Switzerland's Greenhouse Gas Inventory 1990–2010

National Inventory Report 2012

including reporting elements under the Kyoto Protocol

Submission of 13 April 2012
under the United Nations Framework Convention on Climate Change and under the Kyoto Protocol

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Glossary

AD	Activity data
AEF	Area expansion factor
AREA1	Swiss Land Use Statistics 1979/85 (ASCH1 data re-evaluated according to the AREA set of land-use and land-cover categories)
AREA2	Swiss Land Use Statistics 1992/97 (ASCH2 data re-evaluated according to the AREA set of land-use and land-cover categories)
AREA3	Swiss Land Use Statistics, third survey 2004/09
ART	Agroscope Reckenholz-Tänikon Research Station (formerly FAL)
ASCH1	Swiss Land Use Statistics, first survey 1979/85
ASCH2	Swiss Land Use Statistics, second survey 1992/97
BEF, BCEF	biomass expansion factor, biomass conversion and expansion factor
Carbura	Swiss Central Office for the Import of Liquid Fuels
cemsuisse	Association of the Swiss Cement Industry
CC	Combination category
CH_4	Methane, 1995 IPCC GWP: 21 (UNFCCC 2006b, Table 1)
CFC	Chlorofluorocarbon (organic compound: refrigerant, propellant)
CHP	Combined heat and power production
CO	Carbon monoxide
CO_2, CO_2 eq	Carbon dioxide, carbon dioxide equivalent
CORINAIR	CORe INventory of AIR emissions (under the European Topic Centre on Air Emissions and under the European Environment Agency)
CRF	Common reporting format
CSS	Mix of special waste with saw dust; used as fuel in cement kilns
DBH	Diameter (of trees) at breast height
EF	Emission factor
EMEP	European Monitoring and Evaluation Programme (under the Convention on Long-range Transboundary Air Pollution)
EMIS	Swiss national air pollution database
EMPA	Swiss Federal Laboratories for Material Testing and Research
DETEC	Dept. of the Environment, Transport, Energy and Communications
FAL	Swiss Federal Research Station for Agroecology and Agriculture (since 2006: ART)
FCCC	Framework Convention on Climate Change
FiBL	Research Institute of Organic Agriculture
FOCA	Federal Office of Civil Aviation
FOEN	Federal Office for the Environment (former name SAEFL until 2005)

FOITT	Federal Office of Information Technology, Systems and Telecommunication
Gg	Gigagram (10^9 g = 1’000 tons)
GHG	Greenhouse gas
GL, GPG	Guidelines, Good Practice Guidance
GWP	Global Warming Potential
ha	hectare
HFC	Hydrofluorocarbons (e.g. HFC-32 difluoromethane)
HFO	Heavy fuel oil
IDM	FOEN Internal Document Management System
IDP	Inventory Development Plan
IPCC	Intergovernmental Panel on Climate Change
KCA	key category analysis
kha	kilo hectare
LFO	Light fuel oil (Gas oil)
LPG	Liquefied Petroleum Gas (Propane/Butane)
LTO	Landing-Takeoff-Cycle (Aviation)
LULUCF	Land Use, Land-Use Change and Forestry
MSW	Municipal solid waste
NABO	Swiss Soil Monitoring Network
NCV	Net calorific value
NFI 1, NFI 2, NFI 3	First (1983-1985), Second (1993-1995) and Third (2004-2006) National Forest Inventory
NIR	National Inventory Report
NIS	National Inventory System
NMVOC	Non-methane volatile organic compounds
N_2O	Nitrous oxide; 1995 IPCC GWP: 310 (UNFCCC 2006b, Table 1)
NO_x	Nitrogen oxides
PCDD/PCDF	Polychlorinated Dibenzodioxins and -furanes
PFC	Perfluorinated carbon compounds (e.g. Tetrafluoromethane)
SAEFL	Swiss Agency for the Environment, Forests and Landscape (since 2006: Federal Office for the Environment FOEN)
SF_6	Sulphur hexafluoride, 1995 IPCC GWP: 23’900 (UNFCCC 2006b, Table 1)
SFOE	Swiss Federal Office of Energy
SFSO	Swiss Federal Statistical Office
SGCI/SSCI	Schweizerische Gesellschaft für Chemische Industrie / Swiss Society of Chemical Industries
SO_2	Sulphur dioxide
SOC	Soil organic carbon

SVGW/SSIG/SGWA	Schweizerischer Verein des Gas- und Wasserfaches / Société Suisse de l'Industrie du Gaz et des Eaux / Swiss Gas and Water Industry Association
SWISSMEM	Swiss Mechanical and Electrical Engineering Industries (Schweizer Maschinen-, Elektro- und Metallindustrie)
UNECE	United Nations Economic Commission for Europe
UNFCCC	United Nations Framework Convention on Climate Change
VOC	Volatile organic compounds
VSAI/AISA	Vereinigung Schweizer Automobil-Importeure / Association Importateurs Suisses d'Automobiles
VTG	Luftwaffe (Swiss Air Force Administration)
WSL	Swiss Federal Institute for Forest, Snow and Landscape Research

Executive Summary

ES 1 Background Information on Greenhouse Gas Inventories, Climate Change and Supplementary Information Required Under Art. 7.1. KP

ES 1.1 Background Information on Climate Change

Recent findings confirm a warming trend with an observed increase in mean annual temperature of approximately 1.6 °C between 1864 and 2010 for Switzerland. Over the last 100 years, mean annual temperatures increased by 0.12-0.19 °C per decade, with a substantially accelerated warming in recent decades. The most visible change in the Alps resulting from global warming is the retreat of glaciers, which is predicted to continue (FOEN 2009d).

The observed trends in precipitation are less distinct than in temperature. They generally show an increase in winter and spring, whereas for summer and autumn no significant trends are detectable. Regional scenarios predict an increase in mean winter precipitation and a decrease in summer, which will have a marked impact on the hydrological cycle. Further, higher intensity of storms and reduced snowfall and snow cover duration are expected, increasing the risk and frequency of floods, landslides and debris flows.

Concerning biodiversity, climate change is expected to affect species composition, distribution, their cycles, synchronicity, the overall genetic diversity and the provision of ecosystem services. It will enhance the vulnerability of forests and potentially impair their protective, productive and social functions.

For agriculture, a moderate warming of 2°C to 3°C might increase productivity; however, if temperature rose beyond that level, the increase in heat waves and drought periods would prove problematic for the cultivation of land and for livestock husbandry.

Various sectors of the Swiss economy are likely to be adversely affected by progressing climate change: In particular, winter tourism will suffer from increased scarcity of snow, hydroelectric power stations are confronted with altered runoff and sediment transport regimes, and insurance companies may face increased losses due to winter storms and floods. Natural hazards and extreme weather events potentially pose a growing risk to infrastructure and human health. Heat waves and elevated tropospheric ozone levels are cause for serious concern. Finally, it remains to be seen to what extent vector borne diseases spread due to changing climatic conditions. Recently Switzerland has analysed these challenges in detail and developed an effective adaptation strategy in order to hedge against negative effects resulting from climate change in Switzerland (FOEN, 2012b).

ES.1.2 Background Information on Greenhouse Gas Inventories

On 10 December 1993, Switzerland ratified the United Nations Framework Convention on Climate Change (UNFCCC). Since 1996, the submission of its national greenhouse gas inventory has been based on IPCC guidelines. From 1998 onwards, the inventories have been submitted in the Common Reporting Format (CRF).

On 9 July 2003, Switzerland ratified the Kyoto Protocol under the UNFCCC. The Swiss National Inventory System (NIS) according to Article 5.1 of the Kyoto Protocol has been implemented and is fully operational.

The 2012 inventory submission under the United Nations Framework Convention on Climate Change and under the Kyoto Protocol (FOEN 2012) includes the NIR on hand, the greenhouse gas inventory 1990–2010 and the Kyoto Protocol LULUCF tables 2008–2010 in the common reporting format as well as the SEF tables and the standard independent assessment report (SIAR) from the National Registry. As a supplement, the update of the Description of the Quality Management System (FOEN 2012a) is provided.

The Federal Office for the Environment (FOEN) is in charge of compiling the emission data and bears overall responsibility for Switzerland's national greenhouse gas inventory and the national registry. In addition to the FOEN, the Swiss Federal Office of Energy (SFOE), the Agroscope Reckenholz-Tänikon Research Station (ART) and the Federal Office of Civil Aviation (FOCA) participate directly in the compilation of the inventory. Several other administrative offices and research institutions are involved in inventory preparation.

In preparing the National Inventory Report, Switzerland took into account the findings of the in-country review of the inventory submitted in 2004 (UNFCCC 2004), the centralized review of the inventory submitted in 2005 (UNFCCC 2006), the in-country review of the inventory submitted in 2006 (UNFCCC 2007), the centralized reviews of the submissions 2007/2008, and 2009 (UNFCCC 2009, UNFCCC 2010) and the in-country review of submission 2010 (UNFCC 2011). The Annual Review Report for the submission 2011 is currently still in preparation. The recommendations of the "Saturday Paper" are included in the present submission as well (see Chapter 16). Since the draft review report for submission 2011 was not made available until 12 March 2012, the recommendations from the most recent review could only partially be included in present submission.

The structure of the NIR corresponds to the UNFCCC annotated outline (UNFCCC 2009a) and it contains three parts: **PART 1** reports the obligations under the UNFCCC, **PART 2** the additional obligations under the Kyoto Protocol and several **Annexes** with detailed information on selected issues of Part 1 and Part 2.

Chapter 1 of the NIR, the introduction, provides an overview of Switzerland's institutional arrangements for producing the inventory, and the process and methodologies used for inventory preparation.

- The data sources used to compile the national inventory and to estimate greenhouse gas emissions and removals are: the Swiss national air pollution database (EMIS), national energy statistics, data from industry associations, as well as further statistics and models for road transportation, off-road vehicles and machinery, agriculture, land use, land-use change and forestry (LULUCF) and waste. Emissions are calculated according to methodologies recommended by the IPCC and contained in the Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories (IPCC 1997a, 1997b, 1997c), in the IPCC Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories (IPCC 2000), and for LULUCF in the IPCC Good Practice Guidance for Land Use, Land-Use Change and Forestry (IPCC 2003). Furthermore, the 2006 IPCC Guidelines for National Greenhouse Gas Inventories (IPCC 2006) have been consulted in a few cases. However, the nomenclature of the Revised 1996 IPCC Guidelines has been used throughout the current NIR. The data in the EMIS database are pre-processed in order to enable transfer to the CRF Reporter required for reporting under the UNFCCC and under the Kyoto Protocol.
- All inventory data are assembled and prepared for input into the CRF Reporter by the GHG Inventory Core Group, which is responsible for ensuring the conformity of the inventory with the Updated UNFCCC Reporting Guidelines on Annual Inventories (UNFCCC 2006b) and the 2008 Kyoto Protocol Reference Manual (UNFCCC 2008). In the preparation of this report, the Inventory Group was supported by consultants. Their mandate included editing of the NIR, and an analysis of the consistency between the emission modelling and the recommendations of the IPCC Good Practice Guidance. Furthermore, the consultants contributed to the key category analyses and carried out the uncertainty analyses. They were also involved in inventory improvement, e.g. by performing tasks contained in the Inventory Development Plan.
- The inventory quality management system is designed to comply with the objectives of good practice guidance, i.e. to ensure and improve transparency, consistency,

comparability, completeness, accuracy and confidence in national GHG emission and removal estimates. The QA/QC Officer is responsible for enforcement of the defined quality standards. The National Inventory System complies with the ISO 9001:2008 standard (Quality Management System) and is certified by the Swiss Association for Quality and Management Systems (SQS 2010).

- A National Inventory System Supervisory Board was established by decision of the FOEN Directorate in summer 2006. The Board oversees activities related to the GHG Inventory and to the National Registry.
- Furthermore, Chapter 1 provides information on key categories and uncertainties.

Chapter 2 contains an analysis of trends in Switzerland's greenhouse gas emissions by sources and removals by sinks for all sectors.

Chapters 3 to 9 provide principal source and sink category estimates.

Chapter 10 justifies, explains and summarises the recalculations and planned improvements. They result in a very small change (-0.12%) in the base year emissions (1990) and a small change in the latest year of recalculations (2009: 0.98%). The chapter also contains an overview of the planned improvements.

In **PART 2**, **Chapter 11** reports KP LULUCF data, **Chapter 12** presents information on accounting of Kyoto Units, **Chapter 13** lists changes in the National System, **Chapter 14** documents changes in the National Registry, **Chapter 15** provides information on the minimization of adverse effects and **Chapter 16** contains other information including the "Saturday Paper" that resulted from the 2011 review, together with the party's responses.

ES.1.3 Background Information on Supplementary Information Required under Article 7.1. of the Kyoto Protocol (KP)

Chapter 11 of PART 2 as mentioned above, provides information on KP-LULUCF. Switzerland has decided to account for Forest Management under the elective voluntary activities of Article 3, paragraph 4 of the Kyoto Protocol. In accordance with the Annex to Decision 16/CMP.1, credits from Forest Management are capped in the first commitment period. For Switzerland the cap amounts to 1.83 Mt CO_2 (0.5 Mt C) per year, or 9.15 Mt CO_2 for the whole commitment period.

Switzerland has chosen to account annually for emissions and removals from activities under the Kyoto Protocol. The current submission contains the mandatory inventory years 2008, 2009 and 2010. In the NIR, additional information about 1999 to 2007 is included.

ES.2 Summary of National Emission and Removal Related Trends, and Emission and Removals from KP-LULUCF Activities

ES.2.1 GHG Inventory

In 2010, Switzerland emitted approximately 54'247 Gg (kilotonnes) CO_2 equivalent, corresponding to 6.89 tonnes CO_2 equivalent per capita (CO_2: 5.84 tonnes per capita), to the atmosphere, excluding emissions and removals from the sector Land Use, Land-Use Change and Forestry (LULUCF)[1]. For the approximate emissions that are relevant under the Kyoto Protocol see chapter ES.3.3.

Several Key Category Analyses (with, without LULUCF and combined) are carried out for 2010 and for the base year 1990.

[1] Inhabitants in Switzerland in 2010: 7.87 million

- Tier 1 analysis (without LULUCF): For 2010, among a total of 136 categories, 30 have been identified as key categories (level and/or trend) with an aggregated contribution of 96.8% to total national emissions. Of the 30 key categories, 18 are in sector 1 Energy, accounting for 79.7% of total CO_2 equivalent emissions in 2010.
- Tier 2 analysis (without LULUCF): For 2010, among a total of 136 categories, 30 have been identified as key categories (level and /or trend) with an aggregated contribution of 92.9% of the sum of all level assessments weighted with their uncertainty in 2010. Of the 30 key categories, 14 are in sector 1 Energy, accounting for 29.1% of the sum of all level assessments weighted with their uncertainty in 2010. Sector 4 Agriculture accounts for 44.3% of that sum. Tier 2 key category analysis shows that these two sectors have the highest impact on inventory uncertainty.
- A Tier 1 and Tier 2 analysis with LULUCF was conducted as well (see 1.5.1.3 and A1.5).

Table E-1 shows Switzerland's annual GHG emissions by individual GHGs from 1990 (base year) to 2010. Despite clear trends in some GHG emissions (see below), there is no significant trend in the total emissions of the period 1990–2010. Year-to-year variations of total emissions are mainly caused by changing winter temperatures and their effect on CO_2 emissions from fuel combustion (source category 1A4). In 2010, total gross GHG emissions (excluding LULUCF) show an increase of 2.2% compared to the level recorded for 1990 (see also Table E-2).

Table E-1 Summary of Switzerland's GHG emissions in CO_2 equivalent (Gg), 1990–2010 (from CRF Tables 10s5 and 10s5.2). HFCs increased by 47'626% compared to 1990 levels.

Greenhouse Gas Emissions	**1990**	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**
	CO_2 equivalent (Gg)									
CO_2 emissions including net CO_2 from LULUCF	40'764	42'622	43'055	38'813	37'187	38'714	39'742	40'254	41'636	43'087
CO_2 emissions excluding net CO_2 from LULUCF	44'631	46'353	46'245	43'717	42'979	43'357	44'223	43'472	44'702	44'986
CH_4 emissions including CH_4 from LULUCF	4'707	4'668	4'530	4'391	4'307	4'301	4'210	4'114	4'065	4'001
CH_4 emissions excluding CH_4 from LULUCF	4'699	4'667	4'530	4'391	4'305	4'298	4'208	4'102	4'063	4'001
N_2O emissions including N_2O from LULUCF	3'495	3'482	3'450	3'385	3'361	3'330	3'329	3'221	3'215	3'190
N_2O emissions excluding N_2O from LULUCF	3'484	3'476	3'444	3'379	3'353	3'322	3'322	3'208	3'208	3'185
HFCs	0	0	6	14	33	180	225	299	355	418
PFCs	100	85	69	30	18	15	17	20	23	36
SF_6	144	146	148	126	112	98	94	131	160	147
Total (including LULUCF)	**49'210**	**51'003**	**51'259**	**46'760**	**45'017**	**46'637**	**47'619**	**48'038**	**49'453**	**50'879**
Total (excluding LULUCF)	**53'057**	**54'726**	**54'442**	**51'657**	**50'800**	**51'269**	**52'091**	**51'232**	**52'510**	**52'773**

Greenhouse Gas Emissions	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**
	CO2 equivalent (Gg)									
CO_2 emissions including net CO_2 from LULUCF	44'280	45'579	44'431	42'774	44'046	44'489	45'346	43'144	44'688	43'153
CO_2 emissions excluding net CO_2 from LULUCF	44'032	44'873	43'974	45'067	45'637	46'354	45'915	43'923	45'460	44'257
CH_4 emissions including CH_4 from LULUCF	3'935	3'950	3'899	3'805	3'782	3'790	3'798	3'797	3'876	3'816
CH_4 emissions excluding CH_4 from LULUCF	3'934	3'950	3'896	3'800	3'782	3'790	3'797	3'795	3'876	3'816
N_2O emissions including N_2O from LULUCF	3'200	3'221	3'215	3'160	3'152	3'140	3'152	3'177	3'194	3'148
N_2O emissions excluding N_2O from LULUCF	3'194	3'215	3'208	3'152	3'147	3'136	3'147	3'171	3'189	3'143
HFCs	497	590	629	697	799	874	900	934	990	1'023
PFCs	69	45	40	57	53	33	32	29	39	35
SF_6	158	157	168	174	189	213	201	186	244	187
Total (including LULUCF)	**52'137**	**53'542**	**52'383**	**50'666**	**52'021**	**52'539**	**53'429**	**51'266**	**53'031**	**51'362**
Total (excluding LULUCF)	**51'884**	**52'831**	**51'915**	**52'948**	**53'607**	**54'398**	**53'993**	**52'038**	**53'798**	**52'461**

Greenhouse Gas Emissions	**2010**	Change baseyear to 2010 (%)
	CO2 eq.	
CO_2 emissions including net CO_2 from LULUCF	45'078	10.6%
CO_2 emissions excluding net CO_2 from LULUCF	45'963	3.0%
CH_4 emissions including CH_4 from LULUCF	3'816	-18.9%
CH_4 emissions excluding CH_4 from LULUCF	3'816	-18.8%
N_2O emissions including N_2O from LULUCF	3'209	-8.2%
N_2O emissions excluding N_2O from LULUCF	3'204	-8.0%
HFCs	1'073	see caption
PFCs	37	-63.6%
SF_6	155	8.0%
Total (including LULUCF)	**53'367**	**8.4%**
Total (excluding LULUCF)	**54'247**	**2.2%**

With regard to the distribution of emissions by individual greenhouse gases, CO_2 is the largest single contributor to emissions, accounting for 84.7% of total gross GHG emissions (excluding LULUCF) in 2010 (1990: 84.1%). The share of CH_4 decreased from 8.9% (1990) to 7.0% (2010). Over the same period, the share of N_2O decreased from 6.6% to 5.9%, while the share of synthetic gases increased from 0.5% to 2.3%.

Table E-2 Switzerland's total gross GHG emissions (excluding LULUCF) and the contribution of individual gases in CO_2 equivalent (Gg), selected years.

Greenhouse Gas Emissions	1990		1995		2000		2005		2009		2010	
(excluding LULUCF)	Gg CO_2 eq	%	Gg CO_2 eq	%	Gg CO_2 eq	%	Gg CO_2 eq	%	Gg CO_2 eq	%	Gg CO_2 eq	%
CO_2	44'631	84.1%	43'357	84.6%	44'032	84.9%	46'354	85.2%	44'257	84.4%	45'963	84.7%
CH_4	4'699	8.9%	4'298	8.4%	3'934	7.6%	3'790	7.0%	3'816	7.3%	3'816	7.0%
N_2O	3'484	6.6%	3'322	6.5%	3'194	6.2%	3'136	5.8%	3'143	6.0%	3'204	5.9%
HFCs	0	0.0%	180	0.4%	497	1.0%	874	1.6%	1'023	1.9%	1'073	2.0%
PFCs	100	0.2%	15	0.0%	69	0.1%	33	0.1%	35	0.1%	37	0.1%
SF_6	144	0.3%	98	0.2%	158	0.3%	213	0.4%	187	0.4%	155	0.3%
Total (excluding LULUCF)	**53'057**	**100%**	**51'269**	**100%**	**51'884**	**100%**	**54'398**	**100%**	**52'461**	**100%**	**54'247**	**100%**

Figure E-1 shows the shares of 2010 emissions contributed by individual greenhouse gases. As the shares of emissions contributed by the individual gases have remained relatively constant, the diagram is also representative of the other years in the period 1990–2010.

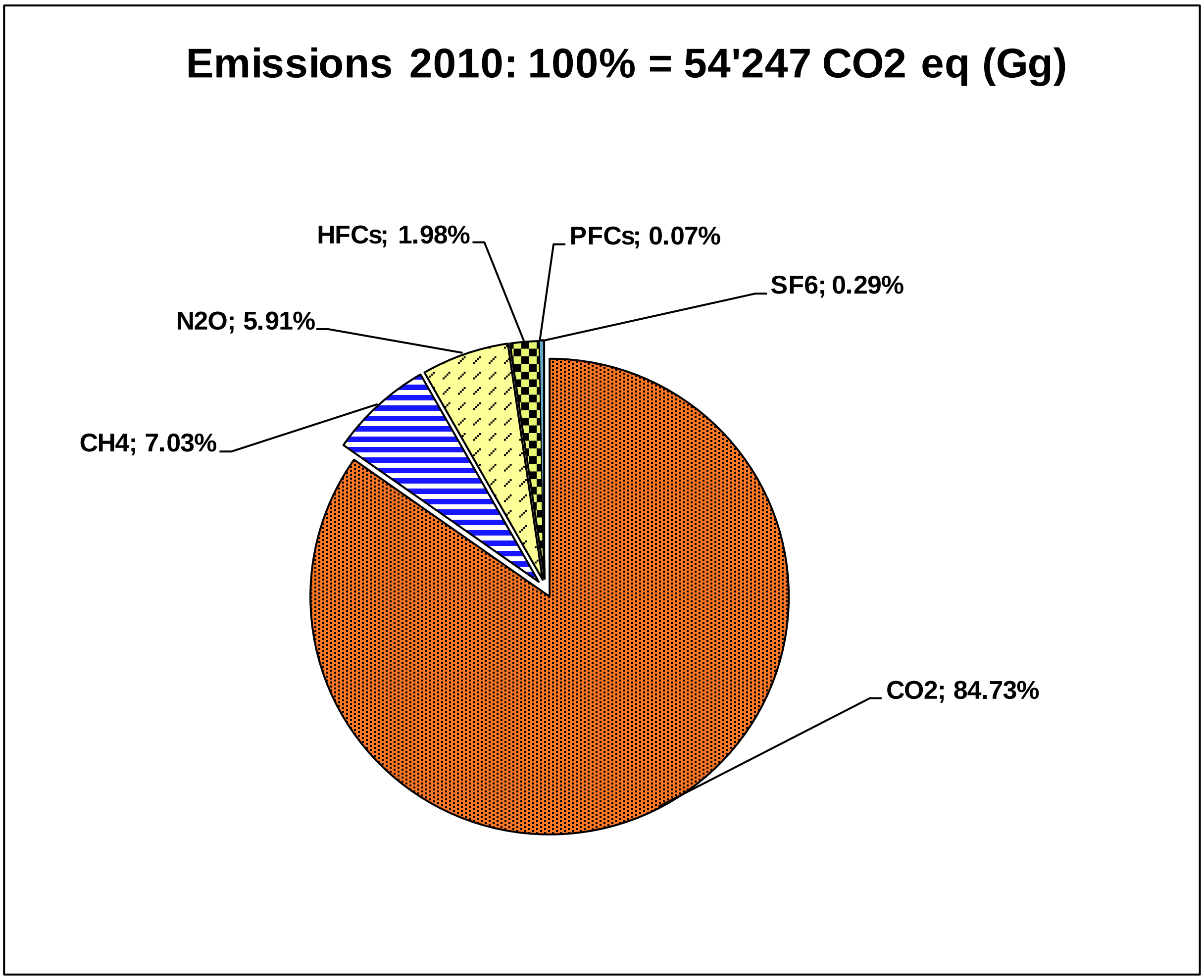

Figure E-1 Contribution of individual gases to Switzerland's GHG emissions (excluding LULUCF) in 2009. 100% = 54'247 Gg CO_2 eq.

For the emission data of 2010 excluding LULUCF, an uncertainty analysis on Tier 1 level was carried out resulting in a **level uncertainty of 3.84% and a trend uncertainty of 2.00% (1990-2010).** The analysis was also carried out including the LULUCF sector resulting in increases of the uncertainties to 4.10% (level uncertainty) and 3.36% (trend uncertainty).

A Tier 2 uncertainty analysis for Switzerland's GHG Inventory is also carried out and contains a level uncertainty for 2010 and a trend uncertainty for the period 1990-2010. The main results of the Monte Carlo simulation are:

- The total **level uncertainty** of the 2010 Swiss emissions is **3.97%** of the total GHG emissions excluding LULUCF. The 95% confidence interval is almost symmetric and lies between **96.2% and 104.2%** of the total GHG emissions.
- The **trend uncertainty** of the 2.24% increase of total emissions excluding LULUCF between 1990 and 2010 is **3.2%.** With a probability of 95%, the change lies within the range of -1.19% to +5.27%,

Taking into account the correlations in Tier 2 analysis between activity data and between emission factors leads to a slight increase in the overall level uncertainty of the GHG emissions compared to Tier 1 analysis.

Chapter 10 explains and justifies recalculations that have been performed since the previous inventory submission to the UNFCCC secretariat in November 2011 after the centralized review 2011. The recalculations result in a marginal decrease of the total base year (1990) emissions of -0.12% in CO_2 equivalents compared to the previous inventory. For the year 2009 emissions, the increase is 0.98% without emissions and removals from LULUCF. If the LULUCF sector is included there is a decrease of 2.36% in 1990 and a decrease of 1.30% in 2009.

ES.2.2 KP-LULUCF Activities

Switzerland reports the mandatory LULUCF activities Afforestation and Deforestation (Reforestation is not occurring in Switzerland) under Article 3, paragraph 3 of the Kyoto Protocol, and Forest Management under the elective voluntary activities of Article 3, paragraph 4 of the Kyoto Protocol. The total contribution of these activities is shown in Table E-3.

Table E-3 Contribution of activities accounted for under Article 3, paragraph 3 and paragraph 4 (Forest Management) of the Kyoto Protocol, Gg CO_2 eq., 1999-2010

Greenhouse gas source and sink activities	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**
	Net CO_2 equivalent emissions/removals (Gg CO_2 eq)						
Article 3.3 activities	239.04	238.64	237.33	235.55	233.50	231.33	174.61
Article 3.4 activities	-1855.92	280.50	730.05	477.17	-2282.30	-1602.81	-1797.00
Total Art. 3.3 and 3.4	**-1616.88**	**519.14**	**967.38**	**712.73**	**-2048.80**	**-1371.49**	**-1622.38**

Greenhouse gas source and sink activities	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**
	Net CO_2 equivalent emissions/removals (Gg CO_2 eq)						
Article 3.3 activities	178.86	210.09	166.33	220.61	215.41		
Article 3.4 activities	-503.00	-784.05	-671.33	-1122.66	-850.38		
Total Art. 3.3 and 3.4	**-324.14**	**-573.96**	**-505.00**	**-902.05**	**-634.97**		

ES.3. Overview of Source and Sink Category Estimates and Trends, including KP-LULUCF Activities

ES.3.1 GHG Inventory (Convention on Climate Change)

Table E-4 and Figure E-2 show the GHG emissions and removals by the main source and sink categories. The energy sector is by far the largest source of national emissions, accounting for 81.1% of the total GHG emissions. There are decreasing trends in the source categories 3. Solvent and Other Product Use, 4. Agriculture, and 6. Waste. However, there is no significant trend in total emissions over the period 1990–2010 due to the dominating emissions of the energy sector with its year-to-year variability caused by changing winter temperatures and their effect on CO_2 emissions from fuel combustion.

Table E-4 Switzerland's GHG emissions and removals by source and sink categories in CO_2 equivalent (Gg), 1990–2010 (from CRF Tables 10s5 and 10s5.2).

Source and Sink Categories	**1990**	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**
	CO_2 equivalent (Gg)									
1. Energy	42'043	44'122	44'134	41'823	40'917	41'486	42'529	41'940	43'184	43'453
1A1 Energy Industries	2'548	2'831	2'917	2'569	2'594	2'624	2'834	2'797	3'121	3'158
1A2 Manufacturing Industries and Construction	6'407	6'395	6'118	5'993	6'091	5'877	5'897	5'946	6'104	6'094
1A3 Transport	14'616	15'086	15'400	14'327	14'519	14'207	14'265	14'822	15'043	15'653
1A4 Other Sectors	17'795	19'153	19'088	18'363	17'172	18'282	19'063	17'913	18'465	18'113
1A5 Other (Military)	206	188	180	171	166	148	137	147	146	132
1B Fugitive emissions from oil and natural gas	472	467	431	399	376	348	332	314	304	304
2. Industrial Processes	3'381	3'023	2'868	2'562	2'724	2'653	2'528	2'466	2'562	2'666
3. Solvent and Other Product Use	472	449	428	403	387	368	347	325	303	288
4. Agriculture	6'138	6'113	6'021	5'940	5'906	5'900	5'849	5'675	5'653	5'583
6. Waste	995	991	963	902	840	835	811	802	783	755
7. Other	28	29	29	28	27	27	27	25	26	26
Total (excluding LULUCF)	53'057	54'726	54'442	51'657	50'800	51'269	52'091	51'232	52'510	52'773
5. Land Use, Land-Use Change and Forestry	-3'847	-3'723	-3'183	-4'897	-5'783	-4'632	-4'472	-3'194	-3'057	-1'894
Total (including LULUCF)	49'210	51'003	51'259	46'760	45'017	46'637	47'619	48'038	49'453	50'879

Source and Sink Categories	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**
	CO_2 equivalent (Gg)									
1. Energy	42'347	43'178	42'310	43'439	43'863	44'476	44'070	42'042	43'601	42'491
1A1 Energy Industries	3'043	3'197	3'286	3'326	3'654	3'843	4'120	3'853	4'046	3'963
1A2 Manufacturing Industries and Construction	6'237	6'316	6'197	6'153	6'240	6'333	6'359	6'108	6'102	5'703
1A3 Transport	15'890	15'599	15'485	15'659	15'781	15'855	15'944	16'285	16'662	16'497
1A4 Other Sectors	16'757	17'643	16'941	17'936	17'834	18'087	17'281	15'449	16'443	15'972
1A5 Other (Military)	136	134	140	125	114	124	127	120	115	116
1B Fugitive emissions from oil and natural gas	283	290	262	239	241	235	238	228	234	239
2. Industrial Processes	2'935	3'039	3'036	3'080	3'342	3'509	3'490	3'514	3'630	3'482
3. Solvent and Other Product Use	273	258	245	235	220	219	218	219	218	218
4. Agriculture	5'571	5'622	5'599	5'509	5'492	5'521	5'545	5'608	5'700	5'637
6. Waste	731	706	698	658	663	646	643	629	624	608
7. Other	26	27	27	27	27	26	26	27	26	25
Total (excluding LULUCF)	51'884	52'831	51'915	52'948	53'607	54'398	53'993	52'038	53'798	52'461
5. Land Use, Land-Use Change and Forestry	253	711	468	-2'282	-1'586	-1'860	-564	-772	-767	-1'099
Total (including LULUCF)	52'137	53'542	52'383	50'666	52'021	52'539	53'429	51'266	53'031	51'362

Source and Sink Categories	**2010**	2010/1990
	CO_2 eq	%
1. Energy	44'017	4.7%
1A1 Energy Industries	4'190	64.5%
1A2 Manufacturing Industries and Construction	5'985	-6.6%
1A3 Transport	16'422	12.4%
1A4 Other Sectors	17'050	-4.2%
1A5 Other (Military)	121	-41.3%
1B Fugitive emissions from oil and natural gas	248	-47.5%
2. Industrial Processes	3'689	9.1%
3. Solvent and Other Product Use	215	-54.5%
4. Agriculture	5'688	-7.3%
6. Waste	612	-38.5%
7. Other	27	-3.6%
Total (excluding LULUCF)	54'247	2.2%
5. Land Use, Land-Use Change and Forestry	-880	-77.1%
Total (including LULUCF)	53'367	8.4%

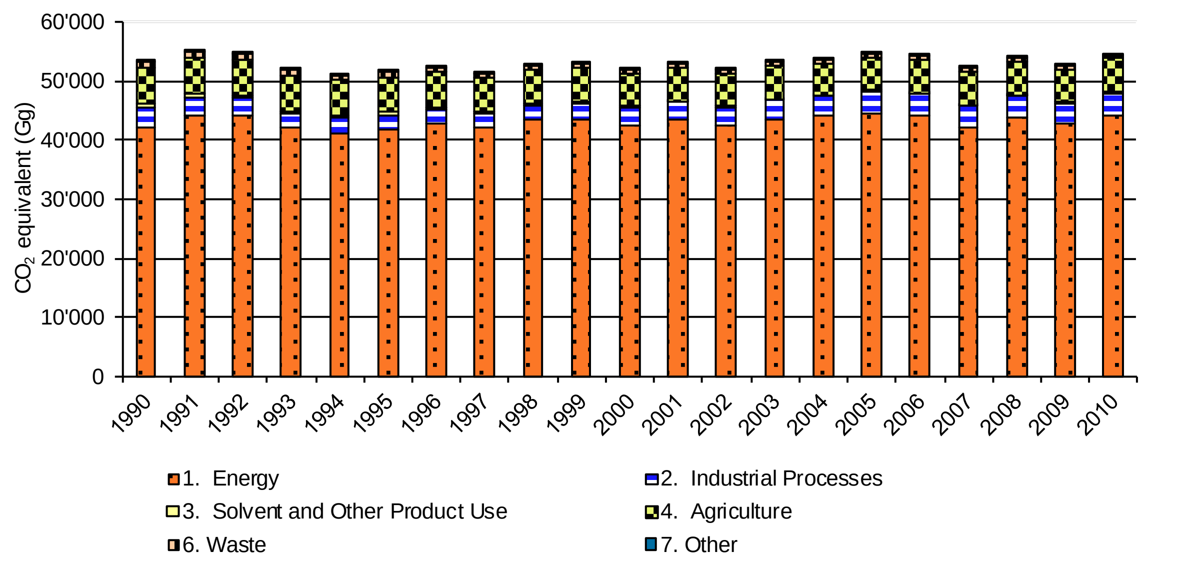

Figure E-2 Switzerland's greenhouse gas emissions in CO_2 equivalent (Gg) by main source categories, 1990–2010 (excluding LULUCF).

Table E-5 shows the contributions of individual sectors to total emissions excl. LULUCF for selected years in more detail. Between 1990 and 2010, the relative contribution of sector 1 Energy increased from 79.2% to 81.1%, whereas emissions from sector 4 Agriculture decreased from 11.6% to 10.5% and those from sector 6 Waste from 1.9% to 1.1%. Sector 2 Industrial Processes contributed 6.4% to total emissions in 1990 and 6.8 % in 2010, but with lower values in between (1995, 2000, 2005).

Table E-5 Switzerland's total gross GHG emissions (excluding LULUCF) in CO_2 equivalent (Gg) and the contribution of individual source categories, selected years.

Source and Sink Categories	**1990**		**1995**		**2000**		**2005**		**2006**	
	Gg CO_2 eq	%	Gg CO_2 eq	%	Gg CO_2 eq	%	Gg CO_2 eq	%	Gg CO_2 eq	%
1. Energy	42'043	79.2%	41'486	80.9%	42'347	81.6%	44'476	81.8%	44'070	81.6%
1A1 Energy Industries	*2'548*	*4.8%*	2'624	*5.1%*	3'043	*5.9%*	3'843	*7.1%*	4'120	*7.6%*
1A2 Manufacturing Industries and Construction	*6'407*	*12.1%*	5'877	*11.5%*	6'237	*12.0%*	6'333	*11.6%*	6'359	*11.8%*
1A3 Transport	*14'616*	*27.5%*	14'207	*27.7%*	15'890	*30.6%*	15'855	*29.1%*	15'944	*29.5%*
1A4 Other Sectors	*17'795*	*33.5%*	18'282	*35.7%*	16'757	*32.3%*	18'087	*33.2%*	17'281	*32.0%*
1A5 Other (Military)	*206*	*0.4%*	148	*0.3%*	136	*0.3%*	124	*0.2%*	127	*0.2%*
1B Fugitive emissions from oil and natural gas	*472*	*0.9%*	348	*0.7%*	283	*0.5%*	235	*0.4%*	238	*0.4%*
2. Industrial Processes	3'381	6.4%	2'653	5.2%	2'935	5.7%	3'509	6.5%	3'490	6.5%
3. Solvent and Other Product Use	472	0.9%	368	0.7%	273	0.5%	219	0.4%	218	0.4%
4. Agriculture	6'138	11.6%	5'900	11.5%	5'571	10.7%	5'521	10.1%	5'545	10.3%
6. Waste	995	1.9%	835	1.6%	731	1.4%	646	1.2%	643	1.2%
7. Other	28	0.1%	27	0.1%	26	0.1%	26	0.0%	26	0.0%
Total (excluding LULUCF)	53'057	100.0%	51'269	100.0%	51'884	100.0%	54'398	100.0%	53'993	100.0%

Source and Sink Categories	**2007**		**2008**		**2009**		**2010**	
	Gg CO_2 eq	%	Gg CO_2 eq	%	Gg CO_2 eq	%	Gg CO_2 eq	%
1. Energy	42'042	80.8%	43'601	81.0%	42'491	81.0%	44'017	81.1%
1A1 Energy Industries	3'853	7.4%	4'046	7.5%	3'963	7.6%	4'190	7.7%
1A2 Manufacturing Industries and Construction	6'108	11.7%	6'102	11.3%	5'703	10.9%	5'985	11.0%
1A3 Transport	16'285	31.3%	16'662	31.0%	16'497	31.4%	16'422	30.3%
1A4 Other Sectors	15'449	29.7%	16'443	30.6%	15'972	30.4%	17'050	31.4%
1A5 Other (Military)	120	0.2%	115	0.2%	116	0.2%	121	0.2%
1B Fugitive emissions from oil and natural gas	228	0.4%	234	0.4%	239	0.5%	248	0.5%
2. Industrial Processes	3'514	6.8%	3'630	6.7%	3'482	6.6%	3'689	6.8%
3. Solvent and Other Product Use	219	0.4%	218	0.4%	218	0.4%	215	0.4%
4. Agriculture	5'608	10.8%	5'700	10.6%	5'637	10.7%	5'688	10.5%
6. Waste	629	1.2%	624	1.2%	608	1.2%	612	1.1%
7. Other	27	0.1%	26	0.0%	25	0.0%	27	0.1%
Total (excluding LULUCF)	52'038	100.0%	53'798	100.0%	52'461	100.0%	54'247	100.0%

ES.3.2 KP-LULUCF Activities

An overview of net CO_2 equivalent emissions and removals of activities under Article 3, paragraph 3 and Forest Management under paragraph 4 of the Kyoto Protocol is shown in Table E-6. For 2010, there results a net removal of -634.97 Gg CO_2. In 2010, Deforestations were responsible for an emission of 238.50 Gg CO_2 equivalent, whereas Afforestations stored -23.08 Gg CO_2 equivalent and Forest Management -850.38 Gg CO_2 equivalent.

Detailed quantitative information of the inventory years 2008, 2009 and 2010 as well as data for the previous years 1999–2007 are reported in Chapter 11.4, Chapter 11.5 and displayed in Table 11-4. Annual changes in the emissions from deforestation can directly be contributed to the changes in the area of Deforestations. Year-to-year fluctuations in removals from Afforestations are due to changes in the yearly afforested area. Other factors responsible for the fluctuations are the application of a logistical growth curve for afforestations and the fact that for afforestations older than 20 years emission factors of forest management are applied (see Chapter 11.3.1.1). Fluctuations in the contribution of Forest Management can mainly be explained by differences in the losses of living biomass (cut and mortality) and stock of dead biomass, whereas changes in the area of managed forest are relatively small.

Table E-6 Contribution of the carbon pools under Activities under Article 3, paragraph 3 and paragraph 4 (Forest Management) of the Kyoto Protocol, Gg CO_2 eq., 1999-2010.

Greenhouse gas source and sink activities	1999	2000	2001	2002	2003	2004	2005
	Net CO_2 equivalent emissions/removals (Gg CO_2 eq)						
A. Article 3.3 activities	**239.04**	**238.64**	**237.33**	**235.55**	**233.50**	**231.33**	**174.61**
A.1. Afforestation and Reforestation	-1.57	-2.15	-2.97	-4.18	-5.69	-7.29	-9.29
A.2. Deforestation	240.61	240.79	240.30	239.74	239.18	238.62	183.91
B. Article 3.4 activities	**-1855.92**	**280.50**	**730.05**	**477.17**	**-2282.30**	**-1602.81**	**-1797.00**
B.1. Forest Management incl. biomass burning	-1855.92	280.50	730.05	477.17	-2282.30	-1602.81	-1797.00
gains living biomass	-12279.01	-12288.92	-12297.53	-12306.01	-12314.58	-12324.28	-12345.86
losses living biomass	10411.75	13530.40	13988.59	13837.99	11189.06	10815.73	11293.34
dead wood pool	2.14	-971.28	-971.35	-1080.35	-1188.60	-103.92	-755.25
sum forest management excl. biomass burning	-1856.28	279.03	728.54	460.47	-2305.28	-1603.63	-1798.91
Total Art. 3.3 and 3.4	**-1616.88**	**519.14**	**967.38**	**712.73**	**-2048.80**	**-1371.49**	**-1622.38**

Greenhouse gas source and sink activities	2006	2007	2008	2009	2010	2011	2012
	Net CO_2 equivalent emissions/removals (Gg CO_2 eq)						
A. Article 3.3 activities	**178.86**	**210.09**	**166.33**	**220.61**	**215.41**		
A.1. Afforestation and Reforestation	-11.39	-14.12	-15.88	-17.74	-23.08		
A.2. Deforestation	190.26	224.21	182.20	238.35	238.50		
B. Article 3.4 activities	**-503.00**	**-784.05**	**-671.33**	**-1122.66**	**-850.38**		
B.1. Forest Management incl. biomass burning	-503.00	-784.05	-671.33	-1122.66	-850.38		
gains living biomass	-12362.71	-12377.48	-12388.78	-12397.41	-12401.07		
losses living biomass	11736.13	12232.90	12371.03	11929.04	11659.37		
dead wood pool	110.60	-657.96	-663.95	-664.91	-118.64		
sum forest management excl. biomass burning	-507.12	-793.59	-672.75	-1124.32	-851.37		
Total Art. 3.3 and 3.4	**-324.14**	**-573.96**	**-505.00**	**-902.05**	**-634.97**		

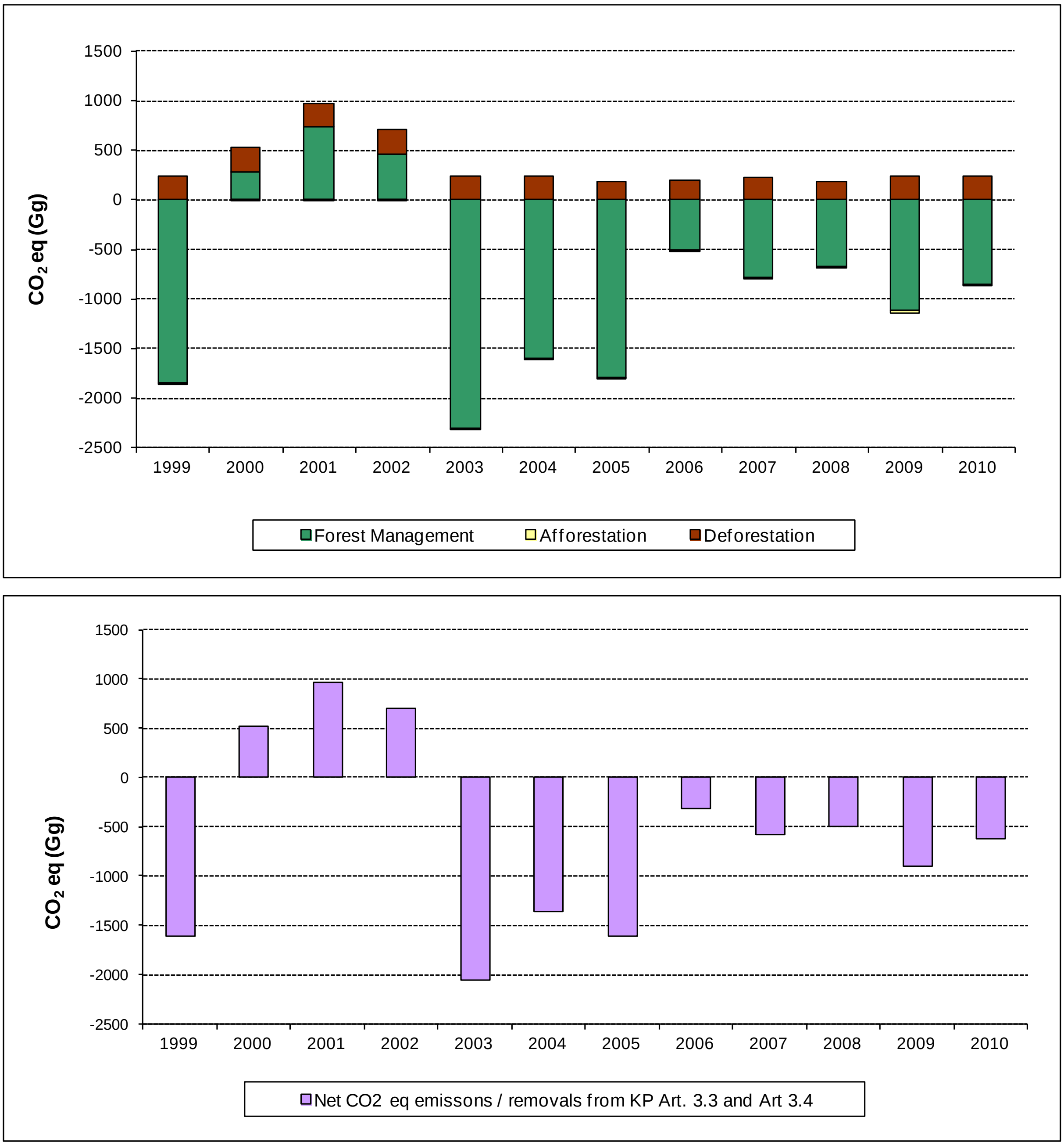

Figure E-3: Emissions (positive sign) and removals (negative sign) of CO_2 eq from Afforestation and Deforestation under Article 3, paragraph 3 and Forest Management under Article 3, paragraph 4 (upper panel) and the total contribution of these activities in CO_2 equivalents (lower panel), 1999-2010.

ES.3.3 GHG Inventory (Kyoto Protocol)

Relevant emissions and removals under the Kyoto Protocol are shown in table E-7 and E-8, sorted by sectors and gases respectively. The reported total emissions differ from those reported under the UNFCCC, as sector 7 Other – in addition to LULUCF and international bunkers – is not accounted for under the Kyoto Protocol. On the other hand, activities under article 3.3 (afforestation, reforestation and deforestation) and 3.4 (forest, cropland and grazing management and revegetation) are taken into account over the commitment period 2008-2012. Under the elective voluntary activities of Article 3, paragraph 4 of the Kyoto Protocol, Switzerland only accounts for forest management. Base year emissions (as shown in tables E-7 and E-8) for the first commitment period are fixed at the value reported in the Initial Report 2006 (FOEN 2006h, UNFCCC 2007a).

Table E-7 Summary of Switzerland's GHG emissions in CO_2 equivalent (Gg), 1990–2010 excluding emissions from sectors LULUCF, Other and International Bunkers.

		Sector	Base year inital report	1990	1991	1992	1993	1994	1995	1996	1997	1998
			CO_2 equivalent (Gg)									
Annex A sources		1 Energy	42'134	42'043	44'122	44'134	41'823	40'917	41'486	42'529	41'940	43'184
		2 Industrial Processes	3'258	3'381	3'023	2'868	2'562	2'724	2'653	2'528	2'466	2'562
		3 Solvent and Other Product Use	466	472	449	428	403	387	368	347	325	303
		4 Agriculture	5'903	6'138	6'113	6'021	5'940	5'906	5'900	5'849	5'675	5'653
		6 Waste	1'030	995	991	963	902	840	835	811	802	783
		Total (Annex A sources)	**52'791**	**53'029**	**54'698**	**54'414**	**51'629**	**50'773**	**51'242**	**52'064**	**51'207**	**52'485**

		Sector	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
			CO_2 equivalent (Gg)									
Annex A sources		1 Energy	43'453	42'347	43'178	42'310	43'439	43'863	44'476	44'070	42'042	43'601
		2 Industrial Processes	2'666	2'935	3'039	3'036	3'080	3'342	3'509	3'490	3'514	3'630
		3 Solvent and Other Product Use	288	273	258	245	235	220	219	218	219	218
		4 Agriculture	5'583	5'571	5'622	5'599	5'509	5'492	5'521	5'545	5'608	5'700
		6 Waste	755	731	706	698	658	663	646	643	629	624
		Total (Annex A sources)	**52'746**	**51'857**	**52'803**	**51'888**	**52'921**	**53'580**	**54'372**	**53'966**	**52'011**	**53'772**
KP-LULUCF	Art.3.3	Afforestation & reforestation										-16
		Deforestation										182
	Art.3.4	Forest management										-671
		Cropland management										NA
		Grazing land management										NA
		Revegetation										NA
		Total (Art. 3.3 + 3.4)										**-505**

		Sector	2009	2010	Base year – 2010
			CO_2 equivalent (Gg)		Change (%)
Annex A sources		1 Energy	42'491	44'017	4%
		2 Industrial Processes	3'482	3'689	13%
		3 Solvent and Other Product Use	218	215	-54%
		4 Agriculture	5'637	5'688	-4%
		6 Waste	608	612	-41%
		Total (Annex A sources)	**52'435**	**54'220**	**3%**
KP-LULUCF	Art.3.3	Afforestation & reforestation	-18	-23	
		Deforestation	238	238	
	Art.3.4	Forest management	-1'123	-850	
		Cropland management	NA	NA	
		Grazing land management	NA	NA	
		Revegetation	NA	NA	
		Total (Art. 3.3 + 3.4)	**-902**	**-635**	

Table E-8 Switzerland's total GHG emissions (excluding LULUCF, Other and International Bunkers) and the contribution of individual gases in CO_2 equivalent (Gg), 1990-2010.

		GHG	Base year inital report	1990	1991	1992	1993	1994	1995	1996	1997	1998
			CO_2 equivalent (Gg)									
Annex A sources		CO_2	44'553	44'620	46'342	46'234	43'705	42'968	43'345	44'211	43'460	44'689
		CH_4	4'370	4'698	4'666	4'529	4'390	4'304	4'297	4'208	4'102	4'062
		N_2O	3'623	3'467	3'459	3'427	3'363	3'338	3'307	3'308	3'195	3'195
		HFCs	0.0	0.0	0.2	6	14	33	180	225	299	355
		PFCs	100	100	85	69	30	18	15	17	20	23
		SF_6	144	144	146	148	126	112	98	94	131	160
		Total (Annex A sources)	**52'791**	**53'029**	**54'698**	**54'414**	**51'629**	**50'773**	**51'242**	**52'064**	**51'207**	**52'485**

		GHG	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
			CO_2 equivalent (Gg)									
Annex A sources		CO_2	44'974	44'019	44'860	43'961	45'054	45'624	46'341	45'902	43'910	45'447
		CH_4	4'001	3'934	3'949	3'895	3'800	3'782	3'789	3'796	3'795	3'875
		N_2O	3'172	3'181	3'201	3'195	3'139	3'134	3'123	3'135	3'158	3'177
		HFCs	418	497	590	629	697	799	874	900	934	990
		PFCs	36	69	45	40	57	53	33	32	29	39
		SF_6	147	158	157	168	174	189	213	201	186	244
		Total (Annex A sources)	**52'746**	**51'857**	**52'803**	**51'888**	**52'921**	**53'580**	**54'372**	**53'966**	**52'011**	**53'772**
KP-LULUCF	Art.3.3	CO_2										166
		CH_4										NO
		N_2O										0.0
	Art.3.4	CO_2										-672
		CH_4										0.3
		N_2O										0.2
		Total (Art. 3.3 + 3.4)										**-505**

		GHG	2009	2010	Base year – 2010
			CO_2 equivalent (Gg)		Change (%)
Annex A sources		CO_2	44'244	45'950	3%
		CH_4	3'816	3'815	-13%
		N_2O	3'131	3'191	-12%
		HFCs	1'023	1'073	NA
		PFCs	35	37	-64%
		SF_6	187	155	8%
		Total (Annex A sources)	**52'435**	**54'220**	**3%**
KP-LULUCF	Art.3.3	CO_2	221	215	
		CH_4	NO	NO	
		N_2O	0.0	0.0	
	Art.3.4	CO_2	-1'123	-851	
		CH_4	0.3	0.2	
		N_2O	0.2	0.1	
		Total (Art. 3.3 + 3.4)	**-902**	**-635**	

ES.4. Other information

Emission trends for indirect greenhouse gases show a very pronounced decline (see Table 2-6 and Figure 2-9). A strict air pollution control policy and the implementation of a large number of emission reduction measures led to a decrease of -50% to -70% in the period 1990-2010 in emissions of air pollutants. The main reduction measures were abatement of exhaust emissions from road vehicles and stationary combustion equipment, taxation of solvents and sulphured fuels, and voluntary agreements with industry sectors (FOEN 2010i, Swiss Confederation 1985, 1997).

Acknowledgements

The GHG inventory preparation is a joint effort which is based on input from many federal agencies, institutions, associations, companies and individuals. Their effort was essential for the successful completion of the present inventory report.

The Federal Office for the Environment would like to acknowledge the valuable support it has received from the many contributors to this document. In particular, it would like to thank all the data suppliers, including the Office of Environmental Protection of the Principality of Liechtenstein for providing its fossil fuel consumption data, as well as experts and both national and international reviewers.

