0,017	23,731	5,039	0,009	29,000	38,000
2010	1 597,021	47,129	0,002	IE	124,965	0,008	58,772	37,092	0,015	96,400	106,000

** 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 italics).

Table 8.22: Activity data and emissions from biogenic waste incineration in 1990 – 2010

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	43,90	409,00	368,00	93,00
1998	400,90	80,20	688,00	642,00	166,00
1999	279,00	55,80	505,00	460,00	116,00
2000	278,30	55,70	521,00	467,00	116,00
2001	225,50	45,10	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	73,40	542,00	416,00	81,00
2005	406,90	102,90	699,00	614,00	131,00
2006	364,20	98,80	639,00	526,00	98,00
2007	246,30	84,60	459,00	387,00	118,00
2008	494,90	65,90	816,00	749,00	92,00
2009	198,40	28,90	387,00	321,00	38,00
2010	180,60	96,40	363,00	267,00	106,00

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 2010 activity data shows that the report from Košice district does not include amount of incinerated waste. Other source[21] 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

[21] *Správa o prevádzke a kontrole spaľovacieho zariadenia, KOSIT, 2010 (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 2010.

Emissions 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 recommends 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, because 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=1.43 kg N_2O/TJ was used in 2010.

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 the 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 has not changed, but the amount of incinerated clinical waste has 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

No recalculations were provided in this submission in the category municipal solid waste incineration.

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 162.06 Gg in 2010, but the emissions without energy use were only 37.09 Gg of CO_2 in 2010. The total N_2O emissions from industrial waste incineration were estimated to 0.024 Gg in 2010, but the emissions without energy use were 0.015 Gg of N_2O in 2010.

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 has been providing information on “incineration with energy recovery” and “incineration without energy recovery”. The analysis of the data allows making 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 corrections in activity data, the emissions of CO_2 were recalculated for in the connection with biogenic emission estimation for 2002 – 2009. This change didn't influence the N_2O emissions.

8.4.4.7 Source specific planned improvements

No specific improvements are planned for the next submission.

Table 8.25: The comparison of 2011 and 2012 submissions of CO2 emissions estimation in industrial waste incineration with and without energy use in 2002 – 2010

Category Industrial Waste Incineration with energy use 1A1a					
	Submission 2011		Submission 2012		Changes in CO_2 eq. in %
Year	ISW Incinerated (TJ)	CO_2 Emissions (Gg)	ISW Incinerated (TJ)	CO_2 Emissions (Gg)	2012/2011
2002	IE	85,700	IE	566,8722	661,46%
2003	IE	70,200	IE	843,3250	1201,32%
2004	IE	51,600	IE	338,2785	655,58%
2005	IE	16,100	IE	451,4450	2804,01%
2006	IE	15,300	IE	394,0462	2575,47%
2007	IE	17,900	IE	240,2023	1341,91%
2008	IE	20,800	IE	637,1660	3063,30%
2009	IE	22,900	IE	251,8434	1099,75%
Category Industrial Waste Incineration without energy use 6C2					
	Submission 2011		Submission 2012		Changes in CO_2 eq. in %
Year	ISW Incinerated (Gg)	CO_2 Emissions (Gg)	ISW Incinerated (Gg)	CO_2 Emissions (Gg)	2012/2011
2002	455,000	24,700	77,324	24,7088	100,04%
2003	638,000	26,400	70,087	26,4183	100,07%
2004	301,000	28,000	56,171	28,0004	100,00%
2005	407,000	21,900	28,527	21,8556	99,80%
2006	364,000	48,500	54,950	48,4881	99,98%
2007	246,000	7,500	22,630	7,5205	100,27%
2008	495,000	5,700	22,864	5,7133	100,23%
2009	198,000	5,000	23,731	5,0388	100,78%

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 owning 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[22]. 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

[22] *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).*

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.

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. These emissions are included in industrial waste incineration 6C2.

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 8.26: The overview of municipal and industrial composting in 1990 – 2010

Year	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	2,370	0,1777
2010	90,700	0,363	0,027	578,500	2,314	0,1736

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 8.27: 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 remains 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 2012 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 2012 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. The recalculations are based on updated or revised methodologies (e.g. COPERT V version 8.1) or updated statistical information (e.g. input data in IP sector). The following table (Table 10.1) presents recalculation difference with the comparison with the previous emission inventory submission (from October 2011). Table 10.2 presents the recalculation differences of national total GHG emissions for all years.

Table 10.1: List of recalculations in the March 2012 submission (version 1.2) against January 2012 submission (version 1.1) with short explanation

Recalculated Category submissions 2012v1.1/2012v1.2		Year	GHG	Explanation
1.AA.1	Public Electricity and Heat Production	2005-2010	CO2, CH4, N2O	Recalculations w ere based on new energy balance, w here the corrections w ere made in carbon balance in refineries, chemical industry and iron and steel industry. The energy balance w as harmonised w ith statistical information. New aggregation of fuels into fuel's groups w as introduced. New estimation of country specific EF for CO2 (reflecting oxidation factors) and default EF for non-CO2 emissions w as provided.
1.AA.2	Manufacturing Industry and Construction	2005-2010	CO2, CH4, N2O	
1.AA..4	Other Sectors	2005-2010	CO2, CH4, N2O	
1.AA.5	Other Stationary	2005-2010	CO2, CH4, N2O	
2.C.1.1	Steel Production	1990-2010	CO2	Recalculation is connected w ith the carbon balance in energy sector category 1.AA.2a, carbon used in technology w as identified and recalculated.
2.IIA.F.2.1	Hard Foam	1999-2010	HFC-134a	New estimation w as provided in this category
2.IIA.F.2.1	Hard Foam	2002-2010	HFC-245fa	Reallocation of emissions from manufacturing to stocks w as provided.
2.IIA.F.2.12	Soft Foam	2002-2010	HFC-365mfc	Reallocation of emissions from manufacturing to stocks w as provided.
2.IIA.F.4.1	Metered Dose Inhalers	2000-2010	HFC-134a	New estimation w as provided in this category.
2.IIA.F.4.1	Metered Dose Inhalers	2010	HFC-227ea	New estimation w as provided in this category.
4.A	Enteric Fermentation - Sheep	1990-2004	CH4	Consistent methodology (Tier 2) w as used for time series w ith corrected data for AGEI and methane EF.
5.A.2.1	Cropland Converted to Forest Land	1990-2010	CO2	Recalculation of carbon stock change in living biomass. The main reason w as recalculation of land areas due to incorrect determination of the length of the transition period.
5.A.2.2	Grassland Converted to Forest Land	1990-2010	CO2	Recalculation of carbon stock change in living biomass. The main reason w as recalculation of land areas due to incorrect determination of the length of the transition period.
5.A.2.5	Other Land Converted to Forest Land	1990-2010	CO2	Recalculation of carbon stock change in living biomass. The main reason w as recalculation of land areas due to incorrect determination of the length of the transition period.

Table 10.2: List of recalculations in the March 2012 submission (version 2012/1.2) against October 2011 submission (version 2011/2.1) with short explanation

Recalculated Category submissions 2011v2.1/2012v1.1		Year	GHG	Explanation
1.AA.1a	Public Electricity and Heat Production - other fuel	2002-2009	CO_2, N_2O	Recalculation of Industrial Solid Waste Incineration with energy recovery under Other Fuels. Correction of activity data.
1.AA.3b	Road Transportation	1990-2009	CO_2	Recalculation by COPERT IV version 8.1 model
1.AA.3b	Road Transportation	1990-2009	CH_4	Recalculation by COPERT IV version 8.1 model
1.AA.3b	Road Transportation	1990-2009	N_2O	Recalculation by COPERT IV version 8.1 model
1.AA.3b	Road Transportation - gaseous fuel	1990-2010	N_2O	New estimation of N_2O emissions from CNG.
2.A.3	Limestone and Dolomite Use	1990-2009	CO_2	Reallocation of the consumption of limestone from Iron and Steel Production 2.C into category 2.A.3
2.B.2	Nitric Acid Production	1990-2009	N_2O	In 2011, thorough survey of measured concentration of N_2O in output gas in Duslo Šaľa was made. The concentrations are measured since 2005. The average value (7.5 kg / 1 t HNO_3) was chosen for the period 1990 – 2004 for medium pressure plant in Duslo Šaľa and for whole period 1990 – 2010 in the second plant in Stražske (the used technologies are very similar). The production of nitric acid, used emission factors and N_2O emissions were recalculated since 1990.
2.B.4.2	Calcium Carbide Production	1992-2009	CO_2	According to the ERT recommendation, the using of limestone was moved into this category from the category 2A3 Limestone and Dolomite Use. Thus, the recalculation for whole time period 1990 – 2010 was made. Because no national data are known only IPCC default factors are used. Emissions from using of the product were calculated only from non-exported calcium carbide which was used for acetylene production.
2.C.2	Ferroalloys Production	1990-2009	CO_2, CH_4	The plant specific emission factors were calculated since 2002 (on the basis of carbon balance) and because of the time series consistency, the Overlap method described in Chapter 7 of 2000 Good Practice Guidance was adopted and new emissions factors were calculated for the time period 1990 – 2001.
2.C.3	Aluminium Production	2006-2009	CO_2	Correction of the content of carbon in anodes, corrected by operator since 2006.
2.F.2	Foam Blowing	2002-2010	HFC245fa, HFC365mfc	Including new estimation based on ERT recommendations.
5.	LULUCF	1990-2009	CO_2	Complete recalculation of all land categories: Forestland, Cropland, Grassland, Settlements and Other Land based on new estimation of area.
6.A.3	Industrial Solid Waste Disposal on Sites	1997-2009	CO_2, CH_4	New estimation of activity data for annual ISW disposal on SWDS.
6.B.2.2	Human Sewage	1990-2009	N_2O	Recalculations based on new estimated data on protein consumption.
6.C.2	Industrial Waste Incineration	1990-2009	CO_2, N_2O	Recalculation of Industrial Solid Waste Incineration with energy recovery under Other Fuels. Correction of activity data.
KP LULUCF	Kyoto Protocol accounting under 3.3 Article	2008, 2009	CO_2	Complete recalculation of afforestration, reforestration and deforestration categories based on new estimation of area.

10.3 Recalculations, including in response to the review process, and planned improvements to the inventory

Due to the late delivery of the draft ARR 2011 report (March 2012), the Slovak National Inventory System is not in position to include improvements for all recommendations identified in the ARR. The manager of NIS will summarize and evaluate 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 the next submission. This report covers the in-country review of the 2011 annual submission of the Slovak Republic, coordinated by the UNFCCC secretariat, in accordance with the decision 22/CMP.1. The in-country review took place from 22^{nd} to 27^{th} August 2011 in Bratislava. Questions of implementation on national system and QA/QC procedures and two adjustments were identified by the ERT during the review. In the conclusions and recommendations summarized in the draft ARR the ERT concludes that the inventory submission has been prepared and reported mostly in accordance with the UNFCCC reporting guidelines but the national system of Slovakia does not fully comply with the guidelines for national systems under Article 5, paragraph 1, of the Kyoto Protocol (annex to decision 19/CMP.1). The annual submission is complete in terms of geographical coverage, years and sectors, as well as mostly complete in terms of categories and gases.