PART 1

1 Introduction

1.1 Background Information on Swiss Greenhouse Gas Inventories, Climate Change and Supplementary Information of the Kyoto Protocol (KP)

1.1.1 Information on Climate Change

The report of the Swiss Advisory Body on Climate Change (OcCC) provides an assessment of the observed and expected impacts of climate change on Switzerland and the vulnerability of various ecological and socio-economic systems (OcCC, 2008). Another report by FOEN (2009d) confirms a warming trend with an observed increase in mean annual temperature of 1.6 °C between 1864 and 2008. Over the last 100 years, mean annual temperatures increased by 0.12-0.19 °C per decade, with a substantially accelerated warming in recent decades. According to the mean estimate, average temperatures will rise by another 1.8 °C in winter and 2.7 °C in summer between 1990 and 2050. The most visible change in the Alps resulting from global warming is the retreat of glaciers, which showed a volume loss of 12% since 1999 (FOEN 2009d). According to the OcCC report, the area covered by alpine glaciers will diminish by about three quarters in case of a medium warming by 2050.

The observed trends in precipitation are less distinct than in temperature. For a number of stations a significant increase in precipitation is found in winter and spring (+2.7 to +3.1% per decade). For summer and autumn no significant trends are detectable. Based on regional climate scenarios, an increase in mean winter precipitation of 8% compared to 1990 is expected north of the Alps by 2050 (11% south of the Alps), and a decrease of 17% in summer (19% south of the Alps). This will have a marked impact on the hydrological cycle: On the Central Plateau and in the very south of Switzerland, small and medium watercourses will dry up more frequently and natural replenishment of groundwater will decrease accordingly. Apart from changes to the average precipitation rate, increased intensity of storms and reduced snowfall and snow cover duration are expected in the coming decades. This is particularly relevant for alpine areas, tourism and forestry due to the risk of more frequent floods, landslides and debris flows.

The warming trend and changing precipitation patterns are expected to have significant effects on ecosystems. The Biodiversity Monitoring Switzerland reports that impacts of climate change are already being observed, for instance, typical alpine vascular plants have shifted uphill over the past few years. Generally, climate change is expected to affect species composition, distribution, their cycles, synchronicity, the overall genetic diversity and the provision of ecosystem services. It will enhance the vulnerability of forests and impair their protective, productive and social functions. For agriculture, a moderate warming of 2°C to 3°C might increase productivity, however, if temperature will rise beyond that level, the increase in heat waves and drought periods would prove problematic for the cultivation of land and for livestock husbandry.

Various sectors of the Swiss economy are likely to be affected by progressing climate change. In particular, the tourism industry will be hit, as the potentially beneficial effects for summer tourism will not compensate for the loss of income in mountain resorts during winter due to scarcity of snow. Hydroelectric power stations may be affected by altered runoff and sediment transport regimes, and insurance companies may face increased losses due to winter storms and floods. Natural hazards and extreme weather events potentially pose a growing risk to infrastructure and human health. Heat waves and elevated tropospheric ozone levels are cause for serious concern, as evidenced by the impacts of the heat wave in 2003. Finally, it remains to be seen to what extent vector borne diseases spread due to changing climatic conditions. Recently Switzerland has analysed these challenges in detail and developed an effective adaptation strategy in order to hedge against negative effects resulting from climate change in Switzerland (FOEN, 2012b).

1.1.2 Information on the Greenhouse Gas Inventory

On 10 December 1993, Switzerland ratified the United Nations Framework Convention on Climate Change (UNFCCC). Since 1996, the submission of its national greenhouse gas inventory has been based on IPCC guidelines. From 1998 onwards, the inventories have been submitted in the Common Reporting Format (CRF): In 2004, Switzerland started submitting a yearly National Inventory Report (NIR) under the UNFCCC.

On 9 July 2003, Switzerland ratified the Kyoto Protocol under the UNFCCC. November 2006 saw the submission of Switzerland's Initial Report under Article 7, paragraph 4 of the Kyoto Protocol (FOEN 2006h). The Swiss National Inventory System (NIS) according to Article 5.1 of the Kyoto Protocol has been implemented and is fully operational. On 6 December 2007, the NIS quality management system was certified to comply with ISO 9001:2000 requirements (SQS 2008); it has been audited and recertified in November 2010 and now includes the accounting and reporting of the national registry as well (ISO 9001:2008, SQS 2010). The April 2008 submission of the Swiss GHG inventory (FOEN 2008) has been Switzerland’s first submission under both the UNFCCC and the Kyoto Protocol.

For the submission in 2010, the NIR has been restructured according to the new outline (UNFCCC 2009a), which includes an extended reporting under the Kyoto Protocol.

The 2012 inventory submission under the United Nations Framework Convention on Climate Change and under the Kyoto Protocol (FOEN 2012) includes the NIR on hand, the greenhouse gas inventory 1990–2010 and the Kyoto Protocol LULUCF tables 2008–2010 in the common reporting format as well as the SEF tables and the standard independent assessment report (SIAR) from the National Registry. As a supplement, the update of the Description of the Quality Management System (FOEN 2012a) is provided.

1.1.3 Supplementary Information Required under Art. 7.1. KP

Switzerland has decided to account for Forest Management under the elective voluntary activities of Article 3, paragraph 4 of the Kyoto Protocol. In accordance with the Annex to Decision 16/CMP.1, credits from Forest Management are capped in the first commitment period. For Switzerland, the cap amounts to 1.83 Mt CO_2 (0.5 Mt C) per year, or 9.15 Mt CO_2 for the whole commitment period.

Switzerland has chosen to account annually for emissions and removals from the LULUCF sector. The current submission contains the mandatory inventory years 2008-2010 in the Common Reporting Format. In addition, Switzerland includes KP-LULUCF information for the years 1999-2007 on a voluntary basis in the NIR.

1.2 Institutional Arrangements for Inventory Preparation

1.2.1 Overview of Institutional, Legal and Procedural Arrangements for Compiling GHG Inventory and Supplementary Information for KP

The Swiss National Inventory System (NIS) is developed and managed under the auspices of the Federal Department of the Environment, Transport, Energy and Communications (DETEC). It is hosted by a DETEC agency, the Federal Office for the Environment (FOEN). As stipulated in the Ordinance on the Internal Organization of DETEC of 13 December 2005, this agency has the lead within the federal administration regarding climate policy and its implementation.

As part of a comprehensive project (Swiss Climate Reporting Project), the FOEN directorate mandated its Economics, Research and Environmental Observation Division in early 2004 to design and establish the NIS in order to ensure full compliance with the reporting requirements of the UNFCCC and the Kyoto Protocol by 2006. Today the responsibility lies within the Climate Division which was established on 1st January 2010. Having regard to the provisions of Art. 5, paragraph 1 of the Kyoto Protocol, the project encompassed the following elements:

- arrangements with partner institutions, relating to
  - roles and responsibilities,
  - participation in the inventory development process,
  - data use, communication and publication,
- inventory development plan,
- setting-up of a QA/QC system,
- official consideration and approval of data,
- upgrading and updating of the national air pollution database (EMIS),
- data documentation and storage.

With the formal approval of Switzerland's initial report under article 7, paragraph 4 of the Kyoto Protocol (FOEN 2006h) by the Federal Council on 8 November 2006 the Swiss NIS became operative. By providing for structures and in defining tasks and responsibilities of institutions, organisations and consultants involved, the NIS itself is a key tool in ensuring and improving the quality as well as the process management of inventory preparation. Figure 1-1 gives a schematic overview of the institutional setting of the NIS.

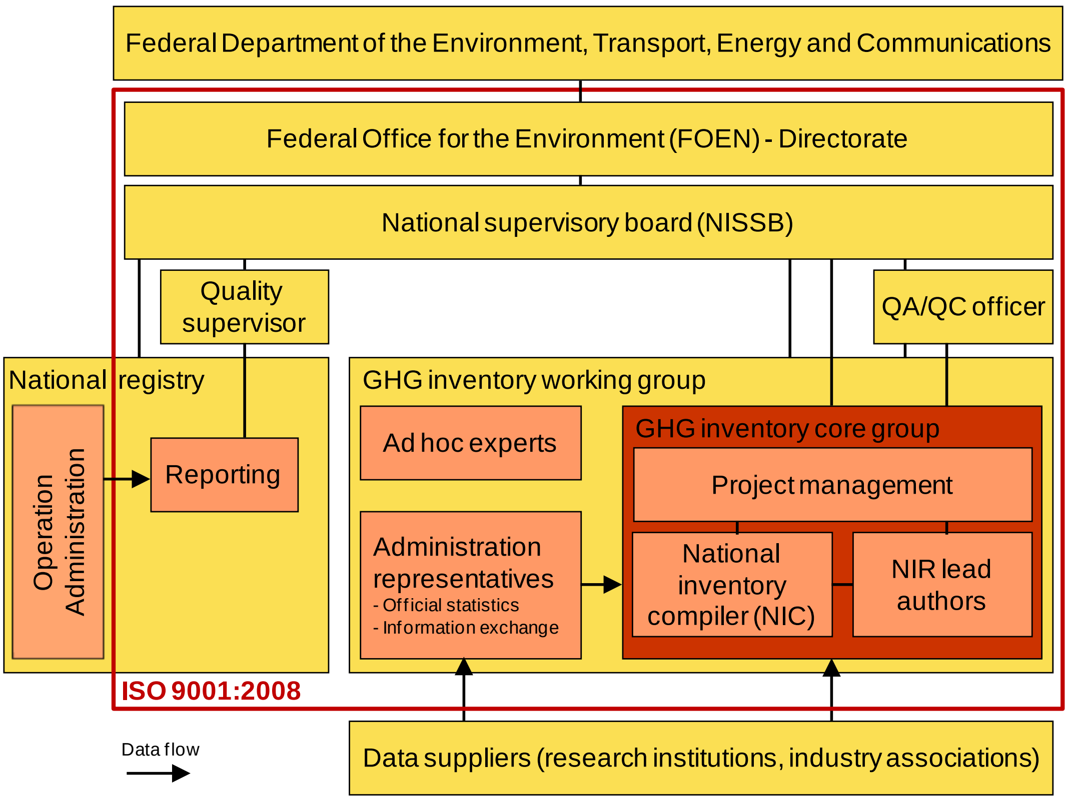

Figure 1-1 Institutional setting of the National Inventory System. The red frame marks the institutions that are included in the ISO 9001:2008 certification.

The **national inventory system supervisory board (NISSB)** was established by decision of the FOEN directorate in summer 2006. The board oversees activities related to the GHG inventory and to the national registry. It is independent of the inventory preparation and the registry administration and, by its composition, combines technical expertise and political authority. In order to put more emphasis on operational and security issues of the national registry, the national supervisory board has updated its formal mandate to explicitly cover registry specific issues and assign the corresponding responsibilities.

The main tasks of the national supervisory board are:

- official consideration of the annual inventory submission and recommendation of the inventory for official approval by the FOEN directorate;
- assessment and approval of the recalculation of inventory data;
- handling of any issues arising from the UNFCCC review process that cannot be resolved at the level of the inventory project management or the registry administration;
- facilitation of any non-technical negotiation, consideration or approval processes involving other institutions within the federal administration;
- support of the registry administration in maintaining a secure and reliable registry environment.

The **national registry** is largely run independently of the national greenhouse gas inventory. Its operation is coordinated by the **registry administrator**, whose work is overseen by the registry **quality supervisor**.

The GHG **QA/QC officer** is responsible for enforcement of the defined quality standards of the national inventory. The officer also advises the national supervisory board on matters relating to the conformity of the inventory with reporting requirements. Tasks and competencies are described in detail in the Description of the Quality Management System (FOEN 2012a), annexed to this report.

The **GHG inventory working group** encompasses all technical personnel involved in the inventory preparation process or representing institutions that play a significant role as suppliers of data. The group as a whole meets at least once per year to take stock of the state of the inventory, discuss priorities in the inventory development process, and to address specific issues of general interest that arise, e.g., from domestic or international reviews.

The **GHG inventory core group** comprises the inventory experts employed at the FOEN or mandated on a regular basis, which are entrusted with specific, major responsibilities for inventory planning, preparation and/or management. All inventory data are assembled and prepared for input into the CRF Reporter by the GHG inventory core group, which is responsible for ensuring the conformity of the inventory with the updated UNFCCC Reporting Guidelines on Annual Inventories (UNFCCC 2006b) and the 2008 Kyoto Protocol Reference Manual (UNFCCC 2008). Further details of the function of the core group and the roles and responsibilities of its members are given in the Description of the Quality Management System (FOEN 2012a).

The core group consists of

- the inventory project management (with overall responsibility for the integrity of the inventory, communication of data, and information exchange with the UNFCCC secretariat);
- the national inventory compiler (responsible for the EMIS inventory data base, key category analyses, and for the CRF tables);

- the NIR lead authors (responsible for the inventory report and carrying out centralized data assessments such as uncertainty analysis);
- selected sectoral experts.

The QA/QC officer, albeit no formal member, attends the meetings of the core group.

The GHG inventory core group coordinates and integrates the activities of data suppliers within and outside the FOEN as well as those of mandated experts. Further data suppliers contributing to the inventory are research institutions and industry associations (Table 1-1). The latter are obliged by Art. 46 of the Environmental Protection Act (Swiss Confederation 1983) to provide the authorities with the information needed to enforce the law and, where necessary, to carry out inquiries.

The formal arrangements (agreements, contracts, and documentations of roles and responsibilities) that have been established to consolidate and formalize cooperation between the relevant partners contributing to, or involved in, the GHG inventory preparation process are described in Chapter H.1.1 of Switzerland's Initial Report under Article 7, paragraph 4 of the Kyoto Protocol (FOEN 2006h).

Information relating to the Swiss GHG inventory is made publicly accessible through a website hosted by FOEN (www.climatereporting.ch), where detailed contact information is also available.

Table 1-1 Suppliers of raw and processed data: 1–15 provide annual updates; 16–20 provide sporadic updates. The IPCC nomenclature (IPCC 1997a) is used for the inventory categories (1A1 = Energy Industries, 1A2 = Manufacturing Industries and Construction etc.). RA = Reference Approach. For further abbreviations and acronyms see the glossary. Coloured boxes mark those sectors to which each data supplier contributes.

	Institution	**Subject**	**Data supplied for inventory category**												
			1A1	1A2	1A3	1A4	1A5	1B	RA	2	3	4	5/KP	6	7
	Data suppliers (annual updates)														
1	FOEN, Air Pollution Control	EMIS Database	■	■		■	■	■		■	■	■		■	■
2	FOEN, Waste and Raw Materials	Waste Statistics	■	■										■	
3	FOEN, Forest Division	Forest Statistics											■		
4	SFOE	Swiss overall energy statistics	■	■	■	■		■	■	■				■	
5	SFOE	Swiss wood energy statistics	■	■		■									
6	FOCA	Civil Aviation			■										
7	Swiss Air Force Administration	Military Aviation					■								
8	SFSO	Agriculture, LULUCF											■		
9	ART	Agriculture, LULUCF										■	■		
10	WSL	National Forest Inventory											■		
11	Prognos/Basics	Energy Consum-ption		■		■									

12	Carbotech	F-gases													
13	Industry Associations: SGCI, Swissmem, VSAI etc.	F-gases													
14	Swiss Petroleum Association	Oil Statistics													
15	Sigmaplan, Meteotest	LULUCF													
	Data suppliers (sporadic updates)														
16	FOEN, Air Pollution Control	Off-road Data-base, NMVOC													
17	SGWA, SGIA	Gas Distribution Losses													
18	EMPA	Various Emission Factors													
19	INFRAS	On-road Emission Model													
20	INFRAS	Off-road Emission Model													

1.2.2 Overview of Inventory Planning

Inventory planning, preparation, and management follow an annual cycle that is documented in Table 1 of the QMS (FOEN, 2012a). It marks milestones in the planning and preparation process in relation to QA/QC activities as specified in the quality manual. Key elements of the cycle contain:

- meetings of the supervisory board, the core group and the working group
- modelling of emissions / removals and implementation in the CRF reporter
- QA/QC activities including checklists and reviews and their inclusion in the inventory development plan
- key category and uncertainty analyses
- official consideration, approval, and submission
- publication and archiving

1.2.3 Overview of Inventory Preparation and Management, Including for Supplementary Information for Kyoto Protocol

The overall responsibility of the inventory preparation is held by the Climate Division at FOEN. The project leader coordinates the activities and oversees the compilation of the inventory and related documentation. QA/QC procedures are also coordinated by the Climate Division, and the QA/QC officer ensures archiving of all relevant data and documentation on the internal document management system of the FOEN. Details regarding the inventory preparation are given in section 1.3, while the QA/QC system is described briefly in section 1.6 and more comprehensively in the QMS supplement (FOEN 2012a).

1.3 Process for Inventory Preparation

1.3.1 GHG Inventory and KP-LULUCF Inventory

All inventory data, including activity data and emission factors for both inventories are compiled centrally by the FOEN. While emissions and removals from sector 5 LULUCF and KP-LULUCF are calculated by the Forest Division, all other sectors are calculated or compiled by the Air Pollution Control and Non-Ionizing Radiation Division. Activity data are provided by the data suppliers (Table 1-1), while emission factors are partly updated by the data suppliers and partly by the Air Pollution Control Division.

1.3.2 Data Collection, Processing and Storage, Including for KP-LULUCF Inventory

The data needed to prepare the UNFCCC greenhouse gas inventory in the CRF is collected by the various data suppliers (Table 1-1). Since the individual data suppliers bear the main responsibility for the quality of data provided, they are also responsible for the collection of activity data, emission factors, and for the selection of methods compliant with the relevant guidelines (IPCC 1997a, 1997b, 1997c, 2000, 2003). Some data suppliers have further started to adopt the good practice guidance presented in the 2006 IPCC guidelines (IPCC 2006). Several QA/QC activities (see Chapter 1.6.1 and FOEN 2012a) ensure and continuously improve the quality of inventory data.

The Air Pollution Control and Non-Ionizing Radiation Division at the FOEN maintain the EMIS database, which contains all the basic data needed to prepare the GHG inventory in the CRF. At the same time, background information on data sources, activity data, emission factors and methods used for emission estimation is documented in the database and/or the NIR.

Figure 1-2 illustrates in a simplified manner the data collection and processing steps leading to the CRF tables required for reporting under the UNFCCC and under the Kyoto Protocol. From EMIS, an interface transfers the data to the CRF Reporter (Version 3.5.2) that generates the CRF tables that are to be submitted using the UNFCCC submission portal released in February 2009. Representative data from the CRF tables are shown in the NIR. The NIR authors and the reviewers control the correctness of the data transferred from EMIS into the NIR. Figures and tables shown in the NIR are exported directly from EMIS. The NIR authors check the correspondence between the exports and the CRF tables. A detailed illustration of the sectoral steps of inventory processing is given in the monitoring protocols of NIS core processes and sub-processes, as shown in a couple of examples in FOEN (2012a).

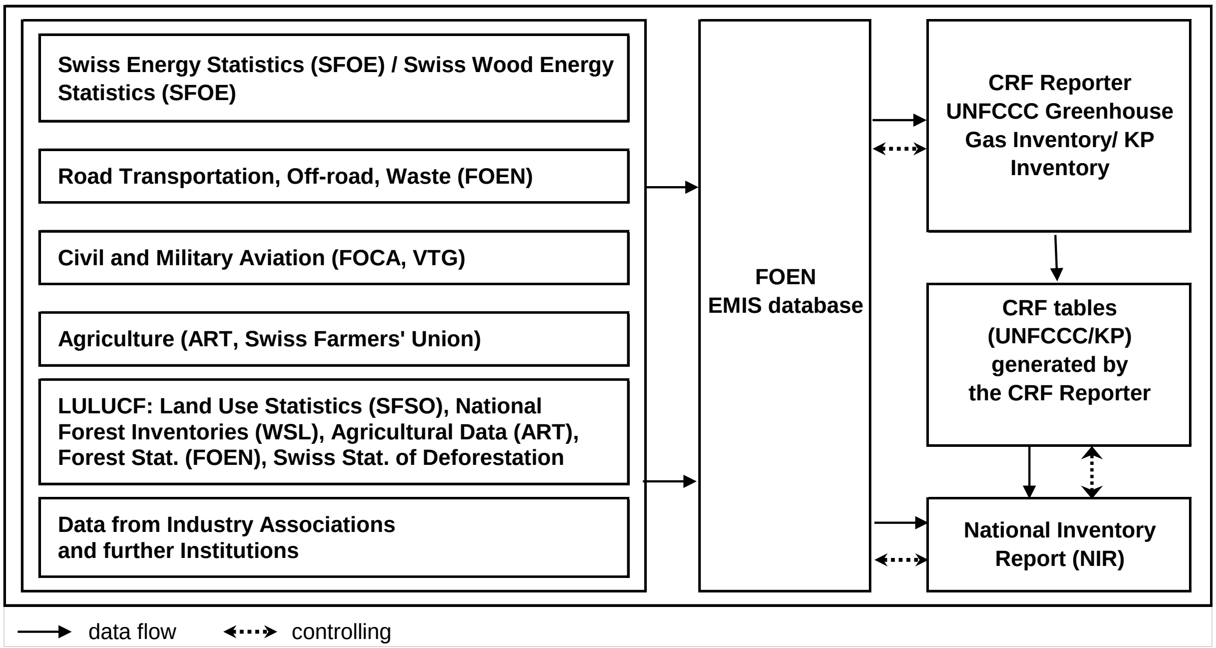

Figure 1-2 Schematic overview: Data collection for EMIS database, CRF Reporter and National Inventory Report (NIR).

1.3.3 QA /QC procedures and extensive review of GHG Inventory and KP-LULUCF Inventory

The national inventory system has an established quality management system (QMS) that complies with the requirements of ISO 9001:2008. Certification has been obtained in 2007 and upheld since through annual audits. An overview over QA/QC procedures and review activities is given in section 1.6.1, a full description of the QMS is provided as a supplement (FOEN 2012a) to the national inventory report.

1.4 Methodologies and Data Sources

1.4.1 GHG Inventory

1.4.1.1 General Description

Emissions are calculated on the basis of the standard methods and procedures published in the Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories (IPCC 1997a, 1997b, 1997c), in IPCC Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories (IPCC 2000), and in IPCC Good Practice Guidance for Land Use, Land-Use Change and Forestry (IPCC 2003). Under the UNFCCC, these guidelines have been adopted for mandatory use in reporting on GHG inventories. The 2006 IPCC Guidelines for National Greenhouse Gas Inventories (IPCC 2006), adopted in April 2006 by the IPCC, have been consulted in a few cases.

One part of the emissions has been calculated by multiplying emission factors and activity rates in the “FOEN EMIS database”. Another part of the emissions has been calculated by the data suppliers listed in Table 1-1 (transport, F-gases, agriculture). In the latter cases, the resulting emission data have been directly inserted into FOEN EMIS database. For further details, see Chapter 1.4.1.3 below.

The national approach for sector 1 Energy is based on import and fuel consumption statistics (fuel sales in the transport sector) in Switzerland (see Chapter 1.4.1.2). The other sectors rely on national statistics and data surveys. For the various sectors, Tier 1, Tier 2 and Tier 3 methodologies according to IPCC Guidelines (IPCC 1997b) and Good Practice Guidance (IPCC 2000) are used. GHG emissions by sources and removals by sinks due to land use, land-use change and forestry (LULUCF sector) are calculated according to IPCC 2003. The following list (Table 1-2) indicates the approaches adopted.

Table 1-2 Summary table for emission factors and methods used (from CRF tables Summary3).

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2		CH_4		N_2O	
	Method applied	Emission factor	Method applied	Emission factor	Method applied	Emission factor
1. Energy	**CS,T1,T2,T3**	**CS,D**	**CS,T1,T2,T3**	**CR,CS,D**	**CS,D,T2,T3**	**CS,D**
A. Fuel Combustion	CS,T1,T2,T3	CS,D	CS,T1,T2,T3	CR,CS,D	CS,D,T2,T3	CS,D
1. Energy Industries	CS,T2	CS	CS,T2	CS	CS,D	CS,D
2. Manufacturing Industries and Constr.	CS,T2	CS	CS,T2,T3	CS	D	D
3. Transport	T1,T2,T3	CS,D	T1,T2,T3	CR,CS,D	CS,D,T2,T3	CS,D
4. Other Sectors	CS,T2	CS	CS,T2	CS	D,T2	CS,D
5. Other	T2	CS	T2	CS	T2	CS
B. Fugitive Emissions from Fuels	CS	CS	CS	CS	NA	NA
1. Solid Fuels	NA	NA	NA	NA	NA	NA
2. Oil and Natural Gas	CS	CS	CS	CS	NA	NA
2. Industrial Processes	**CS,D,T2**	**CS,D**	**CS,T2**	**CS,D**	**T2**	**CS**
A. Mineral Products	CS,D,T2	CS,D	NA	NA	NA	NA
B. Chemical Industry	CS	CS	CS,T2	CS,D	T2	CS
C. Metal Production	CS	CS	NA	NA	NA	NA
D. Other Production	NA	NA				
E. Production of Halocarbons and SF_6						
F. Consumption of Halocarbons and SF_6						
G. Other	CS	CS	NA	NA	NA	NA
3. Solvent and Other Product Use	**CS**	**CS**			**CS**	**CS**
4. Agriculture			**D,T2**	**CR,CS,D**	**CS,D,T1b**	**CR,D**
A. Enteric Fermentation			T2	CS		
B. Manure Management			T2	CS,D	CS	D
C. Rice Cultivation			NA	NA		
D. Agricultural Soils			NA	NA	CS,T1b	D
E. Prescribed Burning of Savannas			NA	NA	NA	NA
F. Field Burning of Agricultural Residues			D	CR	D	CR
G. Other			NA	NA	NA	NA
5. Land Use, Land-Use Change and Forestry	**T1,T2**	**CS**	**T1**	**CS**	**T1**	**D**
A. Forest Land	T1,T2	CS	T1	CS	T1	D
B. Cropland	T2	CS	NA	NA	T1	D
C. Grassland	T2	CS	NA	NA	NA	NA
D. Wetlands	T2	CS	NA	NA	NA	NA
E. Settlements	T2	CS	NA	NA	NA	NA
F. Other Land	T2	CS	NA	NA	NA	NA
G. Other	NA	NA	NA	NA	NA	NA
6. Waste	**CS**	**CS**	**CS,D**	**CS,D**	**CS,D**	**CS,D**
A. Solid Waste Disposal on Land	NA	NA	CS,D	CS,D		
B. Waste-water Handling			CS,D	CS,D	D	CS
C. Waste Incineration	CS	CS	CS	CS	CS	CS,D
D. Other	NA	NA	CS	CS	CS	CS
7. Other (as specified in Summary 1.A)	**CS**	**CS**	**CS**	**CS**	**CS,T1b**	**CS,D**

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	HFCs		PFCs		SF6	
	Method applied	Emission factor	Method applied	Emission factor	Method applied	Emission factor
2. Industrial Processes	**T1,T2**	**CS,D**	**T1,T2**	**CS,D**	**T1,T2,T3**	**CS,D,PS**
A. Mineral Products						
B. Chemical Industry	NA	NA	NA	NA	NA	NA
C. Metal Production	NA	NA	NA	NA	T1	CS
D. Other Production						
E. Production of Halocarbons and SF_6	NA	NA	NA	NA	NA	NA
F. Consumption of Halocarbons and SF_6	T1,T2	CS,D	T1,T2	CS,D	T2,T3	CS,D,PS
G. Other	NA	NA	NA	NA	NA	NA

1.4.1.2 National and Reference Approach for Sector 1 Energy

The Reference Approach is used as a check for (i) overall energy consumption and (ii) the resulting CO_2 emissions reported in source category 1 Energy. In Switzerland, it is applied on the basis of data published in the Swiss overall energy statistics (SFOE 2011). The results of the Reference Approach are compared with the results of the sectoral approach for sector 1 Energy in order to test the quality and completeness of the inventory. For the present inventory, the two approaches show a good correspondence; with CO_2 emissions differing by 0.89% and energy consumption by 0.82% in 2010 (see Chapter 3.2.1).

1.4.1.3 National Air Pollution Database EMIS

A large body of emission data is adopted from Switzerland's national air pollution database EMIS, which is operated by FOEN (FOEN 2006c). EMIS was established at SAEFL (former name of FOEN) in the late 1980s. Its initial purpose was to record and monitor emissions of air pollutants. It has since been extended to cover greenhouse gases, too. Its structure corresponds to the EMEP/CORINAIR system for classifying emission-generating activities. EMEP/CORINAIR uses the Nomenclature for Reporting ("NFR code", UNECE 2003). The Revised 1996 IPCC Guidelines provide a correspondence key between IPCC and EMEP/CORINAIR source categories (IPCC 1997a: Annex 2). EMIS thus contains cross-references to IPCC/UNFCCC coding formats.

EMIS calculates emissions for various pollutants using emission factors and activity data according to the EMEP/CORINAIR methodology. Pollutants in EMIS include sulphur dioxide (SO_2), nitrogen oxides (NO_x), nitrous oxide (N_2O), ammonia (NH_3), non-methane volatile organic compounds (NMVOC), carbon monoxide (CO), hydrochloric acid (HCl), particulate matter, heavy metals (lead, zinc, cadmium, mercury), polychlorinated dibenzodioxins and -furanes (PCDD/PCDF), hydrogen fluoride (HF), hydrofluorocarbons (HFC), perfluorinated carbon compounds (PFC), sulphur hexafluoride (SF_6), methane (CH_4), carbon dioxide CO_2 (fossil/geological origin) and CO_2 (biogenic). The input data originate from a variety of sources, such as production data and emission factors from industry, industry associations and research institutions, as well as population, employment, waste and agriculture statistics. EMIS is documented in an internal FOEN manual for the database (FOEN 2006c).

The original EMIS database underwent a full redesign in 2005/2006. It was extended to incorporate more data sources, updated, and migrated to a new software platform. At the same time, activity data and emission factors were being checked and updated. Emission data from EMIS that are relevant for the GHG inventory are exported to the CRF reporter.

Input data for the EMIS database comprise the SFOE Swiss overall energy statistics, the SFOE Swiss wood energy statistics, FOEN statistics and models for emissions from road transportation, statistics and models of off-road activities, import statistics for F-gases, waste and agricultural statistics, extracts from the National Forest Inventory and the National Forest Statistics (see Figure 1-2).

1.4.2 KP- LULUCF Inventory

Emission factors for parts of sector 5 LULUCF (forest land) and the KP-LULUCF tables are calculated by the Forest Division of the FOEN. A detailed description of the calculation of these emission factors can be found in Chapter 7.3 and Chapter 11.3. Both data sets are imported in the EMIS database (FOEN 2006c).

1.5 Description of Key Categories

1.5.1 GHG Inventory

1.5.1.1 Methodology

The key category analyses are performed according to the IPCC Good Practice Guidance (IPCC 2000, chapter 7) for 1990 and the latest year. A Tier 1 level and trend assessment is applied with the proposed threshold of 95%. A Tier 2 key category analyses has also been carried out for this submission with the proposed threshold of 90% of the sum of all level assessments weighted with their uncertainty.

According to good practice guidance (IPCC 2000), the result of Tier 2 key category analysis should be used when results between Tier 1 and Tier 2 differ. However, it would also be possible to keep Tier 1 key categories as key categories based on qualitative criteria. The GHG inventory core group has agreed to keep Tier 1 key categories in this submission as key categories, even if they are not key in Tier 2 (and vice versa). This procedure would also be compatible with the 2006 IPCC Guidelines (IPCC 2006), which recommend exactly such a procedure of combining results from Tier 1 and Tier 2 categories if results from the two approaches differ. When combining Tier 1 and Tier 2 key category analysis results, we consider a category to be key because of level, if the category is key due to level according to Tier 1 or Tier 2, and a category is considered to be key because of trend, if the category is key due to trend according to Tier 1 or Tier 2.

1.5.1.2 KCA without LULUCF categories

Tier 1

For 2010, among a total of 136 categories, 30 have been identified as key categories with an aggregated contribution of 96.8% to total national emissions. 23 categories are key due to the level assessment, 27 due to the trend assessment.

Of the 30 key categories, 18 are in sector 1 Energy, accounting for 79.7% of total CO_2 equivalent emissions in 2010. The other key categories are from sectors 2 Industrial Processes (5.4%), 3 Solvent and Other Product Use (0.3%), 4 Agriculture (10.4%) and 6 Waste (0.9%). There are three major key sources contributing more than 10 % to the level assessment:

- 1A3b Energy, Fuel Combustion, Road Transportation, Gasoline, CO_2, level contribution 18.0%
- 1A4b Energy, Fuel Combustion, Other Sectors, Residential, Liquid Fuels, CO_2, level contribution 16.0%
- 1A3b Energy, Fuel Combustion, Road Transportation, Diesel, CO_2, level contribution 11.4%

Compared to the key category analysis in the previous inventory report of April 2011 (FOEN 2011), the following categories are new key categories:

- CO_2 emissions from 3 Solvent and Other Products
- N_2O emissions from Wastewater Handling in 6B Waste

The following categories are no longer key categories in Tier 1 compared to the previous submission of April 2011:

- N_2O emissions from Road Transportation, Gasoline in 1A3 Transport
- CH_4 emissions from Biomass in Other Sectors, Residential in 1A4 Other Sectors
- N_2O emissions in 3 Solvent and Other Product use
- CO_2 emissions from 7 Other

The following table shows the contributions of the individual key categories. The complete results of the key category analysis for 2010 are given in Annex A1.2.

Table 1-3 List of Switzerland's Tier 1 key categories 2010 without LULUCF categories, sorted by category code.

Tier 1 Key category analysis 2010 without LULUCF categories									
	A	B	C	D	E-L	E-T	F-T	M	N
No	IPCC Source Categories and fuels if applicable (without LULUCF categories)	Direct GHG	Base Year 1990 Estimate	Year 2010 Estimate [Gg CO2	Level Assessm	Trend Assessm	% Contrib. in Trend	Result level assessm	Result trend assessm
1	1A11. Energy A. Fuel Combustion 1. Energy IndustriesOther Fuels	CO2	1519.73	2582.10	4.76%	0.01854	5.4%	KC level	KC trend
2	1A11. Energy A. Fuel Combustion 1. Energy IndustriesLiquid Fuels	CO2	691.23	965.28	1.78%	0.00466	1.4%	KC level	KC trend
3	1A11. Energy A. Fuel Combustion 1. Energy IndustriesGaseous Fuels	CO2	235.05	540.64	1.00%	0.00541	1.6%	KC level	KC trend
4	1A21. Energy A. Fuel Combustion 2. Manufacturing Industries and ConstructionLiquid Fuels	CO2	3876.46	2890.89	5.33%	0.01934	5.6%	KC level	KC trend
5	1A21. Energy A. Fuel Combustion 2. Manufacturing Industries and ConstructionGaseous Fuels	CO2	1133.30	2216.12	4.09%	0.01906	5.6%	KC level	KC trend
6	1A21. Energy A. Fuel Combustion 2. Manufacturing Industries and ConstructionSolid Fuels	CO2	1227.96	520.65	0.96%	0.01325	3.9%	KC level	KC trend
7	1A21. Energy A. Fuel Combustion 2. Manufacturing Industries and ConstructionOther Fuels	CO2	134.24	315.35	0.58%	0.00321	0.9%	KC level	KC trend
8	1A3a1. EnergyA. Fuel Combustion 3. Transport; Civil Aviation	CO2	252.55	123.55	0.23%	0.00243	0.7%	-	KC trend
9	1A3b1. EnergyA. Fuel Combustion 3. Transport; Road TransportationGasoline	CO2	11335.25	9744.97	17.96%	0.03326	9.7%	KC level	KC trend
10	1A3b1. EnergyA. Fuel Combustion 3. Transport; Road TransportationDiesel	CO2	2587.68	6154.63	11.35%	0.06326	18.5%	KC level	KC trend
11	1A3b1. EnergyA. Fuel Combustion 3. Transport; Road TransportationGasoline	CH4	101.15	22.34	0.04%	0.00146	0.4%	-	KC trend
12	1A4a1. Energy A. Fuel Combustion 4. Other Sectors; Commercial/InstitutionalLiquid Fuels	CO2	4429.39	3607.89	6.65%	0.01660	4.8%	KC level	KC trend
13	1A4a1. Energy A. Fuel Combustion 4. Other Sectors; Commercial/InstitutionalGaseous Fuels	CO2	905.76	1409.10	2.60%	0.00871	2.5%	KC level	KC trend
14	1A4b1. Energy A. Fuel Combustion 4. Other Sectors; ResidentialLiquid Fuels	CO2	10226.25	8688.23	16.02%	0.03187	9.3%	KC level	KC trend
15	1A4b1. Energy A. Fuel Combustion 4. Other Sectors; ResidentialGaseous Fuels	CO2	1409.10	2661.45	4.91%	0.02201	6.4%	KC level	KC trend
16	1A4c1. Energy A. Fuel Combustion 4. Other Sectors; Agriculture/ForestryLiquid Fuels	CO2	547.00	519.96	0.96%	0.00071	0.2%	KC level	-
17	1A51. Energy A. Fuel Combustion 5. OtherLiquid Fuels	CO2	203.58	119.55	0.22%	0.00160	0.5%	-	KC trend
18	1B21. Energy B. Fugitive Emissions from Fuels2. Oil and Natural Gas	CH4	380.43	173.85	0.32%	0.00388	1.1%	-	KC trend
19	2A12. Industrial Proc.A. Mineral Products; Cement Production-CO2	CO2	2524.77	1928.12	3.55%	0.01178	3.4%	KC level	KC trend
20	2F12. Industrial Proc.F. Consumption of Halocarbons and SF6; Refrig. & AC Eq.	HFC	0.02	1011.69	1.86%	0.01824	5.3%	KC level	KC trend
21	3 3. Solvent and Other Product Use	CO2	361.92	157.23	0.29%	0.00384	1.1%	-	KC trend
22	4A4. AgricultureA. Enteric Fermentation	CH4	2657.35	2537.97	4.68%	0.00323	0.9%	KC level	KC trend
23	4B4. AgricultureB. Manure Management	CH4	672.00	645.25	1.19%	0.00075	0.2%	KC level	-
24	4B4. AgricultureB. Manure Management	N2O	453.87	323.52	0.60%	0.00253	0.7%	KC level	KC trend
25	4D14. AgricultureD. Agricultural Soils; Direct Soil Emissions	N2O	1364.15	1189.21	2.19%	0.00371	1.1%	KC level	KC trend
26	4D24. AgricultureD. Agricultural Soils; Pasture, Range and Paddock Manure	N2O	128.10	245.40	0.45%	0.00206	0.6%	KC level	KC trend
27	4D34. AgricultureD. Agricultural Soils; Indirect Emissions	N2O	820.73	710.51	1.31%	0.00232	0.7%	KC level	KC trend
28	6A6. Waste A. Solid Waste Disposal on Land	CH4	688.16	198.00	0.36%	0.00912	2.7%	-	KC trend
29	6B6. Waste B. Wastewater Handling	N2O	184.72	208.89	0.39%	0.00036	0.1%	KC level	-
30	6D6. Waste D. Other	CH4	27.44	95.23	0.18%	0.00121	0.4%	-	KC trend

Table 1-4 List of Switzerland's Tier 1 key categories for the base year 1990 without LULUCF categories, sorted by category code.

Tier 1 Key category analysis for the base year 1990 without LULUCF categories					
	A	B	C	E-L	M
No.	IPCC Source Categories and fuels if applicable (without LULUCF categories)	Direct GHG	Base Year 1990 Estimate [Gg CO2 eq]	Level Assessm.	Result level assessm.
1	1A11. Energy A. Fuel Combustion 1. Energy IndustriesOther Fuels	CO2	1519.73	2.86%	KC level
2	1A11. Energy A. Fuel Combustion 1. Energy IndustriesLiquid Fuels	CO2	691.23	1.30%	KC level
3	1A11. Energy A. Fuel Combustion 1. Energy IndustriesGaseous Fuels	CO2	235.05	0.44%	KC level
4	1A21. Energy A. Fuel Combustion 2. Manufacturing Industries and ConstructionLiquid Fuels	CO2	3876.46	7.31%	KC level
5	1A21. Energy A. Fuel Combustion 2. Manufacturing Industries and ConstructionSolid Fuels	CO2	1227.96	2.31%	KC level
6	1A21. Energy A. Fuel Combustion 2. Manufacturing Industries and ConstructionGaseous Fuels	CO2	1133.30	2.14%	KC level
7	1A3a1. EnergyA. Fuel Combustion 3. Transport; Civil Aviation	CO2	252.55	0.48%	KC level
8	1A3b1. EnergyA. Fuel Combustion 3. Transport; Road TransportationGasoline	CO2	11335.25	21.36%	KC level
9	1A3b1. EnergyA. Fuel Combustion 3. Transport; Road TransportationDiesel	CO2	2587.68	4.88%	KC level
10	1A4a1. Energy A. Fuel Combustion 4. Other Sectors; Commercial/InstitutionalLiquid Fuels	CO2	4429.39	8.35%	KC level
11	1A4a1. Energy A. Fuel Combustion 4. Other Sectors; Commercial/InstitutionalGaseous Fuels	CO2	905.76	1.71%	KC level
12	1A4b1. Energy A. Fuel Combustion 4. Other Sectors; ResidentialLiquid Fuels	CO2	10226.25	19.27%	KC level
13	1A4b1. Energy A. Fuel Combustion 4. Other Sectors; ResidentialGaseous Fuels	CO2	1409.10	2.66%	KC level
14	1A4c1. Energy A. Fuel Combustion 4. Other Sectors; Agriculture/ForestryLiquid Fuels	CO2	547.00	1.03%	KC level
15	1A51. Energy A. Fuel Combustion 5. OtherLiquid Fuels	CO2	203.58	0.38%	KC level
16	1B21. Energy B. Fugitive Emissions from Fuels2. Oil and Natural Gas	CH4	380.43	0.72%	KC level
17	2A12. Industrial Proc.A. Mineral Products; Cement Production-CO2	CO2	2524.77	4.76%	KC level
18	3 3. Solvent and Other Product Use	CO2	361.92	0.68%	KC level
19	4A4. AgricultureA. Enteric Fermentation	CH4	2657.35	5.01%	KC level
20	4B4. AgricultureB. Manure Management	CH4	672.00	1.27%	KC level
21	4B4. AgricultureB. Manure Management	N2O	453.87	0.86%	KC level
22	4D14. AgricultureD. Agricultural Soils; Direct Soil Emissions	N2O	1364.15	2.57%	KC level
23	4D34. AgricultureD. Agricultural Soils; Indirect Emissions	N2O	820.73	1.55%	KC level
24	6A6. Waste A. Solid Waste Disposal on Land	CH4	688.16	1.30%	KC level

There are 24 level key categories in the base year 1990 (see Table 1-4). All of them are also key categories in 2010. Compared to the key category analysis in the previous inventory report of April 2011, CO_2 emissions from 3 Solvents and Other Product is a new key category and CO_2 emissions from 7 Other is no longer key category. This happens because of the transfer of activities from category 7 back to category 3.

Tier 2

For 2010, among a total of 136 categories, 30 have been identified as key categories with an aggregated contribution of 92.9% of the sum of all level assessments weighted with their uncertainty in 2010. 24 categories are key due to the level assessment, 28 due to the trend assessment.

Of the 30 key categories, 14 are in sector 1 Energy, accounting for 29.1% of the sum of all level assessments weighted with their uncertainty in 2010 (13.7%, see Table A - 6). Sector 4 Agriculture accounts for 44.3% of that sum. Tier 2 key category analysis shows that these two sectors have the highest impact on inventory uncertainty. The other key categories are from sectors 2 Industrial Processes (13.8%), 3 Solvent and Other Product Use (1.7%) and 6 Waste (4.0 %). There are four major key sources:

- 1A1 Energy, Fuel Combustion, Energy Industries, Other Fuels, CO_2, contribution of 11.0% to the sum of all level assessments weighted with their uncertainty.
- 2A1 Industrial Processes, Mineral Products, Cement Production, CO_2, contribution of 10.4% to the sum of all level assessment weighted with their uncertainty.
- 4D1, Agricultural Soils; Direct Soil Emissions, N_2O, contribution of 12.2% to the sum of all level assessments weighted with their uncertainty.
- 4D3, Agricultural Soils; Indirect Emissions, N_2O, contribution of 15.2% to the sum of all level assessments weighted with their uncertainty.

Table 1-5 shows the contributions of the individual key categories. The complete results of the key category analysis for 2010 are given in Annex A1.4.

Compared to the submission of April 2011, the following categories are new key categories in Tier 2:

- CH_4 emissions from 1B2 Oil and Natural Gas;
- HFC emissions from 2F9 Other;
- CO_2 emissions in 3 Solvent and Other Products.

No longer key in Tier 2 are the following categories:

- N_2O emissions from Other Fuels in 1A1 Energy Industry;
- N_2O emissions from Gasoline in 1A3b Transport;
- CO_2 emissions from 2A3Limestone and Dolomite Use;
- CO_2 emissions from 7 Other.

Table 1-5 List of Switzerland's Tier 2 key categories 2010 without LULUCF categories, sorted by category code.

Tier 2 Key category analysis 2010 without LULUCF categories									
	A	B	C	D	E-L	E-T	F-T	M	N
No	IPCC Source Categories and fuels if applicable (without LULUCF categories)	Direct GHG	Base Year 1990 Estimate [Gg CO2 eq]	Year 2010 Estimate [Gg CO2 eq]	Level Assessm. with Uncertainty	Trend Assessm. with Uncertainty	% Contrib. in Trend	Result level assessm	Result trend assessm
1	1A11. Energy A. Fuel Comb.1. Energy IndustriesOther Fuels	CO2	1519.73	2582.10	1.51%	0.00586	11.4%	KC level	KC trend
2	1A21. Energy A. Fuel Comb.2. Manufacturing Ind. and Constr.Gaseous Fuels	CO2	1133.30	2216.12	0.20%	0.00096	1.9%	KC level	KC trend
3	1A21. Energy A. Fuel Comb.2. Manufacturing Ind. and Constr.Other Fuels	CO2	134.24	315.35	0.18%	0.00102	2.0%	KC level	KC trend
4	1A21. Energy A. Fuel Comb.2. Manufacturing Ind. and Constr.Solid Fuels	CO2	1227.96	520.65	0.15%	0.00203	4.0%	KC level	KC trend
5	1A21. Energy A. Fuel Comb.2. Manufacturing Ind. and Constr.Liquid Fuels	CO2	3876.46	2890.89	0.12%	0.00043	0.8%	-	KC trend
6	1A3b1. EnergyA. Fuel Comb.3. Transport; Road Transp.Gasoline	CO2	11335.25	9744.97	0.46%	0.00086	1.7%	KC level	KC trend
7	1A3b1. EnergyA. Fuel Comb.3. Transport; Road Transp.Diesel	CO2	2587.68	6154.63	0.25%	0.00142	2.8%	KC level	KC trend
8	1A3b1. EnergyA. Fuel Comb.3. Transport; Road Transp.Gasoline	CH4	101.15	22.34	0.02%	0.00054	1.1%	-	KC trend
9	1A4a1. Energy A. Fuel Comb.4. Other Sectors; Com./Instit.Liquid Fuels	CO2	4429.39	3607.89	0.15%	0.00037	0.7%	KC level	-
10	1A4a1. Energy A. Fuel Comb.4. Other Sectors; Com./Instit.Gaseous Fuels	CO2	905.76	1409.10	0.13%	0.00044	0.9%	KC level	KC trend
11	1A4b1. Energy A. Fuel Comb.4. Other Sectors; ResidentialLiquid Fuels	CO2	10226.25	8688.23	0.36%	0.00072	1.4%	KC level	KC trend
12	1A4b1. Energy A. Fuel Comb.4. Other Sectors; ResidentialGaseous Fuels	CO2	1409.10	2661.45	0.25%	0.00110	2.2%	KC level	KC trend
13	1A4b1. Energy A. Fuel Comb.4. Other Sectors; ResidentialBiomass	CH4	95.89	38.15	0.04%	0.00068	1.3%	-	KC trend
14	1B21. Energy B. Fugitive Emissions from Fuels2. Oil and Natural Gas	CH4	380.43	173.85	0.16%	0.00194	3.8%	KC level	KC trend
15	2A12. Industrial Proc.A. Mineral Products; Cement Production-CO2	CO2	2524.77	1928.12	1.42%	0.00472	9.2%	KC level	KC trend
16	2C12. Industrial Proc.C. Metal Production; Steel Production	CO2	110.80	170.57	0.13%	0.00042	0.8%	KC level	KC trend
17	2F12. Industrial Proc.F. Consumption of Halocarbons and SF6; Refrig. & AC Eq.	HFC	0.02	1011.69	0.22%	0.00219	4.3%	KC level	KC trend
18	2F92. Industrial Proc.F. Consumption of Halocarbons and SF6; Other	SF6	79.58	51.12	0.08%	0.00044	0.8%	-	KC trend
19	2F92. Industrial Proc.F. Consumption of Halocarbons and SF6; Other	HFC	0.00	30.62	0.05%	0.00044	0.9%	-	KC trend
20	3 3. Solvent and Other Product Use	CO2	361.92	157.23	0.14%	0.00192	3.7%	KC level	KC trend
21	3 3. Solvent and Other Product Use	N2O	110.14	57.33	0.08%	0.00080	1.6%	-	KC trend
22	4A4. AgricultureA. Enteric Fermentation	CH4	2657.35	2537.97	0.86%	0.00059	1.2%	KC level	KC trend
23	4B4. AgricultureB. Manure Management	CH4	672.00	645.25	0.65%	0.00041	0.8%	KC level	KC trend
24	4B4. AgricultureB. Manure Management	N2O	453.87	323.52	0.43%	0.00182	3.5%	KC level	KC trend
25	4D14. AgricultureD. Agricultural Soils; Direct Soil Emissions	N2O	1364.15	1189.21	1.68%	0.00283	5.5%	KC level	KC trend
26	4D24. AgricultureD. Agricultural Soils; Pasture, Range and Paddock Manure	N2O	128.10	245.40	0.38%	0.00175	3.4%	KC level	KC trend
27	4D34. AgricultureD. Agricultural Soils; Indirect Emissions	N2O	820.73	710.51	2.08%	0.00368	7.2%	KC level	KC trend
28	6A6. Waste A. Solid Waste Disposal on Land	CH4	688.16	198.00	0.21%	0.00532	10.4%	KC level	KC trend
29	6B6. Waste B. Wastewater Handling	N2O	184.72	208.89	0.15%	0.00014	0.3%	KC level	-
30	6D6. Waste D. Other	CH4	27.44	95.23	0.18%	0.00122	2.4%	KC level	KC trend

Table 1-6 List of Switzerland's Tier 2 key categories for the base year 1990 without LULUCF categories, sorted by category code.

Tier 2 Key category analysis for the base year 1990 without LULUCF categories					
	A	B	C	E-L	M
No.	IPCC Source Categories and fuels if applicable (combined without LULUCF categories)	Direct GHG	Base Year 1990 Estimate [Gg CO2 eq]	Level Assessm. with Uncertainty	Result level assessm.
1	1A11. Energy A. Fuel Combustion 1. Energy IndustriesOther Fuels	CO2	1519.73	0.91%	KC level
2	1A21. Energy A. Fuel Combustion 2. Manufacturing Industries and ConstructionSolid Fuels	CO2	1227.96	0.36%	KC level
3	1A21. Energy A. Fuel Combustion 2. Manufacturing Industries and ConstructionLiquid Fuels	CO2	3876.46	0.16%	KC level
4	1A3b1. EnergyA. Fuel Combustion 3. Transport; Road TransportationGasoline	CO2	11335.25	0.55%	KC level
5	1A3b1. EnergyA. Fuel Combustion 3. Transport; Road TransportationGasoline	N2O	137.27	0.13%	KC level
6	1A4a1. Energy A. Fuel Combustion 4. Other Sectors; Commercial/InstitutionalLiquid Fuels	CO2	4429.39	0.19%	KC level
7	1A4b1. Energy A. Fuel Combustion 4. Other Sectors; ResidentialLiquid Fuels	CO2	10226.25	0.43%	KC level
8	1A4b1. Energy A. Fuel Combustion 4. Other Sectors; ResidentialGaseous Fuels	CO2	1409.10	0.13%	KC level
9	1B21. Energy B. Fugitive Emissions from Fuels2. Oil and Natural Gas	CH4	380.43	0.36%	KC level
10	2A12. Industrial Proc.A. Mineral Products; Cement Production-CO2	CO2	2524.77	1.91%	KC level
11	2F92. Industrial Proc.F. Consumption of Halocarbons and SF6; Other	SF6	79.58	0.12%	KC level
12	3 3. Solvent and Other Product Use	CO2	361.92	0.34%	KC level
13	3 3. Solvent and Other Product Use	N2O	110.14	0.17%	KC level
14	4A4. AgricultureA. Enteric Fermentation	CH4	2657.35	0.92%	KC level
15	4B4. AgricultureB. Manure Management	CH4	672.00	0.69%	KC level
16	4B4. AgricultureB. Manure Management	N2O	453.87	0.61%	KC level
17	4D14. AgricultureD. Agricultural Soils; Direct Soil Emissions	N2O	1364.15	1.97%	KC level
18	4D24. AgricultureD. Agricultural Soils; Pasture, Range and Paddock Manure	N2O	128.10	0.20%	KC level
19	4D34. AgricultureD. Agricultural Soils; Indirect Emissions	N2O	820.73	2.46%	KC level
20	6A6. Waste A. Solid Waste Disposal on Land	CH4	688.16	0.76%	KC level
21	6B6. Waste B. Wastewater Handling	N2O	184.72	0.14%	KC level

There are 21 level Tier 2 key categories in the base year 1990 (see Table 1-6). Compared to the key category analysis in the previous inventory report of April 2011, the following emissions are new key categories 1990:

- N_2O emissions from Gasoline in 1A3b Road Transportation;
- CH_4 emissions from 1B2 Fugitive Emissions from Fuels;
- SF_6 emissions from 2F9 Consumption of Halocarbons and SF6 in Industrial Processes;
- CO_2 emissions from 3 Solvents and Other Product because of a transfer of activities from category 7 Other into this category.

The following categories are no longer key category 1990:

- CO_2 emissions from Gaseous Fuels in 1A2 Manufacturing Industries and Construction;
- CO_2 emissions from Other Fuels in 1A2 Manufacturing Industries and Construction;
- CO_2 emissions from Gaseous Fuels in 1A4a Other Sector;
- CO_2 emissions from 7 Other.

1.5.1.3 Combined KCA without and with LULUCF categories

The key category analysis including LULUCF categories has also been carried out for 2010 and 1990. The complete results of the key category analysis for 2010 are shown in Annex A1. According to IPCC Good Practice Guidance for LULUCF (IPCC 2003, Section 5.4.2), the set of key categories consists of all non-LULUCF key categories that result from the KCA without LULUCF combined with all LULUCF key categories that result from the KCA including LULUCF.