Table 10.3: Response to the review of the 2011 UNFCCC inventory submission

CRF	Issue Identified by the ERT	Slovakia responses
NATIONAL SYSTEM	ERT notes that the national system is not fully ensuring: a. Harmonization of official statistical data and other national data sets to ensure that emissions from the energy sector estimated from the national energy supply balance (reference approach) are consistent with emissions estimated from the fuel use data in the NEIS system (sectoral approach) and/or international organizations.	During the 6 weeks period, sectoral expert for energy (Profing, Mr. Judak), national coordinator and the colleagues from the Dpt. of Climate Change Policy (Ministry of Environment) in cooperation with the Statistical Office of the Slovak Republic (SO SR) provided several comparisons of the national energy statistics, international energy statistics (IEA) and the fuel balance in the National Emission Information System (NEIS). The following steps were taken in order to increase transparency, consistency and comparability of the national reporting in energy sector
	The ERT notes that National System in Slovakia has elaborated a quality assurance/quality control (QA/QC) plan, but the ERT notes that the National System did not succeed to fully implement it.	In response to the ERT recommendation Slovakia prepared during the 6-weeks period detailed plan of action with proposed measures and deadlines to deliver results. Prioritizing the key sources, tier 2 key categories analyses were performed. updating QA/QC plan mostly for agriculture and LULUCF sectors
1. ENERGY	Provide the background information of emission factors of methane and nitrous oxide used to estimate emissions for the reporting and justify their emissions are not underestimated.	New estimation of CO2, CH4 and N2O emissions from the category 1.A.3b - Road Transportation using COPERT IV version 8.1. New estimation of IEF for CH4 and N2O in the category 1.A.3b - Road Transportation.
1. ENERGY	Slovakia reports nitrous oxide emissions from the gaseous fuel in road transportation (1.A.3.b) as not occurring ("NO"), even though it does report activity data and corresponding carbon dioxide and methane emissions in the common reporting format (CRF) table for this category. The ERT notes that methodologies and default emission factor do exist in the Revised 1996 IPCC Guidelines to estimate these emissions.	New estimation of N2O emissions for CNG fuel in the category 1.A.3b - Road Transportation using default EF.
1. ENERGY	Estimate emissions of carbon dioxide from coal mining and handing (1.B.1.a) using the method and default assumptions for carbon dioxide emissions provided in the page 1.112-1.113, Volume 3 of the Revised 1996 IPCC guidelines for national greenhouse gas inventories.	The CO2 volume in fugitive gases is under measurement threshold near to zero due to very limited time from handling to combustion.
2. INDUSTRIAL PROCESSES	Check that the activity does occur or not in the country for all sub-categories and relevant gases (HFCs, PFCs and SF6) under Consumption of Halocarbons and SF6 category, in particular for Foam blowing (2.F.2).	New estimation of actual emissions HFC245ca and HFC365mfc from PUR foam in the category 2IIA.F.2.1 – Consumption of halocarbons and SF6 (hard foam).
5. LULUCF	The ERT recommends that Slovakia provide a clear definition of the litter pool and a clear documentation to prove that this carbon pool is included in the estimates of carbon stock change under mineral soils.	In general, the litter pool could be separated from the carbon pool of mineral soils – depending on existing data in databases. However, we decided to include the litter pool into the mineral soil pool as the change of litter layer is the first but integral part of processes related to soil carbon stock change after afforestation/deforestation. So we use organic carbon pool in mineral soil and carbon pool in organic layer of soil (litter) together.
5. LULUCF	According to paragraph 13 (b) and paragraph 17 of the annex to decision 20/CMP.1, the ERT recommends that Slovakia reconsider the carbon stock change factor with a view to ensuring that the value of removals will not be overestimated at the end of the commitment period reporting.	However, we consider the values of soil carbon stock change FL/CL (2.7 Mg C.ha-1.year-1) comparable with data from literature and reports from countries with similar natural conditions. It seems to be very high as compared to the value of the Czech Republic. But the change factor is much better comparable with other countries in the Alpine biogeographically region (e.g. Austria) than with countries in Continental region or other European biogeographically regions.

The latest published 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.

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 for reporting under the KP in the Slovak Republic

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 periodically the Statistical Yearbook of the Soil Resources in the Slovak Republic. It annually provides 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 districts. The GCCA database includes 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

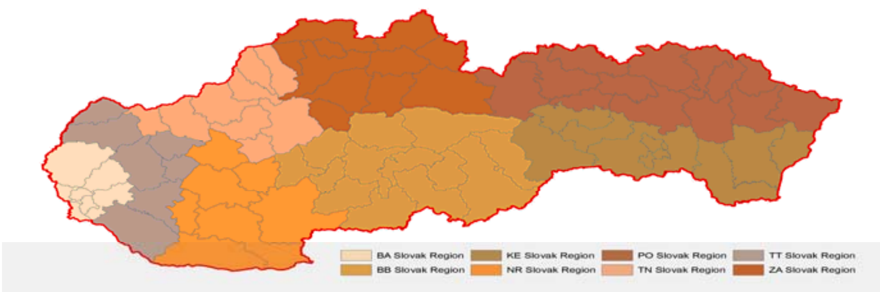
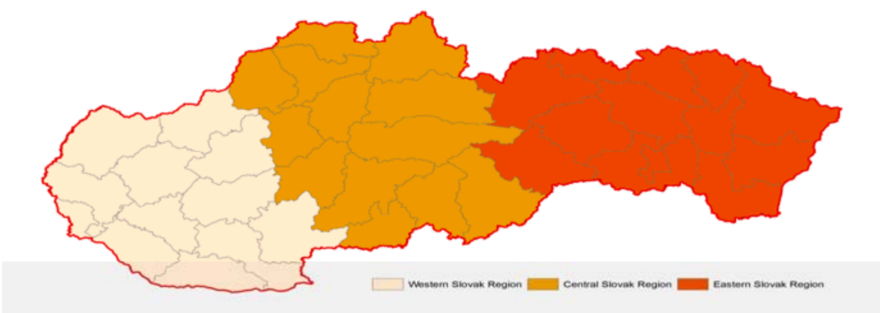


Figure 11.2: Three Slovak regional districts used for the assessment of ARD activities since 1990



Geographical boundaries of these districts are georeferenced by the means of the S – JTSK Krovak system. All maps used in the Slovak Republic are made in coordinated 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 during 1990 – 1995 for whole country (SK) and different districts (WS, CS and ES)

ARF/REF	Total SR [ha]	WS [ha]	CS [ha]	ES [ha]	DEF	WS total [ha]	WS [ha]	CS [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 A/R activities during 1996 – 2010 for whole country (SK) and different districts (BA, TT, TN, NR, ZA, BB, PO and KE)

ARF/REF	Total SR [kha]	BA [kha]	TT [kha]	TN [kha]	NR [kha]	ZA [kha]	BB [kha]	PO [kha]	KE [kha]
1996	**1,5770**	0,0012	0,0036	0,0107	0,0036	0,2068	0,8034	0,3530	0,1949
1997	**3,3950**	0,0595	0,2140	0,0178	0,0000	1,4983	0,1546	1,4270	0,0238
1998	**2,2880**	0,0000	0,0678	0,0047	0,0000	0,8437	0,8647	0,4955	0,0117
1999	**2,1020**	0,0000	0,1198	0,1394	0,0915	0,4705	0,4465	0,3442	0,4901
2000	**1,2920**	0,0029	0,0000	0,0102	0,0219	0,6978	0,1591	0,3562	0,0438
2001	**1,1780**	0,0026	0,0105	0,1210	0,0237	0,6363	0,0131	0,1210	0,2498
2002	**0,7930**	0,0287	0,0076	0,0740	0,0030	0,4486	0,1027	0,0196	0,1088
2003	**1,6480**	0,0082	0,0082	0,1239	0,0599	0,7178	0,3514	0,0463	0,3323
2004	**0,8510**	0,0000	0,0293	0,3199	0,0172	0,1311	0,0578	0,2224	0,0733
2005	**0,8420**	0,0084	0,0756	0,0118	0,0034	0,6000	0,0824	0,0571	0,0034
2006	**1,9450**	0,0756	0,0230	0,0657	0,1544	0,7261	0,0164	0,8247	0,0591
2007	**0,6560**	0,0305	0,0106	0,0398	0,0928	0,0172	0,2081	0,2173	0,0398
2008	**1,4380**	0,0099	0,0128	0,4590	0,1998	0,1587	0,2437	0,1842	0,1700
2009	**1,0480**	0,0176	0,0124	0,0889	0,0310	0,0227	0,2346	0,5044	0,1364
2010	**2,7320**	0,0990	0,0130	0,4410	0,1080	0,0290	1,1620	0,6500	0,2300

Table 11.4: The areas of DEF activities during 1996 – 2010 for whole country (SK) and different districts (BA, TT, TN, NR, ZA, BB, PO and KE)

DEF	Total SR [kha]	BA [kha]	TT [kha]	TN [kha]	NR [kha]	ZA [kha]	BB [kha]	PO [kha]	KE [kha]
1996	**0,4680**	0,0150	0,0390	0,0170	0,0330	0,0430	0,0290	0,1970	0,0950
1997	**0,3880**	0,0340	0,0290	0,0870	0,0190	0,0150	0,0460	0,0130	0,1450
1998	**0,3780**	0,0060	0,0160	0,0110	0,0350	0,0090	0,0400	0,1430	0,1180
1999	**0,2970**	0,0140	0,0260	0,0730	0,0260	0,0320	0,0160	0,0960	0,0140
2000	**0,1270**	0,0100	0,0070	0,0240	0,0100	0,0200	0,0160	0,0300	0,0100
2001	**0,3020**	0,0570	0,0060	0,0150	0,0270	0,0760	0,0290	0,0310	0,0610
2002	**0,1490**	0,0190	0,0260	0,0050	0,0220	0,0080	0,0220	0,0410	0,0060
2003	**0,3210**	0,0400	0,0210	0,1300	0,0090	0,0510	0,0260	0,0160	0,0280
2004	**0,0250**	0,0020	0,0000	0,0020	0,0010	0,0110	0,0020	0,0060	0,0010
2005	**0,5340**	0,2090	0,0210	0,1870	0,0170	0,0120	0,0370	0,0350	0,0160
2006	**0,2390**	0,0180	0,0080	0,0260	0,0100	0,0040	0,0350	0,1210	0,0170
2007	**0,4540**	0,0260	0,0520	0,0470	0,0660	0,0610	0,0230	0,1610	0,0180
2008	**0,3230**	0,0260	0,0290	0,0330	0,0170	0,0590	0,0910	0,0260	0,0410
2009	**0,4620**	0,1990	0,0230	0,0530	0,0440	0,0490	0,0100	0,0430	0,0410
2010	**0,3260**	0,0340	0,0180	0,0270	0,0060	0,0870	0,0250	0,0910	0,0380

In the following table (Table 11.5) there 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 percentage of areas of AR activities during 1996 – 2010 from whole country (SK) and different Slovak districts (BA, TT, TN, NR, ZA, BB, PO and KE)

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
2010	0,0557	0,0482	0,0031	0,0980	0,0170	0,0043	0,1229	0,0724	0,0341

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 32.987 kha in total and 1.57 kha in average by the year in Slovak conditions from 1990 to 2010. In the same time period the total deforestation areas amounted to 7.766 kha in total resp. 0.37 kha in 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 – 2010.

Table 11.6: The differences between AR and D activities during 1990 – 2010

	Afforestation/Reforestation (AR, kha/year)				Deforestation (D, kha/year)					
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
2010	0,035	1,218	1,479	2,732	0,022	0,156	0,066	0,082	0,326	2,406

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 Coll., 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 both in Slovak and English 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:

$$\Delta C_{LFLB} = \Delta C_{LFGROWTH} - \Delta C_{LFLOSS}$$

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:

$$\Delta C_{LFGROWTH} = (\sum A \bullet G_{TOTAL}) \bullet CF$$

$\Delta C_{LFGROWTH}$=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 the 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. These data were published by Priwitzer et al. (2008), Priwitzer et al. (2009) and Pajtík et al. (article under review process). The annual increment of the total tree 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 activity data comes from representative experimental plots. 7 plots per each tree species were established. Then, whole-tree samples including foliages, branches, stem and coarse roots were taken, oven-dried and weighed. We constructed allometic relationships for all tree compartments using tree height and/or diameter on stem base as independent variables. The tree biomass at the sites was measured and calculated by different compartment (stem, branches, roots and foliage) from the measured data using allometric functions. Moreover, soil cores for fine roots (diameter up to 2 mm) estimation were taken. Biomass for all tree compartments was calculated on a hectare base. Biomass allocation into the tree compartments changed with stand size, also, some inter-specific differences were found. Most probably, carbon accumulated in the soil prevailed over carbon fixed in the dendromass.

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 Statistical Office of the Slovak Republic (www.statistics.sk) and represented 35% for spruce, 15% for pine, 46% for beech and 4% for oak in 2010.

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:

$$\Delta C_{LFLOSS} = L_{fellings} + L_{fuelwood} + L_{other\ losses}$$

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}, $L_{other\ losses}$=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 the 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 conditions. 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 conditions.

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:

$$\Delta C_{LOLB} = A_{Conversion} \bullet (B_{After} - B_{Before}) \bullet CF$$

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.

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 the calculation of above ground biomass carbon stocks on forest land prior conversion. 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. 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) were used for calculation of below-ground biomass stocks.

Change in Carbon Stocks in Dead Organic Matter for ARD

Methods to quantify emissions and removals of carbon in dead organic matter pools (deadwood and litter) following conversion of land to forest land (afforestation/reforestation) 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 use categories (cropland, grassland, settlements, other lands) does not produce deadwood or litter (grassland produces 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 realized 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).

The deadwood carbon pool contains from standing dead trees, stumps, coarse laying deadwood and small-sized laying deadwood not included in the litter or soil carbon pools in Slovak conditions. Quantification of deadwood was, unlike abroad, performed in such a way that all its components were determined in the same volume units (m^3 outside bark) in order to enable their aggregation. The volume of standing dead trees was determined from the volume equations of living trees (HSK). In order to determine the stump volume, new regression equations were derived, while the diameter at the top of the cut area D and the stump height H represent input variables. The volume of the lying deadwood with the top diameter of 7 cm was calculated from the measured diameters d1 and d2 (cm) outside bark at both ends and the length of each piece inside the IP or a sub-plot using the Smalian equation (Šmelko 2000). The volume of small-sized lying deadwood (having diameter from 1 to 7 cm) was estimated by the original method, where the volume of small-sized lying deadwood (in m^3) densely arranged in 1 m^2 is calculated from the biometrical model as a function of the middle diameter of small-sized lying deadwood multiplied by the area of IP, estimated coverage of small-sized lying deadwood, and tree species proportion (Šmelko et al. 2008).

Litter includes all non-living biomass with a size less than the minimum diameter chosen for dead wood (e.g., 0 cm) in Slovak condition. This includes the surface organic layer (horizons L, F, H) as usually defined in soil typologies. Live fine roots above the mineral or organic soil (of less than the minimum diameter limit chosen for below-ground biomass) are included in litter because they cannot be distinguished from it empirically. The small-sized lying deadwood (diameter between 0 and 7 cm), in various states of decomposition above the mineral soil are not a part of litter, because they are included in deadwood in Slovak condition. This definition is similar to the definition of surface soil organic layer in forests comprising all humus sublayers or subhorizons (L, F, H – if present) including all non-living parts of biomass (foliage, seeds, buds, flowers). All existing national databases of carbon stocks in forest soil organic layer are based on the same approach and soil data were obtained by standard sampling procedure including this humus layers.

The total carbon stock in litter represents 16.66 Mt (mean value per area unit is 8.3 t/ha). These values are derived from similar datasets of the Forest Monitoring System (FMS) and the National Forest Inventory (NFI) as a part of soil inventory. The net carbon stock change in litter was estimated using the country specific Tier 2 method. It was based on existing data sets from soil inventories and published information (Šály 1998, Kobza et al. 1997, 2002, Pavlenda 2008) with the default assumption of 20 years period for carbon stock equilibrium in „new land-use“ conditions. The mean value of 8.3 Mg C ha^{-1} for C stocks in litter (representing surface organic layer) as well as 0.415 Mg C ha^{-1} yr^{-1} as a net annual accumulation of litter over length of transition period were used for calculation of net carbon stock change in litter. Following equation was used for the calculation:

Annual changes in litter C stocks for ARD = net annual accumulation of litter (Mg C ha^{-1} yr^{-1}) x converted area (kha)

The change in litter carbon stock in each year was calculated as the sum of annual changes in C stocks for each category of land use associated with ARD.

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 value of 166.1 Mg C ha^{-1} for organic carbon stocks in forest soils (including surface organic layer) was used in previous KP LULUCF inventory. According to the recommendation of the ERT this value was reduced to 157.8 Mg C ha^{-1}. The difference is the amount of carbon accumulated in surface organic layer which is now calculated separately. For respective land use categories following reviewed values (calculated as weighted average) were used for calculations of carbon stock changes in mineral soils (0-100 cm, without any surface organic layer) as a result of land use change: Forest Land: 157.8 Mg C ha^{-1}, Grassland: 129.7 Mg C ha^{-1}, Cropland: 108.6 Mg C ha^{-1}, Settlements: 97.3 Mg C ha^{-1}, Other Land: 97.3 Mg C ha^{-1}. The average annual C stock change in mineral soil for ARD was calculated as:

Annual changes in mineral soil C stocks for ARD = average annual change of SOC (Mg C ha^{-1} yr^{-1}) x converted area (kha)

Average annual change of SOC = (mean SOC stock of FL - mean SOC stock of land converted to FL)/20

The following values were calculated for different type of conversion:

Aff/Ref of Cropland – 2.446 Mg C ha^{-1} yr^{-1}, Aff/Ref of Grassland – 1.404 Mg C ha^{-1} yr^{-1}, Aff/Ref of Other Land– 3.024 Mg C ha^{-1} yr^{-1}, Deforestation – 3.024 Mg C ha^{-1} yr^{-1}.

The change in soil carbon stock in each year was calculated as the sum of annual changes in C stocks for each category of land-use associated with land converted to forest or from forest in selected districts. As was mentioned in category Forest land remaining Forest Land, the same values as in previous inventory was used until the validation and final data management from the NFI plots has not been finished. Due to 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 separately as individual carbon pool. 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 are not occurring, neither.

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 following recalculations were performed:

- Calculation of litter carbon stocks as an individual carbon pool for ARD activities.
- Recalculation in deforestation of living (above and below ground) biomass in 2009 for reason of calculation more precisely wood stocks on deforested areas.
- Recalculation in afforestation/reforestation of living (above and below ground) biomass in 2009 for reason of calculation more precisely tree species composition on afforested areas.

11.3.1.5 Uncertainty estimates

The uncertainties are already presented in chapters concerning conversion of Forest land (CL, GL, S, OL to FL and FL to CL, GL, S, OL). According to the expert estimation and based on statistical approach for the estimation of wood stocks in the Slovak forests published by Šmelko et al. (2003) the uncertainty represented 15-20%. The accuracy of above ground biomass annual increment on new afforested areas represented by standard deviation was following: spruce ±1.37 t dm /ha/y, pine ±1.50 t dm/ha/y, beech ±1.56 t dm/ha/y and oak ±0.91 t dm/ha/y. The accuracy of below ground biomass annual increment on new afforested areas represented by standard deviation was following: spruce ±0.22 t dm /ha/y, pine ±0.12 t dm/ha/y, beech ±0.55 t dm/ha/y and oak ±0.24 t dm/ha/y.

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 law. 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 a special plan is needed. 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 considered 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 activities represented 511.99 Gg CO_2 in 2010. Deforestation represents emissions of 180.63 Gg CO_2 in 2010. 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 a revised version of the Initial Report of the Slovak Republic based on FCCC/IRR/2007/SVK from 19th September 2007[23] the quantified emission limitation or reduction commitment of 92% from the base year level has been accepted by the Slovak Republic as is stated 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 (1995). The assigned amount of the

[23] http://unfccc.int/resource/docs/2007/irr/svk.pdf

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 tones of CO_2 equivalent.

Average assigned amount of the Slovak Republic over the first commitment period is:

331 433 516/5 = 66 286 703 tones of CO_2 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 (SEF) tables provide information on AAUs, ERUs, RMUs, CERs, lCERs and tCERs in the Slovak National Emission Registry.

SEF tables are included in the submission for the fourth time (SEF_SK_2012_1_9-17-3 12-4-2012.xls). The tables include all required information on Kyoto units in the Slovak National Emission Registry for the calendar year 2011 as well as information on transfers of the units in 2011 to and from other Parties of the Kyoto Protocol. SEF tables have been filled automatically using SEF reporting module in Seringas software respecting all UNFCCC's requirements and guidance and have been checked for completeness and consistency.

The Standard Electronic Format report for year 2011 has been submitted to the UNFCCC Secretariat electronically. According to the information from Slovak National Emission Registry the current status of the units and reductions of the year 2010 was summarized in the following Table 12.2.

Table 12.2: Statistics of the year 2011 from the Slovak National Emission Registry

	AAU	CER	ERU	RMU
Issuance	0	0	0	0
Acquisition	0	8 432 138	412 000	0
Holding	152 821 296	8 611 783	44 596	0
Transfer	750 000	4 278 722	386 000	0
Cancellation	0	0	0	0
Withdrawal	0	0	0	0
Carry-over	0	0	0	0

12.3 Discrepancies and notifications

Reports R-2 to R-5 provide 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 the Slovak National Emission Registry, no CDM notifications were received, no non-replacements occurred and there were no invalid units identified. Therefore no additional actions or changes of established measures were necessary to be undertaken in order to address discrepancies.

12.4 Publicly accessible information

Public information is accessible in the National Registry Administrator site (https://co2.dexia.sk) and it 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 multiplied by five, whichever value is the lowest. Due to substantive methodology improvements and fulfilled recalculations the Slovak Republic decided to use emission inventory 2010 submitted in 2012 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 229 909 329 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 an estimated commitment period reserve for the Slovak Republic is equal to the 229 909 329 tones of CO_2 equivalent for the submission 2012 emission inventory 2010.

12.6 KP-LULUCF accounting

In 2010, total CO_2 removals from afforestation/reforestation activities were -511.99 Gg of CO_2 (changes in 30.25 kha to the end of 2010). Total CO_2 emissions from deforestation were 180.63 Gg of CO_2 (changes in 6.66 kha to the end of 2010). In 2010, total emissions under the Article 3.3 of the KP - 331.36 Gg with the changed area of 37.69 kha.

Table 12.3: Emissions and removals resulting from activities 3.3 of the KP in 2008 – 2010

Activities	2008	2009	2010	Total
	Net CO2 (Gg)			
A. Article 3.3 activities	-278,64	-187,08	-331,36	**-797,09**
A.1. Afforestation and Reforestation	-453,12	-469,30	-511,99	**-1 434,41**
A.1.1. Units of land not harvested since the beginning of the commitment period	-453,12	-469,30	-511,99	**-1 434,41**
A.1.2. Units of land harvested since the beginning of the commitment period	NA	NA	NA	**NA**
A.2. Deforestation	174,47	282,22	180,63	**637,32**

Emissions are determined as of 15.04.2012

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.[24] 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 2012, submitted on 15th April 2012.

During the last year 2011 several changes concerning the administration of the National Inventory System under article 5.1 the Kyoto Protocol has been undertaken:

- Single National Entity was delegated on the Department on Emissions and Air Quality Monitoring with the permanent staff 2.5 capacity by the director general decree from August 2011.
- According to the Governmental Resolution No. 821/2011 from 19 December 2011, the inter-ministerial High-level Committee on Coordination of Climate Change Policy was established. This Committee is created at the state secretary level and will replace previous co-ordinating body, i.e the High Level Committee on Climate-Energy Package established in August 2008. Committee is chaired by the State Secretary of the Ministry of the Environment, other members are the state secretaries of the Ministry of Economy, Ministry of Agriculture and Rural Development, Ministry of Transport, Construction and Regional Development, Ministry of Education, Science, Research and Sport, Ministry of Health, Ministry of Finance, Ministry of Foreign Affairs and the Head of the Regulatory Office for the Network Industries. Main objectives of inter-ministerial body are to develop and implement national strategy on mitigation and adaptation and to ensure cost-effective meeting of reduction commitments both in middle and long-term frame. Committee will play an important role also in process of evaluation of fulfillment of our climate change objectives and commitments and will regularly submit report on progress in achievement to be considered by the Slovak Government.

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 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

Slovak National Emission Registry Administrator is using software SERINGAS, developed by French company CDC Climat for maintaining its National Registry.

During reported period there have been three updates of the SERINGAS software:

- February 2011, version 5.0.4
- May 2011, version 5.1
- September 2011, version 5.2.1

[24] *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*

There were no changes concerning operation and functioning of the Slovak National Emission Registry from UNFCCC point of view implemented to Production environment during reported period.

The releases dealt mostly with security improvements, functionalities under EU ETS scheme and minor bug's corrections.

- P1.3.1 15/CMP.1 annex II.E paragraph 32(a)

The change of name or contact:

There have been two changes in the contact information of the National Administrator during reported period – Alternate Contact changed in June what was reported to the UNFCCC through our National Focal Point and telephone numbers of National Administrator staff in August for which no paperwork was required.

- P1.3.2 15/CMP.1 annex II.E paragraph 32.(b)

The change of cooperation arrangement:

No change of cooperation arrangement occurred during the reported period. Slovakia did not maintain its National Registry in a consolidated system during reported period.

- P1.3.3 15/CMP.1 annex II.E paragraph 32.(c)

The change to the database or the capacity of National Registry:

No change to the database or to the capacity of the national registry occurred during reported period.

- P1.3.4 15/CMP.1 annex II.E paragraph 32.(d)

The change of conformance to technical standards:

No change to the registry's conformance to technical standards occurred during reported period.

- P1.3.5 15/CMP.1 annex II.E paragraph 32.(e)

The change of discrepancy procedures:

No change of discrepancy procedures occurred during reported period. No discrepancy occurred during reported period.

- P1.3.6 15/CMP.1 annex II.E paragraph 32.(f)

The change of security:

The Slovak National Emission Registry was improved from security point of view during reported period with 3 new releases of software. Recommendations form internal and external penetration testing, as well as the recommendations from European Commission, such as measures preventing session hijacking (version 5.1, May) and cross site scripting (version 5.2.1, September) were implemented.

Slovak National Emission Registry moved to two level authentications (SMS notifications) with version 5.0.4 in early February.

- P1.3.7 15/CMP.1 annex II.E paragraph 32.(g)

The change of list of publicly available information:

No change to the list of publicly available information occurred during reported 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 reported period. The Internet address is https://co2.dexia.sk from the start of the National Registry operation.

- 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 reported 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 reported period.