Tier 1

In the Tier 1 KCA for the year 2010 including LULUCF categories there are five additional categories out of the LULUCF sector:

- CO_2 emissions from 5A1 Forest Land remaining Forest Land (level and trend key category)
- CO_2 emissions from 5A2 Land converted to Forest Land (level and trend key category)
- CO_2 emissions from 5B1 Cropland remaining Cropland (level key category)
- CO_2 emissions from CO_2 emissions from 5C2 Land converted to Grassland (trend key category)
- CO_2 emissions from 5E2 Land converted to Settlements (level key category)

The categories 5A2 Land converted to Forest Land and 5A1 Forest Land remaining Forest Land are large categories, contributing for 2.1% and 1.6% to the level assessment. Categories 5B1, 5C2, and 5E2 contribute less to the level assessment with 0.7%, 0.3% and 0.5%, respectively. For the combined KCA without and with LULUCF these categories are added to the other 30 key categories from the KCA without LULUCF as shown in Table 1-3.

In the KCA for the year 1990, four of these five LULUCF categories are also key categories. Categories 5C2 is not key category for the year 1990. The results of the combined Tier 1 KCA are summarised in Table 1-7 (year 2010) and Table 1-8 (1990).

The five LULUCF key categories 5A1, 5A2, 5B1, 5C2 and 5E2 were also key in the analysis for 2009 as contained in the previous inventory report of April 2011 (FOEN 2011). The category 5C1 Grassland remaining Grassland is not key category for Tier 1 anymore.

Tier 2

In the Tier 2 KCA for 2010 including LULUCF categories, CO_2 emissions from 5A1, 5A2, 5B1, 5C1, 5C2, and 5E2 are key categories out of the LULUCF sector as in Tier 1.

The categories 5A2 Land converted to Forest Land and 5A1 Forest Land remaining Forest Land are large categories, contributing for 5.9% and 3.9% to the level assessment weighted with their uncertainty. Source categories 5B1, 5C1, 5C2 and 5E2 contribute less, with 1.9%, 0.9%, 1.0% and 1.7%, respectively. For the combined KCA without and with LULUCF categories these categories are added to the other 30 key categories from the KCA without LULUCF.

In the KCA for the year 1990, five of these six LULUCF categories are also key categories. Source category 5C2 is not a key category for the year 1990.

The results of the combined Tier 2 KCA are summarised in Table 1-9 (year 2010) and Table 1-10 (year 1990).

Compared to the previous submission of April 2011 (FOEN 2011), 5F2 is not a key category anymore.

Table 1-7 List of Switzerland's Tier 1 key categories, combined KCA without and with LULUCF (in italic) categories 2010, sorted by category code.

Tier 1 Key category analysis 2010 without and with LULUCF categories										
	A	B	C	D	E-L	E-T	F-T	M	N
No	**IPCC Source Categories and fuels if applicable (without and with LULUCF categories)**	**Direct GHG**	**Base Year 1990 Estimate** [Gg CO2 eq]	**Year 2010 Estimate** [Gg CO2 eq]	**Level Assessm**	**Trend Assessm**	**% Contrib. in Trend**	**Result level assessm**	**Result trend assessm**
1	1A11. Energy A. Fuel Comb.1. Energy IndustriesOther Fuels	CO2	1519.73	2582.10	4.76%	0.01854	5.4%	KC level	KC trend
2	1A11. Energy A. Fuel Comb.1. Energy IndustriesLiquid Fuels	CO2	691.23	965.28	1.78%	0.00466	1.4%	KC level	KC trend
3	1A11. Energy A. Fuel Comb.1. Energy IndustriesGaseous Fuels	CO2	235.05	540.64	1.00%	0.00541	1.6%	KC level	KC trend
4	1A21. Energy A. Fuel Comb.2. Manufacturing Ind. and Constr.Liquid Fuels	CO2	3876.46	2890.89	5.33%	0.01934	5.6%	KC level	KC trend
5	1A21. Energy A. Fuel Comb.2. Manufacturing Ind. and Constr.Gaseous Fuels	CO2	1133.30	2216.12	4.09%	0.01906	5.6%	KC level	KC trend
6	1A21. Energy A. Fuel Comb.2. Manufacturing Ind. and Constr.Solid Fuels	CO2	1227.96	520.65	0.96%	0.01325	3.9%	KC level	KC trend
7	1A21. Energy A. Fuel Comb.2. Manufacturing Ind. and Constr.Other Fuels	CO2	134.24	315.35	0.58%	0.00321	0.9%	KC level	KC trend
8	1A3a1. EnergyA. Fuel Comb.3. Transport; Civil Aviation	CO2	252.55	123.55	0.23%	0.00243	0.7%	-	KC trend
9	1A3b1. EnergyA. Fuel Comb.3. Transport; Road Transp.Gasoline	CO2	11335.25	9744.97	17.96%	0.03326	9.7%	KC level	KC trend
10	1A3b1. EnergyA. Fuel Comb.3. Transport; Road Transp.Diesel	CO2	2587.68	6154.63	11.35%	0.06326	18.5%	KC level	KC trend
11	1A3b1. EnergyA. Fuel Comb.3. Transport; Road Transp.Gasoline	CH4	101.15	22.34	0.04%	0.00146	0.4%	-	KC trend
12	1A4a1. Energy A. Fuel Comb.4. Other Sectors; Comml/InstitutLiquid Fuels	CO2	4429.39	3607.89	6.65%	0.01660	4.8%	KC level	KC trend
13	1A4a1. Energy A. Fuel Comb.4. Other Sectors; Comml/InstitutGaseous Fuels	CO2	905.76	1409.10	2.60%	0.00871	2.5%	KC level	KC trend
14	1A4b1. Energy A. Fuel Comb.4. Other Sectors; ResidentialLiquid Fuels	CO2	10226.25	8688.23	16.02%	0.03187	9.3%	KC level	KC trend
15	1A4b1. Energy A. Fuel Comb.4. Other Sectors; ResidentialGaseous Fuels	CO2	1409.10	2661.45	4.91%	0.02201	6.4%	KC level	KC trend
16	1A4c1. Energy A. Fuel Comb.4. Other Sectors; Agric/ForestryLiquid Fuels	CO2	547.00	519.96	0.96%	0.00071	0.2%	KC level	-
17	1A51. Energy A. Fuel Comb.5. OtherLiquid Fuels	CO2	203.58	119.55	0.22%	0.00160	0.5%	-	KC trend
18	1B21. Energy B. Fugitive Emissions from Fuels2. Oil and Natural Gas	CH4	380.43	173.85	0.32%	0.00388	1.1%	-	KC trend
19	2A12. Industrial Proc.A. Mineral Products; Cement Production-CO2	CO2	2524.77	1928.12	3.55%	0.01178	3.4%	KC level	KC trend
20	2F12. Industrial Proc.F. Consumption of Halocarbons and SF6; Refrig. & AC Eq.	HFC	0.02	1011.69	1.86%	0.01824	5.3%	KC level	KC trend
21	3 3. Solvent and Other Product Use	CO2	361.92	157.23	0.29%	0.00384	1.1%	-	KC trend
22	4A4. AgricultureA. Enteric Fermentation	CH4	2657.35	2537.97	4.68%	0.00323	0.9%	KC level	KC trend
23	4B4. AgricultureB. Manure Management	CH4	672.00	645.25	1.19%	0.00075	0.2%	KC level	-
24	4B4. AgricultureB. Manure Management	N2O	453.87	323.52	0.60%	0.00253	0.7%	KC level	KC trend
25	4D14. AgricultureD. Agricultural Soils; Direct Soil Emissions	N2O	1364.15	1189.21	2.19%	0.00371	1.1%	KC level	KC trend
26	4D24. AgricultureD. Agricultural Soils; Pasture, Range and Paddock Manure	N2O	128.10	245.40	0.45%	0.00206	0.6%	KC level	KC trend
27	4D34. AgricultureD. Agricultural Soils; Indirect Emissions	N2O	820.73	710.51	1.31%	0.00232	0.7%	KC level	KC trend
28	5A15. LULUCFA. Forest Land1. Forest Land remaining Forest Land	*CO2*	*3771.35*	*945.76*	*1.64%*	*0.04851*	*13.3%*	*KC level*	*KC trend*
29	5A25. LULUCFA. Forest Land2. Land converted to Forest Land	*CO2*	*1306.70*	*1205.09*	*2.09%*	*0.00115*	*0.3%*	*KC level*	*KC trend*
30	5B15. LULUCFB. Cropland1. Cropland remaining Cropland	*CO2*	*435.28*	*425.31*	*0.74%*	*0.00004*	*0.0%*	*KC level*	-
31	5C25. LULUCFC. Grassland2. Land converted to Grassland	*CO2*	*74.60*	*172.45*	*0.30%*	*0.00179*	*0.5%*	-	*KC trend*
32	5E25. LULUCFE. Settlements2. Land converted to Settlements	*CO2*	*361.84*	*297.07*	*0.52%*	*0.00097*	*0.3%*	*KC level*	-
33	6A6. Waste A. Solid Waste Disposal on Land	CH4	688.16	198.00	0.36%	0.00912	2.7%	-	KC trend
34	6B6. Waste B. Wastewater Handling	N2O	184.72	208.89	0.39%	0.00036	0.1%	KC level	-
35	6D6. Waste D. Other	CH4	27.44	95.23	0.18%	0.00121	0.4%	-	KC trend

Table 1-8 List of Switzerland's Tier 1 key categories for the base year 1990, combined KCA without and with LULUCF (*in italic*) categories, sorted by category code.

Tier 1 Key category analysis for the base year 1990 without and with LULUCF categories					
	A	B	C	E-L	M
No.	**IPCC Source Categories and fuels if applicable (without and with LULUCF categories)**	**Direct GHG**	**Base Year 1990 Estimate** [Gg CO2 eq]	**Level Assessm.**	**Result level assessm.**
1	1A11. Energy A. Fuel Combustion 1. Energy IndustriesOther Fuels	CO2	1519.73	2.86%	KC level
2	1A11. Energy A. Fuel Combustion 1. Energy IndustriesLiquid Fuels	CO2	691.23	1.30%	KC level
3	1A11. Energy A. Fuel Combustion 1. Energy IndustriesGaseous Fuels	CO2	235.05	0.44%	KC level
4	1A21. Energy A. Fuel Combustion 2. Manufacturing Industries and ConstructionLiquid Fuels	CO2	3876.46	7.31%	KC level
5	1A21. Energy A. Fuel Combustion 2. Manufacturing Industries and ConstructionSolid Fuels	CO2	1227.96	2.31%	KC level
6	1A21. Energy A. Fuel Combustion 2. Manufacturing Industries and ConstructionGaseous Fuels	CO2	1133.30	2.14%	KC level
7	1A3a1. EnergyA. Fuel Combustion 3. Transport; Civil Aviation	CO2	252.55	0.48%	KC level
8	1A3b1. EnergyA. Fuel Combustion 3. Transport; Road TransportationGasoline	CO2	11335.25	21.36%	KC level
9	1A3b1. EnergyA. Fuel Combustion 3. Transport; Road TransportationDiesel	CO2	2587.68	4.88%	KC level
10	1A4a1. Energy A. Fuel Combustion 4. Other Sectors; Commercial/InstitutionalLiquid Fuels	CO2	4429.39	8.35%	KC level
11	1A4a1. Energy A. Fuel Combustion 4. Other Sectors; Commercial/InstitutionalGaseous Fuels	CO2	905.76	1.71%	KC level
12	1A4b1. Energy A. Fuel Combustion 4. Other Sectors; ResidentialLiquid Fuels	CO2	10226.25	19.27%	KC level
13	1A4b1. Energy A. Fuel Combustion 4. Other Sectors; ResidentialGaseous Fuels	CO2	1409.10	2.66%	KC level
14	1A4c1. Energy A. Fuel Combustion 4. Other Sectors; Agriculture/ForestryLiquid Fuels	CO2	547.00	1.03%	KC level
15	1A51. Energy A. Fuel Combustion 5. OtherLiquid Fuels	CO2	203.58	0.38%	KC level
16	1B21. Energy B. Fugitive Emissions from Fuels2. Oil and Natural Gas	CH4	380.43	0.72%	KC level
17	2A12. Industrial Proc.A. Mineral Products; Cement Production-CO2	CO2	2524.77	4.76%	KC level
18	3 3. Solvent and Other Product Use	CO2	361.92	0.68%	KC level
19	4A4. AgricultureA. Enteric Fermentation	CH4	2657.35	5.01%	KC level
20	4B4. AgricultureB. Manure Management	CH4	672.00	1.27%	KC level
21	4B4. AgricultureB. Manure Management	N2O	453.87	0.86%	KC level
22	4D14. AgricultureD. Agricultural Soils; Direct Soil Emissions	N2O	1364.15	2.57%	KC level
23	4D34. AgricultureD. Agricultural Soils; Indirect Emissions	N2O	820.73	1.55%	KC level
24	5A15. LULUCFA. Forest Land1. Forest Land remaining Forest Land	*CO2*	*3771.35*	*6.35%*	*KC level*
25	5A25. LULUCFA. Forest Land2. Land converted to Forest Land	*CO2*	*1306.70*	*2.20%*	*KC level*
26	5B15. LULUCFB. Cropland1. Cropland remaining Cropland	*CO2*	*435.28*	*0.73%*	*KC level*
27	5E25. LULUCFE. Settlements2. Land converted to Settlements	*CO2*	*361.84*	*0.61%*	*KC level*
28	6A6. Waste A. Solid Waste Disposal on Land	CH4	688.16	1.30%	KC level

Table 1-9 List of Switzerland's Tier 2 key categories, combined KCA without and with LULUCF (*in italic*) categories 2010, sorted by category code.

Tier 2 Key category analysis 2010 without and with LULUCF categories									
	A	B	C	D	E-L	E-T	F-T	M	N
No	**IPCC Source Categories and fuels if applicable (without and with LULUCF categories)**	**Direct GHG**	**Base Year 1990 Estimate** [Gg CO2 eq]	**Year 2010 Estimate** [Gg CO2 eq]	**Level Assessm. with Uncertainty**	**Trend Assessm. with Uncertainty**	**% Contrib. in Trend**	**Result level assessm**	**Result trend assessm**
1	1A11. Energy A. Fuel Comb.1. Energy IndustriesOther Fuels	CO2	1519.73	2582.10	1.51%	0.00586	11.4%	KC level	KC trend
2	1A21. Energy A. Fuel Comb.2. Manufacturing Ind. and Constr.Gaseous Fuels	CO2	1133.30	2216.12	0.20%	0.00096	1.9%	KC level	KC trend
3	1A21. Energy A. Fuel Comb.2. Manufacturing Ind. and Constr.Other Fuels	CO2	134.24	315.35	0.18%	0.00102	2.0%	KC level	KC trend
4	1A21. Energy A. Fuel Comb.2. Manufacturing Ind. and Constr.Solid Fuels	CO2	1227.96	520.65	0.15%	0.00203	4.0%	KC level	KC trend
5	1A21. Energy A. Fuel Comb.2. Manufacturing Ind. and Constr.Liquid Fuels	CO2	3876.46	2890.89	0.12%	0.00043	0.8%	-	KC trend
6	1A3b1. EnergyA. Fuel Comb.3. Transport; Road Transp.Gasoline	CO2	11335.25	9744.97	0.46%	0.00086	1.7%	KC level	KC trend
7	1A3b1. EnergyA. Fuel Comb.3. Transport; Road Transp.Diesel	CO2	2587.68	6154.63	0.25%	0.00142	2.8%	KC level	KC trend
8	1A3b1. EnergyA. Fuel Comb.3. Transport; Road Transp.Gasoline	CH4	101.15	22.34	0.02%	0.00054	1.1%	-	KC trend
9	1A4a1. Energy A. Fuel Comb.4. Other Sectors; Com./Instit.Liquid Fuels	CO2	4429.39	3607.89	0.15%	0.00037	0.7%	KC level	-
10	1A4a1. Energy A. Fuel Comb.4. Other Sectors; Com./Instit.Gaseous Fuels	CO2	905.76	1409.10	0.13%	0.00044	0.9%	KC level	KC trend
11	1A4b1. Energy A. Fuel Comb.4. Other Sectors; ResidentialLiquid Fuels	CO2	10226.25	8688.23	0.36%	0.00072	1.4%	KC level	KC trend
12	1A4b1. Energy A. Fuel Comb.4. Other Sectors; ResidentialGaseous Fuels	CO2	1409.10	2661.45	0.25%	0.00110	2.2%	KC level	KC trend
13	1A4b1. Energy A. Fuel Comb.4. Other Sectors; ResidentialBiomass	CH4	95.89	38.15	0.04%	0.00068	1.3%	-	KC trend
14	1B21. Energy B. Fugitive Emissions from Fuels2. Oil and Natural Gas	CH4	380.43	173.85	0.16%	0.00194	3.8%	KC level	KC trend
15	2A12. Industrial Proc.A. Mineral Products; Cement Production-CO2	CO2	2524.77	1928.12	1.42%	0.00472	9.2%	KC level	KC trend
16	2C12. Industrial Proc.C. Metal Production; Steel Production	CO2	110.80	170.57	0.13%	0.00042	0.8%	KC level	KC trend
17	2F12. Industrial Proc.F. Consumption of Halocarbons and SF6; Refrig. & AC Eq.	HFC	0.02	1011.69	0.22%	0.00219	4.3%	KC level	KC trend
18	2F92. Industrial Proc.F. Consumption of Halocarbons and SF6; Other	SF6	79.58	51.12	0.08%	0.00044	0.8%	-	KC trend
19	2F92. Industrial Proc.F. Consumption of Halocarbons and SF6; Other	HFC	0.00	30.62	0.05%	0.00044	0.9%	-	KC trend
20	3 3. Solvent and Other Product Use	CO2	361.92	157.23	0.14%	0.00192	3.7%	KC level	KC trend
21	3 3. Solvent and Other Product Use	N2O	110.14	57.33	0.08%	0.00080	1.6%	-	KC trend
22	4A4. AgricultureA. Enteric Fermentation	CH4	2657.35	2537.97	0.86%	0.00059	1.2%	KC level	KC trend
23	4B4. AgricultureB. Manure Management	CH4	672.00	645.25	0.65%	0.00041	0.8%	KC level	KC trend
24	4B4. AgricultureB. Manure Management	N2O	453.87	323.52	0.43%	0.00182	3.5%	KC level	KC trend
25	4D14. AgricultureD. Agricultural Soils; Direct Soil Emissions	N2O	1364.15	1189.21	1.68%	0.00283	5.5%	KC level	KC trend
26	4D24. AgricultureD. Agricultural Soils; Pasture, Range and Paddock Manure	N2O	128.10	245.40	0.38%	0.00175	3.4%	KC level	KC trend
27	4D34. AgricultureD. Agricultural Soils; Indirect Emissions	N2O	820.73	710.51	2.08%	0.00368	7.2%	KC level	KC trend
28	5A15. LULUCFA. Forest Land1. Forest Land remaining Forest Land	*CO2*	*-3771.35*	*-945.76*	*0.60%*	*0.01763*	*26.4%*	*KC level*	*KC trend*
29	5A25. LULUCFA. Forest Land2. Land converted to Forest Land	*CO2*	*1306.70*	*1205.09*	*0.90%*	*0.00050*	*0.7%*	*KC level*	*KC trend*
30	5B15. LULUCFB. Cropland1. Cropland remaining Cropland	*CO2*	*435.28*	*425.31*	*0.29%*	*0.00002*	*0.0%*	*KC level*	-
31	5C15. LULUCFC. Grassland1. Grassland remaining Grassland	*CO2*	*146.77*	*163.58*	*0.14%*	*0.00019*	*0.3%*	*KC level*	-
32	5C25. LULUCFC. Grassland2. Land converted to Grassland	*CO2*	*74.60*	*172.45*	*0.15%*	*0.00091*	*1.4%*	*KC level*	*KC trend*
33	5E25. LULUCFE. Settlements2. Land converted to Settlements	*CO2*	*361.84*	*297.07*	*0.26%*	*0.00050*	*0.7%*	*KC level*	*KC trend*
34	6A6. Waste A. Solid Waste Disposal on Land	CH4	688.16	198.00	0.21%	0.00532	10.4%	KC level	KC trend
35	6B6. Waste B. Wastewater Handling	N2O	184.72	208.89	0.15%	0.00014	0.3%	KC level	-
36	6D6. Waste D. Other	CH4	27.44	95.23	0.18%	0.00122	2.4%	KC level	KC trend

Table 1-10 List of Switzerland's Tier 2 key categories for the base year 1990, combined KCA without and with LULUCF (in italic) categories, sorted by category code

Tier 2 Key category analysis for the base year 1990 without and with LULUCF categories					
	A	B	C	E-L	M
No.	**IPCC Source Categories and fuels if applicable (combined without and with LULUCF categories)**	**Direct GHG**	**Base Year 1990 Estimate** [Gg CO2 eq]	**Level Assessm. with Uncertainty**	**Result level assessm.**
1	1A11. Energy A. Fuel Combustion 1. Energy IndustriesOther Fuels	CO2	1519.73	0.91%	KC level
2	1A21. Energy A. Fuel Combustion 2. Manufacturing Industries and ConstructionSolid Fuels	CO2	1227.96	0.36%	KC level
3	1A21. Energy A. Fuel Combustion 2. Manufacturing Industries and ConstructionLiquid Fuels	CO2	3876.46	0.16%	KC level
4	1A3b1. EnergyA. Fuel Combustion 3. Transport; Road TransportationGasoline	CO2	11335.25	0.55%	KC level
5	1A3b1. EnergyA. Fuel Combustion 3. Transport; Road TransportationGasoline	N2O	137.27	0.13%	KC level
6	1A4a1. Energy A. Fuel Combustion 4. Other Sectors; Commercial/InstitutionalLiquid Fuels	CO2	4429.39	0.19%	KC level
7	1A4b1. Energy A. Fuel Combustion 4. Other Sectors; ResidentialLiquid Fuels	CO2	10226.25	0.43%	KC level
8	1A4b1. Energy A. Fuel Combustion 4. Other Sectors; ResidentialGaseous Fuels	CO2	1409.10	0.13%	KC level
9	1B21. Energy B. Fugitive Emissions from Fuels2. Oil and Natural Gas	CH4	380.43	0.36%	KC level
10	2A12. Industrial Proc.A. Mineral Products; Cement Production-CO2	CO2	2524.77	1.91%	KC level
11	2F92. Industrial Proc.F. Consumption of Halocarbons and SF6; Other	SF6	79.58	0.12%	KC level
12	3 3. Solvent and Other Product Use	CO2	361.92	0.34%	KC level
13	3 3. Solvent and Other Product Use	N2O	110.14	0.17%	KC level
14	4A4. AgricultureA. Enteric Fermentation	CH4	2657.35	0.92%	KC level
15	4B4. AgricultureB. Manure Management	CH4	672.00	0.69%	KC level
16	4B4. AgricultureB. Manure Management	N2O	453.87	0.61%	KC level
17	4D14. AgricultureD. Agricultural Soils; Direct Soil Emissions	N2O	1364.15	1.97%	KC level
18	4D24. AgricultureD. Agricultural Soils; Pasture, Range and Paddock Manure	N2O	128.10	0.20%	KC level
19	4D34. AgricultureD. Agricultural Soils; Indirect Emissions	N2O	820.73	2.46%	KC level
20	5A15. LULUCFA. Forest Land1. Forest Land remaining Forest Land	*CO2*	*3771.35*	*2.31%*	*KC level*
21	5A25. LULUCFA. Forest Land2. Land converted to Forest Land	*CO2*	*1306.70*	*0.95%*	*KC level*
22	5B15. LULUCFB. Cropland1. Cropland remaining Cropland	*CO2*	*435.28*	*0.29%*	*KC level*
23	5C15. LULUCFC. Grassland1. Grassland remaining Grassland	*CO2*	*146.77*	*0.13%*	*KC level*
24	5E25. LULUCFE. Settlements2. Land converted to Settlements	*CO2*	*361.84*	*0.31%*	*KC level*
25	6A6. Waste A. Solid Waste Disposal on Land	CH4	688.16	0.76%	KC level
26	6B6. Waste B. Wastewater Handling	N2O	184.72	0.14%	KC level

Overview of KCA for Tier 1 and Tier 2

Table 1-11 presents an overview on key categories according to the combined KCA without and with LULUCF categories for both Tier 1 and Tier 2, and for both 1990 and 2010.

Table 1-11 Overview on key categories according to the combined KCA without and with LULUCF categories for both Tier 1 and Tier 2, and for both 2010 and 1990, sorted by category code.

Overview on key categories according to the combined KCA without and with LULUCF categories for both Tier 1 and 2, and for both the submission and the base year							
		2010		1990	2010		1990
IPCC Source Categories and fuels if applicable (with LULUCF categories)	Direct GHG	Tier 1	Tier 1	Tier 1	Tier 2	Tier 2	Tier 2
1A11. Energy A. Fuel Comb.1. Energy IndustriesGaseous Fuels	CO2	KC level	KC trend	KC level	-	-	-
1A11. Energy A. Fuel Comb.1. Energy IndustriesLiquid Fuels	CO2	KC level	KC trend	KC level	-	-	-
1A11. Energy A. Fuel Comb.1. Energy IndustriesOther Fuels	CO2	KC level	KC trend	KC level	KC level	KC trend	KC level
1A21. Energy A. Fuel Comb.2. Manufacturing Ind. and Constr.Liquid Fuels	CO2	KC level	KC trend	KC level	-	KC trend	KC level
1A21. Energy A. Fuel Comb.2. Manufacturing Ind. and Constr.Gaseous Fuels	CO2	KC level	KC trend	KC level	KC level	KC trend	-
1A21. Energy A. Fuel Comb.2. Manufacturing Ind. and Constr.Solid Fuels	CO2	KC level	KC trend	KC level	KC level	KC trend	KC level
1A21. Energy A. Fuel Comb.2. Manufacturing Ind. and Constr.Other Fuels	CO2	KC level	KC trend	-	KC level	KC trend	-
1A3a1. EnergyA. Fuel Comb.3. Transport; Civil Aviation	CO2	-	KC trend	KC level	-	-	-
1A3b1. EnergyA. Fuel Comb.3. Transport; Road Transp.Gasoline	CO2	KC level	KC trend	KC level	KC level	KC trend	KC level
1A3b1. EnergyA. Fuel Comb.3. Transport; Road Transp.Diesel	CO2	KC level	KC trend	KC level	KC level	KC trend	-
1A3b1. EnergyA. Fuel Comb.3. Transport; Road Transp.Gasoline	CH4	-	KC trend	-	-	KC trend	-
1A3b1. EnergyA. Fuel Comb.3. Transport; Road Transp.Gasoline	N2O	-	-	-	-	-	KC level
1A4a1. Energy A. Fuel Comb.4. Other Sectors; Com/InstitutLiquid Fuels	CO2	KC level	KC trend	KC level	KC level	-	KC level
1A4a1. Energy A. Fuel Comb.4. Other Sectors; Com/InstitutGaseous Fuels	CO2	KC level	KC trend	KC level	KC level	KC trend	-
1A4b1. Energy A. Fuel Comb.4. Other Sectors; ResidentialLiquid Fuels	CO2	KC level	KC trend	KC level	KC level	KC trend	KC level
1A4b1. Energy A. Fuel Comb.4. Other Sectors; ResidentialGaseous Fuels	CO2	KC level	KC trend	KC level	KC level	KC trend	KC level
1A4b1. Energy A. Fuel Comb.4. Other Sectors; ResidentialBiomass	CH4	-	-	-	-	KC trend	-
1A4c1. Energy A. Fuel Comb.4. Other Sectors; Agriculture/ForestryLiquid Fuels	CO2	KC level	-	KC level	-	-	-
1A51. Energy A. Fuel Comb.5. OtherLiquid Fuels	CO2	-	KC trend	KC level	-	-	-
1B21. Energy B. Fugitive Emissions from Fuels2. Oil and Natural Gas	CH4	-	KC trend	KC level	KC level	KC trend	KC level
2A12. Industrial Proc.A. Mineral Products; Cement Production-CO2	CO2	KC level	KC trend	KC level	KC level	KC trend	KC level
2C12. Industrial Proc.C. Metal Production; Steel Production	CO2	-	-	-	KC level	KC trend	-
2F12. Industrial Proc.F. Consumption of Halocarbons and SF6; Refrig. & AC Eq.	HFC	KC level	KC trend	-	KC level	KC trend	-
2F92. Industrial Proc.F. Consumption of Halocarbons and SF6; Other	SF6	-	-	-	-	KC trend	KC level
2F92. Industrial Proc.F. Consumption of Halocarbons and SF6; Other	HFC	-	-	-	-	KC trend	-
3 3. Solvent and Other Product Use	CO2	-	KC trend	KC level	KC level	KC trend	KC level
3 3. Solvent and Other Product Use	N2O	-	-	-	-	KC trend	KC level
4A4. AgricultureA. Enteric Fermentation	CH4	KC level	KC trend	KC level	KC level	KC trend	KC level
4B4. AgricultureB. Manure Management	CH4	KC level	-	KC level	KC level	KC trend	KC level
4B4. AgricultureB. Manure Management	N2O	KC level	KC trend	KC level	KC level	KC trend	KC level
4D14. AgricultureD. Agricultural Soils; Direct Soil Emissions	N2O	KC level	KC trend	KC level	KC level	KC trend	KC level
4D24. AgricultureD. Agricultural Soils; Pasture, Range and Paddock Manure	N2O	KC level	KC trend	-	KC level	KC trend	KC level
4D34. AgricultureD. Agricultural Soils; Indirect Emissions	N2O	KC level	KC trend	KC level	KC level	KC trend	KC level
5A15. LULUCFA. Forest Land1. Forest Land remaining Forest Land	*CO2*	*KC level*	*KC trend*	*KC level*	*KC level*	*KC trend*	*KC level*
5A25. LULUCFA. Forest Land2. Land converted to Forest Land	*CO2*	*KC level*	*KC trend*	*KC level*	*KC level*	*KC trend*	*KC level*
5B15. LULUCFB. Cropland1. Cropland remaining Cropland	*CO2*	*KC level*	-	*KC level*	*KC level*	-	*KC level*
5C15. LULUCFC. Grassland1. Grassland remaining Grassland	*CO2*	-	-	-	*KC level*	-	*KC level*
5C25. LULUCFC. Grassland2. Land converted to Grassland	*CO2*	-	*KC trend*	-	*KC level*	*KC trend*	-
5E25. LULUCFE. Settlements2. Land converted to Settlements	*CO2*	*KC level*	-	*KC level*	*KC level*	*KC trend*	*KC level*
6A6. Waste A. Solid Waste Disposal on Land	CH4	-	KC trend	KC level	KC level	KC trend	KC level
6B6. Waste B. Wastewater Handling	N2O	KC level	-	-	KC level	-	KC level
6D6. Waste D. Other	CH4	-	KC trend	-	KC level	KC trend	-

1.5.2 KP-LULUCF Inventory

Switzerland identified three key categories for activities under Article 3, paragraphs 3 and 4, of the Kyoto Protocol (forest management, afforestation and reforestation, deforestation). The approach relies on full inventory KCA (with LULUCF), KP - CRF association and qualitative assessment. A detailed description is presented in chapter 11.6.1 and in Table 11-3.

1.6 Quality Assurance and Quality Control (QA/QC)

1.6.1 QA / QC Procedures

In 2002, a total quality management system was introduced within the Federal Office for the Environment (FOEN), within which the GHG inventory was registered as a process. Subsequent to an audit in 2004, an inventory-specific quality management system (QMS) was developed. This QMS is designed to comply with the quality objectives of Good Practice Guidance of IPCC (2000), to ensure and continuously improve transparency, consistency, comparability, completeness, accuracy, and confidence in national GHG emission and removal estimates. Furthermore, Switzerland adopted timeliness as a quality criterion. Switzerland's inventory system is designed to produce a high quality inventory that ensures full compliance with the reporting requirements of the UNFCCC and the Kyoto Protocol.

The quality management system is designed according to a plan-do-check-act cycle (PDCA cycle), which is a generally accepted model according to international standards. Key findings from QA/QC procedures are included in the inventory development plan (IDP), which represents the main instrument for continuous improvement in subsequent inventory cycles. This approach is in accordance with procedures described in decision 19/CMP.1 (UNFCCC 2006a) and in the IPCC Good Practice Guidance (IPCC 2000, chapter 8). The QMS complies with the ISO 9001:2008 standard and has been certified by the Swiss association for quality and management systems (SQS) in December 2007 (SQS, 2008) and re-certified in 2010 (SQS, 2010). Certification is upheld since through annual audits by SQS. Annual audits by SQS are part of the recertification procedure.

The major QMS elements are summarized below. The detailed state of its implementation is documented in the Description of the Quality Management System (FOEN 2012a), submitted alongside this report. All activities are embedded in an annual cycle of inventory planning, preparation, and management (see Table 1 in FOEN 2012a).

1.6.1.1 Responsibilities for QA/QC activities

The national inventory system has a dedicated QA/QC officer who is responsible for coordinating and ensuring compliance with procedures related to quality control and quality assurance. QA/QC activities are carried out by everyone involved in inventory preparation, and various cross-checks are set up to minimise inconsistencies and errors in the inventory. Results from QA/QC activities are documented and reviewed by the QA/QC officer. Based on these feedbacks, suggestions for further improvements of the inventory are developed by the QA/QC officer, which are then discussed in the GHG inventory core group, added to the inventory development plan and assigned to the relevant expert.

1.6.1.2 QA/QC plan

The QA/QC plan is represented by a quality manual as required by the ISO 9001:2008 standard. This quality manual constitutes the core of the quality management system. It consists of a systematic compilation of all documents relevant to quality issues on the FOEN internal document management system. The quality manual contains information regarding requirements, core processes and results of the inventory process and the national registry, as well as QA/QC activities, management and supporting documents (Figure 1-3). The core processes are represented by detailed flowcharts that specify tasks and responsibilities, data sources and collection processes, reference material and guidelines, and archived documents.

The quality manual is reviewed annually by the QA/QC officer and modified after consultation with the project management if necessary. Since 2007, most contributors to the GHG inventory are authorised to access the FOEN-based inventory files by means of a SSL connection to a web platform, including the quality manual with the underlying documents.

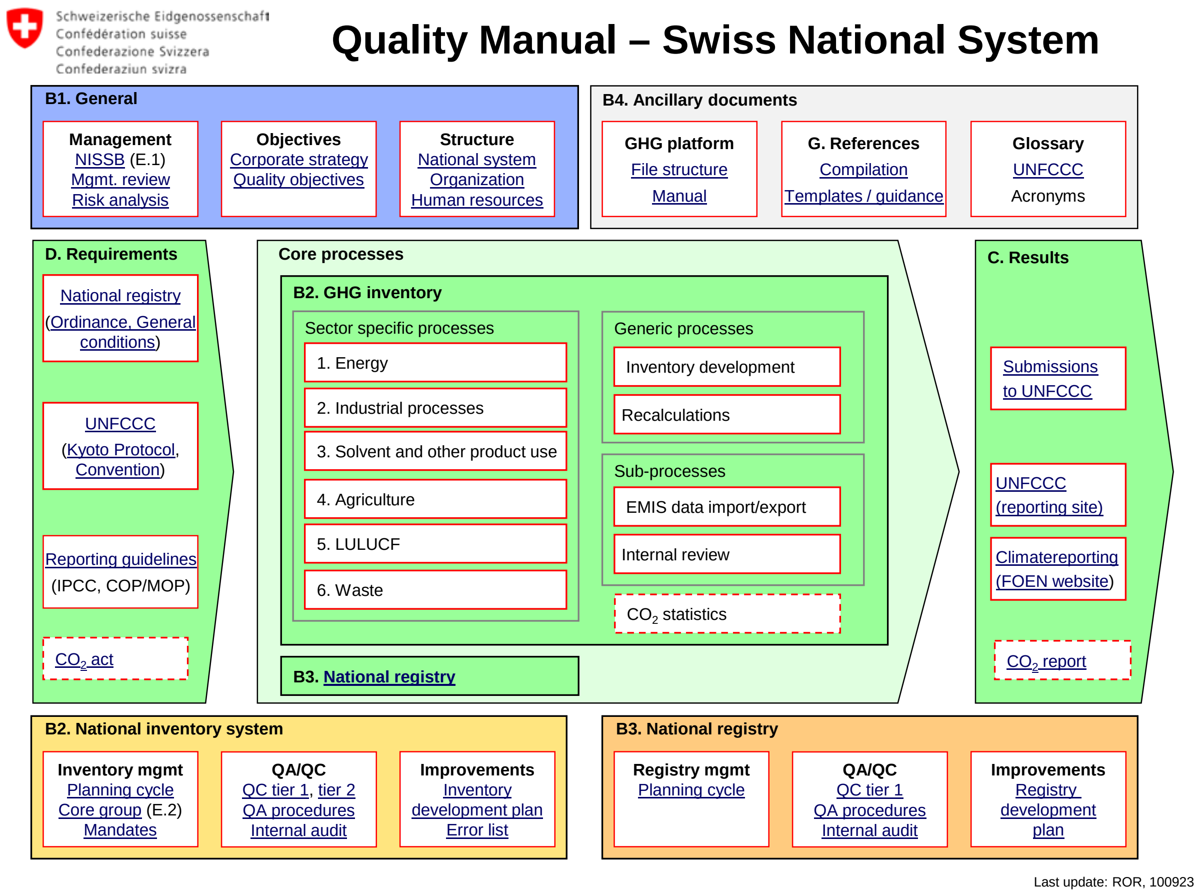

Figure 1-3: Overview of the quality manual of the national inventory system

1.6.1.3 QC procedures

All contributors to the inventory complete checklists that have been designed according to table 8.1 of the Good Practice Guidance (IPCC 2000). During the period of data collection, the data suppliers fill in the checklists. Once completed, the checklists are returned to FOEN. Simultaneously to GHG inventory preparation, the suppliers of emission data, the national inventory compiler, the NIR lead authors, and the project management complete the respective checklists. The QA/QC officer reviews and archives the checklists and contacts the suppliers if concerns about data integrity and/or the performance of quality control procedures arise and arranges for necessary measures to be taken.

In addition to general QC, the inventory project management promotes specific Tier 2 QC procedures both by providing for a FOEN (co-)funding of selected research projects and by initiating internal studies, where appropriate. Significant outcomes are fed into the inventory development plan (IDP; FOEN 2012a, chapter 3) in order to be considered in future inventory submissions.

1.6.1.4 QA review procedures

Apart from the **UNFCCC reviews** of the Swiss inventory, various other efforts are made to assure the high quality standards set out in the quality objectives:

Expert peer reviews are commissioned periodically to provide in-depth analysis of specific sectors. In 2006, energy and industrial processes have been scrutinized, as well as methane emissions from agriculture. In 2009, the waste sector was subject to a domestic expert review. At the end of 2010, a thorough review of the LULUCF sector has taken place. The review of the industrial processes sector is planned to start in May 2012.

Internal reviews of the NIR, GHG inventory CRF tables, Kyoto Protocol LULUCF CRF tables, and the QA/QC supplement are made prior to each submission. They are performed by members of the GHG inventory core group as well as by the staff of the consultants involved in inventory compilation.

The outcomes of all those reviewing activities are evaluated by the project management and the QA/QC officer, resulting in suggestions for amendments and improvements. The core group decides which items are to be followed up and who will take on the responsibility for implementation of the changes in future submissions (see inventory development plan).

FOEN operates a homepage (www.climatereporting.ch) where the Swiss GHG inventories (NIR, CRF tables, QA/QC supplement, UNFCCC review reports); the Swiss national communications and other reports submitted to the UNFCCC and the Kyoto Protocol may be downloaded. On this web site, most papers, internal reports, domestic reviews, Excel calculation sheets, and other difficult-to-access materials (‘grey literature’) quoted in the Swiss GHG inventory are provided online. The climate reporting homepage thus provides the option for public review.

1.6.1.5 Inventory improvements based on recommendations of the ERT

Based on a suggestion made by the review team during the in-country review in 2010, a list of the changes already made in response to questions or recommendations of the ERT is inserted below. Not all recommendations from the latest review could be considered due to the late availability of the draft review report. The first column refers to the year the review took place and the paragraph in the corresponding review report, if available. The second column gives a brief description of the issue; the third column shows what has been improved and where the changes have been implemented. The fourth column refers to the corresponding entry in the inventory development plan (see FOEN 2012a).

Table 1-12 Improvements due to questions or recommendations of the Expert Review Team.

ARR: Year (para.)	Recommendation	Improvement – NIR chapter	IDP
	General		
2010 (24)	Allocation of roles and responsibilities for each sector	With regard to the emission data base (EMIS), each sector is assigned a specific expert at FOEN. This person is also making sure that the data provided by sectoral experts is implemented correctly in the CRF tables. The corresponding NIR authors check consistency between NIR and CRF. The responsibilities are listed on page 3 and 4 of the NIR.	2
2010 (31) 2011(19/20/ 23/32)[2]	Documentation of recalculations at disaggregated level.	Recalculations are described in more detail in the relevant chapters of the NIR under "Source specific recalculations". A more detailed list for internal use is available (in French/German). For every recalculation, the issue of time-series consistency is considered. Where new data is only available for specific years, other years are given additional scrutiny.	3
2011 (14)	Improvements based on key category and uncertainty analyses	There are a couple of studies commissioned by FOEN that target specifically the key categories in areas with large uncertainty, e.g. with regard to 1A1, CO_2 EF other fuels or sector 4 CH_4 EF (FOEN 2012a, Annex D, List of QC tier 2 projects).	
2011 (17)	Reasons for differences in uncertainty analyses between submissions	The differences between the uncertainty analyses including LULUCF for different years have been addressed briefly in chapter 1.7.1.4.	
2010 (32) 2011(21/22/ 23/37)	Enhance QA/QC activities	Recommendations of the ERT are addressed (see items in this table). National peer reviews of specific sectors are carried out periodically, checking, amongst others, methodological aspects and looking at higher-tier methods (e.g. workshop regarding the Yasso model). Procedures to check the CRF tables have been adapted to allow for a two stage control of the tables. An inter-Party comparison of IEF has been made and is documented in the relevant chapters of the NIR under "Source specific QA/QC and verification" (INFRAS 2012). KP-LULUCF undergoes the same QA/QC procedures as all other sectors of the inventory, e.g. it has been subject to the peer review of the LULUCF sector in 2010 (vTI 2011). Transparency has been improved, especially in the industrial processes sector. However, due to reasons of confidentiality, some information cannot be made publicly available, but only disclosed to the ERT.	4/5
2011 (135)	Changes in national registry, in particular with regard to user authentication	Documentation is provided in chapter 14.	
2011 (136/138)	Document changes in reporting information on the minimization of adverse effects	A paragraph has been added at the end of chapter 15.	
	Energy		
2010 (48) 2011 (34)	Provide description of production methods in NIR.	A brief description of the production methods is provided in Chapter 3.2.7.	1
2011 (35)	Provide more information regarding country-specific emission factors	The description and comparison of emission factors has been enhanced considerably in this submission. Furthermore, background data sheets have been translated and will be made available to reviewers on request (see also items below).	
2011 (40)	Coking coal in reference approach	Coking coal is "included elsewhere" in the reference approach. It is included under other bituminous coal (see footnote in chapter 3.2.1).	
2010 (49.) 2011 (41)	Discrepancy between NIR and IEA energy consumption	The discrepancy has been investigated in preparation of the 2011 review. The results of this inquiry have been provided to the ERT and are documented in FOEN 2011d.	2
2010 (51.)	Bunker fuels: Insert table with	The difference between the modelled and actual fuel sales is very small (~3-4%).	3

[2] The final version of the review report ARR/2011/CHE was not available at the time of submission. The numbering of the paragraphs given here corresponds to the draft report of 12 March 2012 and may differ from the final report.

2011 (43)	modelled and actual fuel sales for bunker and domestic aviation	In view of the complexity of the model, the difference is negligible and demonstrates the high quality of the model. Actual fuel sales data are only available for the total sales. Differentiating between domestic and international aviation needs to be done through the modelling approach. For the more recent years, the modelled and actual total fuel sales are listed in Table 3-6a.	
2010 (53.) 2011 (39/45/46)	Feedstock and non-energy use of fuels. Consistency between reference and sectoral approach	Consistency and comparison between RA and SA has been improved.	4
2010 (55.) 2011 (48)	Fossil fraction of waste incinerated in MSW incineration plants	Fossil fuel fraction of municipal waste incinerated has been investigated and included in Chapter 3.2.6.2.	5
2008 (29.)	Composition of imported MSW	The composition of waste was evaluated and included in Chapter 3.2.6.2	6
2011 (35)	EF for various fuels	The main emission factors have been compared to IPCC default values and are discussed in the NIR under "Source specific QA/QC and verification.	7
2010 (58.) 2011 (35)	N_2O IEF in 1A1a	The emission factor of N_2O has been explained in Chapter 3.2.6.2	10
2011 (35)	Provide explanation for EF for CH_4 and N_2O from wood in 1A4b (lower than IPCC range)	Explanations for EF have been provided in Chapter 3.2.9.2	14
2011 (49)	Provide brief explanation what "special waste" comprises under 1A1a	Explanation is provided in Chapter 3.2.6.2	15
2011 (50)	Provide detailed information on fuels used for cement production	See Table 3-28 for an overview of fuel use in cement industry and Table 4-4 for clinker and cement production.	
2011 (51)	CH_4 emissions from gaseous fuels in road transportation	The revisions with regard to 1A3b have been implemented as presented in Chapter 16.	
2011	Restructure the energy chapter of the NIR	As suggested by the ERT in September 2011, the energy chapter has been restructured as to follow the NIR outline provided by the UNFCCC.	16
	Industrial processes		
2010 (62.) 2011 (57)	Improved documentation of processes (including AD, EF, technical description of process)	The processes have been described in more detail in chapter 4 of the NIR. However, due to reasons of confidentiality, some information cannot be made publicly available, but only be disclosed to the ERT.	1
2010 (67.) 2011 (60/61)	Justification of assumptions made for bricks and tiles	All currently available information is provided in chapter 4.2.2.3. We are still awaiting new data from the association of Swiss brick and tile producers.	2
2010 (69.) 2011 (65)	Describe process of HNO_3 production and justify use of EF N_2O	As these data are confidential, no further details are provided in the NIR (section 4.6.1). However, the ERT are provided with the necessary background documents on request.	3
2010 (70.) 2011 (67/68)	Carbide production	Details regarding carbide production are given in section 4.6.1. However, data are confidential and therefore not shown in the NIR, but available to reviewers on request. The CH_4 emissions are reported as discussed in chapter 16 of the NIR.	4
2011	Description of 2C1 and 2C2	Following questions from the ERT 2011, we clarified the description of iron and steel production in the NIR (chapter 4.7.2.1).	7
2011 (69/108)	Reporting of indirect emissions	Indirect emissions are reported in sector 3 Solvents and other product use, as discussed in chapter 16.	
2011 (63)	Revise model for calculating air-conditioning emissions	The error in the model has been corrected and the resulting recalculation is described in 4.10.4 and Carbotech 2012. The corrections led to an increase in the emissions of approx. 15%.	8
	Agriculture		
2011 (72)	Data source for population of cattle	The activity data from the Swiss Farmers Union and the Swiss Federal Statistical Office has been harmonized (see chapter 6.2.2.3)	1
2011 (74)	Description of animal categories	Description improved, very detailed description in ART (2011c) and ART/SHL 2012	7
2010 (85)	NH_3 from fertilizer –investigate emissions rates for various compound mineral fertilizer	NH_3 emissions from fertilizers has been reevaluated and found to be adequate.	6

	LULUCF		
2006 (97)	Grassland biomass: Estimate and report carbon stock changes in living biomass	A justification for the use of constant carbon stocks in living biomass is given in Chapter 7.5.6.	
2008 (79)	Cropland biomass: Develop a higher-tier method to estimate carbon stock changes in living biomass	Annual data for carbon stock in living biomass of CC21 is used, see Chapter 7.4.4.1	5
2010 (95, 118), 2011 (86, 91))	Land converted to forest land: Increase transparency by including a table illustrating the methodological approach	The tables are provided in a separate document (Meteotest 2012a)	9
2010 (96,97) 2011 (87)	Biomass burning: Provide rationale for including CO_2 emissions from biomass under forest and for use of notation key "IE" in CRF Table 5(V)	See Chapter 7.3.4.12. ARR 2011 (87) is answered in part.	7
2011 (89, 111, 121)	Forest Land: Report emissions from drained organic soils.	Emissions from organic soils under forest land are reported using a default emission factor of 0.68 t C ha^{-1} yr^{-1} (see Chapter 7.3.4.9, Chapter 16, and FOEN 2011b).	
2011 (93)	Wetlands: Provide clarification how the methods used for the spatial representation of all lands can distinguish between tree groups under wetlands and forest parcels under forest lands	The methodology to calculate the carbon stock of living biomass for unproductive wetland has been changed and is now based on study results from Mathys and Thürig (2010), see Chapter 7.6.4.1.	
2011 (94)	N_2O emissions from disturbance associated with land-use conversion to cropland: Include documentation on the notation key "NO" or report emissions	Documentation is provided in Chapter 7.4.4.4. Planned improvements with respect to this topic are noted in Chapter 7.4.8.	
	Waste		
2010 (103.) 2011 (101)	Provide description of DOC calculation in the NIR	The details regarding DOC calculation are provided in the EMIS background data sheet and are summarized in Table 8-4. The EMIS background data sheet will be made available to reviewers on request.	2
2010 (106.) 2011 (103)	Use year-specific values of protein consumption for wastewater emissions	Year-specific values of protein consumption are considered (chapter 8.3.2).	3
2010 (110.) 2011 (98/105)	Provide AD for wastewater in CRF 6.B. Improve description of waste water treatment.	Due to the methodology used, the AD for industrial wastewater requested in the CRF is not readily available. Details regarding the emission estimates are provided in the EMIS background data sheets, which will be made available to reviewers on request.	4, 11
2008 (90.) 2011 (104)	Provide detailed information on composting and digesting of organic waste	Emissions from composting and digesting or organic waste are reported in more detail in section 8.5 of the NIR (instead of documentation box to CRF table 6 as suggested by the ERT). Further details are provided in the EMIS background data sheet, which will be made available to reviewers on request.	5
	Other		
2010 (114.) 2011 (107)	Estimate CH_4 and N_2O emissions or use NE	CH_4 and N_2O emissions are estimated and reported in NIR section 9.2 and the corresponding CRF tables	1

1.6.1.6 Documentation and archiving procedures

Inventory data as well as background information on activity data and emission factors are archived by the national inventory compiler in the EMIS data base. EMIS allows to file background information (e.g. interim worksheets; references; rationale for choice of methods) for any subset of inventory-related data (EMIS 2012/ (NFR-Code); FOEN 2006c).

Information on the QMS, all QA/QC activities performed, decisions reached by the experts (minutes), results of key category analyses and uncertainty analyses as well as inventory development (IDP) is documented and archived in the FOEN IDM system and accessible to authorised collaborators via the GHG inventory web platform. All inventory information, as far as needed to reconstruct and interpret inventory data and to describe the inventory system and its functions, is accessible at a single location at the FOEN in Ittigen near Bern.

Data backup is managed by the Federal Office of Information Technology, Systems and Telecommunication (FOITT) using a Storage Area Network. FOITT runs backup facilities at two distinct locations on a daily as well as on a weekly basis.

1.6.2 Verification Activities

The time series have been compared between the current and the previous submission. All activity data, implied emission factors and emissions undergo the triple check:

- the results for 2010 are compared with the results 2009 within the current CRF
- the CRF tables for the year 2009 are compared between the current CRF tables and the CRF tables of submission 2011.
- the CRF tables for the base year 1990 are compared between the current CRF tables and the CRF tables of submission 2011

For each check, the CRF table cells are marked in green if values are identical, in grey if they differ by no more than 20%, in orange if they differ by 20% to 50%, and in red if they differ by more than 50%. The findings are discussed among the core group members and the modelling specialists. All differences are investigated and the reasons for the differences sought. This procedure has already led to the identification of several mistakes, which were subsequently corrected before submission.

The current submission has been reviewed by personnel not directly involved in the preparation of a particular section of the inventory and revised accordingly.

The FOEN supports a monitoring campaign at the high altitude research station Jungfraujoch, where various greenhouse gases are measured continuously. The location of the research station normally provides for analysis of tropospheric background concentrations. However, under special meteorological conditions, an estimate of Swiss emissions can be derived from the measurements. For a couple of F-gases, a comparison of the inventory data with the inferred emissions is presented in Annex A6.1. Further research is needed to refine the approach and apply it to other greenhouse gases.

As an additional activity, the emission factor of all subcategories used in the Swiss Inventory have been compared to the corresponding emission factors of other countries (UNFCCC http://unfccc.int/di/FlexibleQueries.do) and to the IPCC default value if available (INFRAS 2012). If respective Swiss values deviate more than ±10% from other countries' average or from the IPCC default value, explanations for the divergence are provided.

1.6.3 Treatment of Confidentiality Issues

Nearly all of the data necessary to compile the Swiss GHG inventory are publicly available. There are, however, a few exceptions:

- (i) Emission data that refer to a single enterprise are in general confidential.
- (ii)The reporting of disaggregated emissions from F-gases is confidential (not confidential as aggregated data).
- (iii) In the civil aviation sub-sector one data source (FOCA 1991) has been marked confidential by the Federal Office of Civil Aviation (FOCA).

- (iv) Unpublished AREA land use statistics raw data have been temporarily classified confidential by the Swiss Federal Statistical Office (SFSO).

The FOEN collects the data needed for calculating emissions of HFCs, PFCs and SF_6 from private companies or industry associations. In the National Inventory Report, the activity data underlying emission estimates of HFCs, PFCs and SF_6 are only partly presented at the most disaggregated level for reasons of confidentiality. However, complete emissions are reported in aggregated tables.

Confidential data will be made available by the FOEN in line with the procedures agreed under the UNFCCC for the technical review of GHG inventories (UNFCCC 2003).

1.7 Uncertainty Evaluation

1.7.1 GHG Inventory

1.7.1.1 Tier 1 and Tier 2 analysis

The uncertainty analysis Tier 1 of the April 2011 submission (FOEN 2011) has been updated for the present submission. A Tier 2 analysis (Monte Carlo simulation) is carried out every two years and has been updated for this present submission. In this chapter, the main results of the quantitative uncertainty evaluation Tier 1 and Tier 2 are presented. Further information is found in Annex 7.

Uncertainties are assessed in accordance with the IPCC Good Practice Guidance

- Tier 1 methodology (IPCC 2000: p. 6.13ff.)
- Tier 2 methodology, Monte Carlo simulation (IPCC 2000: p. 6.18ff.).

For a number of non-key categories, no precise quantitative uncertainties are available. For those categories, a semi-quantitative assessment has been carried out. Based on results of the 2nd International Workshop on Uncertainty in Greenhouse Gas Inventories (Vienna 27-28 September 2007) a list of overall uncertainties has been defined (see Table 1-13).

In the sectoral chapters (energy, industrial processes, etc.), specific information is provided on the uncertainty estimation for activity data, emission factors or emissions.

All uncertainties are given as half of the 95% confidence interval divided by the mean and expressed as a percentage (approximately two standard deviations) as suggested by the IPCC Guidelines (IPCC 1997a).