14.2 The previous annual review recommendations

There have been no recommendations in the previous Standard Independent Assessment Report for Slovakia (reference no.: IAR/2010/SVK/2/1)

14.3 Public Information

Public information is accessible in the National Registry Administrator site (https://co2.dexia.sk) and it 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.

14.4 Accounting of Kyoto Protocol Units

- 15/CMP.1 annex I.E paragraph 12

No discrepant transactions occurred in 2011.

- 15/CMP.1 annex I.E paragraph 13 & 14

No CDM notifications occurred in 2011.

- 15/CMP.1 annex I.E paragraph 15

No non-replacements occurred in 2011.

- 15/CMP.1 annex I.E paragraph 16

No invalid units exist as at 31st December 2011.

- 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 a significant impact of its internal price mechanism 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 in the 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 phase 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 No. 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 the European Union[25] has provided a significant stimulus for the production of biofuels as well as to the stronger growth of the international trade with biofuels,

[25] *A strong demand growth for biofuels has contributed also a combination of different supporting policies in the EU and USA.*

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.

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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

Those key source categories by level assessment and trend assessment were chosen, of which 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 2010 29 key source categories by level assessment with LULUCF and 26 key source categories without LULUCF. The Slovak Republic determined in year 2010 31 key source categories by trend assessment with LULUCF and 28 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.

Table NIR.3, as contained in the annex to decision 6/CMP.3

Table A1.1: 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

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 2010

IPCC Source Categories	Direct GHG	Base Year Estimate (1990)	Current Year Estimate (2010)	Level Assesment	Cumulative Total of Column E
1.A.3.b Transport - Road Transportation - liquid	CO2	4 503,02	6 443,59	12,30	12,30
1.A.1 Energy Industries - solid	CO2	11 552,58	5 477,15	10,45	22,75
5.A Forest Land	CO2	10 335,39	5 332,61	10,18	32,93
1.A.2 Manufacturing Industries and Construction - solid	CO2	9 825,68	5 168,41	9,86	42,80
1.A.1 Energy Industries - gaseous	CO2	2 844,44	4 016,60	7,67	50,46
1.A.4 Other sector - gaseous	CO2	2 841,82	3 883,84	7,41	57,88
2(I).C.1.1 Steel Production	CO2	3 917,65	3 790,16	7,23	65,11
1.A.2 Manufacturing Industries and Construction - gaseous	CO2	5 723,56	2 308,54	4,41	69,52
6.A Solid Waste Disposal on Land	CH4	469,77	1 615,26	3,08	72,60
4.D.1 Agricultural Soils - Direct	N2O	2 414,06	1 236,07	2,36	74,96
1.A.2 Manufacturing Industries and Construction - liquid	CO2	4 163,11	1 042,46	1,99	76,95
1.A.5.a Other non-specified - gaseous	CO2	1 639,63	926,28	1,77	78,72
2(I).B.2 Nitric Acid Production	N2O	1 187,50	903,75	1,72	80,44
2(I).A.1 Cement Production	CO2	1 438,01	844,58	1,61	82,05
4.A Enteric Fermentation - Cattle	CH4	1 802,03	748,23	1,43	83,48
2(I).A.2 Lime Production	CO2	770,42	728,80	1,39	84,87
1.B.1.b Fugitive Emission from Oil, Natural Gas and Other	CH4	513,50	728,32	1,39	86,26
5.B Cropland	CO2	180,41	714,79	1,36	87,63
1.A.4 Other sector - solid	CO2	7 679,65	497,63	0,95	88,58
2(I).B.1 Ammonia Production	CO2	616,97	484,65	0,93	89,50
4.D.3 Agricultural Soils - Indirect	N2O	995,23	385,76	0,74	90,24
1.A.1 Energy Industries - liquid	CO2	1 540,39	384,44	0,73	90,97
2(I).A.7.2 Magnezite Production	CO2	431,94	376,34	0,72	91,69
4.B Manure Management	N2O	5 442,08	374,44	0,71	92,40
6.B Wastew ater Handling	CH4	413,83	359,52	0,69	93,09
2(I).A.3 Limestone and Dolomite Use	CO2	318,23	340,31	0,65	93,74
5.C Grassland	CO2	327,72	325,94	0,62	94,36
1.B.1.a Coal Mining and Handling	CH4	571,15	319,73	0,61	94,97
2(I).F HFCs emissions	HFCs	0,00	316,96	0,60	95,58
2(I).C.3 Aluminium Production	CO2	121,32	239,38	0,46	96,03
2(I).B.4. Calcium Carbide Production	CO2	0,00	219,10	0,42	96,45
2(I).C.2 Ferroalloys Production	CO2	264,24	200,45	0,38	96,84
1.A.1 Energy Industries - other	CO2	170,30	172,19	0,33	97,16
5.F Other Land	CO2	400,52	137,92	0,26	97,43
5.E Settlements	CO2	121,44	119,44	0,23	97,66
4.B Manure Management	CH4	72,78	119,02	0,23	97,88
4.A Enteric Fermentation - except cattle	CH4	211,90	108,85	0,21	98,09
1.A.4 Other sector - liquid	CO2	386,64	94,64	0,18	98,27
4.D.2 Agricultural Soils - PRP	N2O	221,71	92,96	0,18	98,45
1.A.3.c Transport - Railw ays - liquid	CO2	376,77	87,80	0,17	98,62
6.B Wastew ater Handling	N2O	138,77	87,07	0,17	98,78
3.D Other Solvent Use	N2O	17,05	80,79	0,15	98,94
1.A.3.b Transport - Road Transportation - liquid	N2O	58,64	66,05	0,13	99,06
6.C Waste Composting	N2O	1,86	62,24	0,12	99,18
3.A Paint Application	CO2	94,44	58,88	0,11	99,29
6.C Waste Composting	CH4	1,68	56,22	0,11	99,40
6.C Waste Incineration	CO2	62,70	37,09	0,07	99,47
5.A Forest Land	CH4	14,09	22,91	0,04	99,52
2(I).C.3 Aluminium Production	PFCs	271,37	21,15	0,04	99,56
2(I).F SF6 emissions	SF6	0,03	19,90	0,04	99,59
1.A.3.b Transport - Road Transportation - gaseous	CO2	0,00	19,82	0,04	99,63
1.A.1 Energy Industries - solid	N2O	52,38	19,18	0,04	99,67
3.C Chemical Products, Manufacture and Processing	CO2	18,11	18,53	0,04	99,70
2(I).B.1 Ammonia Production	CH4	24,57	17,80	0,03	99,74
2(I).C.1.5 EAF Steel Production	CO2	18,15	17,60	0,03	99,77
1.A.3.b Transport - Road Transportation - liquid	CH4	24,47	13,37	0,03	99,80
2(I).A.7.1 Glass Production	CO2	7,88	13,15	0,03	99,82
1.A.3.c Transport - Railw ays - liquid	N2O	50,19	11,70	0,02	99,84
1.A.2 Manufacturing Industries and Construction - solid	N2O	41,44	10,19	0,02	99,86
1.A.4 Other sector - gaseous	CH4	5,38	7,40	0,01	99,88
3.B Degreasing and Dry Cleaning	CO2	17,55	6,14	0,01	99,89
1.A.3.a Transport - Civil Aviation - jet kerosen	CO2	7,00	5,44	0,01	99,90
2(I).B.1 Ammonia Production	N2O	7,25	5,25	0,01	99,91
6.C Waste Incineration	N2O	2,73	4,75	0,01	99,92
5.A Forest Land	N2O	12,09	4,65	0,01	99,93
1.A.2 Manufacturing Industries and Construction - gaseous	CH4	10,96	4,40	0,01	99,94
1.A.5.a Other non-specified - solid	CO2	197,91	4,01	0,01	99,94
1.A.5.a Other non-specified - liquid	CO2	34,99	3,73	0,01	99,95
1.A.1 Energy Industries - other	N2O	4,90	3,31	0,01	99,96
1.A.2 Manufacturing Industries and Construction - liquid	N2O	10,79	2,37	0,00	99,96
1.A.4 Other sector - solid	N2O	31,12	2,29	0,00	99,97
1.A.1 Energy Industries - gaseous	N2O	1,53	2,26	0,00	99,97
1.A.4 Other sector - gaseous	N2O	1,59	2,18	0,00	99,97
1.A.5.a Other non-specified - gaseous	CH4	3,10	1,76	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	CH4	1,87	1,53	0,00	99,98
1.A.2 Manufacturing Industries and Construction - gaseous	N2O	3,24	1,30	0,00	99,99
1.A.3.b Transport - Road Transportation - gaseous	CH4	0,00	1,24	0,00	99,99
1.A.1 Energy Industries - solid	CH4	2,53	1,02	0,00	99,99
1.A.2 Manufacturing Industries and Construction - solid	CH4	21,85	0,91	0,00	99,99
1.A.1 Energy Industries - liquid	N2O	3,80	0,90	0,00	99,99
1.A.2 Manufacturing Industries and Construction - liquid	CH4	2,69	0,80	0,00	100,00
1.A.5.a Other non-specified - gaseous	N2O	0,92	0,52	0,00	100,00
1.A.1 Energy Industries - liquid	CH4	1,29	0,48	0,00	100,00
1.A.3.a Transport - Civil Aviation - av. Gasoline	CO2	0,73	0,39	0,00	100,00
1.B.1.b Fugitive Emission from Oil, Natural Gas and Other	CO2	0,15	0,19	0,00	100,00
1.A.3.a Transport - Civil Aviation - jet kerosen	N2O	0,24	0,19	0,00	100,00
1.A.3.c Transport - Railw ays - liquid	CH4	0,62	0,11	0,00	100,00
1.A.4 Other sector - solid	CH4	0,45	0,11	0,00	100,00
2(I).C.2 Ferroalloys Production	CH4	0,00	0,10	0,00	100,00
1.A.4 Other sector - liquid	N2O	0,95	0,07	0,00	100,00
1.A.3.e Transport - Other - liquid	N2O	0,24	0,05	0,00	100,00
1.A.4 Other sector - liquid	CH4	1,07	0,04	0,00	100,00
1.A.5.a Other non-specified - solid	N2O	0,93	0,02	0,00	100,00
1.A.3.a 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.3.b Transport - Road Transportation - gaseous	N2O	0,00	0,01	0,00	100,00
1.A.3.a 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.5.a Other non-specified - liquid	CH4	0,10	0,00	0,00	100,00
1.A.3.e Transport - Other - liquid	CH4	0,01	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.5.a Other non-specified - solid	CH4	0,45	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 2010