1.7.1.2 Data Used

For many key categories, no explicit information on uncertainties is available – e.g., the Swiss overall energy statistics (SFOE 2011) do not provide estimates of uncertainties. For these cases, authors of the NIR chapters, FOEN experts involved and several data suppliers derived estimates of uncertainties based on the IPCC Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories (IPCC 2000) default values and on information concerning the process of data collection for activity data and emission factors (import or sales statistics, surveys or modelling). Several experts from data suppliers were contacted for further information on some of the uncertainties. Some industry associations/sources also provided published or unpublished uncertainty estimates for their data. The data sources can be found in the relevant sub-sections on “Uncertainties and Time-Series Consistency” in each of the sectoral chapters (3–9) below.

Distributions are assumed to be symmetric for the Tier 1 method. For the Tier 2 Monte Carlo simulation asymmetric distributions are also applied.

Uncertainties in the GWP values were not taken into account.

Despite the investigation carried out for the current uncertainty analyses it will be necessary to further motivate institutions to supply not only average data but also estimates of associated uncertainties.

1.7.1.3 Uncertainty Estimates

For categories with no quantitative uncertainty data available, the NIR provides qualitative estimates of uncertainties. The terms high, medium and low data quality is used. In order to extend the quantitative uncertainty analysis to every category, the default values as presented in Table 1-13 are used. They are motivated by the comparison of uncertainty analyses of several countries carried out by de Keizer et al. (2007), as presented at the 2nd Internat. Workshop on Uncertainty in Greenhouse Gas Inventories (Vienna 27-28 September 2007), and by Table A1-1 of IPCC Guidelines, Vol. 1, Annex 1, Managing uncertainties (IPCC 1997a).

Table 1-13 Semi-quantitative uncertainties (2 σ) for non-key categories.

Gas	Uncertainty category	Relative uncertainty
CO_2	low	2%
	medium	10%
	high	40%
CH_4	low	15%
	medium	30%
	high	60%
N_2O	low	40%
	medium	80%
	high	150%
HFC	medium	20%
PFC	medium	20%
SF_6	medium	20%

1.7.1.4 Results of Tier 1 Uncertainty Evaluation

With this submission, results of a new uncertainty evaluation are presented. There is a calculation of the uncertainty excluding the LULUCF sector and an uncertainty evaluation including LULUCF. As described in IPCC (2000) and IPCC (2003), the uncertainty estimates of the LULUCF sector were combined with the uncertainty estimates of the non-LULUCF sector to obtain the total inventory uncertainty. The results of the Tier 1 uncertainty analysis for GHG emissions 2010 are summarised in Table 1-15. Details of the uncertainty estimates for specific sources are provided in the sub-sections on “Uncertainties and Time-Series Consistency” in each of the chapters on source categories below.

The resulting Tier 1 uncertainty in the national total annual CO_2 equivalent emissions **without LULUCF** is estimated to be 3.84% (level uncertainty). Trend uncertainty is 2.00% meaning that the change of the base year (1990) to 2010, reported as +2.24%, lies with a probability of 95% between +0.24% and +4.24%.

Compared to the results of the previous inventory 2009 (level 3.43%, trend 1.96%; FOEN 2011), the level and the trend uncertainties for 2010 for the emissions without the LULUCF sector are slightly higher. This is based on higher emission data as well as higher emission factor uncertainties. In addition, the expansion factors used for the energy combustions (1A2-1A5) in the previous submission for the disaggregation of fuels have been eliminated.

The resulting Tier 1 **total inventory uncertainty** in the national total annual CO_2 equivalent emissions **including LULUCF** sector is estimated to be 4.10% (level uncertainty). Trend uncertainty is 3.36%.

The trend uncertainty including LULUCF has been calculated incorrectly in the submission in April 2011, as the uncertainty introduced by each category in the sector LULUCF has been compared to the total emissions of sector 5 instead of the national total emissions. Therefore, the trend uncertainty has been overestimated significantly.

It should be noted that the present results of the Tier 1 uncertainty analysis for GHG emissions do not, or not fully, take into account the following factors that may further increase uncertainties:

- correlations existing between source categories that have not been considered by the Tier 1 approach (e.g. production data used for industry emissions in both categories 1A2 Manufacturing Industries and 2 Industrial Processes, or cattle numbers used for emissions related to enteric fermentation and animal manure production);
- errors due to the assumption of constant parameters;
- errors due to non-normal, asymmetric distribution of the uncertainties;
- errors due to methodological shortcomings;
- errors due to sources not reported (these are assumed to be very small).

On the other hand, the Tier 2 uncertainty evaluation described below explicitly takes into account correlations between sources and asymmetric distributions.

Ranked by their contribution to uncertainty in the total national emissions level (cf. Column H, Table 1-14), indirect and direct emissions of N_2O from Agricultural Soils, CO_2 from 1A Fuel Combustion Activities (Other fuels) and CO_2 from 2A1 Industrial Processes are the top four contributors. Their combined uncertainty amounts to 7.04% of total national emissions in 2010. The table permits the identification of future areas of improvement in the context of the Inventory Development Plan (IDP).

Table 1-14 Ranked combined level uncertainties for sources in Switzerland.

IPCC GPG Table 6.1
Tier 1 Uncertainty Calculation and Reporting

A	B	C	D	E	F	G	H
IPCC Source category	Gas	Base year emissions 1990	Year 2010 emissions	Activity data uncertainty	Emission factor uncertainty	Combined uncertainty	Combined uncertainty as % of total national emission in year t
		Input data	Input data	Input data	Input data	Calc/Input	
		Gg CO2 eq	Gg CO2 eq	%	%	%	%
4D34. AgricultureD. Agricultural Soils; Indirect Emissions	N2O	820.73	710.51	31.8	163.00	166.1	2.211
4D14. AgricultureD. Agricultural Soils; Direct Soil Emissions	N2O	1'364.15	1'189.21	20.4	80.63	83.2	1.853
1A11. Energy A. Fuel Combustion 1. Energy IndustriesOther Fuels	CO2	1'519.73	2'582.10	10.0	30.00	31.6	1.530
2A12. Industrial Proc.A. Mineral Products; Cement Production-CO2	CO2	2'524.77	1'928.12	2.0	40.00	40.0	1.447
4A4. AgricultureA. Enteric Fermentation	CH4	2'657.35	2'537.97	6.4	17.20	18.4	0.873
4B4. AgricultureB. Manure Management	CH4	672.00	645.25	6.4	54.10	54.5	0.659
1A3b1. EnergyA. Fuel Combustion 3. Transport; Road TransportationGasoline	CO2	11'335.25	9'744.97	2.2	1.36	2.6	0.471
4B4. AgricultureB. Manure Management	N2O	453.87	323.52	29.9	65.30	71.8	0.435
4D24. AgricultureD. Agricultural Soils; Pasture, Range and Paddock Manure	N2O	128.10	245.40	57.3	62.50	84.8	0.390
1A4b1. Energy A. Fuel Combustion 4. Other Sectors; ResidentialLiquid Fuels	CO2	10'226.25	8'688.23	2.2	0.51	2.2	0.366
5B15. LULUCFB. Cropland1. Cropland remaining Cropland	CO2	435.28	425.31	30.0	25.00	39.1	0.311
5E25. LULUCFE. Settlements2. Land converted to Settlements	CO2	361.84	297.07	11.0	50.00	51.2	0.285
1A3b1. EnergyA. Fuel Combustion 3. Transport; Road TransportationDiesel	CO2	2'587.68	6'154.63	2.2	0.47	2.2	0.258
1A4b1. Energy A. Fuel Combustion 4. Other Sectors; ResidentialGaseous Fuels	CO2	1'409.10	2'661.45	2.0	4.60	5.0	0.250
2F12. Industrial Proc.F. Consumption of Halocarbons and SF6; Refrig. & AC Eq.	HFC	0.02	1'011.69	8.5	8.49	12.0	0.227
6A6. Waste A. Solid Waste Disposal on Land	CH4	688.16	198.00	30.0	50.00	58.3	0.216
1A21. Energy A. Fuel Combustion 2. Manufacturing Industries and ConstructionGaseous Fuels	CO2	1'133.30	2'216.12	2.0	4.60	5.0	0.208
1A21. Energy A. Fuel Combustion 2. Manufacturing Industries and ConstructionOther Fuels	CO2	134.24	315.35	10.0	30.00	31.6	0.187
6D6. Waste D. Other	CH4	27.44	95.23	10.0	100.00	100.5	0.179
5C25. LULUCFC. Grassland2. Land converted to Grassland	CO2	74.60	172.45	11.0	50.00	51.2	0.165
1B21. Energy B. Fugitive Emissions from Fuels2. Oil and Natural Gas	CH4	380.43	173.85	35.4	35.36	50.0	0.163
6B6. Waste B. Wastewater Handling	N2O	184.72	208.89	28.3	28.28	40.0	0.157
5C15. LULUCFC. Grassland1. Grassland remaining Grassland	CO2	146.77	163.58	10.0	50.00	51.0	0.156
1A4a1. Energy A. Fuel Combustion 4. Other Sectors; Commercial/InstitutionalLiquid Fuels	CO2	4'429.39	3'607.89	2.2	0.51	2.2	0.152
1A21. Energy A. Fuel Combustion 2. Manufacturing Industries and ConstructionSolid Fuels	CO2	1'227.96	520.65	14.5	5.00	15.4	0.150
3 3. Solvent and Other Product Use	CO2	361.92	157.23	35.4	35.36	50.0	0.147
1A4a1. Energy A. Fuel Combustion 4. Other Sectors; Commercial/InstitutionalGaseous Fuels	CO2	905.76	1'409.10	2.0	4.60	5.0	0.132
2C12. Industrial Proc.C. Metal Production; Steel Production	CO2	110.80	170.57	5.0	40.00	40.3	0.129
1A21. Energy A. Fuel Combustion 2. Manufacturing Industries and ConstructionLiquid Fuels	CO2	3'876.46	2'890.89	2.2	0.51	2.2	0.122
5F25. LULUCFF. Other Land2. Land converted to Other Land	CO2	97.88	121.89	13.0	50.00	51.7	0.118
1A3b1. EnergyA. Fuel Combustion 3. Transport; Road TransportationGasoline	N2O	137.27	111.15	2.2	50.00	50.0	0.104

Table 1-15 Tier 1 uncertainty results for sources in Switzerland 2010 (IPCC 2000, Table 6.1, IPCC 2003).

IPCC GPG Table 6.1
Tier 1 Uncertainty Calculation and Reporting

A	B	C	D	E	F	G	H	I	J	K	L	M
IPCC Source category	Gas	Base year emissions 1990	Year 2010 emissions	Activity data uncertainty	Emission factor uncertainty	Combined uncertainty	Combined uncertainty as % of total national emission in year t	Type A sensitivity	Type B sensitivity	Uncertainty in trend in national emissions introduced by emission factor uncertainty	Uncertainty in trend in national emissions introduced by activity data uncertainty	Uncertainty introduced into the trend in total national emissions
		Input data	Input data	Input data	Input data	Calc/Input						
		Gg CO2 eq	Gg CO2 eq	%	%	%	%	%	%	%	%	%
Total Uncertainty including LULUCF		**49'210**	**53'367**				**4.10**					**3.36**
Emissions without LULUCF												
1A11. Energy A. Fuel Combustion 1. Energy IndustriesBiomass	CH4	4.66	1.24	21.2	21.21	30.0	0.001	-0.0001	0.0000	0.00	0.00	0.00
1A11. Energy A. Fuel Combustion 1. Energy IndustriesGaseous Fuels	CH4	0.54	1.24	21.2	21.21	30.0	0.001	0.0000	0.0000	0.00	0.00	0.00
1A11. Energy A. Fuel Combustion 1. Energy IndustriesLiquid Fuels	CH4	0.49	0.78	21.2	21.21	30.0	0.000	0.0000	0.0000	0.00	0.00	0.00
1A11. Energy A. Fuel Combustion 1. Energy IndustriesSolid Fuels	CH4	0.10	0.00	21.2	21.21	30.0	0.000	0.0000	0.0000	0.00	0.00	0.00
1A11. Energy A. Fuel Combustion 1. Energy IndustriesGaseous Fuels	CO2	235.05	540.64	2.0	4.60	5.0	0.051	0.0058	0.0110	0.03	0.03	0.04
1A11. Energy A. Fuel Combustion 1. Energy IndustriesLiquid Fuels	CO2	691.23	965.28	2.2	0.51	2.2	0.041	0.0044	0.0196	0.00	0.06	0.06
1A11. Energy A. Fuel Combustion 1. Energy IndustriesOther Fuels	CO2	1'519.73	2'582.10	10.0	30.00	31.6	1.530	0.0190	0.0525	0.57	0.74	0.94
1A11. Energy A. Fuel Combustion 1. Energy IndustriesSolid Fuels	CO2	44.84	0.00	14.5	5.00	15.4	0.000	-0.0010	0.0000	0.00	0.00	0.00
1A11. Energy A. Fuel Combustion 1. Energy IndustriesBiomass	N2O	27.72	48.15	56.6	56.57	80.0	0.072	0.0004	0.0010	0.02	0.08	0.08
1A11. Energy A. Fuel Combustion 1. Energy IndustriesGaseous Fuels	N2O	0.13	0.30	56.6	56.57	80.0	0.000	0.0000	0.0000	0.00	0.00	0.00
1A11. Energy A. Fuel Combustion 1. Energy IndustriesLiquid Fuels	N2O	2.15	3.47	56.6	56.57	80.0	0.005	0.0000	0.0001	0.00	0.01	0.01
1A11. Energy A. Fuel Combustion 1. Energy IndustriesOther Fuels	N2O	20.85	47.25	56.6	56.57	80.0	0.071	0.0005	0.0010	0.03	0.08	0.08
1A11. Energy A. Fuel Combustion 1. Energy IndustriesSolid Fuels	N2O	0.24	0.00	56.6	56.57	80.0	0.000	0.0000	0.0000	0.00	0.00	0.00
1A21. Energy A. Fuel Combustion 2. Manufacturing Industries and ConstructionBiomass	CH4	2.46	2.01	21.2	21.21	30.0	0.001	0.0000	0.0000	0.00	0.00	0.00
1A21. Energy A. Fuel Combustion 2. Manufacturing Industries and ConstructionGaseous Fuels	CH4	2.84	5.10	21.2	21.21	30.0	0.003	0.0000	0.0001	0.00	0.00	0.00
1A21. Energy A. Fuel Combustion 2. Manufacturing Industries and ConstructionLiquid Fuels	CH4	2.42	1.20	21.2	21.21	30.0	0.001	0.0000	0.0000	0.00	0.00	0.00
1A21. Energy A. Fuel Combustion 2. Manufacturing Industries and ConstructionOther Fuels	CH4	0.00	0.00	21.2	21.21	30.0	0.000	0.0000	0.0000	0.00	0.00	0.00
1A21. Energy A. Fuel Combustion 2. Manufacturing Industries and ConstructionSolid Fuels	CH4	0.57	0.45	21.2	21.21	30.0	0.000	0.0000	0.0000	0.00	0.00	0.00
1A21. Energy A. Fuel Combustion 2. Manufacturing Industries and ConstructionGaseous Fuels	CO2	1'133.30	2'216.12	2.0	4.60	5.0	0.208	0.0201	0.0450	0.09	0.13	0.16
1A21. Energy A. Fuel Combustion 2. Manufacturing Industries and ConstructionLiquid Fuels	CO2	3'876.46	2'890.89	2.2	0.51	2.2	0.122	-0.0267	0.0587	-0.01	0.18	0.18
1A21. Energy A. Fuel Combustion 2. Manufacturing Industries and ConstructionOther Fuels	CO2	134.24	315.35	10.0	30.00	31.6	0.187	0.0034	0.0064	0.10	0.09	0.14
1A21. Energy A. Fuel Combustion 2. Manufacturing Industries and ConstructionSolid Fuels	CO2	1'227.96	520.65	14.5	5.00	15.4	0.150	-0.0165	0.0106	-0.08	0.22	0.23
1A21. Energy A. Fuel Combustion 2. Manufacturing Industries and ConstructionBiomass	N2O	2.44	10.79	56.6	56.57	80.0	0.016	0.0002	0.0002	0.01	0.02	0.02
1A21. Energy A. Fuel Combustion 2. Manufacturing Industries and ConstructionGaseous Fuels	N2O	0.63	1.24	56.6	56.57	80.0	0.002	0.0000	0.0000	0.00	0.00	0.00
1A21. Energy A. Fuel Combustion 2. Manufacturing Industries and ConstructionLiquid Fuels	N2O	14.96	12.84	56.6	56.57	80.0	0.019	-0.0001	0.0003	0.00	0.02	0.02
1A21. Energy A. Fuel Combustion 2. Manufacturing Industries and ConstructionOther Fuels	N2O	2.31	5.83	56.6	56.57	80.0	0.009	0.0001	0.0001	0.00	0.01	0.01
1A21. Energy A. Fuel Combustion 2. Manufacturing Industries and ConstructionSolid Fuels	N2O	6.57	2.76	56.6	56.57	80.0	0.004	-0.0001	0.0001	-0.01	0.00	0.01
1A3a1. EnergyA. Fuel Combustion 3. Transport; Civil Aviation	CH4	0.24	0.27	42.4	42.43	60.0	0.000	0.0000	0.0000	0.00	0.00	0.00
1A3a1. EnergyA. Fuel Combustion 3. Transport; Civil Aviation	CO2	252.55	123.55	2.2	1.16	2.5	0.006	-0.0031	0.0025	0.00	0.01	0.01
1A3a1. EnergyA. Fuel Combustion 3. Transport; Civil Aviation	N2O	2.46	1.20	106.1	106.07	150.0	0.003	0.0000	0.0000	0.00	0.00	0.00
1A3b1. EnergyA. Fuel Combustion 3. Transport; Road TransportationBiomass	CH4	0.00	0.04	42.4	42.43	60.0	0.000	0.0000	0.0000	0.00	0.00	0.00
1A3b1. EnergyA. Fuel Combustion 3. Transport; Road TransportationDiesel	CH4	1.36	0.65	2.2	20.00	20.1	0.000	0.0000	0.0000	0.00	0.00	0.00
1A3b1. EnergyA. Fuel Combustion 3. Transport; Road TransportationGasoline	CH4	101.15	22.34	2.2	37.00	37.1	0.016	-0.0018	0.0005	-0.07	0.00	0.07
1A3b1. EnergyA. Fuel Combustion 3. Transport; Road TransportationNatural Gas	CH4	0.00	0.27	21.2	21.21	30.0	0.000	0.0000	0.0000	0.00	0.00	0.00
1A3b1. EnergyA. Fuel Combustion 3. Transport; Road TransportationDiesel	CO2	2'587.68	6'154.63	2.2	0.47	2.2	0.258	0.0680	0.1251	0.03	0.39	0.39
1A3b1. EnergyA. Fuel Combustion 3. Transport; Road TransportationGasoline	CO2	11'335.25	9'744.97	2.2	1.36	2.6	0.471	-0.0517	0.1980	-0.07	0.61	0.62
1A3b1. EnergyA. Fuel Combustion 3. Transport; Road TransportationNatural Gas	CO2	0.00	39.05	3.5	3.55	5.0	0.004	0.0008	0.0008	0.00	0.00	0.00
1A3b1. EnergyA. Fuel Combustion 3. Transport; Road TransportationBiomass	N2O	0.00	0.44	106.1	106.07	150.0	0.001	0.0000	0.0000	0.00	0.00	0.00
1A3b1. EnergyA. Fuel Combustion 3. Transport; Road TransportationDiesel	N2O	5.84	18.10	2.2	22.00	22.1	0.007	0.0002	0.0004	0.01	0.00	0.01
1A3b1. EnergyA. Fuel Combustion 3. Transport; Road TransportationGasoline	N2O	137.27	111.15	2.2	50.00	50.0	0.104	-0.0008	0.0023	-0.04	0.01	0.04
1A3b1. EnergyA. Fuel Combustion 3. Transport; Road TransportationNatural Gas	N2O	0.00	0.00	56.6	56.57	80.0	0.000	0.0000	0.0000	0.00	0.00	0.00
1A3c1. EnergyA. Fuel Combustion 3. Transport; RailwaysLiquid Fuels	CH4	0.01	0.01	21.2	21.21	30.0	0.000	0.0000	0.0000	0.00	0.00	0.00
1A3c1. EnergyA. Fuel Combustion 3. Transport; Railways	CO2	28.69	37.77	2.2	0.53	2.3	0.002	0.0001	0.0008	0.00	0.00	0.00
1A3c1. EnergyA. Fuel Combustion 3. Transport; RailwaysLiquid Fuels	N2O	0.38	0.49	106.1	106.07	150.0	0.001	0.0000	0.0000	0.00	0.00	0.00
1A3d1. EnergyA. Fuel Combustion 3. Transport; NavigationGas/Diesel Oil	CH4	0.01	0.02	21.2	21.21	30.0	0.000	0.0000	0.0000	0.00	0.00	0.00
1A3d1. EnergyA. Fuel Combustion 3. Transport; NavigationGasoline	CH4	0.58	0.51	21.2	21.21	30.0	0.000	0.0000	0.0000	0.00	0.00	0.00
1A3d1. EnergyA. Fuel Combustion 3. Transport; Navigation	CO2	111.86	116.98	2.2	0.53	2.3	0.005	-0.0001	0.0024	0.00	0.01	0.01
1A3d1. EnergyA. Fuel Combustion 3. Transport; NavigationGas/Diesel Oil	N2O	0.64	0.76	106.1	106.07	150.0	0.002	0.0000	0.0000	0.00	0.00	0.00
1A3d1. EnergyA. Fuel Combustion 3. Transport; NavigationGasoline	N2O	0.60	0.53	106.1	106.07	150.0	0.001	0.0000	0.0000	0.00	0.00	0.00
1A3ei1. EnergyA. Fuel Combustion 3. Transport; Other non-specified	CH4	0.09	0.04	35.4	35.36	50.0	0.000	0.0000	0.0000	0.00	0.00	0.00
1A3ei1. EnergyA. Fuel Combustion 3. Transport; Other non-specified	CO2	49.01	48.71	3.5	3.55	5.0	0.005	-0.0001	0.0010	0.00	0.00	0.00
1A3ei1. EnergyA. Fuel Combustion 3. Transport; Other non-specified	N2O	0.03	0.03	56.6	56.57	80.0	0.000	0.0000	0.0000	0.00	0.00	0.00
1A4a1. Energy A. Fuel Combustion 4. Other Sectors; Commercial/InstitutionalBiomass	CH4	9.74	5.12	21.2	21.21	30.0	0.003	-0.0001	0.0001	0.00	0.00	0.00
1A4a1. Energy A. Fuel Combustion 4. Other Sectors; Commercial/InstitutionalGaseous Fuels	CH4	2.27	3.75	21.2	21.21	30.0	0.002	0.0000	0.0001	0.00	0.00	0.00
1A4a1. Energy A. Fuel Combustion 4. Other Sectors; Commercial/InstitutionalLiquid Fuels	CH4	2.96	1.57	21.2	21.21	30.0	0.001	0.0000	0.0000	0.00	0.00	0.00
1A4a1. Energy A. Fuel Combustion 4. Other Sectors; Commercial/InstitutionalGaseous Fuels	CO2	905.76	1'409.10	2.0	4.60	5.0	0.132	0.0087	0.0286	0.04	0.08	0.09
1A4a1. Energy A. Fuel Combustion 4. Other Sectors; Commercial/InstitutionalLiquid Fuels	CO2	4'429.39	3'607.89	2.2	0.51	2.2	0.152	-0.0243	0.0733	-0.01	0.23	0.23
1A4a1. Energy A. Fuel Combustion 4. Other Sectors; Commercial/InstitutionalBiomass	N2O	1.45	3.36	56.6	56.57	80.0	0.005	0.0000	0.0001	0.00	0.01	0.01
1A4a1. Energy A. Fuel Combustion 4. Other Sectors; Commercial/InstitutionalGaseous Fuels	N2O	0.51	0.79	56.6	56.57	80.0	0.001	0.0000	0.0000	0.00	0.00	0.00
1A4a1. Energy A. Fuel Combustion 4. Other Sectors; Commercial/InstitutionalLiquid Fuels	N2O	11.28	9.25	56.6	56.57	80.0	0.014	-0.0001	0.0002	0.00	0.02	0.02
1A4b1. Energy A. Fuel Combustion 4. Other Sectors; ResidentialBiomass	CH4	95.89	38.15	20.0	60.00	63.2	0.045	-0.0013	0.0008	-0.08	0.02	0.08
1A4b1. Energy A. Fuel Combustion 4. Other Sectors; ResidentialGaseous Fuels	CH4	3.26	6.26	21.2	21.21	30.0	0.004	0.0001	0.0001	0.00	0.00	0.00
1A4b1. Energy A. Fuel Combustion 4. Other Sectors; ResidentialLiquid Fuels	CH4	6.00	2.63	21.2	21.21	30.0	0.001	-0.0001	0.0001	0.00	0.00	0.00
1A4b1. Energy A. Fuel Combustion 4. Other Sectors; ResidentialSolid Fuels	CH4	3.71	2.28	21.2	21.21	30.0	0.001	0.0000	0.0000	0.00	0.00	0.00
1A4b1. Energy A. Fuel Combustion 4. Other Sectors; ResidentialGaseous Fuels	CO2	1'409.10	2'661.45	2.0	4.60	5.0	0.250	0.0230	0.0541	0.11	0.15	0.19
1A4b1. Energy A. Fuel Combustion 4. Other Sectors; ResidentialLiquid Fuels	CO2	10'226.25	8'688.23	2.2	0.51	2.2	0.366	-0.0487	0.1766	-0.03	0.55	0.55
1A4b1. Energy A. Fuel Combustion 4. Other Sectors; ResidentialSolid Fuels	CO2	54.59	33.60	14.5	5.00	15.4	0.010	-0.0005	0.0007	0.00	0.01	0.01
1A4b1. Energy A. Fuel Combustion 4. Other Sectors; ResidentialBiomass	N2O	10.64	9.82	56.6	56.57	80.0	0.015	0.0000	0.0002	0.00	0.02	0.02
1A4b1. Energy A. Fuel Combustion 4. Other Sectors; ResidentialGaseous Fuels	N2O	0.79	1.50	56.6	56.57	80.0	0.002	0.0000	0.0000	0.00	0.00	0.00

Table 1-15 continued. Tier 1 uncertainty results for sources in Switzerland 2010 (IPCC 2000, Table 6.1, IPCC 2003).

IPCC GPG Table 6.1
Tier 1 Uncertainty Calculation and Reporting

A	B	C	D	E	F	G	H	I	J	K	L	M
IPCC Source category	Gas	Base year emissions 1990	Year 2010 emissions	Activity data uncertainty	Emission factor uncertainty	Combined uncertainty	Combined uncertainty as % of total national emission in year t	Type A sensitivity	Type B sensitivity	Uncertainty in trend in national emissions introduced by emission factor uncertainty	Uncertainty in trend in national emissions introduced by activity data uncertainty	Uncertainty introduced into the trend in total national emissions
		Input data	Input data	Input data	Input data	Calc/Input						
		Gg CO2 eq	Gg CO2 eq	%	%	%	%	%	%	%	%	%
Total Uncertainty including LULUCF		**49'210**	**53'367**				**4.10**					**3.36**
Emissions without LULUCF												
1A4b1. Energy A. Fuel Combustion 4. Other Sectors; ResidentialLiquid Fuels	N2O	25.94	22.06	56.6	56.57	80.0	0.033	-0.0001	0.0004	-0.01	0.04	0.04
1A4b1. Energy A. Fuel Combustion 4. Other Sectors; ResidentialSolid Fuels	N2O	0.29	0.18	56.6	56.57	80.0	0.000	0.0000	0.0000	0.00	0.00	0.00
1A4c1. Energy A. Fuel Combustion 4. Other Sectors; Agriculture/ForestryBiomass	CH4	0.80	0.18	21.2	21.21	30.0	0.000	0.0000	0.0000	0.00	0.00	0.00
1A4c1. Energy A. Fuel Combustion 4. Other Sectors; Agriculture/ForestryGaseous Fuels	CH4	0.09	0.04	21.2	21.21	30.0	0.000	0.0000	0.0000	0.00	0.00	0.00
1A4c1. Energy A. Fuel Combustion 4. Other Sectors; Agriculture/ForestryLiquid Fuels	CH4	1.62	1.38	21.2	21.21	30.0	0.001	0.0000	0.0000	0.00	0.00	0.00
1A4c1. Energy A. Fuel Combustion 4. Other Sectors; Agriculture/ForestryGaseous Fuels	CO2	40.64	15.85	2.0	4.60	5.0	0.001	-0.0006	0.0003	0.00	0.00	0.00
1A4c1. Energy A. Fuel Combustion 4. Other Sectors; Agriculture/ForestryLiquid Fuels	CO2	547.00	519.96	2.2	0.53	2.3	0.022	-0.0015	0.0106	0.00	0.03	0.03
1A4c1. Energy A. Fuel Combustion 4. Other Sectors; Agriculture/ForestryBiomass	N2O	0.21	0.35	56.6	56.57	80.0	0.001	0.0000	0.0000	0.00	0.00	0.00
1A4c1. Energy A. Fuel Combustion 4. Other Sectors; Agriculture/ForestryGaseous Fuels	N2O	0.02	0.01	56.6	56.57	80.0	0.000	0.0000	0.0000	0.00	0.00	0.00
1A4c1. Energy A. Fuel Combustion 4. Other Sectors; Agriculture/ForestryLiquid Fuels	N2O	4.97	5.28	56.6	56.57	80.0	0.008	0.0000	0.0001	0.00	0.01	0.01
1A51. Energy A. Fuel Combustion 5. OtherLiquid Fuels	CH4	0.16	0.12	21.2	21.21	30.0	0.000	0.0000	0.0000	0.00	0.00	0.00
1A51. Energy A. Fuel Combustion 5. OtherLiquid Fuels	CO2	203.58	119.55	2.2	0.53	2.3	0.005	-0.0021	0.0024	0.00	0.01	0.01
1A51. Energy A. Fuel Combustion 5. OtherLiquid Fuels	N2O	2.01	1.18	106.1	106.07	150.0	0.003	0.0000	0.0000	0.00	0.00	0.00
1B21. Energy B. Fugitive Emissions from Fuels2. Oil and Natural Gas	CH4	380.43	173.85	35.4	35.36	50.0	0.163	-0.0049	0.0035	-0.17	0.18	0.25
1B21. Energy B. Fugitive Emissions from Fuels2. Oil and Natural Gas	CO2	91.36	74.04	7.1	7.07	10.0	0.014	-0.0005	0.0015	0.00	0.02	0.02
1B21. Energy B. Fugitive Emissions from Fuels2. Oil and Natural Gas	N2O	0.00	0.00	56.6	56.57	80.0	0.000	0.0000	0.0000	0.00	0.00	0.00
2A12. Industrial Proc.A. Mineral Products; Cement Production-CO2	CO2	2'524.77	1'928.12	2.0	40.00	40.0	1.447	-0.0165	0.0392	-0.66	0.11	0.67
2A22. Industrial Proc.A. Mineral Products; Lime Production-CO2	CO2	53.35	54.23	1.4	1.41	2.0	0.002	-0.0001	0.0011	0.00	0.00	0.00
2A32. Industrial Proc.A. Mineral Products; Limestone and Dolomite Use, Emissions, CO2	CO2	103.25	72.39	10.0	50.00	51.0	0.069	-0.0008	0.0015	-0.04	0.02	0.05
2A72. Industrial Proc.A. Mineral Products; Other non-specified-CO2	CO2	15.12	5.93	1.4	1.41	2.0	0.000	-0.0002	0.0001	0.00	0.00	0.00
2B1. Industrial Proc.B. Chemical Industry	CH4	9.63	8.39	21.2	21.21	30.0	0.005	0.0000	0.0002	0.00	0.01	0.01
2B2. Industrial Proc.B. Chemical Industry	CO2	109.80	121.41	7.1	7.07	10.0	0.023	0.0000	0.0025	0.00	0.02	0.02
2B2. Industrial Proc.B. Chemical Industry	N2O	68.13	60.26	29.0	28.99	41.0	0.046	-0.0003	0.0012	-0.01	0.05	0.05
2C2. Industrial Proc.C. Metal Production; Aluminium Foundries	SF6	0.00	4.88	14.1	14.14	20.0	0.002	0.0001	0.0001	0.00	0.00	0.00
2C2. Industrial Proc.C. Metal Production; Magnesium Foundries	SF6	0.00	29.66	14.1	14.14	20.0	0.011	0.0006	0.0006	0.01	0.01	0.01
2C12. Industrial Proc.C. Metal Production; Steel Production	CO2	110.80	170.57	5.0	40.00	40.3	0.129	0.0010	0.0035	0.04	0.02	0.05
2C32. Industrial Proc.C. Metal Production; Aluminium Production-CO2	CO2	139.26	0.00	7.1	7.07	10.0	0.000	-0.0031	0.0000	-0.02	0.00	0.02
2C32. Industrial Proc.C. Metal Production; Aluminium Production-PFC	PFC	100.17	0.00	13.0	13.01	18.4	0.000	-0.0022	0.0000	-0.03	0.00	0.03
2C52. Industrial Proc.C. Metal Production; Non-ferrous metals-CO2	CO2	1.65	1.85	7.1	7.07	10.0	0.000	0.0000	0.0000	0.00	0.00	0.00
2F12. Industrial Proc.F. Consumption of Halocarbons and SF6; Refrig. & AC Eq.	HFC	0.02	1'011.69	8.5	8.49	12.0	0.227	0.0206	0.0206	0.17	0.25	0.30
2F12. Industrial Proc.F. Consumption of Halocarbons and SF6; Refrigeration	PFC	0.04	7.43	8.5	8.49	12.0	0.002	0.0002	0.0002	0.00	0.00	0.00
2F22. Industrial Proc.F. Consumption of Halocarbons and SF6; Hard Foam	HFC	0.00	13.59	34.6	34.65	49.0	0.012	0.0003	0.0003	0.01	0.01	0.02
2F42. Industrial Proc.F. Consumption of Halocarbons and SF6; Metered Dose Inhalers and Othe	HFC	0.00	14.71	7.8	7.78	11.0	0.003	0.0003	0.0003	0.00	0.00	0.00
2F52. Industrial Proc.F. Consumption of Halocarbons and SF6; Solvents	HFC	0.00	2.37	1.4	1.41	2.0	0.000	0.0000	0.0000	0.00	0.00	0.00
2F52. Industrial Proc.F. Consumption of Halocarbons and SF6; Solvents	PFC	0.00	7.88	1.4	1.41	2.0	0.000	0.0002	0.0002	0.00	0.00	0.00
2F72. Industrial Proc.F. Consumption of Halocarbons and SF6; Semiconductor Manufacture	PFC	0.00	6.63	28.3	28.28	40.0	0.005	0.0001	0.0001	0.00	0.01	0.01
2F92. Industrial Proc.F. Consumption of Halocarbons and SF6; Other	PFC	0.00	14.56	28.3	28.28	40.0	0.011	0.0003	0.0003	0.01	0.01	0.01
2F72. Industrial Proc.F. Consumption of Halocarbons and SF6; Semiconductor Manufacture	SF6	0.00	6.99	28.3	28.28	40.0	0.005	0.0001	0.0001	0.00	0.01	0.01
2F82. Industrial Proc.F. Consumption of Halocarbons and SF6; Electrical Eq.	SF6	64.04	62.47	7.1	7.07	10.0	0.012	-0.0001	0.0013	0.00	0.01	0.01
2F92. Industrial Proc.F. Consumption of Halocarbons and SF6; Other	HFC	0.00	30.62	56.6	56.57	80.0	0.046	0.0006	0.0006	0.04	0.05	0.06
2F42. Industrial Proc.F. Consumption of Halocarbons and SF6; Metered Dose Inhalers and Othe	PFC	0.00	0.00	56.6	56.57	80.0	0.000	0.0000	0.0000	0.00	0.00	0.00
2F92. Industrial Proc.F. Consumption of Halocarbons and SF6; Other	SF6	79.58	51.12	56.6	56.57	80.0	0.077	-0.0007	0.0010	-0.04	0.08	0.09
2G2. Industrial Proc.G. Other	CO2	1.04	0.96	7.1	7.07	10.0	0.000	0.0000	0.0000	0.00	0.00	0.00
3 3. Solvent and Other Product Use	CO2	361.92	157.23	35.4	35.36	50.0	0.147	-0.0048	0.0032	-0.17	0.16	0.23
3 3. Solvent and Other Product Use	N2O	110.14	57.33	56.6	56.57	80.0	0.086	-0.0013	0.0012	-0.07	0.09	0.12
4A4. AgricultureA. Enteric Fermentation	CH4	2'657.35	2'537.97	6.4	17.20	18.4	0.873	-0.0070	0.0516	-0.12	0.47	0.48
4B4. AgricultureB. Manure Management	CH4	672.00	645.25	6.4	54.10	54.5	0.659	-0.0017	0.0131	-0.09	0.12	0.15
4B4. AgricultureB. Manure Management	N2O	453.87	323.52	29.9	65.30	71.8	0.435	-0.0034	0.0066	-0.22	0.28	0.36
4D14. AgricultureD. Agricultural Soils; Direct Soil Emissions	N2O	1'364.15	1'189.21	20.4	80.63	83.2	1.853	-0.0059	0.0242	-0.48	0.70	0.84
4D24. AgricultureD. Agricultural Soils; Pasture, Range and Paddock Manure	N2O	128.10	245.40	57.3	62.50	84.8	0.390	0.0022	0.0050	0.14	0.40	0.43
4D34. AgricultureD. Agricultural Soils; Indirect Emissions	N2O	820.73	710.51	31.8	163.00	166.1	2.211	-0.0036	0.0144	-0.59	0.65	0.88
4D44. AgricultureD. Agricultural Soils; Use of sewage sludge as fertilizers	N2O	28.19	22.56	8.1	80.00	80.4	0.034	-0.0002	0.0005	-0.01	0.01	0.01
4F4. AgricultureF. Field Burning of Agricultural Residues	CH4	10.00	10.00	42.4	42.43	60.0	0.011	0.0000	0.0002	0.00	0.01	0.01
4F4. AgricultureF. Field Burning of Agricultural Residues	N2O	3.91	3.91	106.1	106.07	150.0	0.011	0.0000	0.0001	0.00	0.01	0.01
6A6. Waste A. Solid Waste Disposal on Land	CH4	688.16	198.00	30.0	50.00	58.3	0.216	-0.0111	0.0040	-0.56	0.17	0.58
6A6. Waste A. Solid Waste Disposal on Land	CO2	9.24	0.00	7.1	7.07	10.0	0.000	-0.0002	0.0000	0.00	0.00	0.00
6B6. Waste B. Wastewater Handling	CH4	4.65	45.90	21.2	21.21	30.0	0.026	0.0008	0.0009	0.02	0.03	0.03
6B6. Waste B. Wastewater Handling	N2O	184.72	208.89	28.3	28.28	40.0	0.157	0.0002	0.0042	0.00	0.17	0.17
6C6. Waste C. Waste Incineration	CH4	4.25	2.80	42.4	42.43	60.0	0.003	0.0000	0.0001	0.00	0.00	0.00
6C6. Waste C. Waste Incineration	CO2	54.10	10.68	28.3	28.28	40.0	0.008	-0.0010	0.0002	-0.03	0.01	0.03
6C6. Waste C. Waste Incineration	N2O	16.20	25.90	28.3	28.28	40.0	0.019	0.0002	0.0005	0.00	0.02	0.02
6D6. Waste D. Other	CH4	27.44	95.23	10.0	100.00	100.5	0.179	0.0013	0.0019	0.13	0.03	0.14
6D6. Waste D. Other	CO2	0.00	0.00	7.1	7.07	10.0	0.000	0.0000	0.0000	0.00	0.00	0.00
6D6. Waste D. Other	N2O	5.82	24.15	56.6	56.57	80.0	0.036	0.0004	0.0005	0.02	0.04	0.04
77. Other	CH4	0.55	0.58	42.4	42.43	60.0	0.001	0.0000	0.0000	0.00	0.00	0.00
77. Other	CO2	10.96	13.02	28.3	28.28	40.0	0.010	0.0000	0.0003	0.00	0.01	0.01
77. Other	N2O	16.72	13.63	91.9	91.92	130.0	0.033	-0.0001	0.0003	-0.01	0.04	0.04
LULUCF												
5A15. LULUCFA. Forest Land1. Forest Land remaining Forest Land	CH4	8.19	0.19	10.0	70.00	70.7	0.000	-0.0002	0.0000	-0.01	0.00	0.01
5A15. LULUCFA. Forest Land1. Forest Land remaining Forest LandBiomass Burning, Wildfires	CO2	30.07	0.68	43.0	43.01	60.8	0.001	-0.0006	0.0000	-0.03	0.00	0.03
5A15. LULUCFA. Forest Land1. Forest Land remaining Forest Land	CO2	-3'771.35	-945.76	5.0	36.00	36.3	-0.644	0.0639	-0.0192	2.30	-0.14	2.31
5A15. LULUCFA. Forest Land1. Forest Land remaining Forest Land	N2O	5.30	0.12	10.0	70.00	70.7	0.000	-0.0001	0.0000	-0.01	0.00	0.01
5A25. LULUCFA. Forest Land2. Land converted to Forest Land	CO2	-1'306.70	-1'205.09	24.0	36.00	43.3	-0.977	0.0043	-0.0245	0.16	-0.83	0.85
5B15. LULUCFB. Cropland1. Cropland remaining Cropland	CO2	435.28	425.31	30.0	25.00	39.1	0.311	-0.0009	0.0086	-0.02	0.37	0.37
5B25. LULUCFB. Cropland2. Land converted to Cropland	CO2	47.04	27.07	10.0	50.00	51.0	0.026	-0.0005	0.0006	-0.02	0.01	0.03
5B25. LULUCFB. Cropland2. Land converted to Cropland	N2O	6.14	4.38	10.0	90.00	90.6	0.007	0.0000	0.0001	0.00	0.00	0.00
5C15. LULUCFC. Grassland1. Grassland remaining Grassland	CO2	146.77	163.58	10.0	50.00	51.0	0.156	0.0001	0.0033	0.00	0.05	0.05
5C25. LULUCFC. Grassland2. Land converted to Grassland	CO2	74.60	172.45	11.0	50.00	51.2	0.165	0.0019	0.0035	0.09	0.05	0.11
5D15. LULUCFD. Wetlands1. Wetlands remaining Wetlands	CO2	-2.79	-0.42	30.0	100.00	104.4	-0.001	0.0001	0.0000	0.01	0.00	0.01
5D25. LULUCFD. Wetlands2. Land converted to Wetlands	CO2	19.81	27.69	8.0	50.00	50.6	0.026	0.0001	0.0006	0.01	0.01	0.01
5E15. LULUCFE. Settlements1. Settlements remaining Settlements	CO2	0.57	30.44	11.0	50.00	51.2	0.029	0.0006	0.0006	0.03	0.01	0.03
5E25. LULUCFE. Settlements2. Land converted to Settlements	CO2	361.84	297.07	11.0	50.00	51.2	0.285	-0.0019	0.0060	-0.10	0.09	0.13
5F25. LULUCFF. Other Land2. Land converted to Other Land	CO2	97.88	121.89	13.0	50.00	51.7	0.118	0.0003	0.0025	0.02	0.05	0.05

Table 1-15 continued. Tier 1 uncertainty results for sources in Switzerland 2010 (IPCC 2000, Table 6.1, IPCC 2003).

Table 6.1 (CONTINUED)
Tier 1 Uncertainty Calculation and Reporting

A (continued)					B	N	O	P	Q
IPCC Source category					Gas	Emission factor quality indicator IPCC Default, Measurement based, national Referenced data	Activity data quality indicator IPCC Default, Measurement based, national Referenced data	Expert judgement reference numbers	Reference to section in NIR
1A1	1. Energy	A. Fuel Comb	1. Energy Indu	Gaseous Fue	CO2	M	D		Section 3.3.2
1A1	1. Energy	A. Fuel Comb	1. Energy Indu	Liquid Fuels	CO2	M	R		Section 3.3.2
1A1	1. Energy	A. Fuel Comb	1. Energy Indu	Other Fuels	CO2	R	R		Section 3.3.2
1A2	1. Energy	A. Fuel Comb	2. Manufactur	Gaseous Fue	CO2	M	D		Section 3.3.2
1A2	1. Energy	A. Fuel Comb	2. Manufactur	Liquid Fuels	CO2	M	R		Section 3.3.2
1A2	1. Energy	A. Fuel Comb	2. Manufactur	Solid Fuels	CO2	D	D, R		Section 3.3.2
1A2	1. Energy	A. Fuel Comb	2. Manufactur	Other Fuels	CO2	R	R		Section 3.3.2
1A3a	1. Energy	A. Fuel Comb	3. Transport;	Civil Aviation	CO2	M	R		Section 3.3.2
1A3b	1. Energy	A. Fuel Comb	3. Transport; I	Diesel	CO2	M	R		Section 3.3.2
1A3b	1. Energy	A. Fuel Comb	3. Transport; I	Gasoline	CO2	M	R		Section 3.3.2
1A4a	1. Energy	A. Fuel Comb	4. Other Secto	Gaseous Fue	CO2	M	D		Section 3.3.2
1A4a	1. Energy	A. Fuel Comb	4. Other Secto	Liquid Fuels	CO2	M	R		Section 3.3.2
1A4b	1. Energy	A. Fuel Comb	4. Other Secto	Gaseous Fue	CO2	M	D		Section 3.3.2
1A4b	1. Energy	A. Fuel Comb	4. Other Secto	Liquid Fuels	CO2	M	R		Section 3.3.2
1A4c	1. Energy	A. Fuel Comb	4. Other Secto	Liquid Fuels	CO2	M	R		Section 3.3.2
1A5	1. Energy	A. Fuel Comb	5. Other	Liquid and Ga	CO2	M	R		Section 3.3.2
1A1	1. Energy	A. Fuel Comb	1. Energy Ind.	Other Fuels	N2O	R	R		Section 3.3.2
1A3b	1. Energy	A. Fuel Comb	3b. Road Trar	Gasoline	CH4	R	R		Section 3.3.2
1B2	1. Energy	B. Fugitive En	2. Oil and Natural Gas		CH4	D	D		Section 3.4.3
2A1	2. Industrial P	A. Mineral Products; Cement Production-C			CO2	D	D		Section 4.2.3
2B	2. Industrial P	B. Chemical Industry			N2O	R	R		Section 4.3.3
2C_o	2. Industrial P	C. Metal Production without Aluminium Pro			CO2	R	R		Section 4.4.3
2F	2. Industrial P	F. Consumption of Halocarbons and SF6			PFC	R	R		Section 4.7.3
2F1	2. Industrial P	F. Consumption of Halocarbons and SF6;			HFC	R	R		Section 4.7.3
3	3. Solvent and Other Product Use				CO2	R	R		Section 5.2.3
4A	4. Agriculture	A. Enteric Fermentation			CH4	R	R		Section 6.2.3
4B	4. Agriculture	B. Manure Management			CH4	R	R		Section 6.3.3
4B	4. Agriculture	B. Manure Management			N2O	D	R		Section 6.3.3
4D_o	4. Agriculture	D. Agricultural Soils without 4D1-N2O & 4D			N2O	D	R		Section 6.5.3
4D1	4. Agriculture	D. Agricultural Soils; Direct Soil Emissions			N2O	D	R		Section 6.5.3
4D3	4. Agriculture	D. Agricultural Soils; Indirect Emissions			N2O	D	R		Section 6.5.3
5A1	5. LULUCF	A. Forest Lan	1. Forest Land remaining Fo		CO2	R	R		Section 7.3.5
5A2	5. LULUCF	A. Forest Lan	2. Land converted to Forest		CO2	R	R		Section 7.3.5
5B1	5. LULUCF	B. Cropland	1. Cropland remaining Cropl		CO2	M	R		Section 7.4.5
5E2	5. LULUCF	E. Settlement	2. Land converted to Settlem		CO2	R	R		Section 7.7.5
6A	6. Waste	A. Solid Waste Disposal on Land			CH4	R	R		Section 8.2.3
6B	6. Waste	B. Wastewater Handling			N2O	R	R		Section 8.3.3
6D	6. Waste	D. Other			CH4	R	R		Section 8.5.3
	Rest of sources				CO2	R	R		Exp. est.

1.7.1.5 Results of Tier 2 Uncertainty Evaluation (Monte Carlo)

A Tier 2 uncertainty analysis for Switzerland's GHG Inventory is carried out for the actual inventory and contains a level uncertainty for 2010 and a trend uncertainty for the period 1990-2010.

The principle of the Tier 2 methodology Monte Carlo analysis is to select random values for emission factor and activity data from within their individual probability distributions, and to calculate the corresponding emission values. This procedure is repeated until an adequately stable result has been found. The results of all iterations yield the overall emission probability distribution. In the analysis shown here, Monte Carlo simulations were performed to estimate uncertainties both in emissions and in emission trends, at the source category level as well as for the inventory as a whole. The simulations were run with the commercial software package Crystal Ball (® Oracle). This tool generates random numbers within user-defined probability ranges and probability distributions. As a result, selected statistics are produced for the forecast variables.

a) Uncertainty in emissions

For Tier 2 analysis the exact same source categories and the same uncertainty estimates are used as in Tier 1 analysis.

As a first step, the shape and extent of the probability distributions were derived for the activity data and emission factors, based on measured data, literature or expert judgement. The mean value of the probability distributions was set equal to the value of the GHG inventory. In most cases, normal distributions were assumed. However, for data with a high level of uncertainty, normal distribution would allow negative emissions. For these cases, triangular distributions were used (see Annex 7.2.2). The triangular distributions are positively skewed and produce only positive values, while the upper bound of emissions may be poorly known.

As a second step, emissions were calculated from emission factors multiplied by the corresponding activity data. For those cases where the activity data or emission factor for a specific source category were not available, emissions were modelled directly with the mean value set equal to the value of the GHG inventory and an adequate probability distribution of the emissions.

The Monte Carlo simulation then provided information on the simulated distribution of every single source category and its statistical characteristics (e.g. the corresponding 2.5 and 97.5 percentiles) as well as on the uncertainty of the national total emissions 2010 and base year 1990 (and its statistical characteristics) as well as on the trend uncertainty 1990–2010.

b) Dependent uncertainties

Uncertainties that are dependent on one another (correlations) may have a significant effect on the overall inventory uncertainty.

Special care was taken when deriving the correlations of the source categories of 1A Energy – fuel combustion. In this sector, the uncertainty of the total source category per fuel type is well known, whereas the uncertainty of the sub-categories is not known. According to rules of error propagation, the uncertainty of each subcategory is larger (on the relative level) than the uncertainty of the total. To account for this fact, (negative) correlations between the different fuel activity data were introduced as the uncertainty estimates for the different fuels used are valid only for the total of the respective fuel use in Switzerland.

Further correlations between activity data and emission factors in the agricultural sector and between various other emission factors are included (see Annex 7.2.2.).

Correlations between 1990 and 2010 are also accounted for (see Chapter below).

Note that the setting of correlation coefficients may lead to inconsistencies in the Monte Carlo simulation. In those cases, Crystal Ball software automatically adjusts the corresponding correlation coefficients and sends a message to the user.

Correlation coefficients had to be chosen on a semi-quantitative basis. The following assumptions were made for the coefficients

- very weak correlations: ± 0.2
- weak correlations: ± 0.4
- medium correlations: ± 0.6
- strong correlations: ± 0.8
- perfect correlations: ± 1

c) Uncertainty in emission trends

The trend is defined as the difference between the base year and the year of interest (2010). Hence for estimation of the uncertainty in the emission trends, the Monte Carlo simulation was run for the year 2010 and for the base year 1990. The trend was then derived for the source categories as well as for the total emissions. It was assumed that the activity data of 1990 are positively correlated with the activity data of 2010 (weak correlation coefficients 0.4). Furthermore, the emission factors of the two years are assumed to be positively correlated (strong correlation coefficient 0.8). The probability distributions of the 1990 data are assumed to be of equal shape as the distributions derived for 2010.

d) Results

d1) Results: Uncertainties of national total emissions excluding LULUCF in 2010 and of trend 1990–2010

The Monte Carlo simulations reveal that the uncertainty distribution of the total emissions for 2010 (year t) is slightly narrower than the distribution for the base year 1990. Due to the higher emissions in 2010, it is shifted towards higher mean emissions (see Figure below). The detailed uncertainty estimates as derived from the Monte Carlo simulations are shown in Table A-47.

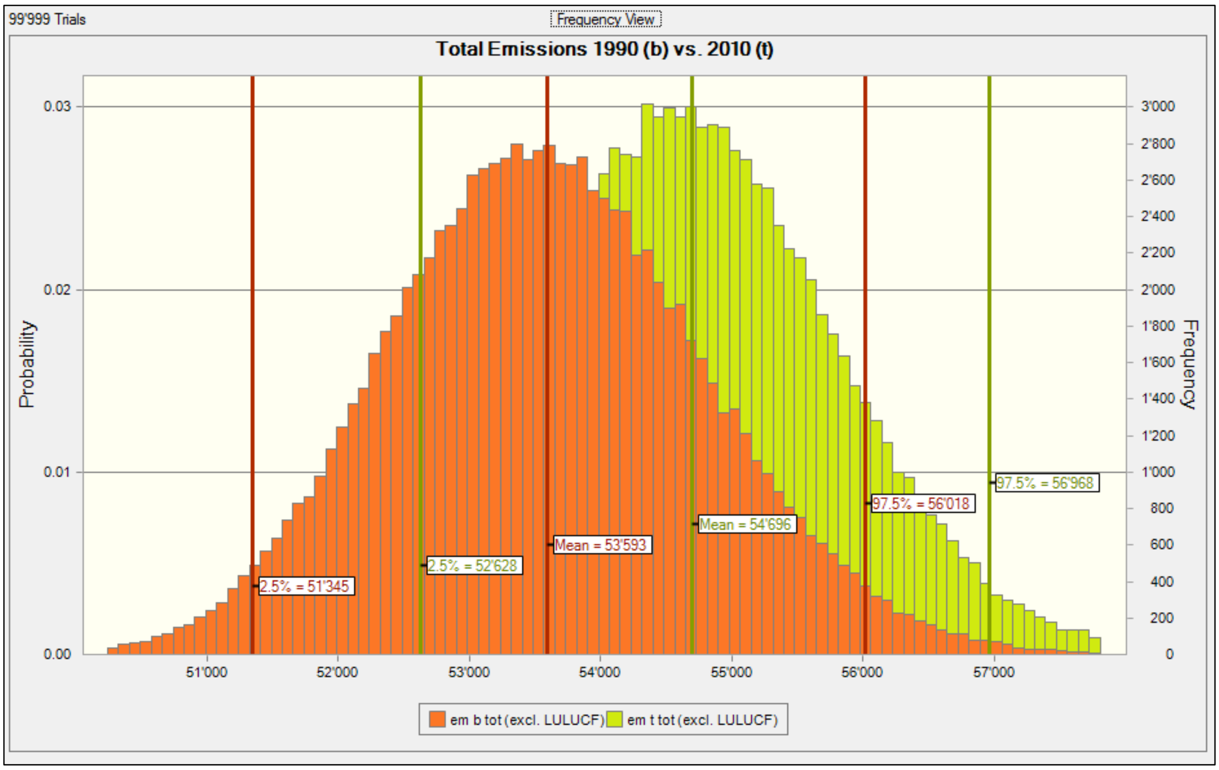

Figure 1-4 Probability distributions of total emissions for the base year (1990, in orange) and for year t (2010, in green). On the x-axis, the total emissions reported in the Swiss inventory (excluding LULUCF) are given in Gg CO_2 equivalent. Number of Monte Carlo runs: 99'999. The vertical lines show simulated mean values (Mean) and the 2.5 and 97.5 percentile values. Note that mean and percentile values correspond to the simulated values and differ slightly from the reported inventory values. For the transformation, see Table A-47 in Annex A7.2.3.