IPCC Source Categories	GHG	Base Year Estimate (1990)	Current Year Estimate (2010)	Level Assesment	Cumulative Total of Column E
1.A.3.b Transport - Road Transportation - liquid	CO2	4 503,02	6 443,59	14,09	14,09
1.A.1 Energy Industries - solid	CO2	11 552,58	5 477,15	11,98	26,07
1.A.2 Manufacturing Industries and Construction - solid	CO2	9 825,68	5 168,41	11,30	37,37
1.A.1 Energy Industries - gaseous	CO2	2 844,44	4 016,60	8,78	46,15
1.A.4 Other sector - gaseous	CO2	2 841,82	3 883,84	8,49	54,64
2(I).C.1.1 Steel Production	CO2	3 917,65	3 790,16	8,29	62,93
1.A.2 Manufacturing Industries and Construction - gaseous	CO2	5 723,56	2 308,54	5,05	67,98
6.A Solid Waste Disposal on Land	CH4	469,77	1 615,26	3,53	71,51
4.D.1 Agricultural Soils - Direct	N2O	2 414,06	1 236,07	2,70	74,21
1.A.2 Manufacturing Industries and Construction - liquid	CO2	4 163,11	1 042,46	2,28	76,49
1.A.5.a Other non-specified - gaseous	CO2	1 639,63	926,28	2,03	78,52
2(I).B.2 Nitric Acid Production	N2O	1 187,50	903,75	1,98	80,49
2(I).A.1 Cement Production	CO2	1 438,01	844,58	1,85	82,34
4.A Enteric Fermentation - Cattle	CH4	1 802,03	748,23	1,64	83,97
2(I).A.2 Lime Production	CO2	770,42	728,80	1,59	85,57
1.B.1.b Fugitive Emission from Oil, Natural Gas and Other	CH4	513,50	728,32	1,59	87,16
1.A.4 Other sector - solid	CO2	7 679,65	497,63	1,09	88,25
2(I).B.1 Ammonia Production	CO2	616,97	484,65	1,06	89,31
4.D.3 Agricultural Soils - Indirect	N2O	995,23	385,76	0,84	90,15
1.A.1 Energy Industries - liquid	CO2	1 540,39	384,44	0,84	90,99
2(I).A.7.2 Magnezite Production	CO2	431,94	376,34	0,82	91,82
4.B Manure Management	N2O	5 442,08	374,44	0,82	92,63
6.B Wastew ater Handling	CH4	413,83	359,52	0,79	93,42
2(I).A.3 Limestone and Dolomite Use	CO2	318,23	340,31	0,74	94,16
1.B.1.a Coal Mining and Handling	CH4	571,15	319,73	0,70	94,86
2(I).F HFCs emissions	HFCs	0,00	316,96	0,69	95,56
2(I).C.3 Aluminium Production	CO2	121,32	239,38	0,52	96,08
2(I).B.4 Carbide Production	CO2	0,00	219,10	0,48	96,56
2(I).C.2 Ferroalloys Production	CO2	264,24	200,45	0,44	97,00
1.A.1 Energy Industries - other	CO2	170,30	172,19	0,38	97,37
4.B Manure Management	CH4	72,78	119,02	0,26	97,63
4.A Enteric Fermentation - except cattle	CH4	211,90	108,85	0,24	97,87
1.A.4 Other sector - liquid	CO2	386,64	94,64	0,21	98,08
4.D.2 Agricultural Soils - PRP	N2O	221,71	92,96	0,20	98,28
1.A.3.c Transport - Railw ays - liquid	CO2	376,77	87,80	0,19	98,47
6.B Wastew ater Handling	N2O	138,77	87,07	0,19	98,67
3.D Other Solvent Use	N2O	17,05	80,79	0,18	98,84
1.A.3.b Transport - Road Transportation - liquid	N2O	58,64	66,05	0,14	98,99
6.C Waste Composting	N2O	1,86	62,24	0,14	99,12
3.A Paint Application	CO2	94,44	58,88	0,13	99,25
6.C Waste Composting	CH4	1,68	56,22	0,12	99,37
6.C Waste Incineration	CO2	62,70	37,09	0,08	99,46
2(I).C.3 Aluminium Production	PFCs	271,37	21,15	0,05	99,50
2(I).F SF6 emissions	SF6	0,03	19,90	0,04	99,54
1.A.3.b Transport - Road Transportation - gaseous	CO2	0,00	19,82	0,04	99,59
1.A.1 Energy Industries - solid	N2O	52,38	19,18	0,04	99,63
3.C Chemical Products, Manufacture and Processing	CO2	18,11	18,53	0,04	99,67
2(I).B.1 Ammonia Production	CH4	24,57	17,80	0,04	99,71
2(I).C.1.5 EAF Steel Production	CO2	18,15	17,60	0,04	99,75
1.A.3.b Transport - Road Transportation - liquid	CH4	24,47	13,37	0,03	99,78
2(I).A.7.1 Glass Production	CO2	7,88	13,15	0,03	99,81
1.A.3.c Transport - Railw ays - liquid	N2O	50,19	11,70	0,03	99,83
1.A.2 Manufacturing Industries and Construction - solid	N2O	41,44	10,19	0,02	99,85
1.A.4 Other sector - gaseous	CH4	5,38	7,40	0,02	99,87
3.B Degreasing and Dry Cleaning	CO2	17,55	6,14	0,01	99,88
1.A.3.a Transport - Civil Aviation - jet kerosen	CO2	7,00	5,44	0,01	99,90
2(I).B.1 Ammonia Production	N2O	7,25	5,25	0,01	99,91
6.C Waste Incineration	N2O	2,73	4,75	0,01	99,92
1.A.2 Manufacturing Industries and Construction - gaseous	CH4	10,96	4,40	0,01	99,93
1.A.5.a Other non-specified - solid	CO2	197,91	4,01	0,01	99,94
1.A.5.a Other non-specified - liquid	CO2	34,99	3,73	0,01	99,94
1.A.1 Energy Industries - other	N2O	4,90	3,31	0,01	99,95
1.A.2 Manufacturing Industries and Construction - liquid	N2O	10,79	2,37	0,01	99,96
1.A.4 Other sector - solid	N2O	31,12	2,29	0,00	99,96
1.A.1 Energy Industries - gaseous	N2O	1,53	2,26	0,00	99,97
1.A.4 Other sector - gaseous	N2O	1,59	2,18	0,00	99,97
1.A.5.a Other non-specified - gaseous	CH4	3,10	1,76	0,00	99,97
1.A.3.e Transport - Other - liquid	CO2	7,00	1,54	0,00	99,98
1.A.1 Energy Industries - gaseous	CH4	1,87	1,53	0,00	99,98
1.A.2 Manufacturing Industries and Construction - gaseous	N2O	3,24	1,30	0,00	99,98
1.A.3.b Transport - Road Transportation - gaseous	CH4	0,00	1,24	0,00	99,99
1.A.1 Energy Industries - solid	CH4	2,53	1,02	0,00	99,99
1.A.2 Manufacturing Industries and Construction - solid	CH4	21,85	0,91	0,00	99,99
1.A.1 Energy Industries - liquid	N2O	3,80	0,90	0,00	99,99
1.A.2 Manufacturing Industries and Construction - liquid	CH4	2,69	0,80	0,00	99,99
1.A.5.a Other non-specified - gaseous	N2O	0,92	0,52	0,00	100,00
1.A.1 Energy Industries - liquid	CH4	1,29	0,48	0,00	100,00
1.A.3.a Transport - Civil Aviation - av. Gasoline	CO2	0,73	0,39	0,00	100,00
1.B.1.b Fugitive Emission from Oil, Natural Gas and Other	CO2	0,15	0,19	0,00	100,00
1.A.3.a Transport - Civil Aviation - jet kerosen	N2O	0,24	0,19	0,00	100,00
1.A.3.c Transport - Railw ays - liquid	CH4	0,62	0,11	0,00	100,00
1.A.4 Other sector - solid	CH4	0,45	0,11	0,00	100,00
2(I).C.2 Ferroalloys Production	CO2	0,00	0,10	0,00	100,00
1.A.4 Other sector - liquid	N2O	0,95	0,07	0,00	100,00
1.A.3.e Transport - Other - liquid	N2O	0,24	0,05	0,00	100,00
1.A.4 Other sector - liquid	CH4	1,07	0,04	0,00	100,00
1.A.5.a Other non-specified - solid	N2O	0,93	0,02	0,00	100,00
1.A.3.a 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.3.b Transport - Road Transportation - gaseous	N2O	0,00	0,01	0,00	100,00
1.A.3.a 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.5.a Other non-specified - liquid	CH4	0,10	0,00	0,00	100,00
1.A.3.e Transport - Other - liquid	CH4	0,01	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.5.a Other non-specified - solid	CH4	0,45	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 2010

IPCC Source Categories	GHG	Base Year Estimate (1990)	Current Year Estimate (2010)	Trend Assesment	% Contribution to Trend	Cummulative total of Column F
1.A.3.b Transport - Road Transportation - liquid	CO2	4 503,02	6 443,59	12,09	13,01	13,01
1.A.1 Energy Industries - solid	CO2	11 552,58	5 477,15	4,47	4,81	17,82
5.A Forest Land	CO2	10 335,39	5 332,61	2,61	2,81	20,63
1.A.2 Manufacturing Industries and Construction - solid	CO2	9 825,68	5 168,41	2,16	2,33	22,96
1.A.1 Energy Industries - gaseous	CO2	2 844,44	4 016,60	7,46	8,03	30,99
1.A.4 Other sector - gaseous	CO2	2 841,82	3 883,84	7,04	7,58	38,57
2(I).C.1.1 Steel Production	CO2	3 917,65	3 790,16	4,69	5,05	43,62
1.A.2 Manufacturing Industries and Construction - gaseous	CO2	5 723,56	2 308,54	3,51	3,78	47,40
6.A Solid Waste Disposal on Land	CH4	469,77	1 615,26	4,29	4,61	52,01
4.D.1 Agricultural Soils - Direct	N2O	2 414,06	1 236,07	0,64	0,69	52,70
1.A.2 Manufacturing Industries and Construction - liquid	CO2	4 163,11	1 042,46	4,60	4,95	57,65
1.A.5.a Other non-specified - gaseous	CO2	1 639,63	926,28	0,16	0,17	57,82
2(I).B.2 Nitric Acid Production	N2O	1 187,50	903,75	0,63	0,68	58,50
2(I).A.1 Cement Production	CO2	1 438,01	844,58	0,03	0,04	58,54
4.A Enteric Fermentation - Cattle	CH4	1 802,03	748,23	1,04	1,12	59,66
2(I).A.2 Lime Production	CO2	770,42	728,80	0,87	0,94	60,59
1.B.1.b Fugitive Emission from Oil, Natural Gas and Other	CH4	513,50	728,32	1,36	1,46	62,05
5.B Cropland	CO2	180,41	714,79	1,95	2,10	64,15
1.A.4 Other sector - solid	CO2	7 679,65	497,63	13,06	14,06	78,21
2(I).B.1 Ammonia Production	CO2	616,97	484,65	0,38	0,41	78,62
4.D.3 Agricultural Soils - Indirect	N2O	995,23	385,76	0,66	0,71	79,33
1.A.1 Energy Industries - liquid	CO2	1 540,39	384,44	1,71	1,84	81,16
2(I).A.7.2 Magnezite Production	CO2	431,94	376,34	0,38	0,41	81,58
4.B Manure Management	N2O	5 442,08	374,44	9,19	9,89	91,46
6.B Wastew ater Handling	CH4	413,83	359,52	0,36	0,39	91,86
2(I).A.3 Limestone and Dolomite Use	CO2	318,23	340,31	0,48	0,52	92,38
5.C Grassland	CO2	327,72	325,94	0,42	0,45	92,83
1.B.1.a Coal Mining and Handling	CH4	571,15	319,73	0,06	0,07	92,90
2(I).F HFCs emissions	HFCs	0,00	316,96	1,02	1,09	93,99
2(I).C.3 Aluminium Production	CO2	121,32	239,38	0,54	0,58	94,57
2(I).B.4. Calcium Carbide Production	CO2	0,00	219,10	0,70	0,76	95,33
2(I).C.2 Ferroalloys Production	CO2	264,24	200,45	0,14	0,15	95,48
1.A.1 Energy Industries - other	CO2	170,30	172,19	0,23	0,24	95,72
5.F Other Land	CO2	400,52	137,92	0,32	0,35	96,07
5.E Settlements	CO2	121,44	119,44	0,15	0,16	96,23
4.B Manure Management	CH4	72,78	119,02	0,24	0,26	96,49
4.A Enteric Fermentation - except cattle	CH4	211,90	108,85	0,06	0,06	96,55
1.A.4 Other sector - liquid	CO2	386,64	94,64	0,43	0,47	97,02
4.D.2 Agricultural Soils - PRP	N2O	221,71	92,96	0,12	0,13	97,15
1.A.3.c Transport - Railw ays - liquid	CO2	376,77	87,80	0,44	0,47	97,63
6.B Wastew ater Handling	N2O	138,77	87,07	0,01	0,02	97,64
3.D Other Solvent Use	N2O	17,05	80,79	0,23	0,24	97,89
1.A.3.b Transport - Road Transportation - liquid	N2O	58,64	66,05	0,10	0,11	97,99
6.C Waste Composting	N2O	1,86	62,24	0,20	0,21	98,20
3.A Paint Application	CO2	94,44	58,88	0,01	0,01	98,21
6.C Waste Composting	CH4	1,68	56,22	0,18	0,19	98,40
6.C Waste Incineration	CO2	62,70	37,09	0,00	0,00	98,40
5.A Forest Land	CH4	14,09	22,91	0,05	0,05	98,46
2(I).C.3 Aluminium Production	PFCs	271,37	21,15	0,45	0,48	98,94
2(I).F SF6 emissions	SF6	0,03	19,90	0,06	0,07	99,01
1.A.3.b Transport - Road Transportation - gaseous	CO2	0,00	19,82	0,06	0,07	99,08
1.A.1 Energy Industries - solid	N2O	52,38	19,18	0,04	0,04	99,12
3.C Chemical Products, Manufacture and Processing	CO2	18,11	18,53	0,02	0,03	99,14
2(I).B.1 Ammonia Production	CH4	24,57	17,80	0,01	0,01	99,16
2(I).C.1.5 EAF Steel Production	CO2	18,15	17,60	0,02	0,02	99,18
1.A.3.b Transport - Road Transportation - liquid	CH4	24,47	13,37	0,00	0,00	99,18
2(I).A.7.1 Glass Production	CO2	7,88	13,15	0,03	0,03	99,21
1.A.3.c Transport - Railw ays - liquid	N2O	50,19	11,70	0,06	0,06	99,28
1.A.2 Manufacturing Industries and Construction - solid	N2O	41,44	10,19	0,05	0,05	99,33
1.A.4 Other sector - gaseous	CH4	5,38	7,40	0,01	0,01	99,34
3.B Degreasing and Dry Cleaning	CO2	17,55	6,14	0,01	0,01	99,35
1.A.3.a Transport - Civil Aviation - jet kerosen	CO2	7,00	5,44	0,00	0,00	99,36
2(I).B.1 Ammonia Production	N2O	7,25	5,25	0,00	0,00	99,36
6.C Waste Incineration	N2O	2,73	4,75	0,01	0,01	99,37
5.A Forest Land	N2O	12,09	4,65	0,01	0,01	99,38
1.A.2 Manufacturing Industries and Construction - gaseous	CH4	10,96	4,40	0,01	0,01	99,39
1.A.5.a Other non-specified - solid	CO2	197,91	4,01	0,36	0,39	99,78
1.A.5.a Other non-specified - liquid	CO2	34,99	3,73	0,05	0,06	99,84
1.A.1 Energy Industries - other	N2O	4,90	3,31	0,00	0,00	99,84
1.A.2 Manufacturing Industries and Construction - liquid	N2O	10,79	2,37	0,01	0,01	99,86
1.A.4 Other sector - solid	N2O	31,12	2,29	0,05	0,06	99,91
1.A.1 Energy Industries - gaseous	N2O	1,53	2,26	0,00	0,00	99,92
1.A.4 Other sector - gaseous	N2O	1,59	2,18	0,00	0,00	99,92
1.A.5.a Other non-specified - gaseous	CH4	3,10	1,76	0,00	0,00	99,92
1.A.3.e Transport - Other - liquid	CO2	7,00	1,54	0,01	0,01	99,93
1.A.1 Energy Industries - gaseous	CH4	1,87	1,53	0,00	0,00	99,93
1.A.2 Manufacturing Industries and Construction - gaseous	N2O	3,24	1,30	0,00	0,00	99,93
1.A.3.b Transport - Road Transportation - gaseous	CH4	0,00	1,24	0,00	0,00	99,94
1.A.1 Energy Industries - solid	CH4	2,53	1,02	0,00	0,00	99,94
1.A.2 Manufacturing Industries and Construction - solid	CH4	21,85	0,91	0,04	0,04	99,98
1.A.1 Energy Industries - liquid	N2O	3,80	0,90	0,00	0,00	99,99
1.A.2 Manufacturing Industries and Construction - liquid	CH4	2,69	0,80	0,00	0,00	99,99
1.A.5.a Other non-specified - gaseous	N2O	0,92	0,52	0,00	0,00	99,99
1.A.1 Energy Industries - liquid	CH4	1,29	0,48	0,00	0,00	99,99
1.A.3.a Transport - Civil Aviation - av. Gasoline	CO2	0,73	0,39	0,00	0,00	99,99
1.B.1.b Fugitive Emission from Oil, Natural Gas and Other	CO2	0,15	0,19	0,00	0,00	99,99
1.A.3.a Transport - Civil Aviation - jet kerosen	N2O	0,24	0,19	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
1.A.4 Other sector - solid	CH4	0,45	0,11	0,00	0,00	99,99
2(I).C.2 Ferroalloys Production	CH4	0,00	0,10	0,00	0,00	99,99
1.A.4 Other sector - liquid	N2O	0,95	0,07	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.4 Other sector - liquid	CH4	1,07	0,04	0,00	0,00	100,00
1.A.5.a Other non-specified - solid	N2O	0,93	0,02	0,00	0,00	100,00
1.A.3.a 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.3.b Transport - Road Transportation - gaseous	N2O	0,00	0,01	0,00	0,00	100,00
1.A.3.a 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.5.a Other non-specified - liquid	CH4	0,10	0,00	0,00	0,00	100,00
1.A.3.e Transport - Other - liquid	CH4	0,01	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.5.a Other non-specified - solid	CH4	0,45	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 2010