The main results of the Monte Carlo simulation are
(further results of Tier 2 Level and Trend analysis are shown in Annex 7.2)

- The total **level uncertainty** of the 2010 Swiss emissions is **3.97%** of the total GHG emissions excluding LULUCF. The 95% confidence interval is almost symmetric and lies between **96.2% and 104.2%** of the total GHG emissions.
- The **trend uncertainty** of the 2.24% increase of total emissions excluding LULUCF between 1990 and 2010 is **3.2%.** With a probability of 95%, the change lies within the range of -1.19% to +5.27%,

Taking into account the correlations in Tier 2 analysis between activity data and between emission factors leads to a slight increase in the overall level uncertainty of the GHG emissions compared to Tier 1 analysis.

d2) Results: Uncertainties including LULUCF

Like in Tier 1 uncertainty analysis, the LULUCF categories are also included for the Tier 2 uncertainty analysis. The total emissions of sector 5 LULUCF categories equal -880 Gg CO_2 eq, increasing the overall level uncertainty by 0.27%. Thus **level uncertainty for 2010 including LULUCF is 4.23%.**

The trend uncertainty of the national total emissions is increased by the inclusion of LULUCF by 1.16%. **Trend uncertainty including LULUCF amounts to 4.36%.**

d3) Results: Uncertainties by gas

For the uncertainties by gas, the Monte Carlo simulation provides results shown in the table below. The relative uncertainty of CO_2 is very low in accordance with the high precision of fuel statistics and carbon contents of fuels. CH_4 and F-gases have medium uncertainties while N_2O has the highest uncertainty in relative and absolute terms.

Table 1-16 Uncertainties by gas 2010

Gas	**Emissions 2010 (excl. LULUCF)** Gg CO2 eq	**Lower bound 2.5 percentile** Gg CO2 eq	**Upper bound 97.5 percentile** Gg CO2 eq	**Mean absolute uncertainty** Gg CO2 eq	**Mean relative uncertainty** %
CO2	45'963	44'729	47'217	1'244	3%
CH4	3'816	3'124	4'515	696	18%
N2O	3'204	2'210	5'443	1'616	44%
HFC	1'073	949	1'197	124	12%
PFC	37	30	43	6	18%
SF6	155	113	197	42	27%
Total	**54'247**	**52'628**	**56'968**	**2'170**	**3.97%**

e) Tornado Diagram

The following chart shows the results of a sensitivity analysis, depicting the most important sources of uncertainty including LULUCF. This can either be a single EF, AD or emissions as a total. The bars depict the amount of uncertainty introduced compared to total emissions (on x-axis).

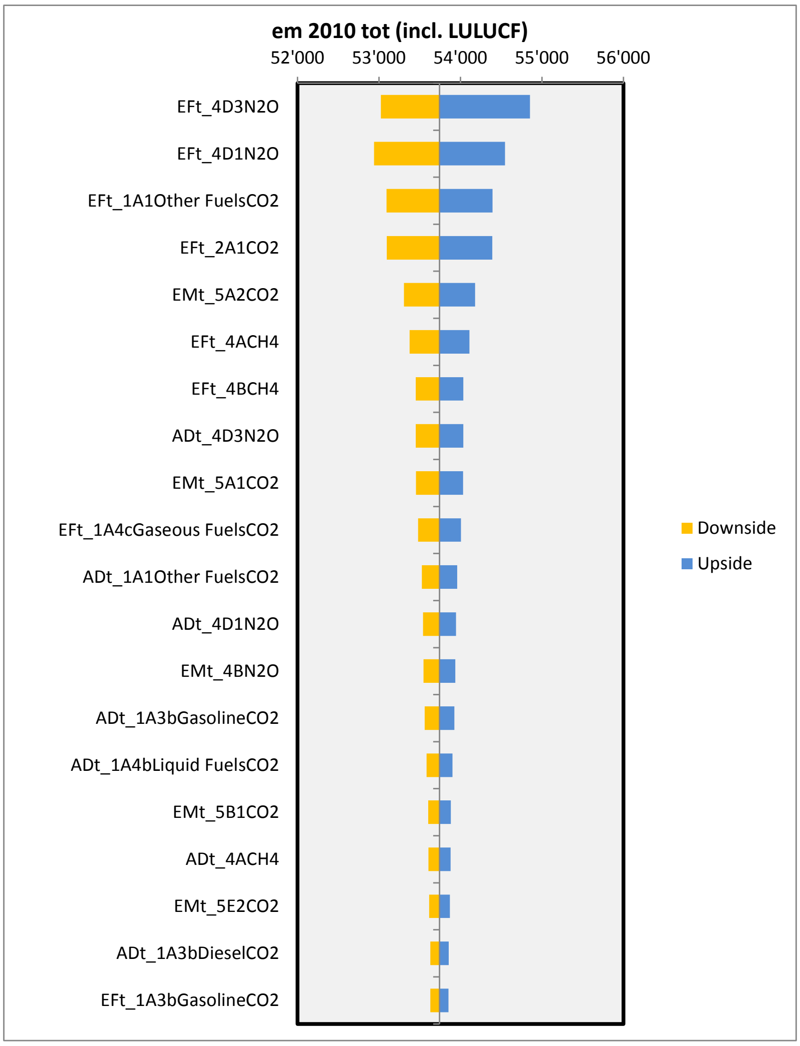

Figure 1-5 Most important sources of uncertainty in 2010 (incl. LULUCF). The bars depict the amount of uncertainty introduced compared to total emissions on x-axis. (The letter “t” in the abbreviation of the sources indicates year t –2010 in the current submission – to distinguish from the base year 0.)

1.7.1.6 Comparison of Tier 1 and Tier 2 Results

In the GHG inventory, some of the uncertainties may become large and their statistical distribution may clearly deviate from normal distributions. Tier 1 uncertainty analysis is based on simple error propagation, which assumes only small and normally distributed uncertainties. The application of the Tier 1 method is therefore not the optimal instrument for determining the uncertainties of a GHG inventory. The more appropriate choice is the Monte Carlo simulation, which is designed for uncertainties of any shape, for any size of uncertainties, any correlated variables and which is recommended by the IPCC Good Practice Guidance (IPCC 2000) as the Tier 2 method. The results of the Monte Carlo simulation are therefore considered to provide a more realistic picture of the uncertainties than the results of the Tier 1 method.

Results from Tier 1 and Tier 2 analysis are fully comparable as they are based on the same categories with the same uncertainty estimates for each of the categories.

The Tier 2 overall level uncertainty of 3.97% for 2010 emissions (excluding LULUCF) is somewhat larger than the 3.84% of the Tier 1 uncertainty analysis.
For the overall trend uncertainty (excl. LULUCF), the Tier 2 result of 3.2% is significantly higher than Tier 1 level uncertainty of 2.0%.

The differences between Tier 1 and Tier 2 analyses arise to the following reasons: The Monte Carlo simulation produces different results as it treats large uncertainties correctly and accounts for other than normal distributions. Furthermore, the correlations between activity data and between emission factors are considered, which is not the case in the Tier 1 analysis. As shown above, the correlations lead to an overall expansion of the uncertainty, especially in trend analysis due to the consideration of correlations in time. Setting the correlations to zero and using normal distributions only, the Tier 2 level uncertainty is identical to Tier 1 level uncertainty.

1.7.2 KP-LULUCF Inventory

Uncertainty estimates for KP-LULUCF activities are presented in chapter 11.3.1.5.

1.8 Completeness Assessment

1.8.1 GHG Inventory

For all known sources, complete estimates are accomplished for all gases. Based on current knowledge, the Swiss inventory under the UNFCCC is complete.

1.8.2 KP-LULUCF Inventory

For all known sources and sinks, complete estimates are accomplished for the current submission. The Swiss LULUCF inventory under the Kyoto Protocol is complete.

2 Trends in Greenhouse Gas Emissions and Removals

This chapter gives an overview of Switzerland's GHG emissions/removals and trends for the period 1990–2010. Numbers in the chapters 2.1-2.4 are relevant for reporting under the UNFCCC, whereas numbers in chapter 2.5 refer to accounting under the KP.

2.1 Aggregated Greenhouse Gas Emissions 2010 (UNFCCC)

In 2010, Switzerland emitted 54'247 Gg CO_2 equivalent (excluding LULUCF) to the atmosphere or 6.89 tonnes CO_2 equivalent per capita (inhabitants 2010: 7.87 million, (SFSO 2011a). The largest contributor gas was CO_2, 45'963 Gg (5.84 tonnes per capita), and the most important source was sector 1 Energy, 44'017 Gg CO_2 equivalent. Table 2-1 shows emissions by gas and sector in Switzerland for the year 2010. A breakdown of Switzerland's total emissions by gas (excluding LULUCF) is given in Figure 2-1. Figure 2-2 charts the relative contributions of the individual sectors (excluding LULUCF) to the emission of each GHG.

Table 2-1 Switzerland's GHG emissions in CO_2 equivalent (Gg) by gas and sector in 2010.

Emissions 2010	**CO_2**	**CH_4**	**N_2O**	**HFCs**	**PFCs**	**SF_6**	**Total**	**Share**
	CO_2 equivalent (Gg)							
1 Energy	43'426	271	319				44'017	81.1%
2 Industrial Processes	2'355	8	60	1'073	37	155	3'689	6.8%
3 Solvent an Other Product Use	157	0	57				215	0.4%
4 Agriculture	0	3'193	2'495				5'688	10.5%
6 Waste	11	342	259				612	1.1%
7 Other	13	1	14				27	0.1%
Total (excluding LULUCF)	45'963	3'816	3'204	1'073	37	155	54'247	100.0%
5 LULUCF	-885	0	5				-880	-1.6%
Total (including LULUCF)	45'078	3'816	3'209	1'073	37	155	53'367	98.4%
International Aviation Bunkers	4'254	1	41.44				*4'297*	
International Marine Bunkers	33	0.0056	0.323				*33*	

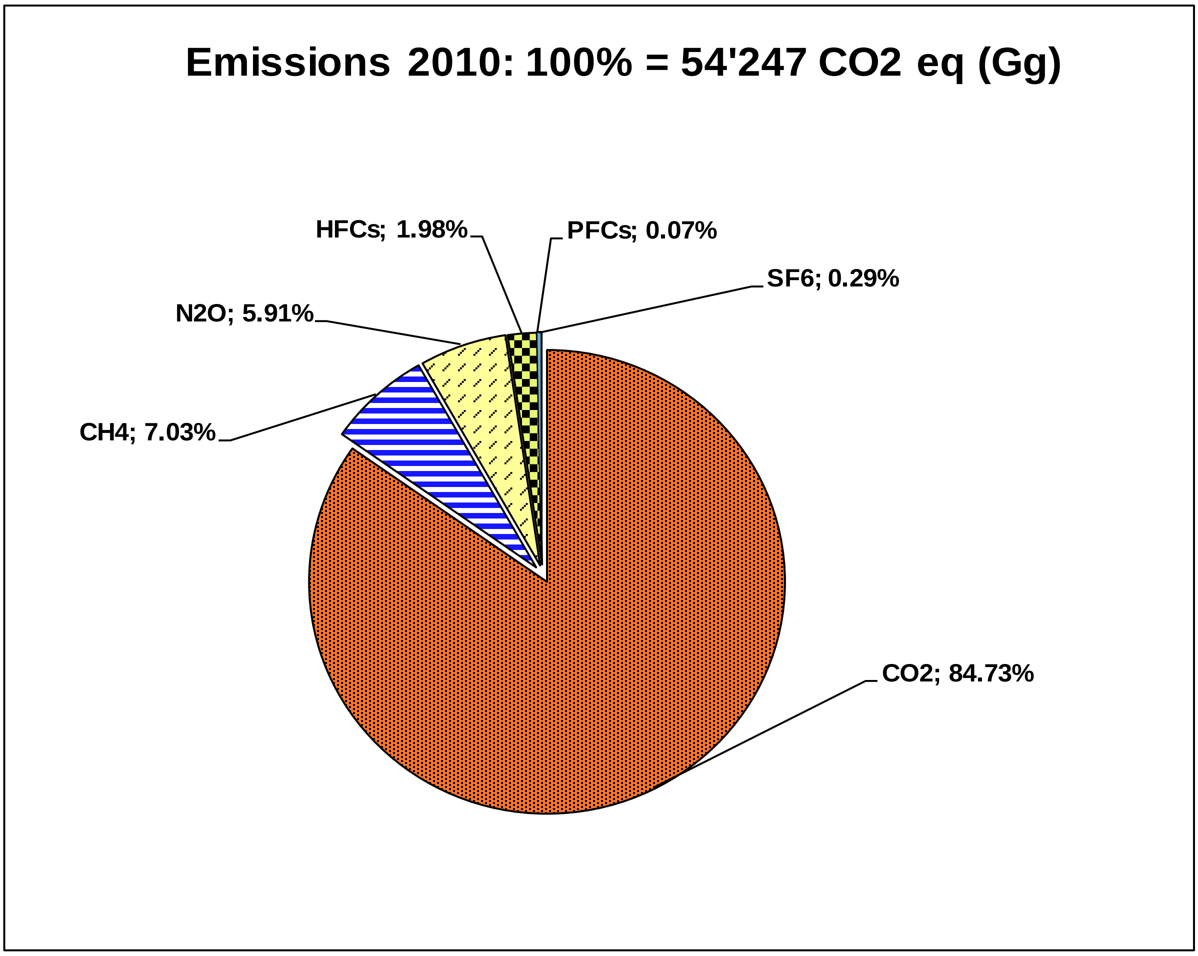

Figure 2-1 Contribution of individual gases to Switzerland's GHG emissions (excluding LULUCF) in 2010. 100% correspond to 54'247 CO_2 eq (Gg).

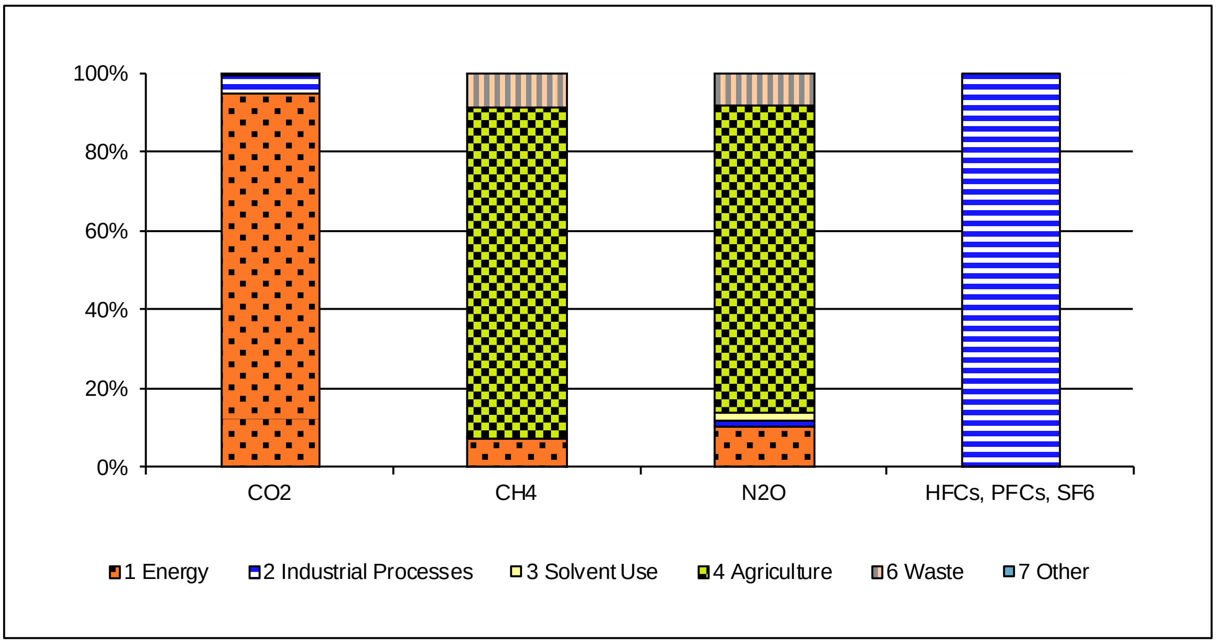

Figure 2-2 Relative contributions of the individual sectors (excluding LULUCF) to GHG emissions in 2010.

Fuel combustion within the energy sector was by far the largest source of emissions of CO_2 in 2010. Emissions of CH_4 and N_2O originated mainly from agriculture, and the F-gas emissions stemmed by definition from industrial processes.

2.2 Emission Trends by Gas

Emission trends by gas for the period 1990–2010 are summarized in Table 2-2.

Table 2-2 Switzerland's GHG emissions in CO_2 equivalent (Gg) by gas; 1990–2010 (corresponds to CRF table 10s5/10s5.2, upper half). The column below on the far right (digits in italics) indicates the percentage change in emissions in 2010 as compared to the base year 1990. HFCs increased by 47'627% when compared to 1990 levels.

Greenhouse Gas Emissions	**1990**	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**
	CO_2 equivalent (Gg)									
CO_2 emissions including net CO_2 from LULUCF	40'764	42'622	43'055	38'813	37'187	38'714	39'742	40'254	41'636	43'087
CO_2 emissions excluding net CO_2 from LULUCF	44'631	46'353	46'245	43'717	42'979	43'357	44'223	43'472	44'702	44'986
CH_4 emissions including CH_4 from LULUCF	4'707	4'668	4'530	4'391	4'307	4'301	4'210	4'114	4'065	4'001
CH_4 emissions excluding CH_4 from LULUCF	4'699	4'667	4'530	4'391	4'305	4'298	4'208	4'102	4'063	4'001
N_2O emissions including N_2O from LULUCF	3'495	3'482	3'450	3'385	3'361	3'330	3'329	3'221	3'215	3'190
N_2O emissions excluding N_2O from LULUCF	3'484	3'476	3'444	3'379	3'353	3'322	3'322	3'208	3'208	3'185
HFCs	0	0	6	14	33	180	225	299	355	418
PFCs	100	85	69	30	18	15	17	20	23	36
SF_6	144	146	148	126	112	98	94	131	160	147
Total (including LULUCF)	**49'210**	**51'003**	**51'259**	**46'760**	**45'017**	**46'637**	**47'619**	**48'038**	**49'453**	**50'879**
Total (excluding LULUCF)	**53'057**	**54'726**	**54'442**	**51'657**	**50'800**	**51'269**	**52'091**	**51'232**	**52'510**	**52'773**

Greenhouse Gas Emissions	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**
	CO2 equivalent (Gg)									
CO_2 emissions including net CO_2 from LULUCF	44'280	45'579	44'431	42'774	44'046	44'489	45'346	43'144	44'688	43'153
CO_2 emissions excluding net CO_2 from LULUCF	44'032	44'873	43'974	45'067	45'637	46'354	45'915	43'923	45'460	44'257
CH_4 emissions including CH_4 from LULUCF	3'935	3'950	3'899	3'805	3'782	3'790	3'798	3'797	3'876	3'816
CH_4 emissions excluding CH_4 from LULUCF	3'934	3'950	3'896	3'800	3'782	3'790	3'797	3'795	3'876	3'816
N_2O emissions including N_2O from LULUCF	3'200	3'221	3'215	3'160	3'152	3'140	3'152	3'177	3'194	3'148
N_2O emissions excluding N_2O from LULUCF	3'194	3'215	3'208	3'152	3'147	3'136	3'147	3'171	3'189	3'143
HFCs	497	590	629	697	799	874	900	934	990	1'023
PFCs	69	45	40	57	53	33	32	29	39	35
SF_6	158	157	168	174	189	213	201	186	244	187
Total (including LULUCF)	**52'137**	**53'542**	**52'383**	**50'666**	**52'021**	**52'539**	**53'429**	**51'266**	**53'031**	**51'362**
Total (excluding LULUCF)	**51'884**	**52'831**	**51'915**	**52'948**	**53'607**	**54'398**	**53'993**	**52'038**	**53'798**	**52'461**

Greenhouse Gas Emissions	**2010**	Change baseyear to 2010 (%)
	CO2 eq.	
CO_2 emissions including net CO_2 from LULUCF	45'078	10.6%
CO_2 emissions excluding net CO_2 from LULUCF	45'963	3.0%
CH_4 emissions including CH_4 from LULUCF	3'816	-18.9%
CH_4 emissions excluding CH_4 from LULUCF	3'816	-18.8%
N_2O emissions including N_2O from LULUCF	3'209	-8.2%
N_2O emissions excluding N_2O from LULUCF	3'204	-8.0%
HFCs	1'073	see caption
PFCs	37	-63.6%
SF_6	155	8.0%
Total (including LULUCF)	**53'367**	**8.4%**
Total (excluding LULUCF)	**54'247**	**2.2%**

The emission trends for individual gases are as follows (see Table 2-2 above, Table 2-3 and Figure 2-3 below):

- Total emissions (excluding LULUCF) show a minimum of 95.7% in 1994 and a maximum of 103.1% in 1991 (100%: value of base year 1990). In 2010, the total emissions were 2.24% higher than the emissions recorded in the base year 1990. CO_2 contributed the largest share of emissions, accounting for 84.7% of the total in 2010.
- Total emissions (including LULUCF) in 2010 show an increase of 8.4% compared to the emissions recorded in the base year 1990. The net CO_2 emissions from LULUCF show considerable variability from year to year, because heavy storms in 1990 and 1999 ("Lothar") and other factors influence the wood harvesting and tree mortality rates in forests. In the period 1990-2010, wood harvesting generally increased and the growth of living biomass decreased. This led to significant reductions in net removals within the LULUCF sector.
- A comparison of CO_2 emissions with the number of heating degree days (definition is shown in footnote 3 on page 73) in the period 1990–2010 (see Figure 2-7 below) indicates a strong correlation between CO_2 emissions and winter climatic conditions.
- Between 1990 and 2010, CH_4 decreased by -18.8%, which was mainly attributable to a reduction of productive livestock that led to a reduction of emissions from enteric fermentation. Moreover, from 2000, a change in waste legislation, banning the disposal of municipal solid waste in landfills, contributed to this trend. The CH_4 share of total GHG emissions decreased from 8.9% in 1990 to 7.0% in 2010.
- In parallel to the reduction of CH_4 due to decreases in livestock populations, N_2O emissions from manure management and agricultural soils declined. Total N_2O emissions dropped by 8.0% between 1990 and 2010 and accounts now for a share of 5.9%.
- HFC emissions increased significantly due to their application as substitutes for CFCs, while PFC emissions declined by -63.6%. SF_6 emissions have shown relatively large fluctuations between 94 and 244 Gg CO_2 eq since 1990. In 2010, SF_6 emissions increased by 8.0% compared to 1990. The share of all F-gases combined rose from 0.5% in 1990 to 2.3% in 2010.

Table 2-3 Switzerland's total GHG emissions (excluding LULUCF) in CO_2 equivalent (Gg), selected years.

Greenhouse Gas Emissions	1990		1995		2000		2005		2009		2010	
(excluding LULUCF)	Gg CO_2 eq	%	Gg CO_2 eq	%	Gg CO_2 eq	%	Gg CO_2 eq	%	Gg CO_2 eq	%	Gg CO_2 eq	%
CO_2	44'631	84.1%	43'357	84.6%	44'032	84.9%	46'354	85.2%	44'257	84.4%	45'963	84.7%
CH_4	4'699	8.9%	4'298	8.4%	3'934	7.6%	3'790	7.0%	3'816	7.3%	3'816	7.0%
N_2O	3'484	6.6%	3'322	6.5%	3'194	6.2%	3'136	5.8%	3'143	6.0%	3'204	5.9%
HFCs	0	0.0%	180	0.4%	497	1.0%	874	1.6%	1'023	1.9%	1'073	2.0%
PFCs	100	0.2%	15	0.0%	69	0.1%	33	0.1%	35	0.1%	37	0.1%
SF_6	144	0.3%	98	0.2%	158	0.3%	213	0.4%	187	0.4%	155	0.3%
Total (excluding LULUCF)	**53'057**	**100%**	**51'269**	**100%**	**51'884**	**100%**	**54'398**	**100%**	**52'461**	**100%**	**54'247**	**100%**

Figure 2-3 shows Switzerland's relative GHG emission trends by gas. The base year 1990 is set to 100%.

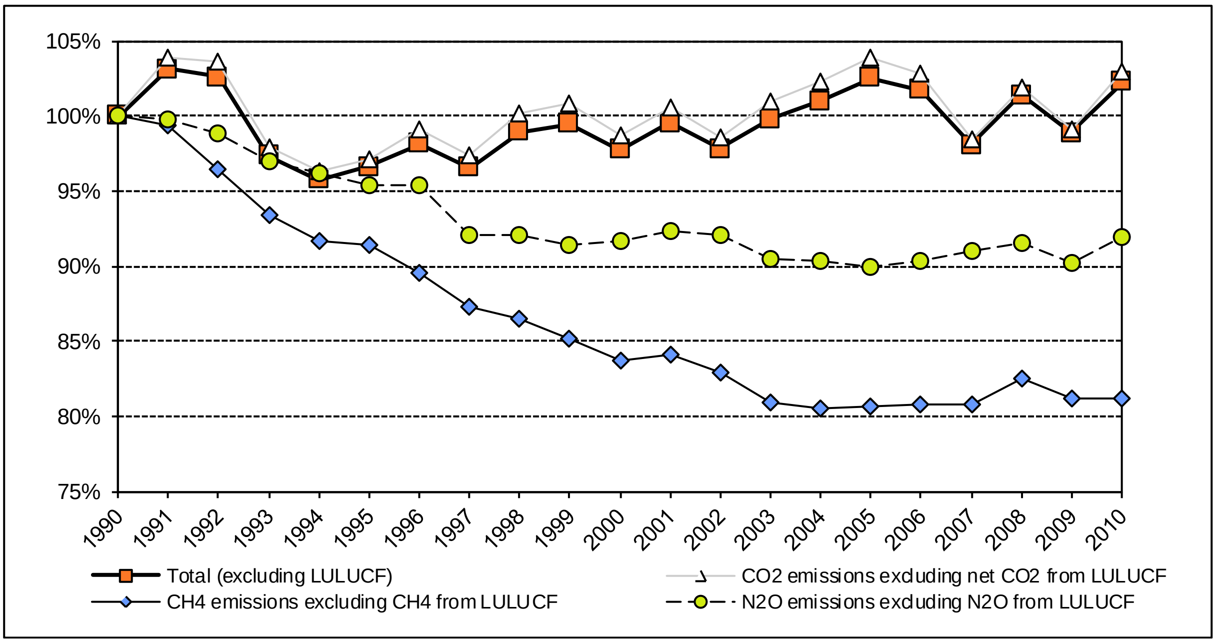

Figure 2-3 Relative trend of Switzerland's GHG emissions excluding LULUCF by gas, 1990–2010 (base year 1990: 100%). The increase of the F-gases is not shown (519 % in 2010, compared to 1990).

2.3 Emission Trends by Sources and Sinks

Table 2-4 shows the emission trends for all major sources and sink categories. As the largest share of emissions originated from the energy sector, the table also includes the contributions of the energy sub-sectors.

Table 2-4 Switzerland's GHG emissions in CO_2 equivalent (Gg) by sources and sinks, 1990–2010. The column below on the far right (digits in italics) indicates the percentage change in emissions in 2010 as compared to the base year 1990.

Source and Sink Categories	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
	CO_2 equivalent (Gg)									
1. Energy	42'043	44'122	44'134	41'823	40'917	41'486	42'529	41'940	43'184	43'453
1A1 Energy Industries	2'548	2'831	2'917	2'569	2'594	2'624	2'834	2'797	3'121	3'158
1A2 Manufacturing Industries and Construction	6'407	6'395	6'118	5'993	6'091	5'877	5'897	5'946	6'104	6'094
1A3 Transport	14'616	15'086	15'400	14'327	14'519	14'207	14'265	14'822	15'043	15'653
1A4 Other Sectors	17'795	19'153	19'088	18'363	17'172	18'282	19'063	17'913	18'465	18'113
1A5 Other (Military)	206	188	180	171	166	148	137	147	146	132
1B Fugitive emissions from oil and natural gas	472	467	431	399	376	348	332	314	304	304
2. Industrial Processes	3'381	3'023	2'868	2'562	2'724	2'653	2'528	2'466	2'562	2'666
3. Solvent and Other Product Use	472	449	428	403	387	368	347	325	303	288
4. Agriculture	6'138	6'113	6'021	5'940	5'906	5'900	5'849	5'675	5'653	5'583
6. Waste	995	991	963	902	840	835	811	802	783	755
7. Other	28	29	29	28	27	27	27	25	26	26
Total (excluding LULUCF)	53'057	54'726	54'442	51'657	50'800	51'269	52'091	51'232	52'510	52'773
5. Land Use, Land-Use Change and Forestry	-3'847	-3'723	-3'183	-4'897	-5'783	-4'632	-4'472	-3'194	-3'057	-1'894
Total (including LULUCF)	49'210	51'003	51'259	46'760	45'017	46'637	47'619	48'038	49'453	50'879

Source and Sink Categories	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
	CO_2 equivalent (Gg)									
1. Energy	42'347	43'178	42'310	43'439	43'863	44'476	44'070	42'042	43'601	42'491
1A1 Energy Industries	3'043	3'197	3'286	3'326	3'654	3'843	4'120	3'853	4'046	3'963
1A2 Manufacturing Industries and Construction	6'237	6'316	6'197	6'153	6'240	6'333	6'359	6'108	6'102	5'703
1A3 Transport	15'890	15'599	15'485	15'659	15'781	15'855	15'944	16'285	16'662	16'497
1A4 Other Sectors	16'757	17'643	16'941	17'936	17'834	18'087	17'281	15'449	16'443	15'972
1A5 Other (Military)	136	134	140	125	114	124	127	120	115	116
1B Fugitive emissions from oil and natural gas	283	290	262	239	241	235	238	228	234	239
2. Industrial Processes	2'935	3'039	3'036	3'080	3'342	3'509	3'490	3'514	3'630	3'482
3. Solvent and Other Product Use	273	258	245	235	220	219	218	219	218	218
4. Agriculture	5'571	5'622	5'599	5'509	5'492	5'521	5'545	5'608	5'700	5'637
6. Waste	731	706	698	658	663	646	643	629	624	608
7. Other	26	27	27	27	27	26	26	27	26	25
Total (excluding LULUCF)	51'884	52'831	51'915	52'948	53'607	54'398	53'993	52'038	53'798	52'461
5. Land Use, Land-Use Change and Forestry	253	711	468	-2'282	-1'586	-1'860	-564	-772	-767	-1'099
Total (including LULUCF)	52'137	53'542	52'383	50'666	52'021	52'539	53'429	51'266	53'031	51'362

Source and Sink Categories	2010	2010/1990
	CO_2 eq	%
1. Energy	44'017	*4.7%*
1A1 Energy Industries	4'190	*64.5%*
1A2 Manufacturing Industries and Construction	5'985	*-6.6%*
1A3 Transport	16'422	*12.4%*
1A4 Other Sectors	17'050	*-4.2%*
1A5 Other (Military)	121	*-41.3%*
1B Fugitive emissions from oil and natural gas	248	*-47.5%*
2. Industrial Processes	3'689	*9.1%*
3. Solvent and Other Product Use	215	*-54.5%*
4. Agriculture	5'688	*-7.3%*
6. Waste	612	*-38.5%*
7. Other	27	*-3.6%*
Total (excluding LULUCF)	54'247	*2.2%*
5. Land Use, Land-Use Change and Forestry	-880	*-77.1%*
Total (including LULUCF)	53'367	*8.4%*

The percentage shares of source categories are shown for selected years in Table 2-5. Figure 2-4 through Figure 2-6 are graphical representations of Table 2-4 data. For the time series of the sub-sectors of 1 Energy see Chapter 3.

Table 2-5 Switzerland's total gross GHG emissions (excluding LULUCF) in CO_2 equivalent (Gg) and the contribution of individual source categories for selected years.

Source and Sink Categories	1990		1995		2000		2005		2006	
	Gg CO_2 eq	%	Gg CO_2 eq	%	Gg CO_2 eq	%	Gg CO_2 eq	%	Gg CO_2 eq	%
1. Energy	42'043	79.2%	41'486	80.9%	42'347	81.6%	44'476	81.8%	44'070	81.6%
1A1 Energy Industries	*2'548*	*4.8%*	2'624	*5.1%*	3'043	*5.9%*	3'843	*7.1%*	4'120	*7.6%*
1A2 Manufacturing Industries and Construction	*6'407*	*12.1%*	5'877	*11.5%*	6'237	*12.0%*	6'333	*11.6%*	6'359	*11.8%*
1A3 Transport	*14'616*	*27.5%*	14'207	*27.7%*	15'890	*30.6%*	15'855	*29.1%*	15'944	*29.5%*
1A4 Other Sectors	*17'795*	*33.5%*	18'282	*35.7%*	16'757	*32.3%*	18'087	*33.2%*	17'281	*32.0%*
1A5 Other (Military)	*206*	*0.4%*	148	*0.3%*	136	*0.3%*	124	*0.2%*	127	*0.2%*
1B Fugitive emissions from oil and natural gas	*472*	*0.9%*	348	*0.7%*	283	*0.5%*	235	*0.4%*	238	*0.4%*
2. Industrial Processes	3'381	6.4%	2'653	5.2%	2'935	5.7%	3'509	6.5%	3'490	6.5%
3. Solvent and Other Product Use	472	0.9%	368	0.7%	273	0.5%	219	0.4%	218	0.4%
4. Agriculture	6'138	11.6%	5'900	11.5%	5'571	10.7%	5'521	10.1%	5'545	10.3%
6. Waste	995	1.9%	835	1.6%	731	1.4%	646	1.2%	643	1.2%
7. Other	28	0.1%	27	0.1%	26	0.1%	26	0.0%	26	0.0%
Total (excluding LULUCF)	53'057	100.0%	51'269	100.0%	51'884	100.0%	54'398	100.0%	53'993	100.0%

Source and Sink Categories	2007		2008		2009		2010	
	Gg CO_2 eq	%	Gg CO_2 eq	%	Gg CO_2 eq	%	Gg CO_2 eq	%
1. Energy	42'042	80.8%	43'601	81.0%	42'491	81.0%	44'017	81.1%
1A1 Energy Industries	3'853	7.4%	4'046	7.5%	3'963	7.6%	4'190	7.7%
1A2 Manufacturing Industries and Construction	6'108	11.7%	6'102	11.3%	5'703	10.9%	5'985	11.0%
1A3 Transport	16'285	31.3%	16'662	31.0%	16'497	31.4%	16'422	30.3%
1A4 Other Sectors	15'449	29.7%	16'443	30.6%	15'972	30.4%	17'050	31.4%
1A5 Other (Military)	120	0.2%	115	0.2%	116	0.2%	121	0.2%
1B Fugitive emissions from oil and natural gas	228	0.4%	234	0.4%	239	0.5%	248	0.5%
2. Industrial Processes	3'514	6.8%	3'630	6.7%	3'482	6.6%	3'689	6.8%
3. Solvent and Other Product Use	219	0.4%	218	0.4%	218	0.4%	215	0.4%
4. Agriculture	5'608	10.8%	5'700	10.6%	5'637	10.7%	5'688	10.5%
6. Waste	629	1.2%	624	1.2%	608	1.2%	612	1.1%
7. Other	27	0.1%	26	0.0%	25	0.0%	27	0.1%
Total (excluding LULUCF)	52'038	100.0%	53'798	100.0%	52'461	100.0%	54'247	100.0%

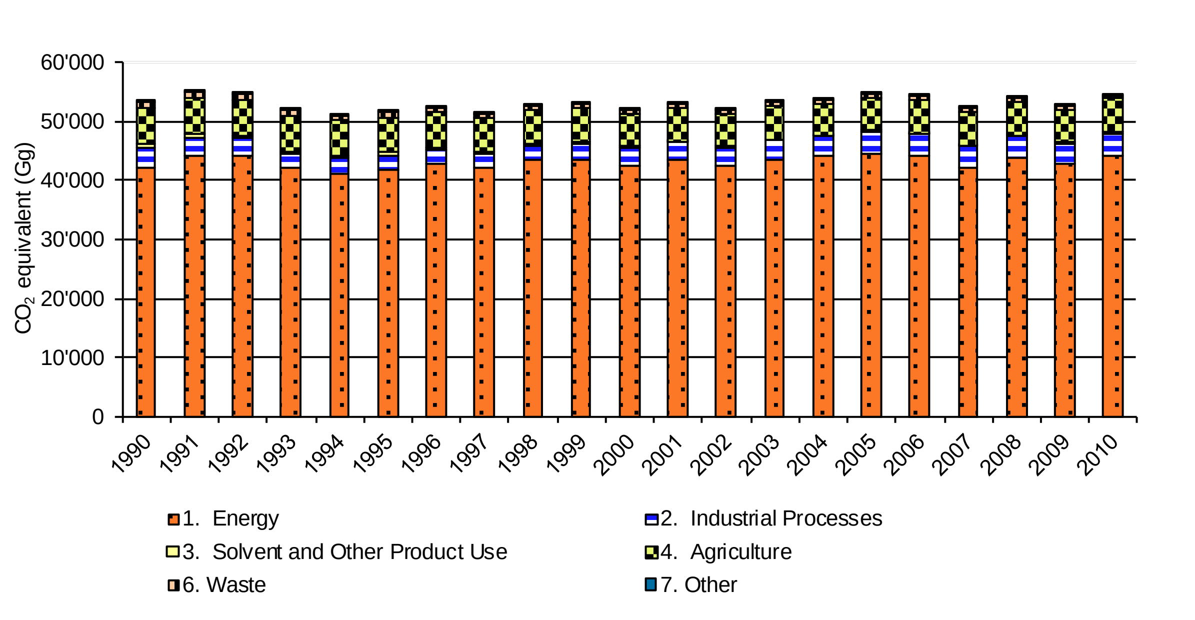

Figure 2-4 Switzerland's GHG emissions in CO_2 equivalent (Gg) by sectors, 1990–2010 (excluding LULUCF).

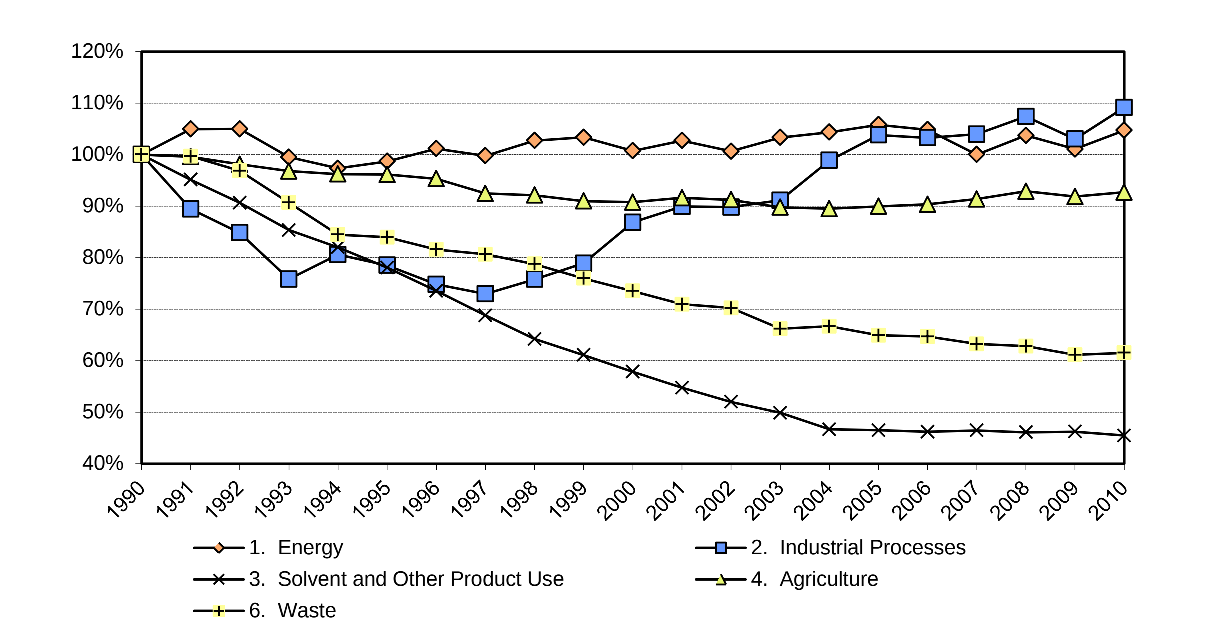

Figure 2-5 Relative emission trends by main source categories (base year 1990 = 100%).

Emission trends for the various sectors are as follows:

- 1 Energy: The variations can only be understood if the trends within the source subcategories are considered separately. See Figure 2-6 and comments below.
- 2 Industrial Processes: In line with economic development, overall emissions in the industry sector showed a decreasing trend in the early 90s and a constant rebound between 1998 and 2010, except for the economically difficult year 2009. Since 2005 the Ordinance on Chemical Risk Reduction (Swiss Confederation 2005) is in place and regulates the use of F-Gases, which led to emission reductions in this subcategory.
- 3 Solvent and Other Product Use: There is a decreasing trend in overall emissions throughout all the years, which is however by far less pronounced since 2004. Whereas overall NMVOC emissions have decreased by -69.0% since 1990, direct CO_2 emissions from the post combustion of NMVOCs have increased. NMVOC emissions, the main source of indirect CO_2 emissions, have diminished between 1990 and 2004 due to their limitation brought by the Ordinance on Air Pollution Control (Swiss Confederation 1985) and due to the introduction of the VOC-tax in 2000 (Swiss Confederation 1997). Since 2004, emissions have remained relatively stable.
- 4 Agriculture: Declining populations of cattle and swine and reduced fertilizer use have led to a decrease in CO_2 equivalent emissions until 2000. Since then, CH_4 emissions remained relatively stable.
- 6 Waste: Total emissions from the source category Waste decreased steadily throughout the period 1990-2003. Since 2000, emissions have been reduced further by a change in legislation: disposal of combustible municipal solid wastes in landfills has been banned, leading to an increasing amount of municipal solid waste being incinerated, with emissions reported under source 1A1 Energy Industries rather than sector 6 Waste. Altogether, “waste-related” emissions incl. emissions from waste management activities reported in sources 1A, 4D and 6 have *increased* since 1990 by 32.7 % (see Figure 8-3 in Chapter 8).

The main source categories within the Energy sector – representing the major sources of Switzerland's GHG emissions – are shown in Figure 2-6.

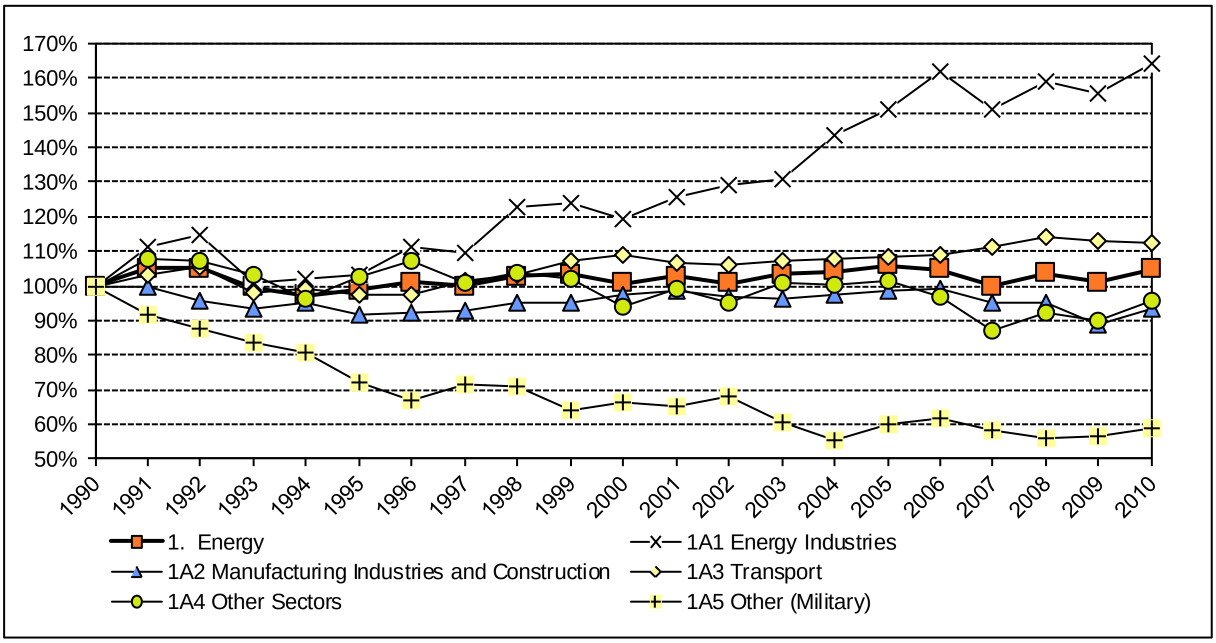

Figure 2-6 Emission trends for the source categories in the sector 1 Energy/1A Fuel Combustion. The trend for the entire sector "1 Energy" is shown in bold. Not included in the figure is the trend for 1B Fugitive Emissions, which continuously decreased from 100% in 1990 to 51% in 2003 and since then remain stable.

It is noteworthy that, due to Switzerland's electricity production structure (about 95% generated by hydroelectric and nuclear power plants in 2010; see SFOE 2011: Table 24), sector 1A1 Energy Industries plays only a minor role – representing not classical thermal power stations but waste incineration plants in the Swiss GHG inventory. The following emission trends are observed within the Energy sector:

- Despite differing trends for the sub-sectors, the overall emissions from the energy sector remain at relatively constant level (bold line in Figure 2-6).
- Overall emissions from sub-sector 1A1 Energy Industry have increased by 64.5% since 1990. Fluctuations are caused by varying combustion activities in the petroleum refinery industry, waste incineration and new installations of district heating. From 2009 to 2010, emissions from Gaseous Fuel consumption also increased by 5.7% due to the coldest winter in the past 15 years (see Figure 2-7). Note that less than 10% of sector 1 Energy emissions stem from 1A1.
- The trend for sub-sector 1A3 Transport shows a slight increase over the period 1990–2010 by 12.4%, but with fluctuations indicating a fairly strong correlation between this sector and overall economic development in Switzerland, with periods of stagnation (1993–1996, 2001–2003 and 2008–2010) and growth (gross value-added) in 1997–2000 and 2004–2008 (SFSO 2009a).
- The trend for sub-sector 1A4 Other Sectors reflects the impact of climatic variations on demand for heating. The strong correlation with the number of "heating degree days"[3] –

[3] Heating degree days: Number of degrees per day calculated as the difference between 20°C (room temperature) and the daily average outdoor temperature for such days where the daily average

used as an index of cold weather conditions – is apparent from Figure 2-7, which shows CO_2 emissions from sub-sector 1A4 Fuel Combustion – Other Sectors (only stationary sources) and the number of heating degree days. In 2010 heating degree days increased by 12% compared to 2009 and CO_2 emissions from fuel combustions augmented simultaneously by 7%. In the period 1990–2010, the number of buildings and apartments increased, as well as the average floor space per person and workplace. Both phenomena resulted in an increase in the total area heated by more than 30%. Over the same period, however, higher standards were specified for insulation and for combustion equipment efficiency for both new and renovated buildings, compensating for the emissions from the additional area heated.

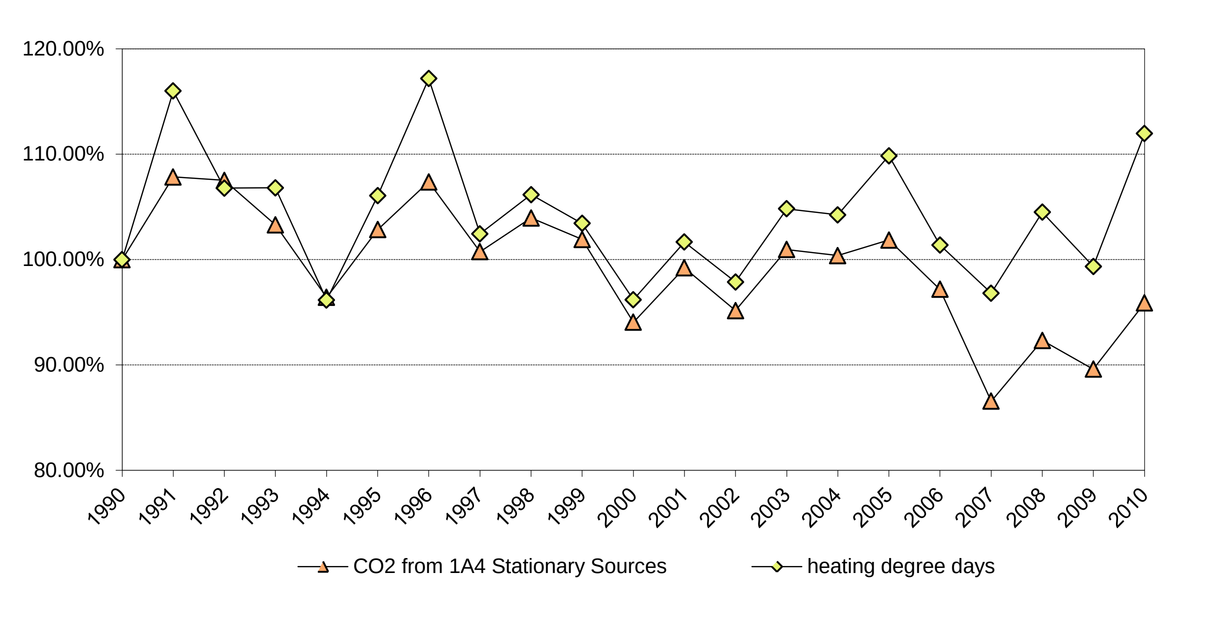

Figure 2-7 Relative trend for CO_2 emissions from 1A4 Fuel Combustion - Other Sectors (stationary sources only) compared with the number of heating degree days.

Figure 2-8 shows the net emissions and removals from the LULUCF sector in Switzerland, which is dominated by biomass dynamics in forests. Before the year 2000 removals were higher than emissions. As the forest carbon sink seems to diminish since the mid-nineties, emissions and removals are almost equal after 2000. However, a strong year to year variation is evident over the whole period.

The reason for the positive values from 2000 to 2002 is the winter storm “Lothar” end of 1999 which caused great damages in the forest stands and increased harvesting.

temperature is below 12°C (e.g. daily outdoor average equals 7°C, then for that day 20 – 7 = 13). The number of degrees per day are summed up for a year t to yield the heating degree days of year t.

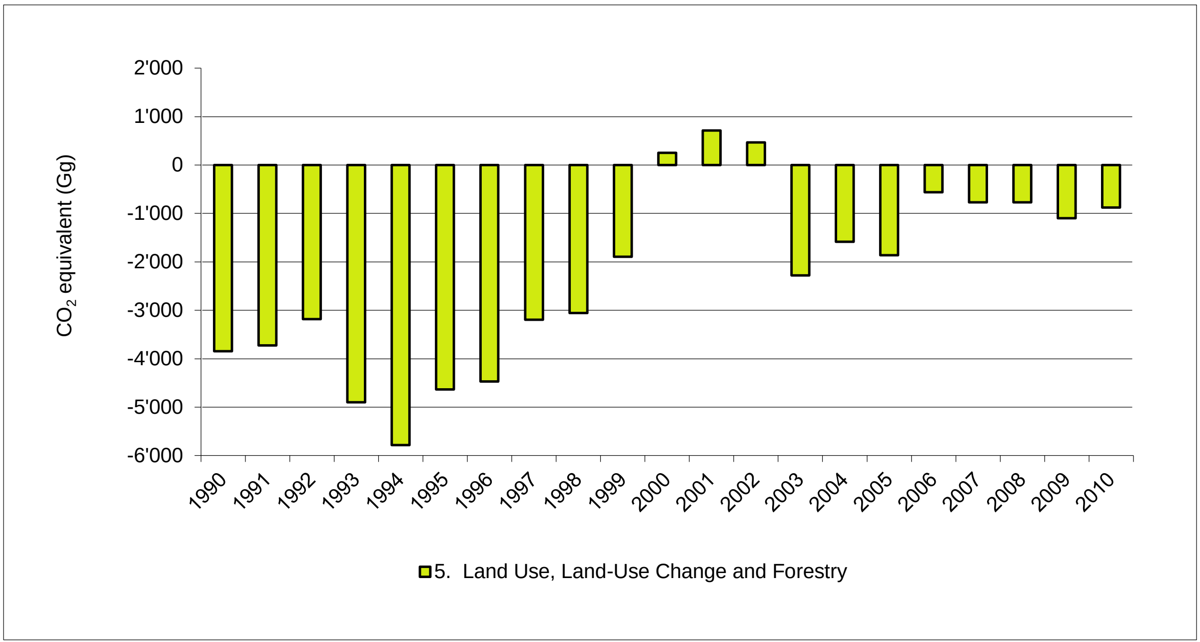

Figure 2-8 Switzerland's net CO_2 equivalent balance of sector Land Use, Land-Use Change and Forestry (LULUCF) 1990–2010 in Gg. Positive values refer to emissions, negative values refer to removals. Note that the annual contributions of CH_4 and N_2O emissions from LULUCF in this period are very small compared to the net CO_2 emissions and removals.

2.4 Emission Trends for Indirect Greenhouse Gases and SO_2

Emission trends for indirect greenhouse gases show a very pronounced decline (see Table 2-6 and Figure 2-9). A strict air pollution control policy and the implementation of a large number of emission reduction measures led to a decrease of -50% to -70% in emissions of air pollutants over the period 1990-2010. The main reduction measures were abatement of exhaust emissions from road vehicles and stationary combustion equipment, taxation of solvents and sulphured fuels, and voluntary agreements with industry sectors (FOEN 2010i, Swiss Confederation 1985, 1997).

Table 2-6 Switzerland's indirect GHG and SO_2 emissions (Gg), 1990–2010 (without NMVOC from LULUCF).

Indirect Greenhouse Gases and SO_2	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
	Gg									
NO_x	150	148	141	129	127	122	118	115	113	113
CO	836	807	756	663	606	564	545	513	489	473
NMVOC	298	284	265	239	218	203	192	180	166	157
SO_2	41	37	34	27	28	25	25	25	23	18

Indirect Greenhouse Gases and SO_2	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
	Gg									
NO_x	110	106	101	98	96	95	92	89	87	83
CO	443	419	390	377	358	340	316	314	310	309
NMVOC	148	139	128	119	110	105	101	98	96	93
SO_2	16	18	17	16	16	17	15	14	14	12

Indirect Greenhouse Gases and SO_2	2010
	Gg
NO_x	82
CO	310
NMVOC	91
SO_2	13

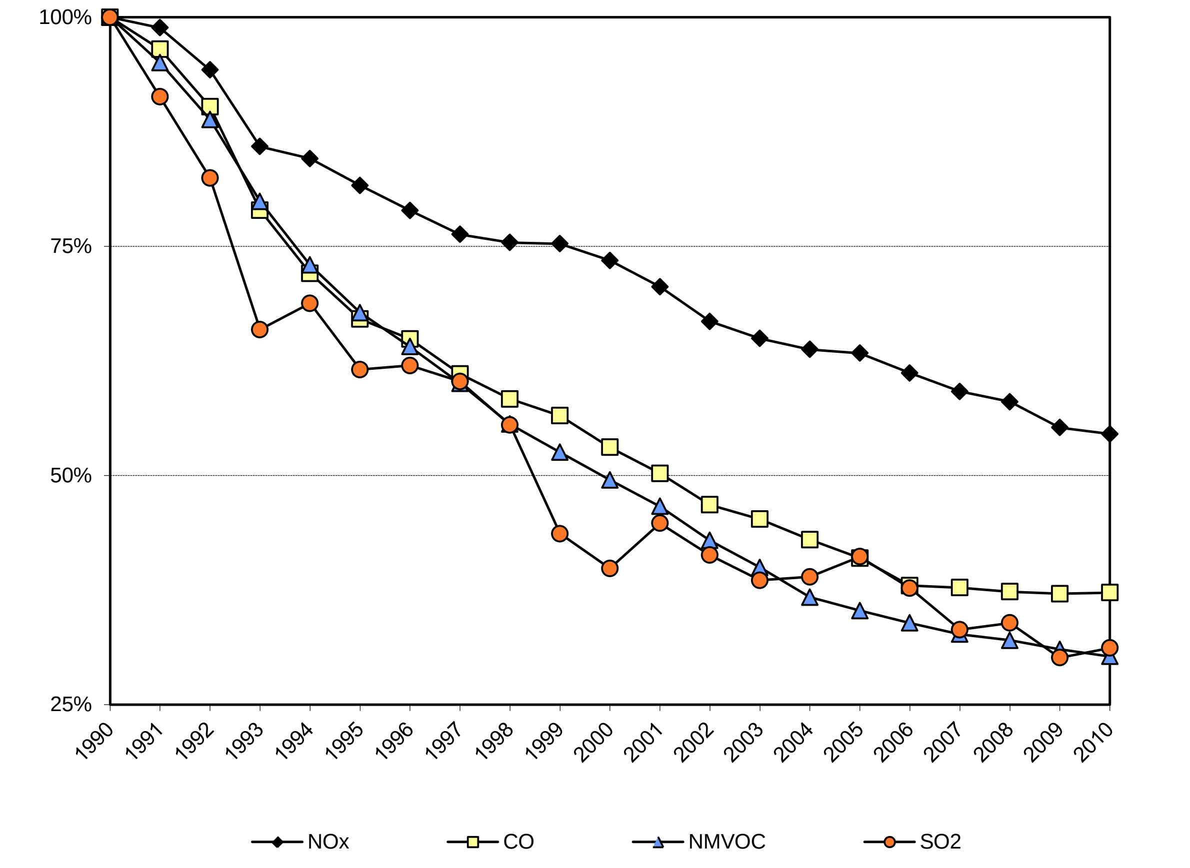

Figure 2-9 Relative trends for indirect GHG and SO_2 emissions (without NMVOC from LULUCF), 1990–2010 (base year 1990 = 100%).

The energy sector was by far the largest source of indirect greenhouse gas emissions (see

Table 2-7), with the only exception being NMVOC, where sector 3 Solvent and Other Product Use accounted for 22.1% of the total. The total shown in

Table 2-7 includes NMVOC emissions from LULUCF, which are estimated at constant 95.5 Gg per year (SAEFL 1996a). This corresponds to 51.3% of the total in 2010.

Table 2-7 Indirect GHG and SO_2 emissions (Gg) by source, 2010. The total NMVOC emissions including NMVOC from LULUCF.

Sources	**NO_x**	**CO**	**NMVOC**	**SO_2**
	Emissions 2010 (Gg)			
1 Energy	76.9	294.1	34.3	11.7
2 Industrial Processes	0.4	6.0	8.6	0.9
3 Solvent and Other Product Use	0.0	0.0	41.0	0.0
4 Agriculture	4.5	7.3	4.6	0.0
5 LULUCF	IE, NE	IE, NE	95.5	NE
6 Waste	0.3	1.4	1.9	0.1
7 Other	0.1	0.8	0.1	0.0
Total	**82.2**	**309.6**	**186.0**	**12.8**

Figure 2-10 shows the relative contributions (excluding LULUCF) of the various sectors for each individual gas (data from

Table 2-7). The energy sector can clearly be identified as the main source of NO_x, CO and SO_2.

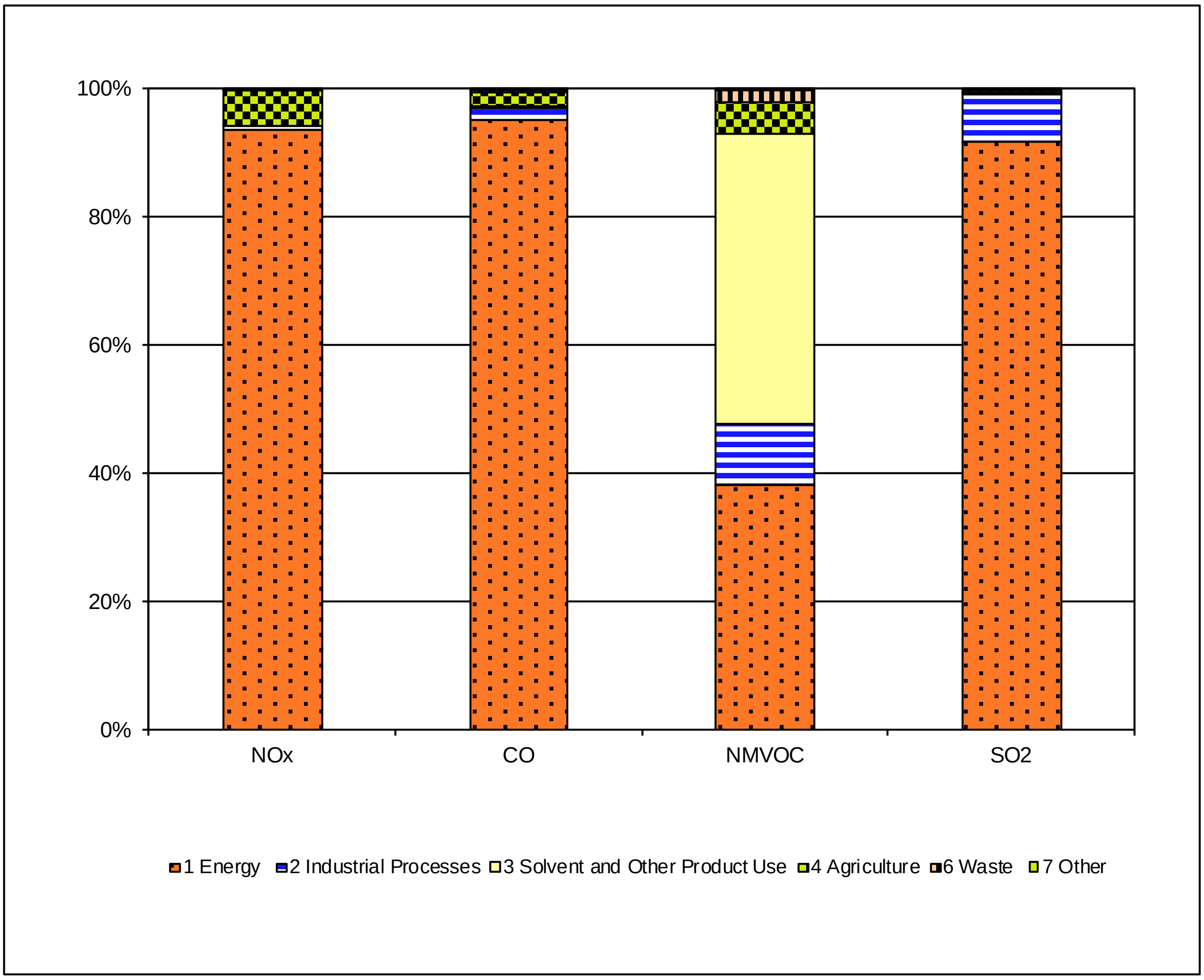

Figure 2-10 Relative contributions of individual sectors to indirect GHG and SO_2 emissions in 2010 (without NMVOC from LULUCF).

2.5 *Emission Trends (Kyoto Protocol)*

Relevant emission and removals under the Kyoto Protocol are shown in Table 2-8 and Table 2-9, sorted by sectors and gases respectively. Base year emissions for the first commitment period are fixed at the value reported in the Initial Report 2006 (FOEN 2006h, UNFCCC 2007a).

Table 2-8 Summary of Switzerland's GHG emissions in CO_2 equivalent (Gg), 1990–2010 excluding emissions from LULUCF, Other and International Bunkers.

		Sector	Base year inital report	1990	1991	1992	1993	1994	1995	1996	1997	1998
			CO_2 equivalent (Gg)									
Annex A sources		1 Energy	42'134	42'043	44'122	44'134	41'823	40'917	41'486	42'529	41'940	43'184
		2 Industrial Processes	3'258	3'381	3'023	2'868	2'562	2'724	2'653	2'528	2'466	2'562
		3 Solvent and Other Product Use	466	472	449	428	403	387	368	347	325	303
		4 Agriculture	5'903	6'138	6'113	6'021	5'940	5'906	5'900	5'849	5'675	5'653
		6 Waste	1'030	995	991	963	902	840	835	811	802	783
		Total (Annex A sources)	**52'791**	**53'029**	**54'698**	**54'414**	**51'629**	**50'773**	**51'242**	**52'064**	**51'207**	**52'485**

		Sector	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
			CO_2 equivalent (Gg)									
Annex A sources		1 Energy	43'453	42'347	43'178	42'310	43'439	43'863	44'476	44'070	42'042	43'601
		2 Industrial Processes	2'666	2'935	3'039	3'036	3'080	3'342	3'509	3'490	3'514	3'630
		3 Solvent and Other Product Use	288	273	258	245	235	220	219	218	219	218
		4 Agriculture	5'583	5'571	5'622	5'599	5'509	5'492	5'521	5'545	5'608	5'700
		6 Waste	755	731	706	698	658	663	646	643	629	624
		Total (Annex A sources)	**52'746**	**51'857**	**52'803**	**51'888**	**52'921**	**53'580**	**54'372**	**53'966**	**52'011**	**53'772**
KP-LULUCF	Art.3.3	Afforestation & reforestation										-16
		Deforestation										182
	Art.3.4	Forest management										-671
		Cropland management										NA
		Grazing land management										NA
		Revegetation										NA
		Total (Art. 3.3 + 3.4)										**-505**

		Sector	2009	2010	Base year – 2010
			CO_2 equivalent (Gg)		Change (%)
Annex A sources		1 Energy	42'491	44'017	4%
		2 Industrial Processes	3'482	3'689	13%
		3 Solvent and Other Product Use	218	215	-54%
		4 Agriculture	5'637	5'688	-4%
		6 Waste	608	612	-41%
		Total (Annex A sources)	**52'435**	**54'220**	**3%**
KP-LULUCF	Art.3.3	Afforestation & reforestation	-18	-23	
		Deforestation	238	238	
	Art.3.4	Forest management	-1'123	-850	
		Cropland management	NA	NA	
		Grazing land management	NA	NA	
		Revegetation	NA	NA	
		Total (Art. 3.3 + 3.4)	**-902**	**-635**	

Table 2-9 Switzerland’s total GHG emissions (excluding LULUCF, Other and International Bunkers) and the contribution of individual gases in CO_2 equivalent (Gg), 1990-2010.

		GHG	Base year inital report	1990	1991	1992	1993	1994	1995	1996	1997	1998
			CO_2 equivalent (Gg)									
Annex A sources		CO_2	44'553	44'620	46'342	46'234	43'705	42'968	43'345	44'211	43'460	44'689
		CH_4	4'370	4'698	4'666	4'529	4'390	4'304	4'297	4'208	4'102	4'062
		N_2O	3'623	3'467	3'459	3'427	3'363	3'338	3'307	3'308	3'195	3'195
		HFCs	0.0	0.0	0.2	6	14	33	180	225	299	355
		PFCs	100	100	85	69	30	18	15	17	20	23
		SF_6	144	144	146	148	126	112	98	94	131	160
		Total (Annex A sources)	**52'791**	**53'029**	**54'698**	**54'414**	**51'629**	**50'773**	**51'242**	**52'064**	**51'207**	**52'485**

		GHG	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
			CO_2 equivalent (Gg)									
Annex A sources		CO_2	44'974	44'019	44'860	43'961	45'054	45'624	46'341	45'902	43'910	45'447
		CH_4	4'001	3'934	3'949	3'895	3'800	3'782	3'789	3'796	3'795	3'875
		N_2O	3'172	3'181	3'201	3'195	3'139	3'134	3'123	3'135	3'158	3'177
		HFCs	418	497	590	629	697	799	874	900	934	990
		PFCs	36	69	45	40	57	53	33	32	29	39
		SF_6	147	158	157	168	174	189	213	201	186	244
		Total (Annex A sources)	**52'746**	**51'857**	**52'803**	**51'888**	**52'921**	**53'580**	**54'372**	**53'966**	**52'011**	**53'772**
KP-LULUCF	Art.3.3	CO_2										166
		CH_4										NO
		N_2O										0.0
	Art.3.4	CO_2										-672
		CH_4										0.3
		N_2O										0.2
		Total (Art. 3.3 + 3.4)										**-505**

		GHG	2009	2010	Base year – 2010
			CO_2 equivalent (Gg)		Change (%)
Annex A sources		CO_2	44'244	45'950	3%
		CH_4	3'816	3'815	-13%
		N_2O	3'131	3'191	-12%
		HFCs	1'023	1'073	NA
		PFCs	35	37	-64%
		SF_6	187	155	8%
		Total (Annex A sources)	**52'435**	**54'220**	**3%**
KP-LULUCF	Art.3.3	CO_2	221	215	
		CH_4	NO	NO	
		N_2O	0.0	0.0	
	Art.3.4	CO_2	-1'123	-851	
		CH_4	0.3	0.2	
		N_2O	0.2	0.1	
		Total (Art. 3.3 + 3.4)	**-902**	**-635**	

The reported total emissions differ from those reported under the UNFCCC, as sector Other – in addition to LULUCF and international bunkers – is not accounted for under the Kyoto Protocol. On the other hand, activities under article 3.3 (afforestation, reforestation and deforestation) and 3.4 (forest-, cropland- and grazing management and revegetation) are taken into account over the commitment period 2008-2012. Under the elective voluntary activities of Article 3, paragraph 4 of the Kyoto Protocol, Switzerland only accounts for forest management.

3 Energy

3.1 Overview

3.1.1 Greenhouse Gas Emissions

This chapter provides information on the estimation of the greenhouse gas emissions from sector energy. The following source categories are reported:

- 1A. Fuel Combustion
- 1B. Fugitive Emissions from Fuels

In Switzerland, the energy sector is the most relevant greenhouse gas source. In 2010, it emitted 44'017 Gg CO_2 equivalent which corresponds to 81.1% of total emissions (54'247 Gg CO_2 equivalent, national total without LULUCF). The emissions of the period 1990–2010 are depicted in Figure 3-1.

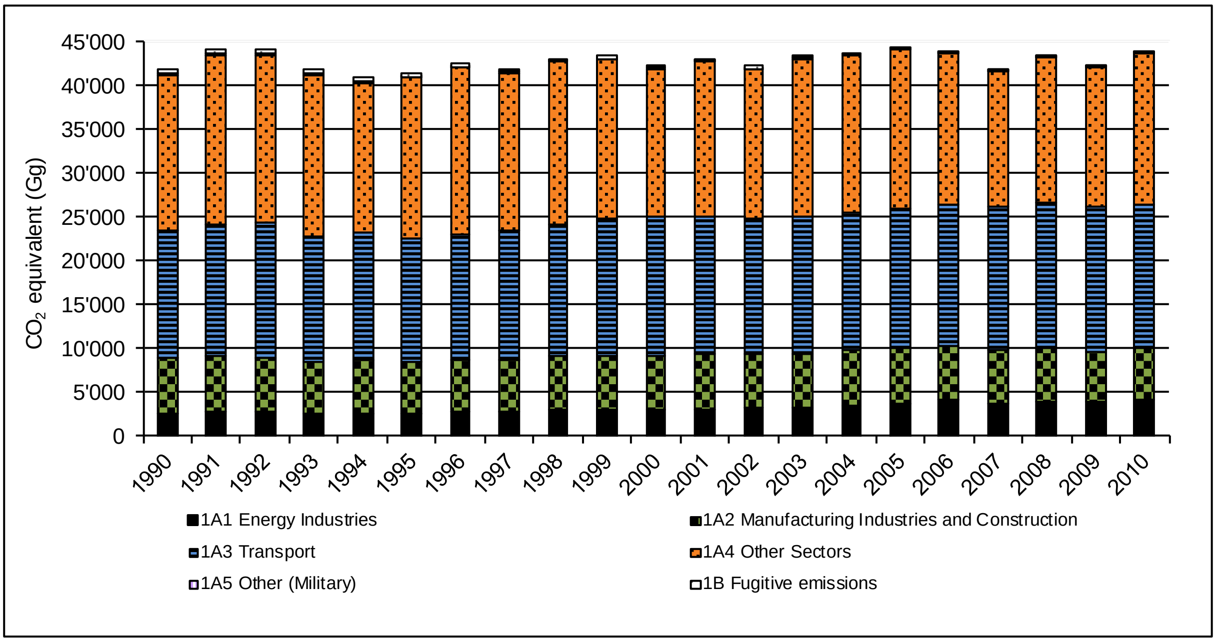

Figure 3-1 Switzerland's GHG emissions of sector 1 Energy 1990–2010 in CO_2 equivalent (Gg).

For the total emissions of the energy sector, there are fluctuations between 97% and 105% in the period 1990–2010 but no trends. The value 2010 is 4.69% higher than the value of the base year. Three sub-categories dominate the emissions:

- 1A3 Transport and 1A4 Other Sectors are the main sources of the sector energy that cover 37.3% and 38.7% of total emissions in 2010 respectively,
- 1A2 Manufacturing Industries and Construction are of minor importance. They contribute in 2010 13.6% to the total emissions of the sector energy.
- 1A1 Energy Industries, 1A5 Other (Military) and 1B Fugitive Emissions only play a minor role. In 2010, they cover 9.5%, 0.3% and 0.6%, respectively, of the total emissions of the sector energy.

The trends of the individual gases are given in the next table and figure:

- By far the most important gas emitted from the sector energy is CO_2. It accounts for 98.7% of the category. Its fluctuations reflect *inter alia* the climatic variability in Switzerland (see Figure 2-7 and related comments).
- In 2010, CH_4 emissions contributed 0.62% to the total emissions of the sector energy. The decreasing trend since 1990 is the result of reduced emissions from gasoline passenger cars due to catalytic converters.
- N_2O contributed 0.72% to the total emissions of the sector energy. The changes in N_2O emissions may be explained by changes in the emission of passenger cars. The first generation of catalytic converters generated N_2O as undesirable by-product in the exhaust gases, leading to an increase of N_2O emissions until 2000. With new converter materials being used, the emission factors are decreasing since 2001.

Table 3-1 GHG emissions of source category 1 Energy by gas in CO_2 equivalent (Gg), 1990–2010.

Gas	**1990**	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**
	CO_2 equivalent (Gg)									
CO_2	41'136	43'218	43'271	41'018	40'140	40'735	41'788	41'225	42'469	42'724
CH_4	624	608	559	513	484	457	435	401	390	391
N_2O	283	296	304	292	292	294	306	314	325	338
Sum	42'043	44'122	44'134	41'823	40'917	41'486	42'529	41'940	43'184	43'453

Gas	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**
	CO_2 equivalent (Gg)									
CO_2	41'643	42'465	41'630	42'775	43'212	43'833	43'436	41'435	42'992	41'900
CH_4	359	361	325	305	298	293	283	272	275	270
N_2O	345	352	354	359	353	350	351	335	334	321
Sum	42'347	43'178	42'310	43'439	43'863	44'476	44'070	42'042	43'601	42'491

Gas	**2010**
	CO_2 eq
CO_2	43'426
CH_4	271
N_2O	319
Sum	44'017

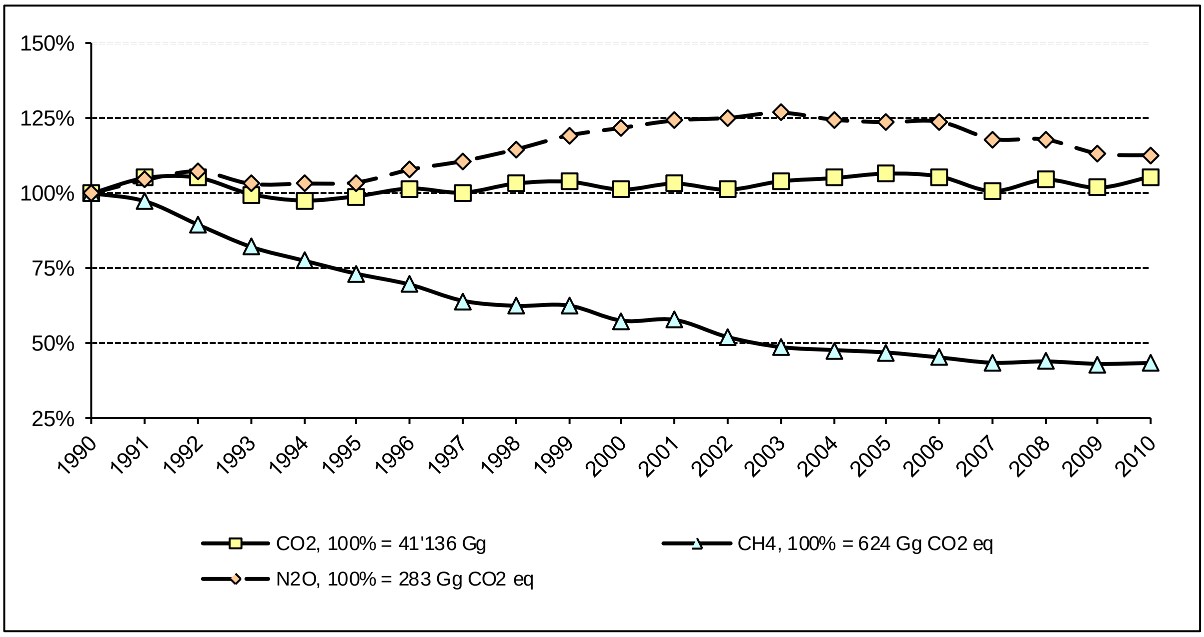

Figure 3-2 Relative trends of the greenhouse gases of source category 1 “Energy” in the period 1990–2010. The base year 1990 represents 100%.

The following table summarises the emissions of the sector energy in 2010. The table includes emissions from international bunkers (aviation and marine) as well as from biomass burning which both are not accounted for in the Kyoto Protocol but are contained in the CRF tables.

Table 3-2 Summary of sector 1 Energy, emissions[4] in 2010 in Gg CO_2 equivalent (Total: rounded values).

Emissions 2010	**CO_2**	**CH_4**	**N_2O**	***Total***
	CO_2 equivalent (Gg)			
1 Energy	43'426.4	271.5	319.1	*44'017*
1A Fuel Combustion	43'352.3	97.6	319.1	*43'769*
1A1 Energy Industries	4'088.0	3.3	99.2	*4'190*
1A2 Manufacturing Industries and Construction	5'943.0	8.8	33.5	*5'985*
1A3 Transport	16'265.7	24.1	132.7	*16'422*
1A4 Other Sectors	16'936.1	61.4	52.6	*17'050*
1A5 Other (Military)	119.6	0.1	1.2	*121*
1B Fugitive Emissions from Fuels	74.0	173.8	NO	*248*
International Bunkers	4'287.0	1.3	41.8	*4'330*
CO_2 Emissions from Biomass	6'640.6	0.0	0.0	*6'641*

In 2010, the Swiss greenhouse gas inventory identifies in Tier 1 analysis 30 key sources (without LULUCF), 18 of which belong to the energy sector. In Tier 2 analysis, 30 key sources are found including 14 in sector energy (without LULUCF), see Chapter 1.5. The key categories from the energy sector are depicted in Figure 3-3. Most dominant are the CO_2 emissions from 1A3b Transport (gasoline, CO_2) and 1A4b Other Sectors (liquid fuels, CO_2).

[4] Biomass CO_2 emissions from 1 Energy in the Table above and in the CRF inventory are for technical reasons incomplete. For full biomass CO_2 emissions see Section 3.2.5.

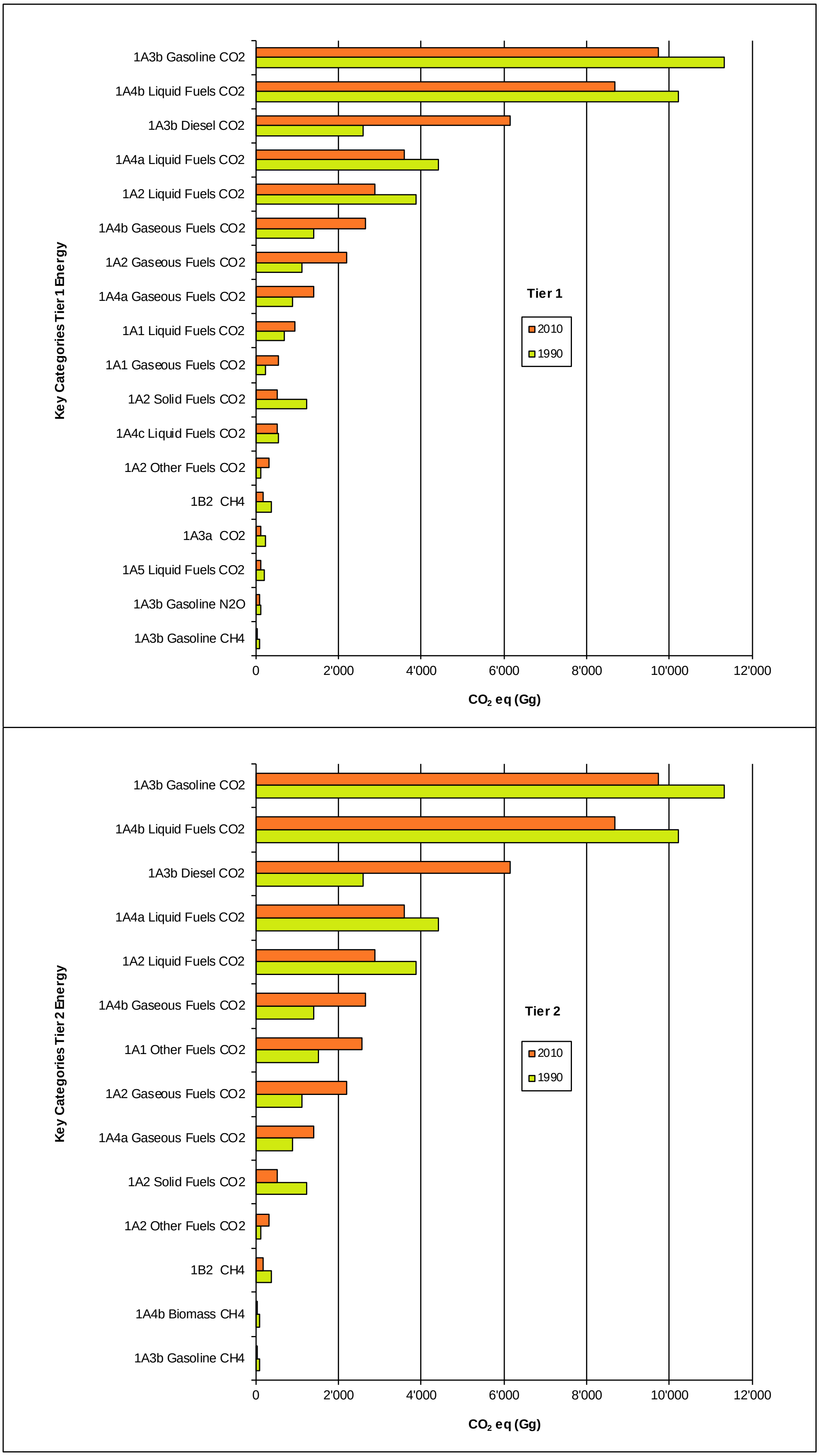

Figure 3-3 Key sources in the Swiss GHG inventory from the energy sector. Top: Tier 1, bottom Tier 2 analysis.

3.1.2 CO_2 Emission Factors

The CO_2 emission factors used for the calculation of the emissions of 1 Energy are shown in Table 3-3. Further details are given in Annex A2.1, Methodology for Estimating CO_2 Emissions. Note that the CO_2 emission factors are constant over the whole time period 1990-2010, which is supported by measurement campaigns of NCV and carbon content of fuels in 1999, 2008 and 2011 (EMPA 1999, Intertek 2008, Intertek 2012). Measurements will be repeated periodically. For further details see Annex 2.1.

Table 3-3 CO_2 emission factors for fossil and biofuels. The values are assumed to be constant over the period 1990-2010. The value for natural gas also holds for CNG (compressed natural gas).

CO_2 Emission Factors 1990-2010			
Fuel	**t CO_2 / TJ**	**t CO_2 / t**	**Data sources**
Diesel Oil	73.6	3.15	SFOE (2001), Intertek (2008)
Gas Oil	73.7	3.14	SFOE (2001), Intertek (2008)
Gasoline	73.9	3.14	SFOE (2001), Intertek (2008)
Lignite	96.1	2.26	FOEN (2011k)
Bituminous Coal	92.7	2.36	FOEN (2011k)
Jet Kerosene	73.2	3.15	SFOE (2001), Intertek (2008)
Natural Gas	55.0	2.56	SFOE (2001)
Propane/Butane (LPG)	65.5	---	SFOE (2001)
Residual Fuel Oil	77.0	3.17	SFOE (2001), Intertek (2008)
Fuel	t CO_2 / TJ	t CO_2 / t	
Biodiesel	73.6		EMIS (2012/1A3b)
Bioethanol	73.9		EMIS (2012/1A3b)
Biogas	55.0		EMIS (2012/1A3b)
Vegetable oil	73.6		EMIS (2012/1A3b)
Wood	92.0		EMIS (2012/1A solid fuels/wood) SFOE (2001)

3.1.3 Feedstocks

Energy data are taken from the Swiss overall energy statistics (SFOE 2011). These statistics account for production, imports, exports, transformation and stock changes. Hence all figures for energy consumption, on which the Swiss GHG inventory is based, correspond to apparent consumption figures.

In the Reference Approach of the GHG inventory, carbon stored in feedstocks has to be subtracted from fuel import to report the effective CO_2 emissions correctly. The data for feedstocks is taken from the Swiss overall energy statistics (SFOE 2011). The most important feedstock in Switzerland is bitumen.

3.1.4 Energy flow and energy consumption

As mentioned above, the Swiss overall energy statistics (SFOE 2011) serves as basic input for the emission calculation. It is updated annually and contains all the information on primary and final energy consumption. Table 3-4 shows the energy balance in Switzerland in 2010. An energy flow chart for 2010 and for the base year 1990 are given in Annex 3.1.1.

Table 3-4 Energy balance for Switzerland 2010 (SFOE 2011).

			Holzenergie	Kohle	Müll und Industrie-abfälle	Rohöl	Erdöl-produkte	Gas	Wasserkraft	Kern-brennstoffe	Übrige erneuerbare Energien	Elektrizität	Fernwärme	Total
			Energie du bois	Charbon	Ord. mén. et déchets ind.	Pétrole brut	Produits pétroliers	Gaz	Energie hydraulique	Combustibles nucléaires	Autres énergies renou-velables	Electricité	Chaleur à distance	Total
			(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Inlandproduktion	Production indigène	(a)	39 340	–	54 640	–	–	–	134 820	–	16 540	–	–	245 340
+ Import	Importation	(b)	1 190	5 530	–	194 000	310 950	126 010	–	274 960	170	240 600	–	1 153 410
+ Export	Exportation	(c)	– 600	0	–	–	– 17 480	–	–	–	–	–238 730	–	– 256 810
+ Lagerveränderung[1]	Variation de stock[1]	(d)	–	890	–	40	44 980	–	–	–	–	–	–	45 910
= Bruttoverbrauch	Consommation brute	(e)	39 930	6 420	54 640	194 040	338 450	126 010	134 820	274 960	16 710	1 870	0	1 187 850
+ Energieumwandlung:	Transformation d'énergie:													
• Wasserkraftwerke	• Centrales hydrauliques	(f)	–	–	–	–	–	–	– 134 820	–	–	134 820	–	0
• Kernkraftwerke	• Centrales nucléaires	(g)	–	–	–	–	–	–	–	–274 960	–	90 740	1 300	– 182 920
• konventionell-thermische Kraft-, Fernheiz- und Fernheizkraftwerke	• Centrales thermiques class., chauffage à distance, centrales chaleur-force	(h)	– 1 130	–	– 44 610	–	– 540	– 9 830	–	–	–	11 270	17 610	– 27 230
• Gaswerke	• Usines à gaz	(i)	–	–	–	–	–	–	–	–	–	–	–	–
• Raffinerien	• Raffineries	(j)	–	–	–	– 194 040	192 610	–	–	–	–	–	–	– 1 430
• Diverse Erneuerbare	• Renouvelables div.	(k)	– 710	–	–	–	–	210	–	–	– 1 960	1 680	0	– 780
+ Eigenverbrauch des Energiesektors, Netzverluste, Verbrauch der Speicherungen	Consommation propre du secteur énergétique, pertes de réseau Pompage d'accumulation	(l)	–	–	–	–	– 14 160	– 880	–	–	–	– 25 150	– 1 650	– 41 840
+ Nichtenergetischer Verbrauch	Consommation non énergétique	(m)	–	–	–	–	– 22 100	–	–	–	–	–	–	– 22 100
= Endverbrauch	Consommation finale	(n)	38 090	6 420	10 030	0	494 260	115 510	0	0	14 750	215 230	17 260	911 550
Haushalte	Ménages	(o)	20 740	400	–	–	118 160	48 390	–	–	9 900	67 020	6 910	271 520
Industrie	Industrie	(p)	9 670	6 020	10 030	–	32 910	35 660	–	–	1 150	69 370	6 300	171 110
Dienstleistungen	Services	(q)	6 950	–	–	–	47 080	24 130	–	–	2 740	63 840	4 050	148 790
Verkehr	Transport	(r)	–	–	–	–	294 740	710	–	–	430	11 390	–	307 270
Statistische Differenz inkl. Landwirtschaft	Différence statistique, y compris l'agriculture	(s)	730	0	0	–	1 370	6 620	–	–	530	3 610	0	12 860

A time series of the final energy consumption is depicted in Figure 3-4. The total consumption has increased by 14.2% in the period 1990-2010. Simultaneously significant substitutions occurred: heating fuel consumption decreased by -19.5%, natural gas and transport fuel consumption increased by 82.1% and 16.4%, and electricity by 28.4%.

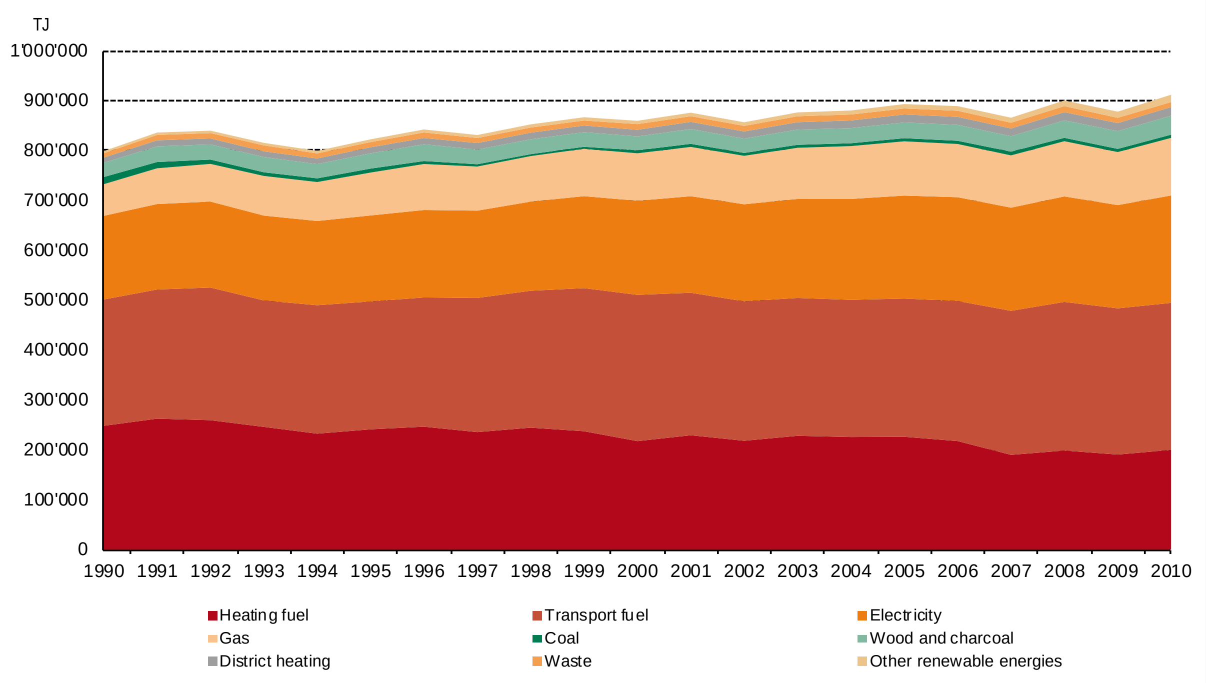

Figure 3-4 Final energy consumption in Switzerland between 1990 and 2010 by fuel type (SFOE 2011). Note that Liechtenstein's consumption of heating and transport fuel is included in the numbers. It corresponds to 0.68% of the Swiss fuel consumption. See Section 3.1.5

3.1.5 Correction of Fuel Consumption Related to Liechtenstein

The Swiss overall energy statistics (SFOE 2011) contains the fossil fuel consumption of the Principality of Liechtenstein (about 36'200 inhabitants, 32'700 employees in industrial and service sector) except for natural gas, since the two countries form a customs and monetary union governed by a customs treaty. Thus, all imports of liquid fossil fuel into Switzerland also contain the fuel consumed in Lichtenstein, which needs to be subtracted from the imports. The following method is being applied to get the correct Swiss fuel consumption:

Liechtenstein's energy consumption is taken from its energy statistics [see Table 3-4 in Liechtenstein's NIR (OEP 2011)]. In 2010 the sum of fossil fuels used in Liechtenstein was 3'999 TJ that corresponds to 0.68% of the Swiss consumption. The total consumption of every fuel (gasoline, diesel oil, gas oil etc.) is subtracted from the corresponding figures of the Swiss overall energy statistics. This procedure is carried out for every year 1990–2010. The Swiss emissions are then modelled using the correctly reduced activity data.

3.1.6 Disaggregation of the energy consumption

Figure 3-5 shows the disaggregation procedure of the fuel consumption. The total due to the sales principle is given in the Swiss overall energy statistics (SFOE 2011). The statistics also contains the split into energy consumption and energy transformation, further splits into residential, commercial and transportation as well as into public electricity, district heatings and refineries. The fuel consumption of wood is based on the Swiss wood energy statistics (SFOE 2011b). Further disaggregations are carried out with the help of models run by FOEN, FOCA and the companies Cepe, Basics, INFRAS, Prognos, TEP, Eicher+Pauli as well as the oil industry association (EV). The models of Cepe and Basics, now run by TEP and Prognos are described in detail in Annex A3.1.2.

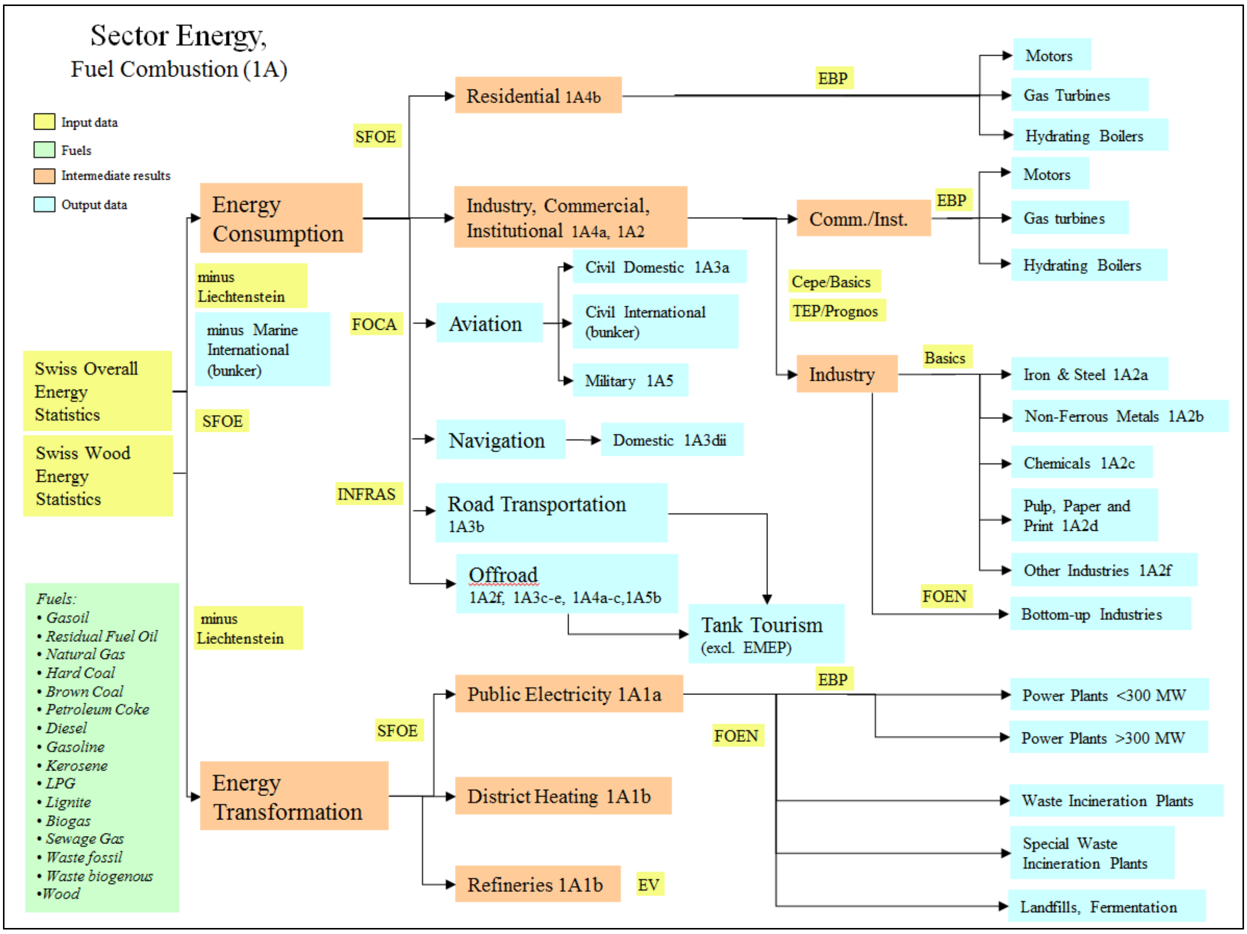

Figure 3-5 Schematic disaggregation of 1A Fuel Consumption.

3.2 *Source Category 1A – Fuel Combustion Activities*

3.2.1 Comparison Sectoral Approach- Reference Approach

Two methods are applied for modelling CO_2 emissions from the energy sector, the Sectoral (or National) Approach and the Reference Approach. For the inventory under the Framework Convention on Climate Change and the Kyoto Protocol the Sectoral (National) Approach is used. The Reference Approach is only used for verification purposes (quality control activity).

The Sectoral Approach uses specific methods for the different source categories: Fossil fuel consumption statistics (top-down approach, Tier 1) and bottom-up modelling of fuel consumption (bottom-up, Tier 2 and Tier 3).

The Reference Approach however, corresponds to a top-down approach (Tier 1) based on net quantities of fuel imported into Switzerland. Therefore the fossil fuel supply statistics is used: All imports and exports of primary fuels (crude oil, natural gas, coal[5]), secondary fuels (gasoline, diesel oil etc.) and stock changes stem from the Swiss overall energy statistics (SFOE 2011). Subsequently the apparent consumption, the net carbon emissions, and the effective CO_2 emissions are calculated for the Reference Approach as prescribed in the CRF tables 1A(b)–1A(d). Thus the Reference Approach covers the CO_2 emissions of all net

[5] Coking coal is included under other bituminous coal in the reference approach.

imported primary fuels, emissions from crude oil treatment (secondary fuel production) in the two Swiss refineries and emissions of imported secondary fuels. In 2010 38% of all fossil fuels sold in Switzerland were produced in Swiss refineries (EV 2011) from primary fuels.

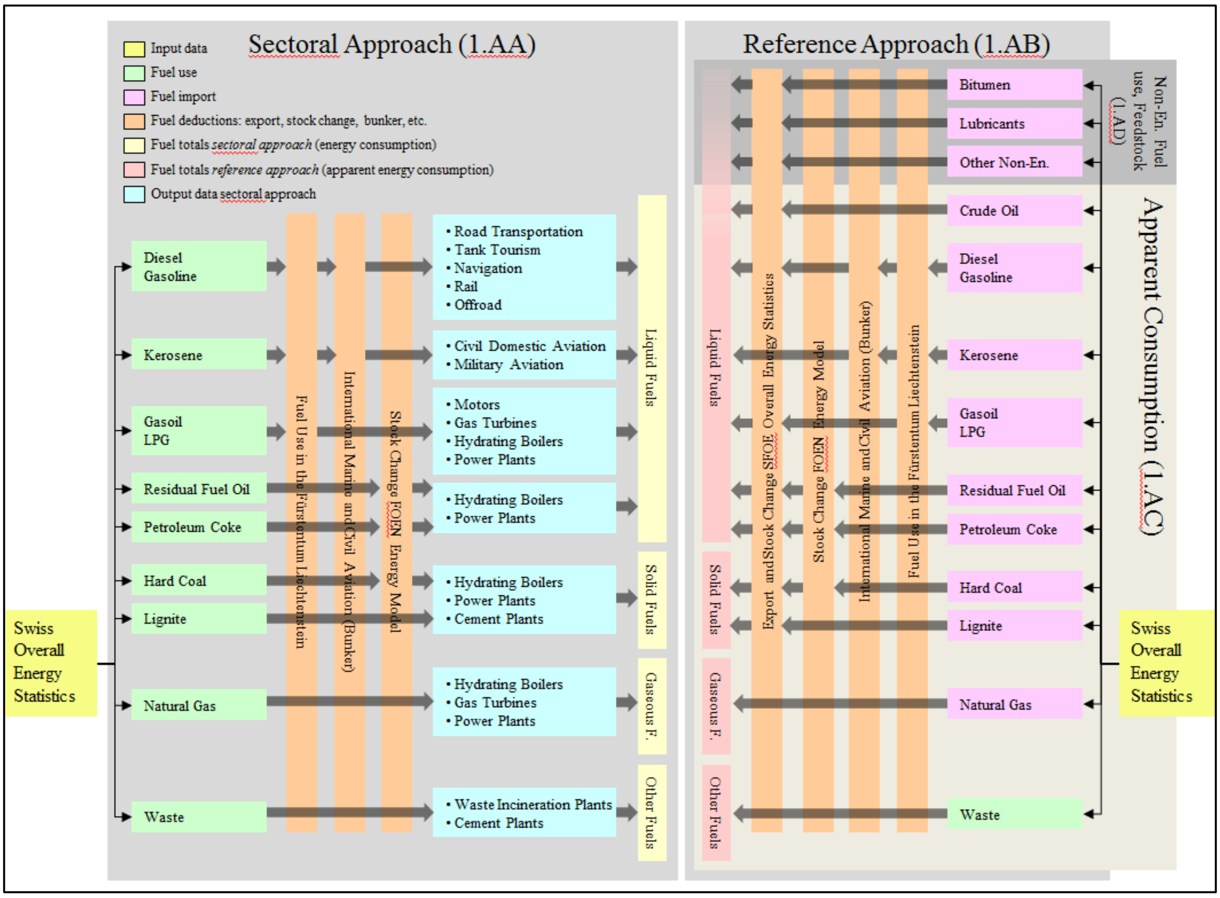

Figure 3-6 Calculation of the Reference and Sectoral Approach. The input data for both approaches stems from the Swiss overall energy statistics (SFOE 2011) but while the Reference Approach considers the net import/export balance, the Sectoral Approach considers the fuel use of the SFOE.

All necessary data for calculating the Reference Approach is implemented in the EMIS database, and all the data on import, export, bunkers, stock changes, apparent consumption, carbon emission factors, carbon stored and actual emissions are calculated within EMIS under the following conditions:

- The oxidation factor is consequently set to 1.0 due to the following reason: Combustion installations in Switzerland have very good combustion properties; combined emissions of CO and unburnt VOC lie in the range of only 0.1 to 0.3 percent of CO_2 emissions for oil and gas combustion. Since most of the coal used in Switzerland goes to the cement industry, also for coal an oxidation factor of 1.0 was chosen (cf. Chapter 3.2.5.1.)[6]
- For the Reference Approach, Liechtenstein's fuel consumption is subtracted from the input figures of fuel consumption, which originally include Liechtenstein's consumption except for natural gas (see also Chapter 3.1.5).

[6] EC 2004, Annex VII, Section 2.1.1: "In cement kilns the incomplete combustion of fossil fuels is negligible, due to the very high combustion temperatures, long residence time in kilns and minimal residual carbon found in clinker. Carbon in all kiln fuels shall therefore be accounted for as fully oxidized (oxidation factor = 1.0)."

As well, the differences between Reference and Sectoral Approach are calculated within EMIS. The results 1990-2010 are shown in Table 3-5 and in Figure 3-7. The CO_2 emissions (excluding non-energy use and feedstocks) agree very well except for 1995 which shows a significantly larger difference. For all years the differences lie between -0.07% and 2.09%. For the corresponding energy consumption (excluding non-energy use and feedstocks) the differences show the same development and lie between 0.00% and 2.08%.

The difference between Reference and Sectoral Approach is strongly influenced by the assumed energy content of crude oil. The value currently used is provided by the Swiss overall energy statistics (SFOE, 2011). However, the energy content of crude oil from the main Swiss import countries might be slightly lower (e.g. 42.1 GJ/t) than the value given in SFOE (2011; 43.2 GJ/t)). Using these lower values would result in the differences between Reference and Sectoral Approach fluctuating around 0 (approx. +/-1%).

Table 3-5 Differences in energy consumption and CO_2 emissions between the Reference and the Sectoral (National) Approach from CRF Table1.A(c). The difference is calculated according to [(RA-SA)/SA] 100% with RA = Reference Approach, SA = Sectoral (National) Approach. Energy consumption: excluding non-energy use and feedstocks

Difference between Reference and Sectoral Approach										
	1990	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**
	%									
Energy Consumption	0.73	0.84	0.76	0.74	1.11	2.08	0.54	0.45	0.93	0.17
CO_2 Emissions	0.58	0.63	0.55	0.60	1.05	2.09	0.37	0.35	0.95	0.10

	2000	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**
	%									
Energy Consumption	0.06	0.81	0.15	0.37	0.72	0.11	0.77	0.70	0.65	0.80
CO_2 Emissions	-0.07	0.73	0.09	0.24	0.67	0.00	0.81	0.74	0.68	0.91

	2010
	%
Energy Consumption	0.82
CO_2 Emissions	0.89

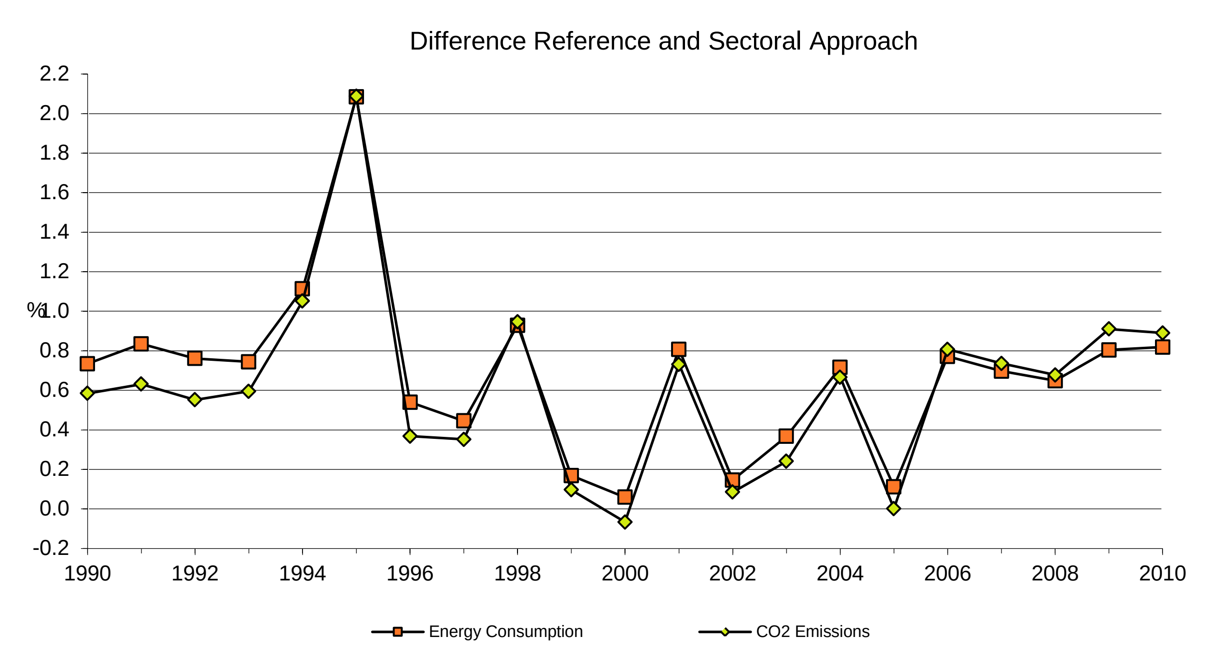

Figure 3-7 Time series for the differences between Reference and Sectoral Approach. Numbers are taken from Table 3-5.

After the major revision of the last submission (INFRAS 2010a), the calculation of the Reference Approach has been further improved in consistency and in agreement with the Swiss Federal Office of Energy.

3.2.2 International Bunker Fuels

3.2.2.1 Source Category Description

By definition, GHG emissions from the use of International Bunker Fuels are **not a key category** (IPCC 2000).

For Switzerland, the sources of international bunker emissions are primarily aviation, but there are also some marine bunkers occurring from the use of diesel oil for navigation activities on the river Rhine between Basel and Rotterdam (NL). Newly, this submission also includes bunkers of the two international Swiss lakes (Lake of Geneva, Lake of Constance).