IPCC Source Categories	GHG	Base Year Estimate (1990)	Current Year Estimate (2010)	Trend Assesment	% Contribution to Trend	Cummulative total of Column F
1.A.3.b Transport - Road Transportation - liquid	CO2	4 503,02	6 443,59	13,79	13,78	13,78
1.A.1 Energy Industries - solid	CO2	11 552,58	5 477,15	5,17	5,17	18,94
1.A.2 Manufacturing Industries and Construction - solid	CO2	9 825,68	5 168,41	2,53	2,53	21,47
1.A.1 Energy Industries - gaseous	CO2	2 844,44	4 016,60	8,51	8,51	29,97
1.A.4 Other sector - gaseous	CO2	2 841,82	3 883,84	8,03	8,02	38,00
2(I).C.1.1 Steel Production	CO2	3 917,65	3 790,16	5,34	5,33	43,33
1.A.2 Manufacturing Industries and Construction - gaseous	CO2	5 723,56	2 308,54	4,05	4,04	47,37
6.A Solid Waste Disposal on Land	CH4	469,77	1 615,26	4,90	4,89	52,27
4.D.1 Agricultural Soils - Direct	N2O	2 414,06	1 236,07	0,74	0,74	53,01
1.A.2 Manufacturing Industries and Construction - liquid	CO2	4 163,11	1 042,46	5,28	5,28	58,29
1.A.5.a Other non-specified - gaseous	CO2	1 639,63	926,28	0,19	0,19	58,48
2(I).B.2 Nitric Acid Production	N2O	1 187,50	903,75	0,72	0,72	59,19
2(I).A.1 Cement Production	CO2	1 438,01	844,58	0,05	0,05	59,24
4.A Enteric Fermentation - Cattle	CH4	1 802,03	748,23	1,20	1,19	60,43
2(I).A.2 Lime Production	CO2	770,42	728,80	0,99	0,99	61,42
1.B.1.b Fugitive Emission from Oil, Natural Gas and Other	CH4	513,50	728,32	1,55	1,55	62,97
1.A.4 Other sector - solid	CO2	7 679,65	497,63	14,97	14,95	77,92
2(I).B.1 Ammonia Production	CO2	616,97	484,65	0,43	0,43	78,35
4.D.3 Agricultural Soils - Indirect	N2O	995,23	385,76	0,76	0,76	79,11
1.A.1 Energy Industries - liquid	CO2	1 540,39	384,44	1,96	1,96	81,07
2(I).A.7.2 Magnezite Production	CO2	431,94	376,34	0,44	0,44	81,50
4.B Manure Management	N2O	5 442,08	374,44	10,53	10,52	92,02
6.B Wastew ater Handling	CH4	413,83	359,52	0,41	0,41	92,44
2(I).A.3 Limestone and Dolomite Use	CO2	318,23	340,31	0,55	0,55	92,99
1.B.1.a Coal Mining and Handling	CH4	571,15	319,73	0,08	0,08	93,06
2(I).F HFCs emissions	HFCs	0,00	316,96	1,16	1,16	94,23
2(I).C.3 Aluminium Production	CO2	121,32	239,38	0,61	0,61	94,84
2(I).B.4 Carbide Production	CO2	0,00	219,10	0,80	0,80	95,64
2(I).C.2 Ferroalloys Production	CO2	264,24	200,45	0,16	0,16	95,80
1.A.1 Energy Industries - other	CO2	170,30	172,19	0,26	0,26	96,06
4.B Manure Management	CH4	72,78	119,02	0,28	0,28	96,33
4.A Enteric Fermentation - except cattle	CH4	211,90	108,85	0,06	0,06	96,40
1.A.4 Other sector - liquid	CO2	386,64	94,64	0,50	0,50	96,90
4.D.2 Agricultural Soils - PRP	N2O	221,71	92,96	0,14	0,14	97,04
1.A.3.c Transport - Railw ays - liquid	CO2	376,77	87,80	0,50	0,50	97,54
6.B Wastew ater Handling	N2O	138,77	87,07	0,02	0,02	97,56
3.D Other Solvent Use	N2O	17,05	80,79	0,26	0,26	97,82
1.A.3.b Transport - Road Transportation - liquid	N2O	58,64	66,05	0,11	0,11	97,93
6.C Waste Composting	N2O	1,86	62,24	0,22	0,22	98,15
3.A Paint Application	CO2	94,44	58,88	0,01	0,01	98,16
6.C Waste Composting	CH4	1,68	56,22	0,20	0,20	98,37
6.C Waste Incineration	CO2	62,70	37,09	0,00	0,00	98,37
2(I).C.3 Aluminium Production	PFCs	271,37	21,15	0,52	0,52	98,88
2(I).F SF6 emissions	SF6	0,03	19,90	0,07	0,07	98,95
1.A.3.b Transport - Road Transportation - gaseous	CO2	0,00	19,82	0,07	0,07	99,03
1.A.1 Energy Industries - solid	N2O	52,38	19,18	0,04	0,04	99,07
3.C Chemical Products, Manufacture and Processing	CO2	18,11	18,53	0,03	0,03	99,10
2(I).B.1 Ammonia Production	CH4	24,57	17,80	0,01	0,01	99,11
2(I).C.1.5 EAF Steel Production	CO2	18,15	17,60	0,02	0,02	99,14
1.A.3.b Transport - Road Transportation - liquid	CH4	24,47	13,37	0,00	0,00	99,14
2(I).A.7.1 Glass Production	CO2	7,88	13,15	0,03	0,03	99,17
1.A.3.c Transport - Railw ays - liquid	N2O	50,19	11,70	0,07	0,07	99,24
1.A.2 Manufacturing Industries and Construction - solid	N2O	41,44	10,19	0,05	0,05	99,29
1.A.4 Other sector - gaseous	CH4	5,38	7,40	0,02	0,02	99,31
3.B Degreasing and Dry Cleaning	CO2	17,55	6,14	0,02	0,02	99,32
1.A.3.a Transport - Civil Aviation - jet kerosen	CO2	7,00	5,44	0,00	0,00	99,33
2(I).B.1 Ammonia Production	N2O	7,25	5,25	0,00	0,00	99,33
6.C Waste Incineration	N2O	2,73	4,75	0,01	0,01	99,34
1.A.2 Manufacturing Industries and Construction - gaseous	CH4	10,96	4,40	0,01	0,01	99,35
1.A.5.a Other non-specified - solid	CO2	197,91	4,01	0,42	0,42	99,77
1.A.5.a Other non-specified - liquid	CO2	34,99	3,73	0,06	0,06	99,83
1.A.1 Energy Industries - other	N2O	4,90	3,31	0,00	0,00	99,83
1.A.2 Manufacturing Industries and Construction - liquid	N2O	10,79	2,37	0,01	0,01	99,85
1.A.4 Other sector - solid	N2O	31,12	2,29	0,06	0,06	99,91
1.A.1 Energy Industries - gaseous	N2O	1,53	2,26	0,00	0,00	99,91
1.A.4 Other sector - gaseous	N2O	1,59	2,18	0,00	0,00	99,92
1.A.5.a Other non-specified - gaseous	CH4	3,10	1,76	0,00	0,00	99,92
1.A.3.e Transport - Other - liquid	CO2	7,00	1,54	0,01	0,01	99,93
1.A.1 Energy Industries - gaseous	CH4	1,87	1,53	0,00	0,00	99,93
1.A.2 Manufacturing Industries and Construction - gaseous	N2O	3,24	1,30	0,00	0,00	99,93
1.A.3.b Transport - Road Transportation - gaseous	CH4	0,00	1,24	0,00	0,00	99,93
1.A.1 Energy Industries - solid	CH4	2,53	1,02	0,00	0,00	99,94
1.A.2 Manufacturing Industries and Construction - solid	CH4	21,85	0,91	0,04	0,04	99,98
1.A.1 Energy Industries - liquid	N2O	3,80	0,90	0,00	0,00	99,99
1.A.2 Manufacturing Industries and Construction - liquid	CH4	2,69	0,80	0,00	0,00	99,99
1.A.5.a Other non-specified - gaseous	N2O	0,92	0,52	0,00	0,00	99,99
1.A.1 Energy Industries - liquid	CH4	1,29	0,48	0,00	0,00	99,99
1.A.3.a Transport - Civil Aviation - av. Gasoline	CO2	0,73	0,39	0,00	0,00	99,99
1.B.1.b Fugitive Emission from Oil, Natural Gas and Other	CO2	0,15	0,19	0,00	0,00	99,99
1.A.3.a Transport - Civil Aviation - jet kerosen	N2O	0,24	0,19	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
1.A.4 Other sector - solid	CH4	0,45	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.4 Other sector - liquid	N2O	0,95	0,07	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.4 Other sector - liquid	CH4	1,07	0,04	0,00	0,00	100,00
1.A.5.a Other non-specified - solid	N2O	0,93	0,02	0,00	0,00	100,00
1.A.3.a 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.3.b Transport - Road Transportation - gaseous	N2O	0,00	0,01	0,00	0,00	100,00
1.A.3.a 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.5.a Other non-specified - liquid	CH4	0,10	0,00	0,00	0,00	100,00
1.A.3.e Transport - Other - liquid	CH4	0,01	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.5.a Other non-specified - solid	CH4	0,45	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