Table 3-6 Specification of Swiss source category International Bunkers.

International Bunker Fuels	Specification	Data Source
Civil Aviation	Country specific model (Tier 3a)	FOCA 2006, 2007, 2008, 2009, 2010, 2011
Marine Bunkers	Navigation on the Rhine river north to Basel (Tier 1) Navigation on foreign territory of the Lake of Geneva and Constance (Bodensee)	CARBURA 2010 SBS, URh, CGN (INFRAS 2011a)

3.2.2.2 Methodological Issues

The methodologies used are described in chapter 3.2.7.3, a). The emissions from civil aviation (domestic and international) are calculated with a Tier 3a method. The emission factors are country specific with one exception N_2O (IPCC default). The activity data of the bunker is summarised in Table 3-7 (see also Table 3-30).

Due to the detailed information about activity data, the resulting fuel consumption is considered complete. In spite of this, there remain small differences between the fuel consumption modelled bottom-up and the total fuel sold (SFOE 2011). In 1990, the modelled consumption adds up to 1.01 million tons, whereas 1.05 million tons were sold. The difference of 4% is considered to be acceptable, because discrepancies of 10% can easily result from fuelling strategies of airlines (FOCA investigation showed that airlines are calculating whether it is economically beneficial to refuel at a place with lower fuel prize.) In order to match the bottom up calculation with the fuel quantity sold, any occurring difference is attributed to international bunker emissions. The factor between calculated international fuel consumption and adjusted international fuel consumption is used to scale the bunker emissions linearly. For instance in 1990, the bunker fuel consumption and the emissions had to be expanded by the factor 1.045. For 2006, they had to be reduced by the factor 0.974 (FOCA 2007). For 2010, the correction factor was 0.969 (FOCA 2010). For the more recent years, the modelled and actual total fuel sales are listed in Table 3-6a.

Table 3-6a Comparison between modelled and actual fuel sales in bunker fuel consumption for aviation.

Modelled and actual fuel sales	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**
	t					
Modelled domestic fuel sales	38'754	38'550	43'968	37'627	39'626	39'252
Modelled international fuel sales	1'152'614	1'196'731	1'287'062	1'391'656	1'345'919	1'395'428
Total modelled fuel sales (FOCA)	1'191'368	1'235'281	1'331'030	1'429'283	1'385'545	1'434'680
Actual fuel sales (GEST)	1'148'131	1'203'868	1'289'152	1'382'835	1'324'224	1'390'824
Difference between FOCA and GEST	3.8%	2.6%	3.2%	3.4%	4.6%	3.2%
Correction factor	0.962	0.974	0.968	0.966	0.954	0.969

Emissions from marine bunkers are calculated with a Tier 1 method. The emission factors are country specific and in accordance with Table 3-3. Activity data of these bunkers is summarised in Table 3-7.

Since there is an exemption from the existing fuel taxation, activity data on marine river bunkers on the Rhine are well documented by the customs administration as well as by CARBURA, the Swiss organisation for the compulsory stockpiling of oil products. From the latter, coherent data series are used. A comparison with the data by the customs administration over a period of 13 years reveals very high correlation. Therefore data on marine bunkers is considered to be consistent.

Activity data for the marine lake bunkers are not very well documented for the whole time series. Data from 1995 on have been provided by the three concerned companies. For older data proxies, such as passenger data on a national basis had to be consulted. As marine lake bunkers provide only a minor share of the total marine bunkers this approach seems to be justifiable.

Table 3-7 International bunker fuels. Consumption of kerosene and diesel oil in TJ. (Note that Liechtenstein's kerosene consumption is subtracted, see Chapter 3.1.5.)

Civil Aviation and Marine Navigation (bunker)	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
	Fuel consumption in TJ									
Total international aviation(1A3ai)	41'884	40'872	43'499	45'342	46'840	49'918	51'975	53'983	56'599	60'805
Total marine bunkers (1A3di)	812	750	765	763	826	755	671	662	504	554
Total	42'696	41'623	44'265	46'105	47'666	50'673	52'646	54'645	57'103	61'360
1990 = 100%	100%	97%	104%	108%	112%	119%	123%	128%	134%	144%

Civil Aviation and Marine Navigation (bunker)	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
	Fuel consumption in TJ									
Total international aviation(1A3ai)	63'687	60'097	55'468	49'763	46'896	47'671	50'109	53'543	57'844	55'238
Total marine bunkers	494	427	353	434	439	495	465	481	443	434
Total	64'181	60'524	55'820	50'196	47'335	48'166	50'574	54'024	58'287	55'671
1990 = 100%	150%	142%	131%	118%	111%	113%	118%	127%	137%	130%

Civil Aviation and Marine Navigation (bunker)	2010
	F. c. in TJ
Total international aviation(1A3ai)	58'118
Total marine bunkers	446
Total	58'563
1990 = 100%	137%

3.2.2.3 Uncertainties and Time-Series Consistency

See remarks in Chapter 3.2.8.3, sections Aviation (1A3a).

3.2.2.4 Source-Specific QA/QC and Verification

The time series have been compared between the current and the previous submission as well as available energy data. All activity data, implied emission factors and emissions undergo the triple check:

- the results for 2010 are compared with the results 2009 within the current CRF
- the CRF tables for the year 2009 are compared between the current CRF tables and the CRF tables of submission 2011.
- the CRF tables for the base year 1990 are compared between the current CRF tables and the CRF tables of submission 2011

3.2.2.5 Source-Specific Recalculations

Marine Bunkers from navigation on the two international lakes of Geneva and Constance are reported for the first time with this submission.

3.2.2.6 Source-Specific Planned Improvements

No further planned improvements.

3.2.3 Feedstocks and Non-Energy Use of Fuels

The following feedstocks and fuels used for non-energy purposes are listed in the Swiss energy statistics (SFOE 2011) and reported in CRF Table 1A (d) as feedstocks and non-energy use:

- bitumen,
- lubricants,

- other fuels containing: other petrols, other diesels, paraffin & waxes, petroleum coke and white spirit.

3.2.4 CO_2 Capture from Flue Gases and Subsequent CO_2 Storage if Applicable

(Not applicable for Switzerland.)

3.2.5 Country-Specific Issues

3.2.5.1 Oxidation Factors

For the calculation of CO_2 emissions, an oxidation factor of 100% is assumed for all fossil fuel combustion processes (including coal). A first reason is that technical standards for combustion installations in Switzerland are high. A second reason is that the small fraction of originally non-oxidised carbon retained in ash, particulates or soot is likely to be oxidized later naturally due to degradation processes.

As the fuel consumption of gaseous fuels strongly increased (1990 to 2010: +83.7% to 126'017 TJ), overestimating of oxidation factors for gaseous fuels would tend to overestimate emission increase and would therefore be conservative. As the consumption of liquid fuels decreased (1990 to 2010: -3.5% to 448'689 TJ) overestimating of oxidation factors for liquid fuels would tend to overestimate emission reduction and would therefore not be conservative. Because of the reasons mentioned above for the assumption of an oxidation factor of 100%, the possible overestimation of emission decrease is considered to be of minor importance.

For coal, IPCC 1996 provides a global average oxidation factor of 98.0%. However, a large share of coal in Switzerland is used in cement industry. In cement production, an oxidation factor of 100% is assumed according to EU guidelines (EC 2004).

The consumption of coal plays a minor role in Switzerland. It decreased over the considered period (1990 to 2010 by -58.5% to 5'933 TJ). In case of a decrease, overestimating of oxidation factors may tend to overestimate emission decrease. However, the main remaining consumer of coal in Switzerland is the cement industry that accounts for 77% of total Swiss coal consumption in 2010 (EMIS 2012/1A2fi Zementwerke Feuerung). With a large share of coal used in cement production, and under the assumption of high efficiency coal boilers, the overestimation of emission decrease may become minor.

Therefore, for all fuel combustion activities, an oxidation factor of 100% is assumed in Switzerland.

3.2.5.2 CO_2 from Biomass

A description of the methodology for calculating CO_2 emissions from the combustion of biomass is included in the relevant Chapters 3 (Energy) and 8 (Waste).

Energy related emissions from municipal solid waste (MSW) incineration plants are reported under 1A1 Energy Industries (see Section 3.2.6.1). With the present submission, biogenic CO_2 emissions from the share of organic matter in municipal solid waste are now reported in the CRF tables in the biomass fuel category. The following CO_2 emissions are not foreseen for reporting in the CRF: 2D2 (Industrial Processes, Food and Drink), 3D5 (Other – consumption of tobacco), 4F (Field Burning of Agricultural Residues), 6A (Solid Waste Disposal on Land) and 6D (composting and fermentation of waste).

Therefore, the CO_2 emissions from biomass in the CRF are incomplete. The following table provides an overview of effective biomass CO_2 emissions in Switzerland in 2010 and their reporting in the CRF (without land-use, land-use change and forestry). Data is provided from the CRF and the SAEFL internal GHG files.

Biomass CO_2 emissions do not count for the national total emissions and are a memo item only.

Table 3-8 Effective biomass CO_2 emissions in Switzerland in 2010 and their representation in the CRF.

Biomass CO_2 emissions	**Unit**	**2010**	**Note**
1A1 Energy Industries (without MSW incineration)	Gg	356	Included in CRF
1A1 Energy generation from MSW Incineration	Gg	2'507	Included in CRF
1A2d Use of waste derived fuels in cellulose production	Gg	0	Included in CRF
1A2f Manufacturing Industry and Construction	Gg	1'208	Included in CRF
thereof use of waste derived fuels in cement production	Gg	189	
1A3 Transport	Gg	41	Included in CRF
1A4 Other Sectors (Commercial/Institutional, Residential)	Gg	2'534	Included in CRF
2D Industrial Processes, Other (food and drink, charcoal)	Gg	16	Not included in CRF
3D Other (consumption of tabacco)	Gg	14	Not included in CRF
4F Agriculture, Burning of Residues	Gg	116	Not included in CRF
6A Solid Waste Disposal on Land	Gg	31	Not included in CRF
6B Wastewater Handling	Gg	131	Not included in CRF
6C Waste Incineration (without MSW incineration)	Gg	105	Included in CRF
6D Other Waste (compost and fermentation of waste)	Gg	370	Not included in CRF
Total biomass combustion CO_2 emissions included in CRF	Gg	6'751	
Total energy related biomass combustion CO_2 emissions included in CRF 1A	Gg	6'641	See table "Summary 2" in CRF
Total biomass CO_2 emissions in Switzerland 2010	Gg	7'428	

3.2.5.3 Wood firing

In the Energy Sector 1A (sub-categories 1A1, 1A2, 1A4), the NO_x, CO, CH_4, and NMVOC emission factors for wood combustion processes are based on a study for wood combustion (EMIS 2012/1A solid fuels/wood) and depend on the specific wood firing system, see table below. The categories of wood combustion units have been restructured and specified according to the Swiss wood energy statistics (SFOE 2011b), see Table 3-9.

Table 3-9 Range of values of emission factors for wood firing

	Unit	**CH_4**	**NO_x**	**CO**	**NMVOC**
Wood combustion	g/GJ	2.9 – 240	61 – 220	146 – 4830	7 – 550

Table 3-10 New categories of wood firing systems based on SFOE 2011b

Wood combustion, categories
Open fireplaces
Closed fireplaces, log wood stoves
Pellet stoves
Log wood hearths
Log wood boilers
Log wood dual chamber boilers
Automatic chip boilers < 50 kW
Automatic pellet boilers < 50 kW
Automatic chip boilers 50-500 kW w/o wood processing companies
Automatic pellet boilers 50-500 kW
Automatic chip boilers 50-500 kW within wood processing companies
Automatic chip boilers > 500 kW w/o wood processing companies
Automatic pellet boilers > 500 kW
Automatic chip boilers > 500 kW within wood processing companies
Combined chip heat and power plants
Plants for renewable waste from wood products

3.2.6 Source Category 1A1 - Energy Industries

3.2.6.1 Source Category Description

Tier 1 Key categories 1A1
CO_2 from the combustion of Liquid Fuels (level and trend)

CO_2 from the combustion of Gaseous Fuels (level and trend) CO_2 from the combustion of Other Fuels (level and trend)

Tier 2 Key categories 1A1
CO_2 from the combustion of Other Fuels (level and trend)

According to IPCC guidelines, source category 1A1 “Energy Industries” comprises emissions from fuels combusted by fuel extraction and energy producing industries.

In Switzerland, fuel extraction is not occurring and 1A1 includes only emissions from the production of heat and/or electricity for sale to the public. Energy Industries (source category 1A1) therefore comprise:

- “Public Electricity and Heat Production” including heat and power production in municipal solid waste incineration plants and special waste incineration (1A1a)
- “Petroleum Refining” (1A1b).
- Manufacture of Solid Fuels and Other Energy Industries (1A1c) does not occur.

Emissions from the industry producing heat and/or electricity for their own use are included in category 1A2 “Manufacturing Industries and Construction”. Emissions from producers of heat and/or power for their own use in waste incineration plants, however, are included in 1A1.

In Switzerland, electricity production is dominated by hydroelectric power plants (56.5%) and nuclear power stations (38%). Other sources such as (fossil fuelled) combined heat and power generation, and power generation from solar, wind and biomass account only for about 5.5% of the electricity generated in Switzerland (SFOE 2011; table 24; data for the year 2010).

Table 3-11 Specification of source category 1A1 “Energy Industries”

1A1	Source	Specification	Data Source
1A1a	Public Electricity and Heat Production	Main source are waste incineration plants with heat and power generation (Other fuels) and public district heating systems, including a small fraction of CHP. The only fossil fuelled public electricity generation unit “Vouvry” (300 MW_e; no public heat production) ceased operation in 1999.	Waste incineration: AD: FOEN 2011f; EMIS 2012/1A1a EF: SAEFL 2005g; EMIS 2012/1A1a Other sources: AD: SFOE 2011: SFOE 2011a; SFOE 2011b; EV 2011; EMIS 2012/1A1a EF: SAEFL 2000; SFOE 2001; EMIS 2012/1A1a, EMIS 2012/1A solid fuels/wood
1A1b	Petroleum Refining	Combustion activities supporting the refining of petroleum products, excluding evaporative emissions.	AD: EV 2011, SFOE 2011; EMIS 2012/1 Energy model EF: Industry data; EMIS 2012/Energy model
1A1c	Manufacture of Solid Fuels and Other Energy Industries	Not occurring in Switzerland	-

3.2.6.2 Methodological Issues

a) Public Electricity and Heat Production (1A1a)

The public electricity and heat production in Switzerland includes:

- Fossil fuel combustion of light fuel oil, heavy fuel oil, natural gas and coal.
- Waste-to-energy through the incineration of municipal solid waste and special waste (Other fuels)
- Biomass combustion includes wood and renewable waste (excluding biomass in municipal solid waste) and biogas generation from co-generation of landfills and fermentation engines

Methodology

Except for waste incineration, the method used for fuel combustion in Public Electricity and Heat Production (1A1a) is a country specific Tier 2 method. A top-down approach based on aggregated fuel consumption data from the Swiss overall energy statistics is used to calculate emissions. These sources are characterised by rather similar industrial combustion processes and the same emission factors are applied throughout these sources. Emissions of GHGs are calculated by multiplying fuel consumption (in TJ) by emission factors.

For waste incineration, the method used is a country specific method. For heat and/or power generation in municipal solid waste and special waste incineration plants the GHG emissions are calculated by multiplying the waste quantity incinerated by emission factors.

For wood combustion in district combined heat and power units and plants for renewable waste from wood products the GHG emissions are calculated by multiplying the used wood chips and wood waste quantities by emission factors.

For fermentation engines and co-generation on landfills the GHG emissions are calculated by multiplying quantities of combusted CH_4 by emission factors.

An oxidation factor of 100% is assumed for all combustion processes and fuels (see sub-section on oxidation factors in 3.2.5.1).

Emission Factors

(a) Waste incineration with heat and/or power generation (reported under "Other fuels")
Emission factors for CO_2, N_2O, NO_x, CO, NMVOC and SO_2 emissions per ton of waste incinerated are country specific based on measurements and expert estimates, documented in the EMIS database (EMIS 2012/1A1a Kehricht- und Sondermüllverbrennungsanlagen). Emission factors are taking into account flue gas cleaning standards in incineration plants. CH_4 is not occurring because of the high combustion temperatures in waste incineration plants. A recent study evaluated the waste incinerated in Switzerland (national and imported waste). Based on this information, the share of organic matter in the waste incinerated in MSW incineration plants is estimated to be 53.1% based on analysis of EMPA (EMIS 2012/1A1a Kehrichtverbrennungsanlagen). In addition as mentioned in the Section Waste a detailed analysis was realised to provide more information on emission factors and activity data of digesting organic waste. The results have been included in this submission (see Recalculations). The burn-out efficiency in modern municipal solid and hazardous waste incineration plants is very high.

(b) Other Public Electricity and Heat Production
The emission factors for CO_2 are country specific and based on measurements and analysis of fuel samples carried out by the Swiss Federal Laboratories for Materials Testing, Research EMPA and Intertek (EMPA 1999; Intertek 2008; carbon emission factor

documented in SFOE 2001, Table 45: p. 51; net calorific values on p. 61. See also Annex 2.1.1).

The activity data on LFO use in the CRF includes LPG consumption. This is due to statistical reasons in the Swiss overall energy statistics (SFOE 2011). Therefore the LFO emission factor for CO_2 used for the CRF (see table below) results as a weighted average of the gas oil emission factor and LPG emission factor.

Emission factors for CH_4, NO_x, CO and NMVOC are country specific based on comprehensive life cycle analysis of industrial boilers, documented in SAEFL 2000 (pp. 14-27). For NO_x emission factors, expert judgement has been used to estimate the fraction of low-NO_x burners. The emission factors for NO_x and CO for natural gas and light fuel oils have been recalculated for the time series based on a new study as documented in EMIS (EMIS 2012/1 Energy Model).

For the related N_2O emissions the default emission factors from IPCC 1997c have been used.

Emission factors for co-generation from landfills and fermentation engines are considered to be the same as for natural gas engines in commercial and institutional buildings (EMIS 2012/1 Energy Model). Emission factors for the use of wood in district combined heat and power units as well as for plants for renewable waste from wood products are based on SAEFL 2000 (pp.26) and a new study for wood use in the sector 1A (EMIS 2012/1A solid fuels/wood). Categories for the use of wood in the 1A sector have been restructured on the basis of the Swiss wood energy statistics (SFOE 2011b), and recalculated for the entire time series with this submission.

The following table presents the emission factors used in 1A1a:

Table 3-12 Emission Factors for 1A1a Public Electricity and Heat Production in Energy Industries in 2010. Emission factors for waste incineration are provided per ton of waste incinerated for both municipal solid waste incineration and special waste incineration.

1A1a Public Electricity/Heat	CO_2	CO_2 bio.	CH_4	N_2O	NO_x	CO	NMVOC	SO_2
	t/TJ	t/TJ	kg/TJ	kg/TJ	kg/TJ	kg/TJ	kg/TJ	kg/TJ
Light fuel oil	73.5		1.0	0.6	36	7	2.0	24
Heavy fuel oil	77.0		4.0	0.8	125	15	4.0	291
Natural gas	55.0		6.0	0.1	19	11	2.0	0.5
Other (waste-to-energy), fossil	99.4		NA	5.9	32	7	1.2	4
Other (waste-to-energy), biogenic		105.4	NA	6.3				
Biomass (wood, renewable waste)		92.0	2.9	1.6	168	292	6.7	20
Biogas (co-generation from landfills, fermentation engines)		98.6	59	0.005	49	67	2.7	14

In the table above, the CO_2 emission factor of light fuel oil (73.5 t/TJ) is a weighted average emission factor including both gas oil (73.7 t/TJ) and LPG (65.5 t/TJ) emissions.

The emission factor of CO_2 from Other Fuels (99.4 t/TJ) has considerably increased compared to the last submission and is exceptionally high compared to the emission factors of other countries. In the present submission, the calculation method of the emissions of waste incineration has changed. In previous submissions, the split between fossil and biogen matter was realised through the split of the CO_2 emission factor in fossil and biogen. To this “adjusted” emission factor, the total amount of waste energy content was applied to get the activity data from waste incineration.

Previous submissions:

$Emissions_{fossil} = EF_{fossil} \times AD_{total}$; $Emissions_{biogen} = EF_{biogen} \times AD_{total}$

Where:

$EF_{fossil} = EF_{total} \times P_{fossil}$ (P = percentage of fossil vs. biogen)

$EF_{biogen} = EF_{total} \times (1-P_{fossil})$ (P = percentage of fossil vs. biogen)

$EF_{total} = EF_{fossil} + EF_{biogen}$

In this submission, the split between fossil and biogen matter was realised on the activity data and a general emission factor for both (fossil and biogen) was applied.

Current submission:

$Emissions_{fossil} = EF_{total} \times AD_{fossil}$; $Emissions_{biogen} = EF_{total} \times AD_{biogen}$

Where:

$AD_{fossil} = AD_{total} \times P_{fossil}$ (P = percentage of fossil vs. biogen)

$AD_{biogen} = AD_{total} \times (1-P_{fossil})$ (P = percentage of fossil vs. biogen)

$AD_{total} = AD_{fossil} + AD_{biogen}$

The final result of the emission is the same as the previous years.

Previous submissions:

$Emissions_{total} = Emissions_{fossil} + Emissions_{biogen} = (EF_{fossil} \times AD_{total}) + (EF_{biogen} \times AD_{total}) = (EF_{fossil} + EF_{biogen}) \times AD_{total} = EF_{total} \times AD_{total}$

Current submissions:

$Emissions_{total} = Emissions_{fossil} + Emissions_{biogen} = (EF_{total} \times AD_{fossil}) + (EF_{total} \times AD_{biogen}) = EF_{total} \times (AD_{fossil} + AD_{biogen}) = EF_{total} \times AD_{total}$

This change in the calculation method implies that the emission factor increased significantly as it now combines the fossil and biogen matter (EMIS 2012/1A1a Kehrichtverbrennungsanlagen, EMIS2012/1A1aSondermüllverbrennungsanlagen).

The emission factor for N_2O from Other Fuels is exceptionally high with 5.87 kg/TJ. The value is considerably higher than in other countries and as the IPCC default value. This is because Swiss waste incineration plants include catalytic after-treatment and dispose of DeNOx-installations which produce N_2O as a by-product. Because of that, the emission factor for N_2O doubled between 1990 and 2003. Since then, it is decreasing based on improved DeNOx-equipments. It is expected that the N_2O emission factor will further decrease until 2020 (EMIS 2012/1A1a Kehrichtverbrennungsanlagen).

Activity Data

(a) Municipal solid waste incineration ("Other fuels")

Municipal solid waste includes waste generated in households and waste from other sources of similar composition. Energy recovery from municipal solid waste incineration is mandatory in Switzerland and plants are equipped with energy recovery systems (Schwager 2005). The emissions from heat and/or power generation in municipal solid waste incineration plants are therefore reported under category 1A1a[7]. Included are also emissions from the incineration of special waste, because these plants are also equipped with energy recovery systems. Activity data for waste incineration is taken from FOEN 2011f and provided in the table below.

Special waste is composed by hazardous waste with high calorific value, wastewater and sludge with organic load, inorganic solids and dusts, inorganic sludge containing heavy metals, acids and alkalis, PCB-containing wastes, non-metallic shredder residues, contaminated soil, filter materials and chemicals residues and others.

[7] In earlier submissions, some of the emissions from municipal solid waste incineration have been reported also under category 6C.

Table 3-13 Activity data for 1A1a "Other fuels": municipal solid waste and special waste incinerated with heat and/or power generation 1990 to 2010.

Source/fuel	Unit	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
1A1a Other fuels											
Total Other fuels in 1A1a	Gg	2'603	2'477	2'467	2'441	2'411	2'433	2'471	2'535	2'655	2'824
Municipal solid waste	Gg	2'470	2'340	2'310	2'310	2'250	2'270	2'290	2'337	2'419	2'586
Special waste	Gg	133	137	157	131	161	163	181	198	237	238

Source/fuel	Unit	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
1A1a Other fuels											
Total Other fuels in 1A1a	Gg	3'040	3'163	3'258	3'226	3'366	3'527	3'896	3'816	3'865	3'827
Municipal solid waste	Gg	2'801	2'936	3'027	2'995	3'135	3'297	3'646	3'580	3'610	3'597
Special waste	Gg	239	227	232	231	231	230	250	236	255	230

Source/fuel	Unit	2010
1A1a Other fuels		
Total Other fuels in 1A1a	Gg	3'968
Municipal solid waste	Gg	3'717
Special waste	Gg	252

The table above documents the increase by 50% of municipal solid waste incinerated from 1990 to 2010. This is due to the fact that since 1st of January 2000, disposal on landfill sites of waste which can be incinerated is prohibited by law. See also Chapter 8.4 on Waste Incineration. This increase results in CO_2 emissions from "Other fuels" in category 1A1 being a key category regarding trend. The increase is also partly due to municipal solid waste imported from neighbouring countries to optimize the load factor of MSW incineration plants.

Other Public Electricity and Heat Production

Activity data on fuel consumption (TJ) for Public Electricity and Heat Production (1A1a) is extracted from the Swiss overall energy statistics. The activity data for 2010 correspond to the consumption of LFO, HFO and natural gas (SFOE 2011; tables 21, 26, and 28; EV 2011). "Other fuel" is calculated from the annual amount of municipal solid waste incinerated with heat and/or electricity (seeTable 3-13).

Activity data for co-generation from landfills and fermentation engines is taken from the Swiss renewable energies statistics (SFOE 2011a).

Activity data for wood for district combined heat and power units and for plants for renewable waste from wood products are taken from the Swiss wood energy statistics (SFOE 2011b).

Table 3-14 Activity data in 1A1a Public Electricity/Heat.

1A1a Public Electricity /Heat	Unit	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Total fuel consumption	TJ	40'284	41'590	43'486	38'664	38'135	39'092	42'023	42'843	48'101	49'220
Light fuel oil	TJ	980	1'790	1'917	1'662	810	554	810	1'065	852	1'065
Heavy fuel oil	TJ	3'195	5'006	6'336	1'748	1'541	1'791	2'420	1'063	4'093	1'227
Natural gas	TJ	4'274	4'708	4'672	4'636	4'734	5'327	6'597	6'960	6'807	9'075
Coal	TJ	484	102	102	76	76	51	0	0	0	0
Other (waste-to-energy), fossil	TJ	13'874	13'363	13'718	13'379	13'842	14'029	14'492	15'396	16'899	17'514
Other (waste-to-energy), biogenic	TJ	16'895	16'006	15'967	16'216	16'038	16'235	16'419	17'265	18'386	19'270
Biomass (wood, renewable waste)	TJ	301	297	360	404	441	466	636	466	431	412
Biogas (co-generation from landfills, fermentation engines)	TJ	282	320	414	542	653	639	650	629	633	657

1A1a Public Electricity /Heat	Unit	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Total fuel consumption	TJ	49'596	51'790	52'699	53'859	54'928	57'172	60'493	58'531	60'410	60'136
Light fuel oil	TJ	810	852	810	1'065	810	1'321	1'278	810	469	554
Heavy fuel oil	TJ	0	371	377	455	350	289	297	0	0	0
Natural gas	TJ	8'192	8'537	8'755	9'699	9'674	9'711	8'553	7'800	8'339	7'951
Coal	TJ	0	0	0	0	0	0	0	0	0	0
Other (waste-to-energy), fossil	TJ	18'564	18'995	19'321	19'559	20'492	21'551	24'023	23'770	24'687	24'502
Other (waste-to-energy), biogenic	TJ	20'807	21'814	22'164	21'740	22'294	22'956	24'857	24'031	23'858	23'395
Biomass (wood, renewable waste)	TJ	547	583	689	774	813	844	939	1'457	2'309	2'873
Biogas (co-generation from landfills, fermentation engines)	TJ	677	637	584	567	496	500	546	663	749	861

1A1a Public Electricity /Heat	Unit	2010
Total fuel consumption	TJ	63'968
Light fuel oil	TJ	512
Heavy fuel oil	TJ	52
Natural gas	TJ	9'830
Coal	TJ	0
Other (waste-to-energy), fossil	TJ	25'978
Other (waste-to-energy), biogenic	TJ	23'786
Biomass (wood, renewable waste)	TJ	2'956
Biogas (co-generation from landfills, fermentation engines)	TJ	854

The table above shows that Other fuels are the major component with 78% of the total fuel consumptions. The fossil fuels contribute with a total of 16% while natural gas has the major contribution. Biomass and Biogas contribute with 6% to the total fuel consumption.

The table above documents the increase of Other Fuel consumption (fossil) by 87% from 1990 to 2010. This increase is one of the reasons for category 1A1 Other Fuels – CO_2 being a key category regarding trend. The consumption of Natural Gas increased by 30% and the consumption of liquid fuels decreased by 48% for light fuel oil and 99% for heavy fuel oil. These developments show why the CO_2 emissions from liquid, gaseous and other fuels are key categories in this submission.

b) Petroleum Refining (1A1b)

Methodology

For fuel combustion in Petroleum Refining (1A1b), a country specific Tier 2 bottom-up method is used. The calculations are generally based on measurements and data from individual sources from the refining industry. The greenhouse gas emissions are calculated by multiplying the fuel consumption by the respective emission factor.

Emission Factors

Emission factors for CO_2, CH_4, N_2O, CO, NMVOC and SO_2 are country specific based on measurements and data from industry and expert estimates, documented in the EMIS database (EMIS 2012/1 Energy model) and in SAEFL 2000.

The following table presents the emission factors used in 1A1b:

Table 3-15 Emission Factors for 1A1b Petroleum Refining in 2010.

Source/fuel	CO_2	CH_4	N_2O	NO_x	CO	NMVOC	SO_2
	t/TJ	kg/TJ	kg/TJ	kg/TJ	kg/TJ	kg/TJ	kg/TJ
1A1 b Petroleum Refining							
Heavy fuel oil	77	4	0.8	110	15	2.5	490
Gas (refinery LPG)	59.3	1	0.6	55	15	2.3	25
P-Coke	91.4	10	1.6	200	100	10.0	500

Activity Data

Activity data on fuel combustion (TJ) for Petroleum Refining (1A1b) is extracted from the Annual Reports of the Swiss Petroleum Association (EV 2011).

Table 3-16 Activity data for 1A1b Petroleum Refining.

Source/fuel	Unit	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
1A1b Petroleum Refining Fuel Consumption											
Total	TJ	5'906	8'670	8'137	9'290	10'679	10'317	11'092	10'693	11'022	11'353
Heavy fuel oil	TJ	1'296	1'216	998	1'054	1'426	1'834	1'618	1'780	1'428	1'698
Gas (refinery LPG)	TJ	4'610	7'454	7'139	8'237	9'253	8'483	9'474	8'913	9'594	9'655
Petroleum coke	TJ	0	0	0	0	0	0	0	0	0	0

Source/fuel	Unit	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
1A1b Petroleum Refining Fuel Consumption											
Total	TJ	10'091	10'909	11'447	10'525	14'360	14'579	15'998	13'640	15'089	14'406
Heavy fuel oil	TJ	1'952	1'936	1'518	1'769	1'339	906	692	1'159	707	742
Gas (refinery LPG)	TJ	8'139	8'973	9'929	8'756	11'901	11'678	13'311	10'766	11'687	11'424
Petroleum coke	TJ	0	0	0	0	1'120	1'995	1'995	1'715	2'695	2'240

Source/fuel	Unit	2010
1A1b Petroleum Refining Fuel Consumption		
Total	TJ	14'115
Heavy fuel oil	TJ	895
Gas (refinery LPG)	TJ	11'015
Petroleum coke	TJ	2'205

The table above documents the increase of gas (refinery LPG) consumption for petroleum refining by 139% from 1990 to 2010 and is therefore key category in the present submission. This is explained by the fact that in 1990 one of the two Swiss refineries operated at reduced capacity and in later years resumed full production, leading to higher fuel consumption in the following years.

Since 2004, one of the Swiss refineries is using petroleum coke as a fuel.

3.2.6.3 Uncertainties and Time-Series Consistency

Overview of uncertainty in aggregated fuel consumption activity data (1A1 Fuel Combustion):

Details of uncertainty analysis of activity data (fuel consumption) in 1A1 are provided in the table below. For each fuel type, uncertainties of net import or net production data (column C) and uncertainties of stock changes (if applicable) have been estimated. From this, the combined uncertainty of final consumption of fuels has been calculated (column H).

Table 3-17 Details of uncertainty analysis of fuels in 1A1.

A	B	C	D	E	F	G	H	I
Fuel type (IPCC 2000)	Corresponding fuel type in SFOE 2010	Net import/ net production Input data =Import-Export	Import/ production data uncertainty Input data	Correction for stock changes etc. =G-C	Correction uncertainty Input data	Consumption Input data	Final consumption uncertainty =WURZEL((C*D)^2+(E*F)^2)/G	Comment
		[TJ]	[%]	[TJ]	[%]	[TJ]	[%]	
Liquid fuels	Erdölprodukte	405'862	1.0	44'980	20	450'842	2.2	1
Gaseous fuels	Gas	126'010	2	0	0	126'010	2.0	2
Solid fuels	Kohle	5'530	5	890	100	6'420	14.5	3
Other fuels	Müll- und Industrieabfälle	54'640	10	0	0	54'640	10.0	4

Comments:

1 Col. D: Expert estimate from carbura (email M. Ruffer 24.1.05; overall uncertainty has been doubled to account for 95% interval). - Col. F: Conservative interpretation of rough expert estimate from carbura ("one-digit uncertainty", i.e. 10% is one sigma, resulting in unc = 2*sigma = 20%).

2 Col. D: 2% is GPG default value for developed countries siehe unten

3 Col. D: 5% is GPG default value for developed countries (IPCC 2000 p. 2.1). - Col. G:expert estimate

4 Col. D: An uncertainty of amount of waste of 10% is assumed (expert judgement), because waste input is reasonably well measured since the nineties.

Data on stock changes is taken from the Swiss overall energy statistics (SFOE 2011; Table 4). Accordingly, also net import/net production data were taken from the Swiss overall energy statistics for the present uncertainty analysis.

Uncertainty in CO_2 emission factors in fuel combustion (1A1)

Liquid fuels: Total uncertainty of net calorific values for liquid fuels is taken as a proxy for the uncertainty of the CO_2 emission factor of liquid fuels. Net calorific values are based on the determination of the gross calorific value and the calculation of the net calorific value by the Swiss Federal Laboratories for Materials Testing and Research EMPA. To this aim, a set of fuel samples of different sources has been selected that is representative for the fuels traded in Switzerland in the year 1998. Assuming that this data on the uncertainty of the net calorific value is representative for the uncertainty of the emission factors in fuel combustion, a combined uncertainty of 0.51% (defined as two standard deviations, STD) results for the emission factor. In 2008, an extended measurement programme was conducted for the country-specific net calorific values (NCVs) and EFs for liquid fuels (Intertek 2008). The results of this programme have confirmed the values from 1998 and the assumption of constant NCVs for fuels sold within Switzerland.

Table 3-18 Results from the analysis of the low calorific values of liquid fuels in Switzerland (EMPA 1999).

Fuel	Net calorific value liquid fuels						
	Mean [GJ/t]	STD [GJ/t]	STD [%]	Uncertainty [%]	=(C*G)^2 [GJ^2/t^2]	No. of samples []	Share 2010 (approx.)
Heavy fuel oil	41.2	0.85	2.06	4.13	0.000019	6	1%
Light fuel oil	42.6	0.13	0.31	0.61	0.003421	10	45%
Diesel	42.8	0.10	0.23	0.47	0.000518	10	23%
Gasoline	42.5	0.29	0.68	1.36	0.008043	30	31%
Jet kerosene	43.0	0.25	0.58	1.16	0.000003	10	1%
Sum	42.6				0.012005	66	100%
Combined STD/Unc		0.110 =SQR(sum(E))	0.26	0.51			

Gaseous fuels: The uncertainty of the emission factor for CO_2 has been derived from data on measurements of the low calorific value of natural gas in the grid. SGWA (2007) provides a range of -2.3% and +2.3%. Interpreting 2.3% as one standard deviation, an uncertainty of 4.6% results (i.e. two standard deviations).

Solid fuels: For the uncertainty of the emission factor for CO_2, the IPCC Good Practice Guidance default value of 5% for countries with well-developed energy data systems is used (IPCC 2000: p. 2.15).

Other fuels (waste to energy): The dominant factor influencing the uncertainty of CO_2 emissions from municipal solid waste incineration (1A1) is the fraction of fossil carbon in the waste. For the fraction of C in incinerated waste an uncertainty of 20% has been estimated, and for the fraction of fossil C in total C an uncertainty of 10% has been estimated, resulting in a preliminary uncertainty estimate of 30% for the waste incineration CO_2 emission factor (SAEFL 2005h).

Resulting uncertainty in CO_2 emissions in fuel combustion (1A1)

The table below provides the results of the quantitative Tier 1 analysis [following Good Practice Guidance; IPCC (2000): p. 6.13ff] estimating uncertainties of CO_2 emissions from fuel combustion activities.

Table 3-19 Results from Tier 1 uncertainty calculation and reporting for CO_2 emissions in 1A Fuel Combustion.

A	B	C	D	E	F	G	H	I	J	K	L	M
IPCC Source category	Gas	Base year emissions 1990	Year 2010 emissions	Activity data uncertainty	Emission factor uncertainty	Combined uncertainty	Combined uncertainty as % of total national emission in year t	Type A sensitivity	Type B sensitivity	Uncertainty in trend in national emissions introduced by emission factor uncertainty	Uncertainty in trend in national emissions introduced by activity data uncertainty	Uncertainty introduced into the trend in total national emissions
1A11. Energy A. Fuel Combustion 1. Energy IndustriesGaseous Fuels	CO2	235.05	540.64	2.0	4.6	5.0	0.051	0.0058	0.0110	0.03	0.03	0.04
1A11. Energy A. Fuel Combustion 1. Energy IndustriesLiquid Fuels	CO2	691.23	965.28	2.2	0.5	2.2	0.041	0.0044	0.0196	0.00	0.06	0.06
1A11. Energy A. Fuel Combustion 1. Energy IndustriesOther Fuels	CO2	1'519.73	2'582.10	10.0	30.0	31.6	1.530	0.0190	0.0525	0.57	0.74	0.94
1A11. Energy A. Fuel Combustion 1. Energy IndustriesSolid Fuels	CO2	44.84	0.00	14.5	5.0	15.4	0.000	-0.0010	0.0000	0.00	0.00	0.00
1A21. Energy A. Fuel Combustion 2. Manufacturing Industries and ConstructionGaseous Fuels	CO2	1'133.30	2'216.12	2.0	4.6	5.0	0.208	0.0201	0.0450	0.09	0.13	0.16
1A21. Energy A. Fuel Combustion 2. Manufacturing Industries and ConstructionLiquid Fuels	CO2	3'876.46	2'890.89	2.2	0.5	2.2	0.122	-0.0267	0.0587	-0.01	0.18	0.18
1A21. Energy A. Fuel Combustion 2. Manufacturing Industries and ConstructionOther Fuels	CO2	134.24	315.35	10.0	30.0	31.6	0.187	0.0034	0.0064	0.10	0.09	0.14
1A21. Energy A. Fuel Combustion 2. Manufacturing Industries and ConstructionSolid Fuels	CO2	1'227.96	520.65	14.5	5.0	15.4	0.150	-0.0165	0.0106	-0.08	0.22	0.23
1A3a1. EnergyA. Fuel Combustion 3. Transport; Civil Aviation	CO2	252.55	123.55	2.2	1.2	2.5	0.006	-0.0031	0.0025	0.00	0.01	0.01
1A3b1. EnergyA. Fuel Combustion 3. Transport; Road TransportationDiesel	CO2	2'587.68	6'154.63	2.2	0.5	2.2	0.258	0.0680	0.1251	0.03	0.39	0.39
1A3b1. EnergyA. Fuel Combustion 3. Transport; Road TransportationGasoline	CO2	11'335.25	9'744.97	2.2	1.4	2.6	0.471	-0.0517	0.1980	-0.07	0.61	0.62
1A3b1. EnergyA. Fuel Combustion 3. Transport; Road TransportationNatural Gas	CO2	0.00	39.05	3.5	3.5	5.0	0.004	0.0008	0.0008	0.00	0.00	0.00
1A3c1. EnergyA. Fuel Combustion 3. Transport; Railways	CO2	28.69	37.77	2.2	0.5	2.3	0.002	0.0001	0.0008	0.00	0.00	0.00
1A3d1. EnergyA. Fuel Combustion 3. Transport; Navigation	CO2	111.86	116.98	2.2	0.5	2.3	0.005	-0.0001	0.0024	0.00	0.01	0.01
1A3ei1. EnergyA. Fuel Combustion 3. Transport; Other non-specified	CO2	49.01	48.71	3.5	3.5	5.0	0.005	-0.0001	0.0010	0.00	0.00	0.00
1A4a1. Energy A. Fuel Combustion 4. Other Sectors; Commercial/InstitutionalGaseous Fuels	CO2	905.76	1'409.10	2.0	4.6	5.0	0.132	0.0087	0.0286	0.04	0.08	0.09
1A4a1. Energy A. Fuel Combustion 4. Other Sectors; Commercial/InstitutionalLiquid Fuels	CO2	4'429.39	3'607.89	2.2	0.5	2.2	0.152	-0.0243	0.0733	-0.01	0.23	0.23
1A4b1. Energy A. Fuel Combustion 4. Other Sectors; ResidentialGaseous Fuels	CO2	1'409.10	2'661.45	2.0	4.6	5.0	0.250	0.0230	0.0541	0.11	0.15	0.19
1A4b1. Energy A. Fuel Combustion 4. Other Sectors; ResidentialLiquid Fuels	CO2	10'226.25	8'688.23	2.2	0.5	2.2	0.366	-0.0487	0.1766	-0.03	0.55	0.55
1A4b1. Energy A. Fuel Combustion 4. Other Sectors; ResidentialSolid Fuels	CO2	54.59	33.60	14.5	5.0	15.4	0.010	-0.0005	0.0007	0.00	0.01	0.01
1A4c1. Energy A. Fuel Combustion 4. Other Sectors; Agriculture/ForestryGaseous Fuels	CO2	40.64	15.85	2.0	4.6	5.0	0.001	-0.0006	0.0003	0.00	0.00	0.00
1A4c1. Energy A. Fuel Combustion 4. Other Sectors; Agriculture/ForestryLiquid Fuels	CO2	547.00	519.96	2.2	0.5	2.3	0.022	-0.0015	0.0106	0.00	0.03	0.03
1A51. Energy A. Fuel Combustion 5. OtherLiquid Fuels	CO2	203.58	119.55	2.2	0.5	2.3	0.005	-0.0021	0.0024	0.00	0.01	0.01

Qualitative estimate of further uncertainties of non-CO_2 non-key category emissions in 1A Fuel Combustion

Uncertainty in emissions of other non-CO_2 gases are estimated to be medium resulting in 30% for CH_4 and 80% for N_2O (see Table 1-13).

Consistency and Completeness in 1A1 Fuel Combustion

Consistency:

- Time series for 1A1 are all consistent.
- CO_2 emissions from biomass in 1 Energy (memo item) are only partly included in the CRF, see Section 3.2.5.

Completeness:

- All estimates in the sector 1A1 are assumed to be complete.

3.2.6.4 Source-specific QA/QC and Verification

a) General

At the level of total energy-related CO_2 emissions, a quality control consists in the comparison of emissions modelled using the Sectoral Approach with emissions calculated from fuel consumption according to the Swiss overall energy statistics of SFOE. The differences in total CO_2 emissions for the years 1990–2010 are negligible - indicating the completeness of the inventory.

The cross-check of the Reference and Sectoral Approach is also used for an assessment of emissions related to the consumption of fuels in the energy sector. Again, a good agreement between the two approaches is found (see Chapter 3.2.1).

The quality control activities have been documented in checklists as described in Chapter1.6

b) Specific Energy Industries (1A1a)

The time series have been compared between the current and the previous submission as well as available energy data. All activity data, implied emission factors and emissions undergo the triple check:

- the results for 2010 are compared with the results 2009 within the current CRF
- the CRF tables for the year 2009 are compared between the current CRF tables and the CRF tables of submission 2011
- the CRF tables for the base year 1990 are compared between the current CRF tables and the CRF tables of submission 2011

The emission factor of category 1A1 used in the Swiss Inventory have been compared to the corresponding emission factors of other countries (UNFCCC http://unfccc.int/di/FlexibleQueries.do) and to the IPCC default value if available (INFRAS 2012). The emission factor for CO_2 from Other Fuels and the emission factor for N_2O from Other Fuels are higher than the emission factors in other countries. Please see section 3.2.6.2.

3.2.6.5 Source-Specific Recalculations

- 1A: The activity data of all fuels of the overall time series have been recalculated based on the new data from SFOE 2011.
- 1A: The activity data of wood consumption have been recalculated for the overall time series based on the new data from SFOE 2011b.
- The double-counting of the energy from waste incineration has been eliminated. In previous submissions, the activity data (TJ) of waste incineration was counted in category 1A1a Biomass and 1A1a Other Fuels. Now, the activity data is split between 1A1a Biomass and 1A1a Other fuels according to the fossil/biogenic fraction of the waste. This also implicates a change in the implied emission factors of these categories.
- The share of fossil and organic matter in the municipal solid waste has been revised based on results of the continuation of the FOCAWIN study (fossil carbon dioxide emission from waste incineration facilities) by EMPA (Mohn 2011). The actual share of fossil matter in municipal waste is calculated to be 47.8% on average. This value is assumed for the share in 2011. Until 2002, the value remains constant at 40%. In between 2002 and 2011, the values have been linearly interpolated. This results in a corresponding change of emission factors of fossil and biogenic carbon and recalculations for the emission for the years 2003 – 2009.New process description for biogas installations led to a recalculation in the activity data and emission factors for the whole time series of biomass emissions.
- Activity data of incineration plants have been recalculated based on the correction of the calorific value of waste.
- Biomass consumption is now consistently reported in Table 3-14 and CRF.

3.2.6.6 Source-Specific Planned Improvements

The uncertainty estimation of the energy statistics will be evaluated for the next submission.

3.2.7 Source Category 1A2 - Manufacturing Industries and Construction

3.2.7.1 Source Category Description

Tier 1 Key categories 1A2
CO_2 from the combustion of Liquid Fuels (level and trend)
CO_2 from the combustion of Solid Fuels (level and trend) CO_2 from the combustion of Gaseous Fuels (level and trend) CO2 from the combustion of Other Fuels (level and trend)
Tier 2 Key categories 1A2
CO_2 from the combustion of Liquid Fuels (trend)
CO_2 from the combustion of Solid Fuels (level and trend)
CO_2 from the combustion of Gaseous Fuels (level and trend)
CO_2 from the combustion of Other Fuels (level and trend)

The source category 1A2 "Manufacturing Industries and Construction" comprises all emissions from the combustion of fuels in stationary boilers, gas turbines and engines within manufacturing industries and construction. This includes emissions from conventional and waste fuel use in cement production.

With the present submission, off-road construction and industrial vehicles and machinery are now also reported in 1A2.

Not included are combustion installations in the commercial/institutional and the residential sector as well as in agriculture/forestry. These are included in category 1A4 ("Other Sectors").

In line with the IPCC guidelines, non-energy cement industry emissions of CO_2 from calcination are reported in category 2, Industrial Processes.

Table 3-20 Specification of source category 1A2 "Manufacturing Industries and Construction"

1A2	Source	Specification	Data Source
1A2a	Iron and Steel	Iron and Steel industry	AD: SFOE 2011, Prognos/Basics, 2011 and industry data; EMIS 2012/1A2a EF: EMIS 2012/1A2a, SAEFL 2000
1A2b	Non-ferrous Metals	Non-ferrous Metals industry	AD: Same as in 1A2a, EMIS 2012/1A2b EF: EMIS 2012/1A2b, SAEFL 2000
1A2c	Chemicals	Chemical industry	1 Energy model
1A2d	Pulp, Paper and Print	Pulp, Paper and Print industry	Same as in 1A2b, EMIS 2012/1A2d
1A2e	Food Processing, Beverages and Tobacco	Food Processing, Beverages and Tobacco industry	1 Energy model

1A2	Source	Specification	Data Source
1A2f	Other (Combustion Installations in Industries)		
1A2f i		Category 1A2f i contains Cement, Lime, Brick and tile, Fine ceramics, Asphalt concrete plants, Container glass, Glass, Glass wool, Mineral wool, Fibreboard Production, industrial fossil fuel and biomass boilers and engines that do not provide heat or electricity to the public.	EKV 1991, SFOE 2011b, EMIS 2012/1A solid fuels/wood, EMIS 2012/1A2fi
1A2f ii		Category 1A2f ii contains off-road construction and industrial vehicles and machinery.	INFRAS 2008

The fuel used in the iron manufacturing is coke. No process-based CO_2-Emissions are produced in the iron manufacturing as steel scrap is used together with coal to produce iron.

The production of steel in Switzerland is based totally on the use natural gas. Until 1995 around 25% of the fuel used was provided by heavy fuel oil while the other 75% was provided by natural gas. The closure of the only utility using heavy fuel oil in 1995 (Monteforno) resulted in the total switch to 100% use of natural gas since then. The non-ferrous metals industry uses natural gas and light fuel oil for the drying of chips.

The chemical industry uses natural gas and light fuel oil for its processes. A small amount of solid fuels is also used.

The pulp and paper industry uses majorly natural gas as fuel and a small amount of light fuel oil for its production.

The food processing, beverage and tobacco industry uses a mix of natural gas and light fuel oil as fuel. Some small amount of solid fuels is also applied in its processes.

The fuels used in the other manufacturing industries uses different fuels depending on the sector and industry:

- The production of fine ceramics is based on the use of natural gas and light fuel oil. The use of natural gas was around 83% in 1990 and increased in the last years constantly up to 98%. For further information on the fine ceramics sector, please see 4.2.2.3.
- In Switzerland, rock wool is produced by only one producer. The production of rock wool is based on the founding of rocks at a temperature of around 1500 degrees in a cupola furnace fuelled by coke. Additionally, some gas and a small amount of fuel oil are used in the production. For further information on the rock wool production, please see 4.2.2.3.
- The brick and tile production is realised in Switzerland by around 20 producing plants. The fuels used in the production process are light fuel oil, natural gas as well as small amounts of paper-making residues and wood. For further information on the brick and tile production, please see 4.2.2.3.
- The glass production includes three types of glass: container glass, tableware glass and glass wool. The production of these includes mainly natural gas. Only for the container glass production, light fuel oil is used for 78% and natural gas for 22% of the production. For further information on the glass production, please see 4.2.2.7.
- The fibre board production is realised by only one company in Switzerland. The fuels used include light fuel oil, biomass and natural gas. While in 2000, the share of these

fuels was 40% fuel oil, 10% biomass and 50% natural gas, the use of light fuel oil was eliminated in 2009 and since then the share of used fuels is 70% biomass and 30% natural gas.

- The production of mixed goods includes majorly bituminous goods for the production of street coverage. A total of 110 production sites are producing the mixed goods. The used fuels for the production include majorly light fuel oil (71% in 2010) and natural gas (22%) as well as some small amount of electricity (7%).
- The cement production is based on the use of alternative fuels and ordinary fuels. Alternative fuels include for example recycling products, animal residues or tires coal. Ordinary fuels are coal, light fuel oil, coke and natural gas.

3.2.7.2 Methodological Issues

For fuel combustion in Manufacturing Industries and Construction (1A2) a country specific Tier 2/3 method is used. The method combines both bottom-up and top-down elements (see table below). Emissions of GHGs are calculated by multiplying levels of activity by emission factors.

- A top-down method based on aggregated fuel consumption data from the Swiss overall energy statistics and energy-economic modelling is used to calculate overall emissions of each of the categories 1A2a to 1A2f. Identical emission factors for each fuel type are applied throughout these sources with the exception of 1A2f. The unit of emission factors refers to fuel consumption (in TJ).
- A bottom-up (Tier2/Tier3) method is used to calculate the emissions for a part of the activities in the categories in 1A2a, 1A2b, 1A2d and 1A2f (see Table 3-21). This bottom-up approach does not change overall emissions of the gases CO_2, CH_4 and N_2O in these categories, as in each of the categories, the difference between the bottom-up part and the top-down allocation for the entire category is allocated to other sources in this category (with the exception of the fossil part of waste combustion in cement industry and the mobile off-road sources, both in 1A2f). Estimates for heavy fuel oil and coal consumption for the bottom-up part of 1A2f exceeded the amounts allocated top-down for 1A2f in some years. It was interpreted that this was due to stock changes, and corresponding corrections were made. Activities which were determined bottom-up are: Cupola furnaces in iron foundries and reheating furnaces in steel plants (1A2a); Aluminium second smelter and non-ferrous metal foundries (1A2b); biomass use in Pulp, Paper and Print (1A2d); Cement, Lime, Brick and tile, Fine ceramics, Asphalt concrete plants, Container glass, Glass, Glass wool, Mineral wool, Fibreboard production and industrial biogas boilers and engines that do not provide heat or electricity to the public (all in 1A2f i) and mobile off-road sources including construction and industrial vehicles and machinery (1A2f ii). The calculations are based on measurements and data from individual point sources from industry. Emission factors refer both to fuel consumption (in TJ) or production data (e.g. in tons of steel or cement produced). A bottom-up approach is also used to estimate CO_2 emissions from waste derived fuels used in cement industry ("Other fuels").

Table 3-21 Overview on methods applied to calculate GHG emissions in 1A2.

1A2	Source	Specification	Data Source
1A2a	Iron and Steel		
	Cupola furnaces in iron foundries and reheating furnaces in steel plants	Bottom-up	EMIS 2012/1A2a
	Other sources in 1A2a	Top-down	

1A2	Source	Specification	Data Source
1A2b	Non-Ferrous Metals Aluminium second smelter and non-ferrous metal foundries Other sources in 1A2b	 Bottom-up Top-down	 EMIS 2012/1A2b
1A2c	Chemicals	Top-down	EMIS 2012/1 Energy model
	1A2d Pulp, Paper and Print Biomass (waste derived fuels from paper and pulp) All other fuels	 Bottom-up Top-down	 Industry data, EMIS 2012/1A2d
1A2e	Food Processing, Beverages, and Tobacco	Top-down	EMIS 2012/1 Energy model
1A2f 1A2f i 1A2f ii	Other Cement/Lime/Glass/… industry Other sources (fossil fuel boilers and engines, wood boilers) Mobile off-road sources (construction and industrial vehicles and machinery)	 Bottom-up Top-down Bottom up	 Industry data, EMIS 2012/1A2fi INFRAS 2008

An oxidation factor of 100% is assumed for all combustion processes and fuels (see sub-section on oxidation factors in the beginning of Section 3.2.5.1).).

Emission factors

Top-down approach
For all sources and gases where a top-down approach is applied, emission factors are the same as for source category 1A1a.

The emission factors for CO_2 are country specific and based on measurements and analyses of fuel samples carried out by the Swiss Federal Laboratories for Materials Testing, Research EMPA and Intertek (EMPA 1999; Intertek 2008; carbon emission factor documented in SFOE 2001, Table 45: p. 51; net calorific values on p. 61. See also Annex A2.1.1).