Annex 2: Other detailed methodological descriptions for individual source or sink categories, including for KP-LULUCF activities – Comparison of RA and IEA statistics

Comparison for coal	Anthracite	Coking Coal	Other Bit. Coal	Sub-bit. Coal	Lignite/ Brown Coal	Peat	Patent Fuel	Coke Oven Coke	Gas Coke	Coal Tar	BKB/PB	Gas Works Gas	Coke Oven Gas	Blast Furnace Gas	Oxygen Steel Furnace Gas
Unit	***10^3 t***											***TJ (gross)***			
Production	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
From Other Sources	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Imports	0,00	357,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Exports	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Stock Changes	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Domestic Supply	0,00	357,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Statistical Differences	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Transformation	0,00	357,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Electricity Plants															
CHP Plants															
Heat Plants															
Other Transformation															
Energy Industry Own use	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Losses															
Final Consumption	**0,00**	**0,00**	**0,00**	**0,00**	**0,00**	**0,00**	**0,00**	**0,00**	**0,00**	**0,00**	**0,00**	**0,00**	**0,00**	**0,00**	**0,00**

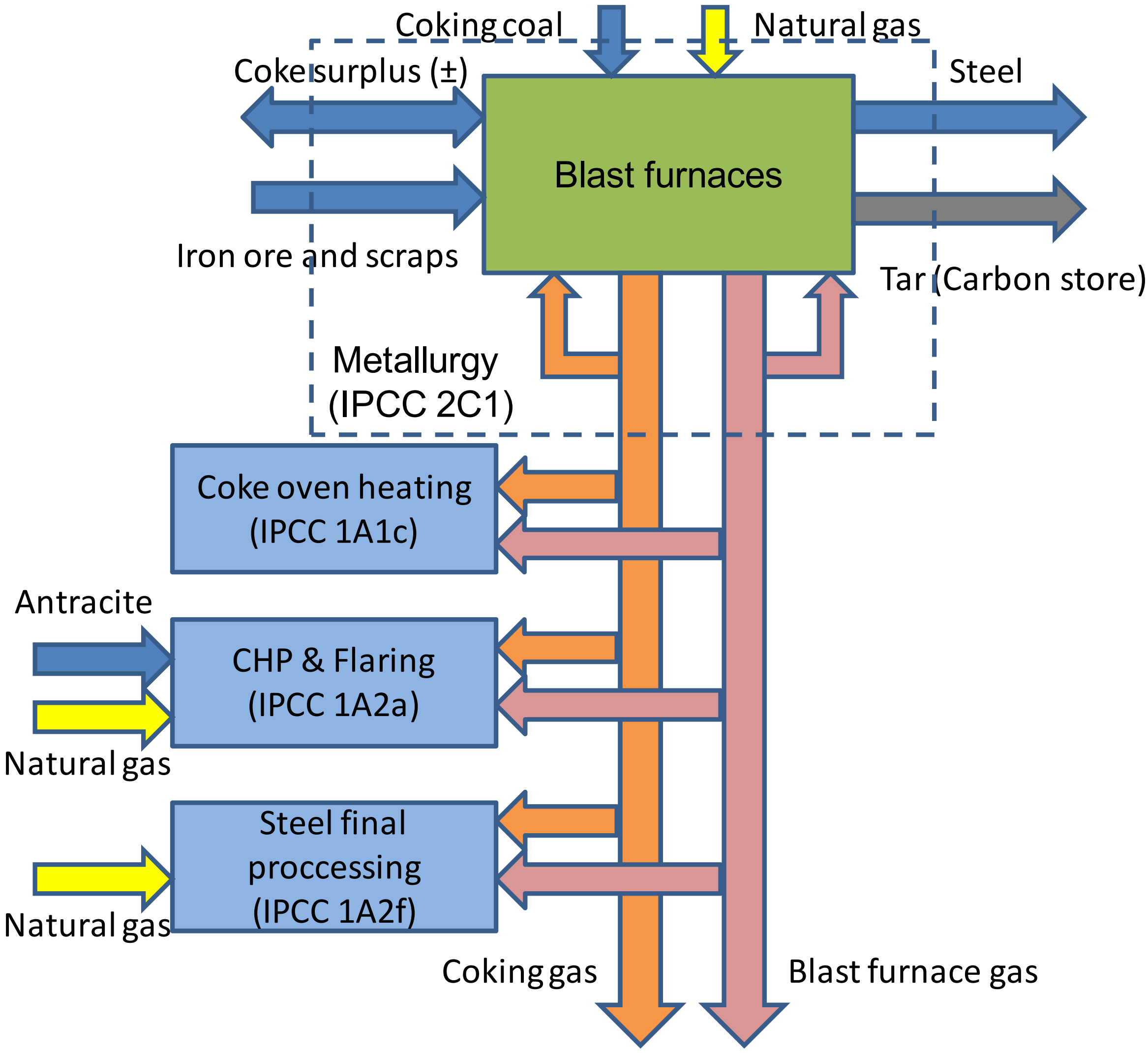
Comparison for oil		Crude Oil	Natural Gas Liquids	Refinery Feedstocks	Additives / Oxygenates	Of which Biofuels	Other Hydrocarbons	TOTAL	Difference IEA-SOSR-RA
Indigenous Production	(+) 1	13,00	3,00		0,00		0,00	16,00	**0,00**
From Other Sources	(+) 2				383,00	197,00	136,00	519,00	**0,00**
Backflows to Refineries	(+) 3			205,00				205,00	**0,00**
Products Transferred	(+) 4			129,00				129,00	**0,00**
Total Imports (Balance)	(+) 5	5 465,00	0,00	0,00	2,00		0,00	5 467,00	**0,00**
Total Exports (Balance)	(-) 6	13,00	0,00	0,00	0,00		0,00	13,00	**0,00**
Direct Use	(-) 7	0,00	0,00	0,00	0,00	0,00	0,00	0,00	**0,00**
Stock Changes (National Territory)	(+) 8	-12,00	0,00	0,00	0,00	0,00	4,00	-8,00	**0,00**
Refinery Intake (Calculated)	(=) 9	5 453,00	3,00	334,00	385,00	197,00	140,00	6 315,00	**0,00**
Statistical Differences	(-) 10	0,00	0,00	0,00	0,00	0,00	0,00	0,00	**0,00**
Refinery Intake (Observed)	(=) 11	5 453,00	3,00	334,00	385,00	197,00	140,00	6 315,00	
MEMO ITEMS:									
Refinery Losses	12	28,00	0,00	0,00	2,00	2,00	1,00	31,00	**0,00**
STOCK LEVELS:									
Opening Stock Level (National Territory)	13	539,00	0,00	0,00	0,00	0,00	4,00	543,00	
Closing Stock Level (National Territory)	14	551,00	0,00	0,00	0,00	0,00	0,00	551,00	**0,00**

Comparison for NG	IEA (TJ)	SO SR (TJ)	NCV (kJ/m³)	mil.m³	Difference	FLOW	IEA (TJ)	SO SR (TJ)	NCV (kJ/m³)	mil.m³	Difference
Production	3 696,15	4 108,00	35 550,00	103,97	**1,11**	Coal liquefaction plants	0,00	0,00			**0,00**
Imports	209 391,87	232 724,00	34 347,60	6 096,26	**1,11**	Liquefaction (LNG) / regasification plants	0,00	0,00			**0,00**
Exports	0,00	0,00			**0,00**	Gas-to-liquids (GTL) plants	0,00	0,00			**0,00**
International marine bunkers	0,00	0,00			**0,00**	Own use in electricity, CHP and heat plants	-34,21	38,00			**-1,11**
International aviation bunkers	0,00	0,00			**0,00**	Pumped storage plants	0,00	0,00			**0,00**
Stock changes	-3 538,68	-3 933,00	34 367,40	-102,97	**1,11**	Nuclear industry	0,00	0,00			**0,00**
Total primary energy supply	209 549,34	232 899,00	34 367,40	6 097,33	**1,11**	Charcoal production plants	0,00	0,00			**0,00**
Transfers	0,00	0,00			**0,00**	Non-specified (energy)	-309,53	344,00			**-1,11**
Statistical differences	0,00	0,00			**0,00**	Losses	0,00	0,00			**0,00**
Transformation processes	-47 722,40	53 040,00			**-1,11**	Total final consumption	154 947,48	172 213,00			**1,11**
Main activity producer electricity plants	-6 047,16	6 721,00			**-1,11**	Industry	37 173,80	41 316,00			**1,11**
Autoproducer electricity plants	0,00	0,00			**0,00**	Iron and steel	6 390,86	7 103,00			**1,11**
Main activity producer CHP plants	-15 941,66	17 718,00			**-1,11**	Chemical and petrochemical	5 119,54	5 690,00			**1,11**
Autoproducer CHP plants	-1 443,19	1 604,00			**-1,11**	Non-ferrous metals	1 339,73	1 489,00			**1,11**
Main activity producer heat plants	-15 975,82	17 756,00			**-1,11**	Non-metallic minerals	6 871,33	7 637,00			**1,11**
Autoproducer heat plants	-1 477,40	1 642,00			**-1,11**	Transport equipment	2 542,69	2 826,00			**1,11**
Heat pumps	0,00	0,00			**0,00**	Machinery	3 126,62	3 475,00			**1,11**
Electric boilers	0,00	0,00			**0,00**	Mining and quarrying	68,37	76,00			**1,11**
Chemical heat for electricity production	0,00	0,00			**0,00**	Food and tobacco	3 229,20	3 589,00			**1,11**
Blast furnaces	0,00	0,00			**0,00**	Paper, pulp and print	3 950,79	4 391,00			**1,11**
Gas works	0,00	0,00			**0,00**	Wood and wood products	240,24	267,00			**1,11**
Coke ovens	0,00	0,00			**0,00**	Construction	1 099,50	1 222,00			**1,11**
Patent fuel plants	0,00	0,00			**0,00**	Textile and leather	1 133,66	1 260,00			**1,11**
BKB plants	0,00	0,00			**0,00**	Non-specified (industry)	2 061,33	2 291,00			**1,11**
Oil refineries	0,00	0,00			**0,00**	Transport	16 594,88	18 444,00			**1,11**
Petrochemical plants	0,00	0,00			**0,00**	Domestic aviation	0,00	0,00			**0,00**
Coal liquefaction plants	0,00	0,00			**0,00**	Road	0,00	0,00			**0,00**
Gas-to-liquids (GTL) plants	0,00	0,00			**0,00**	Rail	0,00	0,00			**0,00**
For blended natural gas	0,00	0,00			**0,00**	Pipeline transport	16 182,78	17 986,00			**1,11**
Charcoal production plants	0,00	0,00			**0,00**	Domestic navigation	0,00	0,00			**0,00**
Non-specified (transformation)	-6 837,17	7 599,00			**-1,11**	Non-specified (transport)	412,06	458,00			**1,11**
Energy industry own use	-6 879,46	7 646,00			**-1,11**	Other	92 382,96	102 677,00			**1,11**
Coal mines	-5,40	6,00			**-1,11**	Residential	55 759,80	61 973,00			**1,11**
Oil and gas extraction	-687,39	764,00			**-1,11**	Commercial and public services	35 283,42	39 215,00			**1,11**
Blast furnaces	-446,27	496,00			**-1,11**	Agriculture/forestry	1 339,73	1 489,00			**1,11**
Gas works	0,00	0,00			**0,00**	Fishing	0,00	0,00			**0,00**
Gasification plants for biogases	0,00	0,00			**0,00**	Non-specified (other)	0,00	0,00			**0,00**
Coke ovens	-2,68	3,00			**-1,12**	Non-energy use	8 795,88	9 776,00			**1,11**
Patent fuel plants	0,00	0,00			**0,00**	Non-energy use industry/transformation/energy	8 795,88	9 776,00			**1,11**
Oil refineries	-5 393,98	5 995,00			**-1,11**	Memo: Feedstock use in petrochemical industry	8 795,88	9 776,00			**1,11**

Annex 3: CO_2 reference approach and comparison with sectoral approach, and relevant information on the national energy balance – Methodology for carbon balance of Iron and Steel production

The national methodology was revised in this submission. In Slovakia, pig iron and steel are produced by EAF and in blast furnaces. The plant with blast furnaces is a complex one with many energy-related installations (coke ovens, heating plant etc.). In order to balance the carbon in the plant the simplified scheme of the plant was created (see Figure A3.1). Consumption of limestone is not included in the scheme because CO_2 emissions from limestone consumption are included in 2A3 category – Limestone and Dolomite Use.

Figure A3.1: The simplified distribution scheme of the complex plant for pig iron and steel production



On the basis of the scheme, the carbon balance is estimated. All the streams are recalculated on the basis of conversion unit and carbon EF from energy sector (or on the basis of content of carbon in material – iron ore, steel) to mass of carbon. The carbon balance consists of four steps:

1. Balance of the category 2C1
2. Balance of the category 1A1c
3. Balance of the category 1A2a
4. Balance of the category 1A2f

Table A3.1: Balance of the category 2C1

Stream	Activity data	NCV	EF(C)	Carbon [kt]
Coking coal	2 516,80 kt	28,95 TJ / kt	25,92 t/TJ	1 888,566
Coke surplus	327,63 kt	26,72 TJ / kt	29,84 t / TJ	261,228
Natural gas	36,14 mil. m3	34,42 TJ / mil. m3	15,1 t / TJ	18,783
Tar	-57 kt	33,49 TJ / kt	19,44 t / TJ	-37,11
Coking gas	-657,13 kt	17,22 TJ / kt	12,92 t / TJ	-146,2
Blast furnace gas	-4227,88 kt	3,15 TJ / kt	71,24 t / TJ	-948,762
Iron ore	2 606,32 kt		2,16×10-4	0,563
Steel	-4401,78 kt		7,7×10-4	-3,389
Total				**1 033,68**

It follows from the carbon balance that CO_2 emissions in 2C1 category (from that plant) represent the value 3 790.16 Gg (carbon × 44/12).

Table A3.2: Balance of the category 1A1c

Stream	Activity data	NCV	EF(C)	Carbon [kt]
Coking gas	112,45 kt	17,22 TJ / kt	12,92 t / TJ	25,02
Blast furnace gas	1 445,87 kt	3,15 TJ / kt	71,24 t / TJ	324,46
Total				**349,48**

It follows from the carbon balance that CO_2 emissions in 1A1c category (from that plant) represent the value 1 255.82 Gg (carbon × 44/12). It was assumed that oxidation factor was 0.98.

Table A3.3: Balance of the category 1A2a

Stream	Activity data	NCV	EF(C)	Carbon [kt]
Anthracite	395,70 kt	27,43 TJ / kt	26,43 t / TJ	286,87
Natural gas	20,77 mil. m3	34,42 TJ / mil. m3	15,1 t / TJ	10,80
Coking gas	264,87 kt	17,22 TJ / kt	12,92 t / TJ	58,93
Blast furnace gas	2 360,68 kt	3,15 TJ / kt	71,24 t / TJ	529,72
Total				**886,35**

It follows from the carbon balance that CO_2 emissions in 1A2a category (from that plant) represent the value 3 185.54 Gg (carbon × 44/12). It was assumed that oxidation factor was 0.98 except of the natural gas, where it was 0.995.

Table A3.4: Balance of the category 1A2f

Stream	Activity data	NCV	EF(C)	Carbon [kt]
Natural gas	37,97 mil. m3	34,42 TJ / mil. m3	15,1 t / TJ	19,73
Coking gas	270,29 kt	17,22 TJ / kt	12,92 t / TJ	60,13
Blast furnace gas	336,89 kt	3,15 TJ / kt	71,24 t / TJ	75,6
Total				**155,47**

It follows from the carbon balance that CO_2 emissions in 1A2f category (from that plant) represent the value 559.74 Gg (carbon × 44/12). It was assumed that oxidation factor was 0.98 except of the natural gas, where it was 0.995.

Balance of the output from the plant

The output from the plant was 9.39 kt of coking gas (2.09 kt C) and 0 kt of blast furnace gas (0 kt). The CO_2 emissions are not calculated in this balance. The coking and BF gas are sold and they are balanced in the place of consumption.

It should be also noted that the balance is only for one plant. In Slovakia, there are some other plants included in the above categories. Therefore the emissions calculated from this balance can be lower than those presented in each individual category.

Annex 4: Assessment of completeness

A.5.1 GHG inventory

No NE key categories have been reported in 2012 submission for 1990 – 2010.

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 5: Tables 6.1 and 6.2 of the IPCC good practice guidance

Annex 5 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 did not provide 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 A5.1: Tier 1 uncertainty calculation and reporting in 2010

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	16 107,71	10 050,38	5,00	5,00	7,07	1,79	0,00	0,16	-0,01	1,13	1,13	D	D
1.A.2 Manufacturing Industries and Construction	CO2	19 712,35	8 519,41	5,00	5,00	7,07	1,51	-0,06	0,14	-0,32	0,96	1,01	D	D
1.A.3.a Transport - Civil Aviation	CO2	7,74	5,84	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	4 503,02	6 463,41	1,00	5,00	5,10	0,83	0,06	0,10	0,29	0,15	0,32	D	R
1.A.3.c Transport - Railw ays	CO2	376,77	87,80	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	4 476,12	5,00	5,00	7,07	0,00	0,00	0,00	0,00	0,00	0,00	D	R
1.A.5.a Other non-specified	CO2	1 872,53	934,02	5,00	5,00	7,07	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	CO2	0,15	0,19	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	844,58	2,00	5,60	5,95	0,00	0,00	0,00	0,00	0,00	0,00	R	R
2(I).A.2 Lime Production	CO2	770,42	728,80	3,00	1,90	3,55	0,00	0,00	0,00	0,00	0,00	0,00	R	R
2(I).A.3 Limestone and Dolomite Use	CO2	318,23	340,31	1,90	1,90	2,69	0,01	0,00	0,00	0,00	0,01	0,01	R	R
2(I).A.7 Magnezite Production	CO2	431,94	376,34	2,00	2,00	2,83	0,00	0,00	0,00	0,00	0,00	0,00	R	R
2(I).A.7 Glass Production	CO2	7,88	13,15	2,00	2,00	2,83	0,02	0,00	0,01	0,00	0,01	0,01	R	R
2(I).B.1 Ammonia Production	CO2	616,97	484,65	2,00	5,00	5,39	0,10	0,01	0,01	0,03	0,03	0,05	R	R
2(I).B.4 Carbide Production	CO2	0,00	219,10	2,00	5,00	5,39	0,12	-0,01	0,01	-0,03	0,04	0,05	R	R
2(I).C.1 Iron and Steel Production	CO2	3 935,80	3 807,76	2,00	5,00	5,39	0,02	0,00	0,00	-0,01	0,01	0,01	R	R
2(I).C.3 Aluminium Production	CO2	121,32	239,38	2,00	5,00	5,39	0,00	0,00	0,00	0,00	0,00	0,00	R	R
2(I).C.2 Ferroalloys Production	CO2	264,24	200,45	2,00	5,00	5,39	0,22	0,02	0,03	0,10	0,07	0,13	D	D
3. Solvent Use	CO2	130,10	83,56	2,00	5,00	5,39	0,05	0,00	0,01	0,01	0,02	0,02	D	D
5.A Forest Land	CO2	-10 335,39	-5 332,61	100,00	100,00	141,42	0,20	0,00	0,00	0,09	0,13	0,15	D	D
5.B Cropland	CO2	-180,41	-714,79	100,00	100,00	141,42	0,11	0,00	0,00	-0,01	0,07	0,07	D	D
5.C Grassland	CO2	-327,72	-325,94	100,00	100,00	141,42	0,06	0,00	0,00	-0,03	0,04	0,05	D	D
5.E Settlements	CO2	121,44	119,44	100,00	100,00	141,42	0,00	0,00	0,00	0,00	0,00	0,00	D	D
5.F Other Land	CO2	400,52	137,92	100,00	100,00	141,42	0,24	0,00	0,00	0,05	0,15	0,16	D	D
6.C Waste Incineration	CO2	62,70	37,09	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	6,03	3,00	50,00	50,09	0,00	0,00	0,00	0,00	0,00	0,00	D	D
1.A.2 Manufacturing Industries and Construction	CH4	37,17	7,31	3,00	50,00	50,09	0,00	0,00	0,00	0,00	0,00	0,00	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	24,47	15,04	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	0,91	0,00	0,01	0,10	0,02	0,10	D	R
1.A.3.e Transport - Other	CH4	0,01	0,00	1,00	40,00	40,01	0,01	0,00	0,00	0,00	0,00	0,00	D	R
2(I).B.1 Ammonia Production	CH4	24,57	17,80	3,00	5,00	5,83	0,01	0,00	0,00	0,01	0,01	0,01	D	R
2(I).C.2 Ferroalloys Production	CH4	0,00	0,10	3,00	5,00	5,83	0,05	0,00	0,01	-0,02	0,03	0,04	D	R
1.A.4 Other sector	CH4	389,42	122,04	5,00	40,00	40,31	1,74	-0,01	0,03	-0,37	0,19	0,42	D	D
1.A.5.a Other non-specified	CH4	3,65	1,93	3,00	50,00	50,09	0,01	0,00	0,00	0,00	0,00	0,00	D	D
1.B.1.a Coal Mining and Handling	CH4	571,15	319,73	5,00	7,00	8,60	0,02	0,00	0,00	0,00	0,01	0,01	R	R
1.B.1.b Fugitive Emission from Oil, Natural Gas and Other	CH4	513,50	728,32	2,00	5,00	5,39	0,00	0,00	0,00	0,00	0,00	0,00	R	R
4.A Enteric Fermentation	CH4	2 013,93	857,08	5,00	20,00	20,62	0,03	0,00	0,00	0,02	0,01	0,02	D	D
4.B Manure Management	CH4	368,66	119,02	5,00	45,00	45,28	0,41	0,00	0,01	0,13	0,04	0,14	D	D
5.A Forest Land	CH4	14,09	22,91	5,00	5,00	7,07	7,07	0,00	0,63	0,00	4,49	4,49	D	D
6.A Solid Waste Disposal on Land	CH4	469,77	1 615,26	5,00	50,00	50,25	0,00	0,00	0,00	0,00	0,00	0,00	D	R
6.B Wastew ater Handling	CH4	413,83	359,52	5,00	50,00	50,25	0,00	0,00	0,00	0,00	0,00	0,00	R	R
6.C Waste Composting	CH4	1,68	56,22	5,00	50,00	50,25	0,00	0,00	0,00	0,00	0,00	0,00	R	R
1.A.1 Energy Industries	N2O	62,61	31,67	3,00	50,00	50,09	0,00	0,00	0,00	0,00	0,00	0,00	D	D
1.A.2 Manufacturing Industries and Construction	N2O	58,75	16,23	3,00	50,00	50,09	0,00	0,00	0,00	0,00	0,00	0,00	D	D
1.A.3.a Transport - Civil Aviation	N2O	0,25	0,19	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	58,64	68,37	1,00	50,00	50,01	0,00	0,00	0,00	0,00	0,00	0,00	D	R
1.A.3.c Transport - Railw ays	N2O	50,19	11,70	1,00	50,00	50,01	0,00	0,00	0,00	0,00	0,00	0,00	D	R
1.A.3.d Transport - Navigation	N2O	0,00	0,01	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	27,32	3,00	50,00	50,09	0,00	0,00	0,00	0,00	0,00	0,00	R	R
1.A.5.a Other non-specified	N2O	1,93	1,04	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	1 187,50	903,75	2,00	4,00	4,47	0,00	0,00	0,00	0,00	0,00	0,00	R	R
2(I).B.1 Ammonia Production	N2O	7,25	5,25	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	80,79	5,00	5,00	7,07	0,00	0,00	0,00	0,00	0,00	0,00	R	D
4.B Manure Management	N2O	1 074,32	374,44	5,00	150,00	150,08	0,00	0,00	0,00	0,00	0,00	0,00	R	R
4.D Agricultural Soils	N2O	3 631,01	1 714,79	20,00	200,00	201,00	0,00	0,00	0,00	0,00	0,00	0,00	R	R
5.A Forest Land	N2O	12,09	4,65	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	138,77	87,07	5,00	50,00	50,25	0,00	0,00	0,00	0,00	0,00	0,00	R	R
6.C Waste Incineration	N2O	2,73	4,75	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	62,24	5,00	50,00	50,25	0,00	0,00	0,00	0,00	0,00	0,00	R	R
Emissions of ODS	HFCs,	271,40	358,02	10,00	0,40	10,01	0,00	0,00	0,01	0,00	0,08	0,08	D	D
	Total:	62 740,45	39 798,73			Total H =	7,77	Level Uncertainty			Total M =	4,78	Trend Uncertainty	

Annex 6: Additional information to be considered as part of the annual inventory submission

Table A6.1: The certificate of conformity with the standard SHMU

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

REG. NO. **14/2010** LEADER OF CERTIFICATION BODY DATE OF ISSUE: **19.4.2010** VALIDITY: **18.4.2013**

IAF SNAS Reg. No. 242/Q-034 ACERT

Table A6.2: The certificate of conformity with the standard SHMU

ACERT

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