The activity data on LFO use from the Swiss overall energy statistics (SFOE 2011) includes also LPG consumption. Therefore the LFO emission factor for CO_2 is a mixed emission factor that results as a weighted average of the gas oil emission factor and LPG emission factor as in 1A1a (See Section 3.2.6.7).

The coal emission factor for CO_2 is the emission factor of hard coal. For net calorific values see Annex A2.1.1.

Emission factors for CH_4, NO_x, CO and NMVOC are country specific based on comprehensive life cycle analysis of industrial boilers, documented in SAEFL 2000 (pp. 14-27). For NO_x emission factors, expert judgement has been used to estimate the fraction of low-NO_x burners. The emission factors for NO_x and CO for natural gas and light fuel oil have been recalculated for the entire time series based on a new study as documented in EMIS (EMIS 2012/1 Energy Model). For top-down N_2O emissions the default emission factors from IPCC 1997c have been used. NO_x, CO, NMVOC and SO_2 implied emission factors for each of the categories (see Table 3-22) were revised to have a more coherent allocation of emissions to fuel use in different processes.

All emission factors for biomass are based on SAEFL 2000 (pp. 26ff) and a new study for wood combustion (EMIS 2012/1A solid fuels/wood).

The following table presents the emission factors used for the sources in categories 1A2a-f. Categories 1A2a-e and part of 1A2f are calculated with the top-down approach:

Table 3-22 Emission factors for sources in 1A2a-f for 2010. For sources that include activities calculated bottom-up (see Table 3-21 further above), the table shows implied emission factors.

1A2 Emission factors (mix of bottom-up and top-down approach (modelling)) for GHG	**CO_2 clim.**	**CO_2 bio.**	**CH_4**	**N_2O**
	t/TJ	t/TJ	kg/TJ	kg/TJ
1A2a Iron and Steel				
Light fuel oil	73.5		1	0.6
Heavy fuel oil (including petrolkoks)	82.7		2	0.5
Coal	92.7		10	1.6
Natural gas	55.0		6	0.1
1A2b Non-Ferrous Metals				
Light fuel oil	73.5		1	0.6
Heavy fuel oil (including petrolkoks)	77.0		4	0.8
Natural gas	55.0		6	0.1
1A2c Chemicals				
Light fuel oil	73.5		1	0.6
Heavy fuel oil	70.7		4	0.7
Coal	92.7		10	1.6
Natural gas	55.0		6	0.1
1A2d Pulp, Paper and Print				
Light fuel oil	73.5		1	0.6
Heavy fuel oil (including petrolkoks)	77.0		4	0.8
Natural gas	55.0		6	0.1
1A2e Food Processing, Beverages and Tobacco				
Light fuel oil	73.5		1	0.6
Heavy fuel oil (including petrolkoks)	69.7		4	0.7
Coal	92.7		10	1.6
Natural gas	55.0		6	0.1
1A2fi Other				
Light fuel oil	73.5		1.0	1.7
Heavy fuel oil (including petrolkoks)	84.0		1.9	0.4
Coal	93.5		3.7	1.6
Natural gas	55.0		6.1	0.1
Biomass (exclusive of biogenic waste derived fuel in cement industry)		84.6	8.0	1.3
Other fuels (fossil and biogenic waste derived fuel in cement industry)	51.6	31.0	NA	4.0
1A2fii Diesel and gasoline for construction and industrial machinery	73.6		2.1	2.8

Remark: In the table above, the CO_2 emission factor of light fuel oil of 73.5 t/TJ is a weighted average emission factor including both gas oil (73.7t/TJ) and LPG (65.5t/TJ) emissions (the same as in 1A1a; see Section 3.2.6.2a)). The CO_2 emission factor for coal in 1A2f Other (93.5 t/TJ in 2010) is an implied emission factor. The CO_2 emission factor for HFO is a weighted average emission factor for heavy fuel oil and petroleum coke. In previous submissions, petroleum coke has been reported under solid fuels. It is now reported as liquid fuel emissions of CH_4, N_2O and NMVOC from the use of biomass (black liquor). In 1A2d Pulp, Paper and Print are included in the emissions from the related heavy fuel oil use for the biomass boiler.

Regarding the N_2O emission factor of Biomass, the reported value of 2.07 kg/TJ is lower than the average of the emission factors of the reporting countries and lower than the IPCC default value of 4. This low value is comparable to those used by the surrounding countries as for example Germany (2.3 kg/TJ) or Austria (2.7 kg/TJ).

The emission factors of CO_2 and N_2O of Other Fuels did significantly decrease since the last submission based on measurements of the emissions of alternative fuels realised in the cement sector (see Recalculations). With this decrease, the reported values are within the mean emission factors of the reporting countries. The CO_2 emission factor is now similar to the factor in Germany and the European Union and the N_2O emission factor corresponds to the upper end of the IPCC default value.

The emission factors of the precursors of 1A2 are provided in Annex A3.1.3.

Bottom-up approach

By default, the same emission factors for CO_2, CH_4 and N_2O are used for the bottom-up as for the top-down approach, unless more specific information is available on emission factors. Following IPCC Tier 3, bottom-up emission factors for emissions other than CO_2, CH_4 or N_2O are based on production data (e.g. tons of cement or steel produced) or on fuel consumption. Implied emission factors for NO_x, CO, NMVOC and SO_2 for each of the categories (see Table 3-22) were revised in order to gain a more coherent allocation of emissions to fuel consumption within the different processes.

The emission factors for CO_2 are country specific and based on measurements and analysis of fuel samples carried out by the Swiss Federal Laboratories for Materials Testing, Research EMPA and Intertek (EMPA 1999; Intertek 2008; carbon emission factor documented in SFOE 2001, Table 45: p. 51; net calorific values on p. 61). For net calorific values see Annex A2.1.1.

The coal emission factor for CO_2 in source category 1A2f is an implied emission factor.

Emission factors for CH_4, CO and NMVOC are country specific based on measurements and data from industry and expert estimates, documented in the EMIS database (EMIS 2012/1A2a,1A2b,1A2d,1A2fi). They have been updated for the recent years by expert judgement. Emission factors for N_2O are determined by default values except for the waste incineration categories where country specific emission factors were applied.

The following two tables present the emission factors used in the bottom-up approach for emissions of Iron and Steel (1A2a) and for the cement industry.

Table 3-23 Emission factors for sources in Iron and Steel 1A2a in 2010.

1A2a Iron and Steel (Coke and gas)	**CO_2**	**CH_4**	**N_2O**	**NO_x**	**CO**	**NMVOC**	**SO_2**
	t/TJ	kg/TJ		g/t iron			
Coke cupolas	92.7	10	1.6	67	11'000	40	1'500
	t/TJ	kg/TJ		g/t steel			
Gas (steel plants)	55	6	0.1	75	0.5	2.8	0.7

Table 3-24 Emission factors for cement industry in 2010 (NO: not occurring). Source: EMIS data base (EMIS 2012/1A2f). Emission factors for CO_2 are fuel specific; they are the same as in the top-down approach (see Table 3-22).

Cement industry (part of 1A2f)	**CO_2**	**CH_4**	**N_2O**	**NO_x**	**CO**	**NMVOC**	**SO_2**
	t/TJ	g/t cement					
Cement	fuel specific	NA	17.8	840	1'400	45	361

These cement fuel consumption emission factors describe emissions from average fuel mix (of liquid, solid, gaseous and waste derived fuels).

The consumption of "Other" fuels in 1A2 refers to the use of waste derived fuels in the cement industry. The following table provides an overview of the emission factors per ton of waste used. The net calorific values and other characteristics of waste derived fuels are taken from FOEN internal data sources, EMIS 2012/1A2fi Zementwerke Feuerung and the other characteristics of waste derived fuels are from Hackl, A., Mauschitz, G. 2003.

Table 3-25 Emission factors and other characteristics of waste derived fuels ("Other fuels") used in the cement industry. Sources: FOEN internal data sources, EMIS 2012/1A2fi Zementwerke Feuerung and calculations as documented in EMIS 2012/1A2fi

	NCV	**EF CO_2 Tot.**	**Fraction biomass-C**
Waste derived fuel	MJ/kg	kg CO_2/GJ	%
Waste oil	32.50	74.40	0
Sewage sludge (dried)	9.40	94.50	100
Wood	16.30	99.90	100
Solvents and residues from distillation	23.60	74.00	1
Waste Tyres and rubber	26.40	84.00	27
Plastics	25.20	84.70	28
Animal meal	16.80	86.70	100
Mix of special waste with saw dust (CSS)	9.20	102.40	78
Waste coke from coke filters	23.70	97.00	0
Sawdust	16.30	99.90	100
Mixed industrial waste	18.34	74.00	0
Other fossil waste fuels	20.85	97.00	0
Agricultural waste / other biomass	12.72	110.00	100

The emissions of the mobile off-road sources (1A2f ii) are calculated by the same approach as for all other off-road categories. The emissions are calculated with a Tier 2 method. Some details of the emission modelling that hold for all off-road families are described in Annex A3.1.6 Off-road vehicles. Activity data and emission factors were updated and the emission calculation was carried out in a new database structured in analogy to the on-road database (INFRAS 2008).

The emission modelling is carried out for 1990, 1995, 2000, 2005, 2010 etc. For the GHG inventory the missing years 1991, 1992 etc. are interpolated linearly by vehicle category. For the mobile sources diesel oil and gasoline are used as fuels and for industry there is consumption of some CNG reported for forklifts.

Emission factors for mobile off-road sources

- The emission factors for CO_2 are country specific and are assumed to be constant in the period 1990-2010 with values 73.6 t/TJ for diesel oil, 73.9 t/TJ for gasoline and 55.0 t/TJ for CNG (equal to natural gas). See Table 3 - 3.
- For SO_2 the emission factors are country specific and are given in Table Table A - 11 in Annex A2.2.
- The emission factors for all other gases are country specific and shown in Table A - 20 to Table A - 23 in the Annex A3.1.6 (INFRAS 2008) The NMVOC emissions are calculated as the difference of VOC and CH_4 emissions.

Note that emission factors in the unit of kg/h may be downloaded by query from the public part of the off-road database INFRAS (2008), see footnote 14 on page 104.

Activity data

Top-down approach

Activity data on fuel consumption (TJ) for “top-down” sources in category 1A2 (see Table 3-21 above) are based on aggregated fuel consumption data from the Swiss overall energy statistics (SFOE 2011) and energy-economic modelling. A detailed description of the modelling work for the disaggregation of fuel consumption to the level of 1A2a-f is provided in Annex A3.1.2. The resulting disaggregated fuel consumption data for 1990 to 2010 is provided in the table below.

Table 3-26 Activity data fuel consumption in 1A2 Manufacturing Industries and Construction 1990 to 2010; "Other Fuels" occur only in the category 1A2fi, where they refer to waste fuels in cement production as well as diesel and gasoline for construction and industrial machinery. The consumption of the waste fuels in cement production has been calculated (in TJ) bottom-up from the amount (in tons) of waste derived fuels used. Fuel consumption of mobile sources 1A2f has also been calculated bottom-up

Source	**Unit**	**1990**	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**
1A2 Manufacturing Industries and Constr. (Total)	TJ	93'870	95'276	93'250	92'548	94'340	92'666	94'954	95'907	98'231	98'378
Light fuel oil	TJ	26'072	28'766	28'743	27'928	27'438	27'337	28'744	31'553	33'530	33'500
Heavy fuel oil	TJ	19'970	18'366	17'706	15'249	15'684	11'038	11'733	10'584	10'157	9'783
Coal	TJ	13'237	10'850	6'965	6'458	7'004	7'247	4'885	3'650	3'219	3'502
Natural gas	TJ	20'605	22'794	25'022	27'353	28'647	30'224	31'101	32'128	32'968	33'013
Biomass	TJ	6'601	6'898	6'998	7'102	7'156	7'581	8'589	8'030	8'159	8'401
Other Fuels	TJ	7'386	7'602	7'817	8'459	8'410	9'239	9'903	9'963	10'198	10'179
1A2a Iron and Steel	TJ	3'205	3'257	3'481	3'405	3'383	2'884	3'034	3'254	3'374	3'361
Light fuel oil	TJ	815	829	833	815	795	652	662	722	763	776
Heavy fuel oil	TJ	590	566	621	540	538	242	205	219	227	231
Coal	TJ	241	293	274	235	262	199	190	193	210	184
Natural gas	TJ	1'559	1'569	1'753	1'815	1'789	1'791	1'977	2'120	2'175	2'170
Biomass	TJ	0	0	0	0	0	0	0	0	0	0
Other Fuels	TJ	0	0	0	0	0	0	0	0	0	0
1A2b Non-Ferrous Metals	TJ	511	600	457	468	459	647	688	886	976	1'117
Light fuel oil	TJ	240	241	225	201	206	216	214	251	268	271
Heavy fuel oil	TJ	2	2	2	1	1	2	1	1	1	1
Coal	TJ	0	0	0	0	0	0	0	0	0	0
Natural gas	TJ	269	358	230	266	252	429	473	634	707	845
Biomass	TJ	0	0	0	0	0	0	0	0	0	0
Other Fuels	TJ	0	0	0	0	0	0	0	0	0	0
1A2c Chemicals	TJ	15'422	14'673	14'557	13'952	14'398	15'501	15'833	15'407	15'279	14'444
Light fuel oil	TJ	3'117	3'197	2'753	2'874	2'731	3'750	3'736	3'409	2'985	2'726
Heavy fuel oil	TJ	1'865	1'265	1'001	1'241	978	543	556	522	417	316
Coal	TJ	97	95	91	87	99	97	83	71	66	65
Natural gas	TJ	10'343	10'116	10'712	9'751	10'590	11'109	11'459	11'404	11'811	11'336
Biomass	TJ	0	0	0	0	0	0	0	0	0	0
Other Fuels	TJ	0	0	0	0	0	0	0	0	0	0
1A2d Pulp, Paper and Print	TJ	11'634	11'266	12'694	12'476	13'302	11'788	10'960	11'276	11'119	10'882
Light fuel oil	TJ	539	788	986	927	861	954	1'051	992	1'036	1'124
Heavy fuel oil	TJ	5'226	4'701	4'307	3'671	3'337	3'120	2'972	3'179	3'150	2'999
Coal	TJ	983	600	109	0	0	0	0	0	0	0
Natural gas	TJ	2'800	3'280	5'581	6'354	7'662	6'357	5'495	5'579	5'323	5'064
Biomass	TJ	2'085	1'898	1'711	1'524	1'441	1'358	1'442	1'526	1'610	1'694
Other Fuels	TJ	0	0	0	0	0	0	0	0	0	0
1A2e Food Processing, Beverages and Tobacco	TJ	7'294	7'690	7'126	7'507	7'247	8'038	8'911	8'785	9'050	9'564
Light fuel oil	TJ	4'636	4'806	4'741	4'843	4'822	4'847	5'071	4'989	5'237	5'241
Heavy fuel oil	TJ	1'379	1'209	1'100	994	882	880	815	662	603	579
Coal	TJ	217	204	249	202	157	193	266	232	103	126
Natural gas	TJ	1'061	1'472	1'036	1'467	1'385	2'119	2'757	2'902	3'107	3'617
Biomass	TJ	0	0	0	0	0	0	0	0	0	0
Other Fuels	TJ	0	0	0	0	0	0	0	0	0	0
1A2fi Other	TJ	55'805	57'790	54'936	54'740	55'552	53'809	55'528	56'299	58'433	59'009
Light fuel oil	TJ	16'724	18'906	19'205	18'268	18'021	16'919	18'010	21'189	23'241	23'361
Heavy fuel oil	TJ	10'907	10'624	10'676	8'801	9'947	6'251	7'183	6'002	5'759	5'656
Coal	TJ	11'699	9'658	6'242	5'934	6'487	6'759	4'346	3'152	2'840	3'126
Natural gas	TJ	4'572	6'000	5'709	7'700	6'970	8'419	8'940	9'489	9'846	9'981
Biomass	TJ	4'516	5'000	5'287	5'578	5'716	6'223	7'147	6'504	6'548	6'707
Other Fuels	TJ	1'874	1'901	1'927	2'380	2'142	2'781	3'322	3'259	3'371	3'229
1A2fii Diesel and gasoline for construction and industrial machinery	TJ	5'512	5'701	5'890	6'079	6'268	6'458	6'581	6'704	6'827	6'951

Table 3-26 continued: Activity data fuel consumption in 1A2 Manufacturing Industries and Construction.

Source	Unit	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
1A2 Manufacturing Industries and Constr. (Total)	TJ	101'147	103'492	102'171	102'770	104'568	105'623	106'182	103'389	103'953	97'162
Light fuel oil	TJ	33'268	33'569	33'878	33'655	32'880	32'533	31'626	29'145	28'589	27'278
Heavy fuel oil	TJ	7'776	7'703	6'523	5'752	6'332	6'849	7'218	5'114	4'904	4'040
Coal	TJ	5'211	5'473	5'330	5'078	4'785	5'067	5'448	6'540	5'881	5'461
Natural gas	TJ	35'147	35'788	34'564	35'494	36'963	37'626	38'160	38'262	39'689	35'901
Biomass	TJ	8'798	9'128	9'537	10'184	10'423	10'671	10'953	11'757	11'858	11'322
Other Fuels	TJ	10'947	11'830	12'339	12'607	13'186	12'876	12'776	12'572	13'033	13'160
1A2a Iron and Steel	TJ	3'742	3'917	3'869	3'911	3'568	3'368	3'444	3'448	3'457	3'047
Light fuel oil	TJ	816	828	819	803	775	713	734	731	724	654
Heavy fuel oil	TJ	238	249	220	217	193	190	183	188	179	143
Coal	TJ	154	242	341	373	122	129	157	83	115	68
Natural gas	TJ	2'534	2'598	2'490	2'517	2'477	2'336	2'369	2'446	2'440	2'182
Biomass	TJ	0	0	0	0	0	0	0	0	0	0
Other Fuels	TJ	0	0	0	0	0	0	0	0	0	0
1A2b Non-Ferrous Metals	TJ	1'104	1'011	972	1'000	1'069	1'061	864	756	725	544
Light fuel oil	TJ	272	259	262	262	251	243	212	187	171	145
Heavy fuel oil	TJ	1	1	1	0	1	0	0	0	0	0
Coal	TJ	0	0	0	0	0	0	0	0	0	0
Natural gas	TJ	831	751	709	738	817	817	652	568	554	399
Biomass	TJ	0	0	0	0	0	0	0	0	0	0
Other Fuels	TJ	0	0	0	0	0	0	0	0	0	0
1A2c Chemicals	TJ	14'983	15'944	15'380	15'003	15'255	15'449	16'377	16'438	16'211	16'491
Light fuel oil	TJ	3'034	3'213	3'120	3'059	3'103	3'144	3'300	3'508	3'506	3'569
Heavy fuel oil	TJ	308	375	219	155	179	184	288	275	106	140
Coal	TJ	64	54	49	46	45	43	45	48	46	39
Natural gas	TJ	11'577	12'302	11'992	11'743	11'929	12'078	12'743	12'608	12'553	12'743
Biomass	TJ	0	0	0	0	0	0	0	0	0	0
Other Fuels	TJ	0	0	0	0	0	0	0	0	0	0
1A2d Pulp, Paper and Print	TJ	11'126	11'197	11'716	11'602	10'534	10'739	9'544	7'948	6'838	4'597
Light fuel oil	TJ	1'092	1'043	1'081	1'031	994	953	940	602	380	373
Heavy fuel oil	TJ	2'529	2'624	2'473	2'376	2'270	2'206	2'353	1'000	1'000	800
Coal	TJ	0	0	0	0	0	0	0	0	0	0
Natural gas	TJ	5'811	6'084	6'420	6'310	5'241	5'527	4'174	4'247	4'134	3'424
Biomass	TJ	1'694	1'447	1'741	1'885	2'029	2'053	2'076	2'099	1'324	0
Other Fuels	TJ	0	0	0	0	0	0	0	0	0	0
1A2e Food Processing, Beverages and Tobacco	TJ	9'353	8'827	9'032	8'992	9'139	9'114	9'139	9'177	9'291	8'611
Light fuel oil	TJ	5'168	5'049	5'006	4'958	4'737	4'689	4'535	4'257	4'184	4'054
Heavy fuel oil	TJ	520	476	456	411	446	397	298	339	326	280
Coal	TJ	72	83	167	151	60	68	67	73	36	9
Natural gas	TJ	3'593	3'219	3'403	3'472	3'896	3'960	4'238	4'509	4'746	4'268
Biomass	TJ	0	0	0	0	0	0	0	0	0	0
Other Fuels	TJ	0	0	0	0	0	0	0	0	0	0
1A2f Other	TJ	60'839	62'596	61'202	62'263	65'004	65'893	66'814	65'621	67'430	63'873
Light fuel oil	TJ	22'886	23'177	23'590	23'542	23'020	22'791	21'905	19'859	19'623	18'482
Heavy fuel oil	TJ	4'180	3'979	3'154	2'592	3'243	3'871	4'095	3'312	3'292	2'678
Coal	TJ	4'921	5'094	4'773	4'508	4'558	4'827	5'178	6'336	5'685	5'346
Natural gas	TJ	10'801	10'835	9'550	10'715	12'604	12'908	13'984	13'884	15'264	12'886
Biomass	TJ	7'104	7'681	7'796	8'299	8'394	8'619	8'878	9'658	10'534	11'322
Other Fuels	TJ	3'873	4'717	5'185	5'414	5'953	5'604	5'500	5'293	5'750	5'873
1A2fii Diesel and gasoline for construction and industrial machinery	TJ	7'074	7'113	7'153	7'193	7'232	7'272	7'276	7'279	7'283	7'286

Table 3-26 continued: Activity data fuel consumption in 1A2 Manufacturing Industries and Construction.

Source	**Unit**	**2010**
1A2 Manufacturing Industries and Constr. (Total)	TJ	102'933
Light fuel oil	TJ	27'521
Heavy fuel oil	TJ	3'990
Coal	TJ	5'571
Natural gas	TJ	40'293
Biomass	TJ	11'975
Other Fuels	TJ	13'584
1A2a Iron and Steel	TJ	3'535
Light fuel oil	TJ	762
Heavy fuel oil	TJ	188
Coal	TJ	44
Natural gas	TJ	2'541
Biomass	TJ	0
Other Fuels	TJ	0
1A2b Non-Ferrous Metals	TJ	888
Light fuel oil	TJ	165
Heavy fuel oil	TJ	1
Coal	TJ	0
Natural gas	TJ	723
Biomass	TJ	0
Other Fuels	TJ	0
1A2c Chemicals	TJ	17'370
Light fuel oil	TJ	3'725
Heavy fuel oil	TJ	227
Coal	TJ	46
Natural gas	TJ	13'372
Biomass	TJ	0
Other Fuels	TJ	0
1A2d Pulp, Paper and Print	TJ	4'418
Light fuel oil	TJ	241
Heavy fuel oil	TJ	100
Coal	TJ	0
Natural gas	TJ	4'077
Biomass	TJ	0
Other Fuels	TJ	0
1A2e Food Processing, Beverages and Tobacco	TJ	8'450
Light fuel oil	TJ	3'734
Heavy fuel oil	TJ	371
Coal	TJ	19
Natural gas	TJ	4'325
Biomass	TJ	0
Other Fuels	TJ	0
1A2f Other	TJ	68'273
Light fuel oil	TJ	18'894
Heavy fuel oil	TJ	3'103
Coal	TJ	5'462
Natural gas	TJ	15'255
Biomass	TJ	11'975
Other Fuels	TJ	6'294
1A2fii Diesel and gasoline for construction and industrial machinery	TJ	7'290

The table above documents the increase of natural gas consumption for manufacturing industries by 96%, the increase of other fuels by 84%, the decrease of coal consumption by 58% and the decrease of heavy fuel oil of 80% respectively from 1990 to 2010. This is mainly due to the shift of fuel consumption in the cement production in Switzerland. Since 1990, the consumption of coal and coke in the cement production reduced by 49% from 12'119 TJ to 6'152 TJ in 2010. On the other hand, the use of alternative fuels increased by a factor 4.4 from 66'500 to 294'343 t in the same period. This shift in fuel mix is the reason for CO_2 emissions from the use of Liquid, Solid Gaseous and Other Fuels in category 1A2 being key categories regarding trend.

Bottom-up approach

Activity data on iron and steel production that is used to calculate bottom-up emissions from cupola furnaces in iron foundries and reheating furnaces in steel plants is based on data from EMIS 2012/1A2a.

Table 3-27 Activity data: Production in Iron and Steel that is used to calculate bottom-up emissions from sources in 1A2a (EMIS 2012/1A2a).

Source/production	Unit	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
1A2a Iron and Steel											
Iron foundries: cupol ovens	Gg	90	72	68	54	55	60	51	53	57	56
Steel plants: reheating furnaces	Gg	1'108	1'155	1'245	1'276	1'230	716	738	789	880	918

Source/production	Unit	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
1A2a Iron and Steel											
Iron foundries: cupol ovens	Gg	55	49	37	34	31	32	31	33	37	15
Steel plants: reheating furnaces	Gg	1'022	1'048	1'125	1'142	1'226	1'158	1'252	1'264	1'312	933

Source/production	Unit	2010
1A2a Iron and Steel		
Iron foundries: cupol ovens	Gg	16
Steel plants: reheating furnaces	Gg	1'217

The table above documents the activity data of the iron and steel production. It shows the decrease of the emissions in iron foundries by more than 82% and the increase of emissions in steel plants by 10% between 1990 and 2010.

Activity data on cement production have been received from the industry association cemsuisse (EMIS 2012/1A2fi Zementwerke Feuerung) (See Table 4-4 in Chapter 4.2.2 a). For the year 1990, activity data for fuel use in cement production from EKV 1991 has been used.

The amount of waste derived fuels used in cement industry (in tons) is provided by the following table. Data has been collected from estimates by FOEN experts and cemsuisse (Cemsuisse 2011). The activity data is used to calculate CO_2 emissions from "Other fuels" in 1A2f.The following table provides an overview of fuel use in cement industry in energy units (TJ):

Table 3-28 Activity data: Overview on fuel use in cement industry.

Source	Unit	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Cement industry											
Cement, total incl. waste	TJ	15'124	13'220	12'212	11'276	12'695	11'991	10'597	9'481	9'334	9'564
Cement fossil without waste	TJ	13'249	11'319	10'285	8'896	10'553	9'210	7'276	6'222	5'963	6'335
HFO	TJ	2'378	3'413	4'668	3'635	4'942	3'158	3'842	3'512	3'451	3'517
Coal	TJ	10'510	7'892	5'550	5'213	5'584	5'885	3'400	2'700	2'450	2'697
Gas	TJ	362	14	67	48	27	168	34	10	62	121
Cement, waste derived fuel	TJ	1'874	1'901	1'927	2'380	2'142	2'781	3'322	3'259	3'371	3'229
Waste oil	TJ	1'170	1'138	1'105	1'528	1'209	1'485	1'515	1'258	1'510	1'404
Sewage sludge (dried)	TJ	9	9	9	19	65	128	175	240	217	279
Wood	TJ	0	0	0	0	106	322	396	320	0	0
Solvents and residues from distillation	TJ	283	378	472	283	126	181	274	410	375	271
Waste tyres and rubber	TJ	330	304	277	441	402	415	420	366	363	321
Plastics	TJ	0	0	0	0	27	55	176	274	507	552
Animal meal	TJ	0	0	0	0	0	0	197	233	223	211
Mix of special waste with saw dust (CSS)	TJ	23	14	5	51	147	135	111	100	117	132
Waste coke from coke filters	TJ	59	59	59	59	59	59	59	59	59	59
Sawdust	TJ	0	0	0	0	0	0	0	0	0	0
Mixed industrial waste	TJ	0	0	0	0	0	0	0	0	0	0
Other fossil waste fuels	TJ	0	0	0	0	0	0	0	0	0	0
Agricultural waste / other biomass	TJ	0	0	0	0	0	0	0	0	0	0

Source	Unit	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Cement industry											
Cement, total incl. waste	TJ	10'006	10'620	10'310	10'238	10'384	9'789	8'608	8'955	8'982	9'099
Cement fossil without waste	TJ	6'321	6'120	5'308	4'981	4'617	4'374	3'289	3'847	3'417	3'411
HFO	TJ	1'799	1'431	1'308	838	1'269	1'275	1'123	1'087	135	1'094
Coal	TJ	4'500	4'678	3'989	4'142	3'332	3'096	2'162	2'742	3'278	2'313
Gas	TJ	22	11	11	0	16	4	4	17	4	4
Cement, waste derived fuel	TJ	3'685	4'500	5'001	5'257	5'767	5'415	5'319	5'108	5'565	5'689
Waste oil	TJ	1'520	1'342	1'584	1'490	1'536	1'411	1'279	844	866	1'278
Sewage sludge (dried)	TJ	333	349	360	386	407	494	560	549	511	475
Wood	TJ	0	0	0	0	0	0	0	0	0	61
Solvents and residues from distillation	TJ	426	516	725	739	1'002	976	981	1'295	1'476	1'032
Waste tyres and rubber	TJ	421	476	460	568	519	645	568	525	794	828
Plastics	TJ	572	599	526	524	770	841	926	1'013	995	1'119
Animal meal	TJ	198	1'030	1'172	1'378	1'326	856	799	664	658	621
Mix of special waste with saw dust (CSS)	TJ	158	129	116	113	163	133	146	164	157	131
Waste coke from coke filters	TJ	59	59	59	59	46	58	60	0	0	0
Sawdust	TJ	0	0	0	0	0	0	0	0	0	0
Mixed industrial waste	TJ	0	0	0	0	0	0	0	2	1	1
Other fossil waste fuels	TJ	0	0	0	0	0	0	0	48	105	137
Agricultural waste / other biomass	TJ	0	0	0	0	0	0	0	5	2	7

Source	Unit	2010
Cement industry		
Cement, total incl. waste	TJ	11'873
Cement fossil without waste	TJ	5'763
HFO	TJ	1'242
Coal	TJ	4'500
Gas	TJ	21
Cement, waste derived fuel	TJ	6'109
Waste oil	TJ	1'253
Sewage sludge (dried)	TJ	477
Wood	TJ	292
Solvents and residues from distillation	TJ	1'189
Waste tyres and rubber	TJ	842
Plastics	TJ	1'252
Animal meal	TJ	624
Mix of special waste with saw dust (CSS)	TJ	123
Waste coke from coke filters	TJ	0
Sawdust	TJ	6
Mixed industrial waste	TJ	0
Other fossil waste fuels	TJ	45
Agricultural waste / other biomass	TJ	7

Underlying data for the activity data on mobile off-road sources (1A2f) like vehicle stock and operating hours are shown in Table A - 29 to Table A - 31 in Annex A3.1.6.

3.2.7.3 Uncertainties and Time-Series Consistency

The uncertainty of CO_2 emissions from fuel combustions is described in the uncertainty analysis of the Energy Industries (1A1) in Chapter 3.2.6.3. Uncertainty in emissions of other non-CO_2 gases is estimated to be medium: 30% for CH_4 and 80% for N_2O (see Table 1-13).

Consistency and Completeness in 1A2 Fuel Combustion

Consistency:

- Time series for 1A2 are all consistent.

Completeness:

- All estimates in the sector 1A2 are assumed to be complete.

3.2.7.4 Source-specific QA/QC and Verification

a) General

See Chapter 3.2.6.4.

b) Specific: Manufacturing Industries and Construction (1A2)

The time series have been compared between the current and the previous submission as well as available energy data. All activity data, implied emission factors and emissions undergo the triple check:

- the results for 2010 are compared with the results 2009 within the current CRF
- the CRF tables for the year 2009 are compared between the current CRF tables and the CRF tables of submission 2011.
- the CRF tables for the base year 1990 are compared between the current CRF tables and the CRF tables of submission 2011.

The emission factors of category 1A2 used in the Swiss Inventory have been compared to the corresponding emission factors of other countries (UNFCCC http://unfccc.int/di/FlexibleQueries.do) and to the IPCC default values if available (INFRAS 2012). The emission factor for N_2O from Biomass is lower than the mean value of the other countries and the default emission factor from IPCC. The emission factors of CO_2 and N_2O of Other Fuels are also slightly different from the mean values of other countries emission factors. Please see section 3.2.7.2.

3.2.7.5 Source-Specific Recalculations

- 1A: The activity data of all fuels of the overall time series has been recalculated based on the new data from SFOE 2011.
- 1A: The activity data of wood consumption has been recalculated for the overall time series based on the new data from SFOE 2011b.
- The CO_2-emission factors for bituminous coal and lignite have been determined by measurements commissioned by cemsuisse. In previous submissions, a mixed emission factor has been applied. The emission factors for brown coal and bituminous coal have been separated accordingly. The emission factor for bituminous coal from changed from 94 to 92.7 t/TJ and for brown coal from 104 to 96.1 t/TJ.

- The emission factor for petroleum coke (1A2fi) has been adapted from 94 to 91.4 t/TJ based on the measurements commissioned by cemsuisse.
- The CO_2 emission factor for alternatives fuels used in cement production (1A2fi) has been recalculated based on the measurements commissioned by cemsuisse. The N_2O emission factor has not been measured, so the default factor is used.
- The activity data and emission factors for CO_2, CH_4 and N_2O of glass production (1A2fi) was recalculated based on a correction of the previously counted liquid petroleum gas as natural gas instead of fuel oil.

3.2.7.6 Source-Specific Planned Improvements

The uncertainty estimation of the energy statistics will be evaluated for the next submission.

3.2.8 Source Category 1A3- Transport

3.2.8.1 Source Category Description:

Tier 1 Key Categories 1A3
CO_2 from the combustion of Gasoline (level and trend)
CO_2 from the combustion of Diesel (level and trend)
CH_4 from the combustion of Gasoline (trend)

Tier 2 Key Categories 1A3b
CO_2 from the combustion of Gasoline (level and trend)
CO_2 from the combustion of Diesel (level and trend)
CH_4 from the combustion of Gasoline (trend)

The source category includes civil aviation, road transportation, railways, navigation and other transportation. Further off-road transportation is included in category 1A2 Manufacturing Industries and Construction, in 1A4 Other Sectors and 1A5 Other (Military). For information on bunker fuel emissions from international aviation and navigation, see Chapter 3.2.2.

Table 3-29 Specification of Swiss source category 1A3 "Transport".

1A3	Transport	Specification	Data Source
1A3a	Civil Aviation (National)	Large (jet, turboprop, business jet) and small (piston) aircrafts, helicopters	AD: SFOE 2011, FOCA 2006, 2006a, 2007, 2008, 2009, 2010, 2011.
1A3b	Road Transportation	Light and heavy motor vehicles, coaches, two-wheelers	AD: SFOE 2011, Method, EF: FOEN 2010i, Hausberger et al. 2009, EEA 2010.
1A3c	Railways	Diesel locomotives	Method, AD, EF: INFRAS 2008
1A3d	Navigation (National)	Passenger ships, motor and sailing boats on the Swiss lakes	Method, AD, EF: INFRAS 2008,
1A3e	Pipeline Transportation	Compressor station in Ruswil, Lucerne.	AD: SFOE 2011, SGWA 2005, SGIA 2011, Swissgas 2008 EF: Battelle 1994, Xinmin 2004, SGWA 2007

3.2.8.2 Methodological Issues

In Switzerland, Transport (1A3) contains the sub-categories

- Aviation (1A3a, national/domestic civil aviation),
- Road Transportation (1A3b),
- Railways (1A3c),
- Navigation (1A3d, national/domestic navigation).
- Compressor station for gas distribution (1A3e)

a) Aviation (1A3a)

Tier 1 Key Categories 1A3a
CO_2 from the combustion of fuel in civil aviation (trend)

Tier 2 Key Categories 1A3a
There are no Tier 2 Key categories in 1A3a

The emissions of civil aviation are modelled by a Tier 3a method developed by FOCA (2006). FOCA is represented in the emissions technical working group (CAEP WG3) and in the modelling and database group (CAEP MDG) of the International Civil Aviation Organisation (ICAO). FOCA is directly involved in the development of ICAO guidance material for the calculation of aircraft emissions and in the update of the IPCC guidelines (via the secretariat of ICAO CAEP (Committee on Aviation Environmental Protection). The Tier 3a method applied for the emission modelling is in line with the methods developed in the working groups mentioned. Note that the 2006 IPCC Guidelines for National Greenhouse Gas Inventories (IPCC 2006) have been prepared by the IPCC Task Force on National Greenhouse Gas Inventories and have been adopted in April 2006 by the IPCC. Under the UNFCCC, they have not yet been adopted for mandatory use in reporting on GHG inventories. Formally, the method therefore should be considered as a country specific method until improvement.

The modelling scheme for civil aviation starting with aircraft basic data, activity data, emission factors and ending with emissions imported into EMIS database is shown in Figure 3-8.

The Tier 3a method follows standard modelling procedures on the level of single movements based on detailed movement statistics. The primary key for all calculations is the aircraft tail number, which allows to calculate on the most precise level, namely on the level of the individual aircraft and engine type. Every aircraft is linked to the FOCA engine data base containing emission factors for more than 600 individual engines with different power settings. Emissions in the landing and take-off cycle (LTO) are calculated with aircraft category dependant flight times and corresponding power settings. Cruise emissions are calculated based on the individual aircraft type and the trip distance for every flight. For piston-engine powered aircraft and helicopters, to the knowledge of FOCA, it has been the only provider of publicly available engine data and a full methodology, so far. All piston engine data and study results have been published in 2007 (FOCA 2007a). The guidance on the determination of helicopter emissions has been published in 2009 (FOCA 2009a).

The movement database from Swiss Airports contains departure and destination airport. With this information, all flights from and to Swiss airports are separated into domestic (national) and international flights prior to the emission calculation. The emissions of domestic flights are reported under 1A3a Civil Aviation, the emissions of international flights are reported under international bunker emissions (memo items).

The emission factors used are country specific or are taken from the ICAO engine emissions databank, from EMEP/CORINAIR databases (EEA 2002), Swedish Defence Research Agency (FOI) and Swiss FOCA measurements (precursors). Cruise emission factors are generally calculated from the values of the ICAO engine emissions databank, adjusted to cruise conditions by using the Boeing Fuel Flow Method 2. For N_2O, the IPCC default emission factor is used. Activity data are derived from a detailed movement statistics.

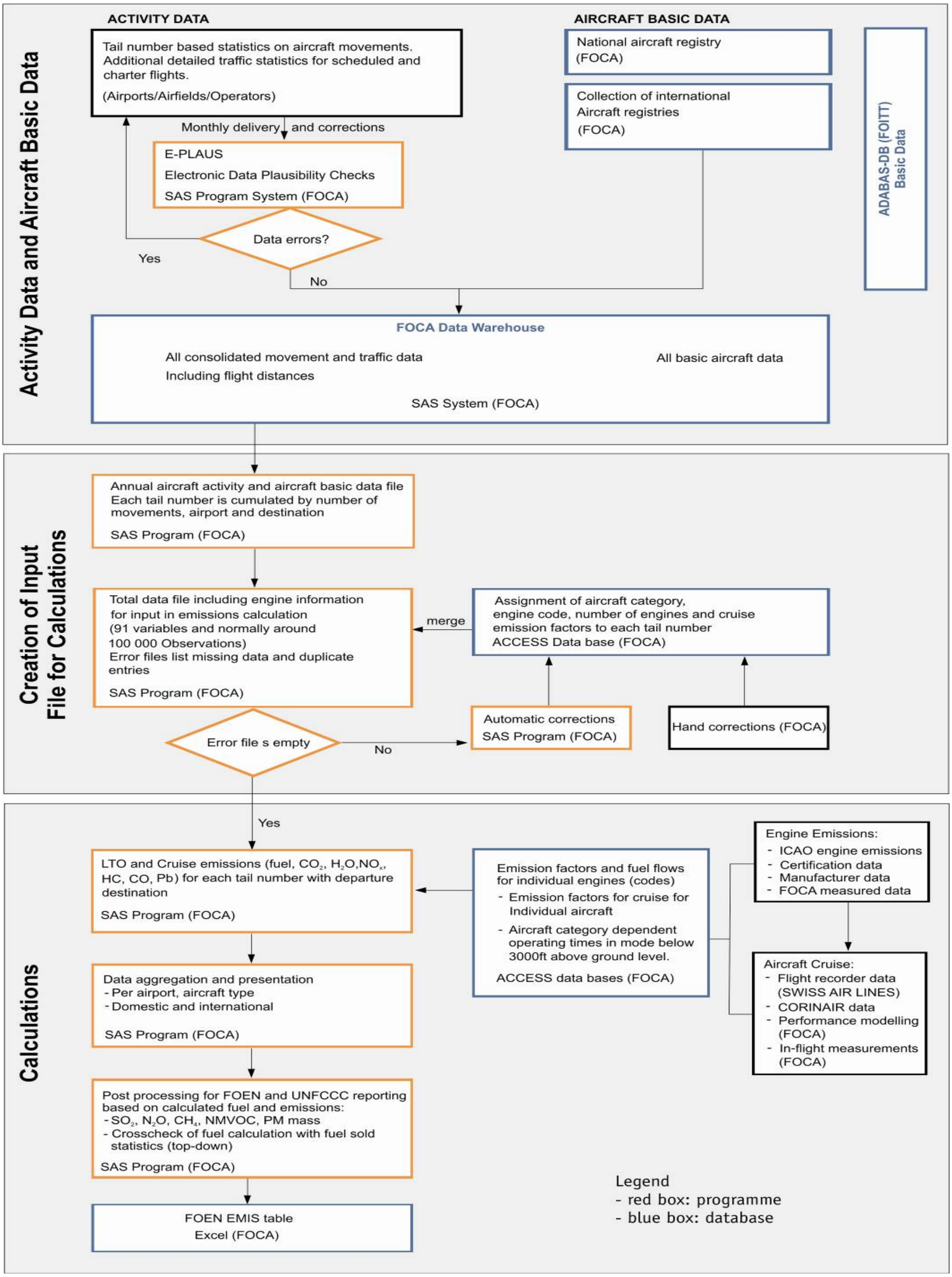

Figure 3-8 Modelling scheme (activity data, emission factors, emissions) for civil aviation.

A complete emission modelling (LTO and cruise emissions for domestic and international flights) has been carried out by Swiss FOCA for 1990, 1995, 2000, 2002, 2004–2010. The results of the emission modelling have been transmitted from FOCA to FOEN in an aggregated form. FOEN (the NIC) calculated the implied emission factors 1990, 1995, 2000, 2002, 2004 and carried out a linear interpolation for the years in-between. The interpolated implied emission factors were multiplied with the annual fuel sold from Swiss overall energy statistics (SFOE in respective years), providing the missing emissions of civil aviation for the years 1991-1994, 1996-1999, 2001 and 2003.

Details of emission factors and activity data follow below. Further tables containing more information are also given in Annex A3.1.4, more detailed descriptions of the emission modelling may be found in FOCA (2006).

Emission Factors

Kyoto gases:

- CO_2: The value of 73.2 t/TJ is country specific and is based on measurements and analyses of fuel samples (see Table 3-3). Small yearly variations have been neglected so far.
- CH_4, NMVOC (country specific; CORINAIR): VOC emissions (see “Precursors” below) are split into CH_4 and NMVOC by a constant share of 0.1 (CH_4) and 0.9 (NMVOC)[8]. For CH_4, the average emission factor for domestic flights is 2.0 kg/TJ in 2010, average LTO is 3.8 kg/TJ, cruise 0.70 kg/TJ (FOCA 2010).
- N_2O: The IPCC default value 2.3 kg/TJ is used for the whole period 1990-2010 (IPCC 1997b).

SO_2 (IPCC):

- The emission factor is taken from the IPCC Guidelines 1996, 23.0 kg/TJ, and is assumed to be constant over the period 1990–2010 (IPCC 1997c, chp 1.4.2.6)

Precursors (country specific; CORINAIR):

- Assignment of emission factors for the 1990 and 1995: The fleet that operated in and from Switzerland during those years has been analysed. The corresponding most frequent engines within an aircraft category (ICAO Code) have been assigned to every aircraft type.
- Assignment of emission factors for the year 2000, 2002, 2004 to 2010: The actual engine of every single aircraft operating in and from Switzerland has been assigned. FOCA uses the aircraft tail number as the key variable which links activity data and individual aircraft engine information (see Annex A3.1.4 Table “Aircraft Engine Combinations”).

FOCA uses the following emission factors of NO_X, VOC, CO and further pollutants:

LTO:
The Swiss FOCA engine emissions database consists of more than 600 individual engine

[8] The share of 0.1 for methane is maintained until general acceptance of necessary corrections is reached. Studies indicate that during cruise, Methane exhaust concentrations are lower than Methane ambient concentrations, see Wiesen et al. (1994), Spicer et al. (1994) and Knighton et al. (2009). A first remark has been made in Table 1-52 of the IPCC Guidelines 1996.

data sets. Jet engine factors for engines above 26.7 kN thrust (emission certificated) are identical to the ICAO engine emissions databank. Emission factors for lower thrust engines, piston engines and helicopters were taken from manufacturers or from own measurements. Emission factors for turboprops could be obtained in collaboration with the Swedish Defence Research Agency (FOI).

Cruise:
The fuel flows of the whole Airbus fleet (which produces a great portion of the Swiss inventory) have been modelled on the basis of real operational aircraft data from flight data recorders (FDR) of Swiss International Airlines. Pollutant emission factors have been modelled on the basis of the ICAO engine databank and corrected to cruise conditions using FDR engine parameters and the Boeing Fuel Flow Method 2. Part of the cruise emission factors are taken from EMEP/CORINAIR (EEA 2002) and from former CROSSAIR (FOCA 1991). Other missing aircraft types have been modelled on the basis of FOCA aircraft performance modelling and the ICAO engine emissions databank, using the Boeing Fuel Flow Method 2, as well. For piston engine aircraft and helicopters, Swiss FOCA has produced its own data, which were taken under real flight conditions (2005 data, FOCA 2009a).

Activity data

Scheduled and charter aviation

The statistical basis has been extended after 1996. Therefore, the modelling details are not exactly the same for the years 1990-1995 as for the subsequent years. The source for the 1990 and 1995 modelling is the movement statistics, which records information for every movement on airline, number of seats, Swiss airport, arrival/departure, origin/destination, number of passengers, distance. From 1996 onwards, every movement in the FOCA statistics also contains the individual aircraft tail number (aircraft registration). This is the key variable to connect airport data and aircraft data. The statistics may contain more than one million records with individual tail numbers. All annual aircraft movements recorded are split into domestic and international flights (there are 416’111 aircraft movements in the total of scheduled and charter traffic in 2010 (FOCA 2011)).

Non-scheduled, non-charter and General Aviation (including Helicopters)

- Airports and most of the airfields report individual aircraft data (aircraft registration). FOCA may therefore compute the inventory for small aircraft with Tier 3a method, too. However, for 1990 and 1995, the emissions data for non-scheduled, non-charter and General Aviation (helicopters etc.) could not be calculated with a Tier 3a method. Its fuel consumption is estimated to be 10% of the domestic fuel consumption. Data were taken from two FOCA studies (FOCA 1991, FOCA 1991a). For 2000-2007, all movements from airfields are known, which allows a more detailed modelling of the emissions (FOCA 2007a).
- Helicopters: The movements are taken from "Unternehmensstatistik der Schweizer Helikopterunternehmen” (FOCA 2004), which is updated annually. From fleet composition data, a split of 87% single engine helicopters and 13% twin engine helicopter can be derived. Note that all emissions from helicopter are considered domestic. There is a helicopter base in the Principality of Liechtenstein consuming a certain very small amount of fuel contained in the Swiss statistics. Thus, its consumption leads to domestic instead of international bunker emissions (about 0.4 Gg CO_2). FOCA and FOEN decided to report these emissions as Swiss-domestic since it is a very small amount and the effort for a separation would be considerable.
  In 2007, the determination of the activity data has been changed to electronical transmission and plausibility checks (software E-Plaus). Due to a higher resolution, the number of helicopter movements increased statistically (not in real-world) leading to an

overestimation of the helicopter emissions since then and improvements are about to be implemented. However, the development of detailed helicopter emissions modelling has to be considered as fine tuning, given the fact that helicopter emissions usually represent an order of 0.1% of the civil aviation total emissions.

Fuel consumption: Table 3-30 summarises the activity data for domestic aviation (1A3a). International aviation, which belongs to the memo items, international bunkers/aviation, is indicated, as well (see also Chapter 3.2.2).

Note that the fuel consumption reported in the CRF is identical to the consumption due to the fuel sales reported in the Swiss overall energy statistics (see e.g. SFOE 2011) while the consumptions of military aircraft and of Liechtenstein's helicopter consumption is subtracted (see Section 3.1.5). In fact, the emission model run by FOCA overestimates fuel consumption by ca. 3%. However, the domestic fuel consumption is reported according to the modelled value (conservative estimation), whereas the international fuel consumption (bunker) is scaled downwards so that the sum of domestic and international fuel consumption becomes identical with the fuel sold, as reported in the Swiss overall energy statistics.

Table 3-30 Fuel consumption of civil aviation in TJ. The "domestic" consumption and the corresponding emissions are reported under 1A3a, the "international" consumption is reported under Memo items, international bunkers (FOCA 2007a, 2007, 2008, 2009, 2010).

Civil Aviation	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
	Fuel consumption in TJ									
Total domestic (1A3aii)	3'450	3'194	3'217	3'165	3'077	3'075	2'972	2'850	2'742	2'684
Total international (1A3ai)	41'884	40'872	43'499	45'342	46'840	49'918	51'975	53'983	56'599	60'805
Sum	45'334	44'067	46'717	48'508	49'917	52'993	54'946	56'833	59'341	63'489
1990 = 100%	100%	97%	103%	107%	110%	117%	121%	125%	131%	140%

Civil Aviation	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
	Fuel consumption in TJ									
Total domestic (1A3aii)	2'539	2'296	2'028	1'951	1'963	1'699	1'658	1'891	1'618	1'704
Total international (1A3ai)	63'687	60'097	55'468	49'763	46'896	47'671	50'109	53'543	57'844	55'238
Sum	66'225	62'393	57'495	51'714	48'859	49'370	51'766	55'434	59'462	56'942
1990 = 100%	146%	138%	127%	114%	108%	109%	114%	122%	131%	126%

Civil Aviation	2010
	Fuel consump-tion in TJ
Total domestic (1A3aii)	1'688
Total international (1A3ai)	58'118
Sum	59'805
1990 = 100%	132%

b) Road Transportation (1A3b)

Tier 1 Key categories 1A3b
CO_2 from the combustion of gasoline (level and trend)
CO_2 from the combustion of diesel (level and trend)
CH_4 from the combustion of gasoline (trend)

Tier 2 Key categories 1A3b
CO_2 from the combustion of gasoline (level and trend)
CO_2 from the combustion of diesel (level and trend)
CH_4 from the combustion of gasoline (trend)

CO_2

The CO_2 emissions are calculated with a Tier 1 method (top-down) as suggested by IPCC Good Practice Guidance (IPCC 2003) using country specific emission factors. The emission factors are derived from the carbon content of fuels (see Table 3-3). The activity data corresponds to the amounts of gasoline and diesel fuel sold in Switzerland (sales principle). The numbers are taken from the national fuel statistics which is part of the Swiss overall energy statistics (SFOE 2011).

The consumption of biofuels is reported for Road Transportation as well. Fuels involved, emission factors and activity data are summarised in a comment to the EMIS database (EMIS/2012 1A3bi-viii “Strassenverkehr”). Most important data sources stem from the Swiss overall energy statistics (SFOE 2011) the Swiss renewable energy statistics (2011a) and the Swiss Federal Customs Administrations (SFCA 2008, 2011).

Other gases

The other gases are modelled with a well-documented country specific method (SAEFL 1995, 2004, 2004a, FOEN 2010i, INFRAS 2010, Hausberger et al. 2009). The approach corresponds methodologically to Box 1 in the decision tree of Figure 2.5 (p. 2.45) of IPCC Good Practice Guidance.

The emission computation is based on two sets of data:

- Traffic activity data: transport performance in vehicle kilometres (hot emissions), number of starts/stops and vehicle stock (cold start, evaporation emissions and running losses)
- Emission factors: specific pollutant emissions in grams per unit (vehicle kilometres, start/stop or vehicle)

For the calculation of emissions these two data sets are multiplied for all other gases as follows:

*emission (gram) = activity data (veh-km/a) * emission factor (gram/veh-km/a),*

Further details of emission modelling are given in Annex A3.1.5.

Data collection: Activity data

The activity data is derived from different data sources:

- Vehicle stock: The Federal vehicle registration database (SFSO 2010b) supplies the number of vehicles (including age distributions) per vehicle category[9]. With the help of a fleet turnover model the vehicle categories are split up into so called « sub-segments », which are used to link with the specific emission factors (vehicle category/size class/fuel type/emission concept (see also INFRAS 2010).
- Transport performance: The transport performance (mileage) is calculated from the specific mileage per vehicle (based on household surveys/Mikrozensus ARE/SFSO 2005) times the number of vehicles. This figure is calibrated to the official statistics of traffic performance (SFSO 2009c and SFSO 2010c)
- Numbers of starts/stops: Derived from vehicles stock, with data on trip length distributions and parking time distributions (ARE/SFSO 2005).

For the determination of the non CO_2 greenhouse gases and the precursors, the transport performance must be attributed to so called “traffic situations” (characteristic pattern of

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[9] The vehicle registration in Switzerland delivers all inputs to build up the fleet composition 1990-2010 which is characterised e.g. by vehicle category, engine capacity, fuel type, total weight, vehicle age and exhaust technology.

driving behaviour) which serve as a key to select the appropriate emission factor. The relative shares of these traffic situations is derived from a national road traffic model (operated by the Federal Office of Spatial Development, see ARE 2010). The traffic model is based on an origin-destination matrix that is assigned to a network of about 20'000 road segments. The model is calibrated partly bottom-up and partly top-down: Bottom-up by a number of traffic counts from the national traffic-counter network (333 stations all over Switzerland, FEDRO 2010), and top-down by the total of the mileage per vehicle category. Furthermore, it supplies the attributes needed for assigning a "traffic situation" to each road segment.

Due to fuel price differences in the vicinity of the national borders, gasoline stations sell relevant amounts of gasoline to foreign car owners. This amount of fuel is mainly consumed abroad ("tank tourism") but the whole amount must be reported as national under 1A3b Road Transportation. For the CO_2 emissions, the amount of tank-tourism is irrelevant since it is included in the sales principle. The non-CO_2 emissions related to the "tank tourism", however, are not captured by the traffic model. For the purpose of assuring completeness within the GHG inventory, these emissions are quantified on the basis of the difference between fuel consumption according to the Swiss overall energy statistics (sales principle) and fuel consumption derived from the traffic model. The resulting amount of "tank tourism" fuel is multiplied with mean emission factors to determine the related emissions of CH_4, N_2O, NO_x, CO, NMVOC, and SO_2. For CO_2, which dominates the emissions by a factor of approx. 1'000-10'000, the use of Swiss mean factors is correct, since the carbon content constitutes the emission factor. For CH_4 and N_2O there are differences between the Swiss mean factors and the implied emission factors of the four neighbouring countries Austria, France, Germany, Italy as a comparison with their implied emission factors for 1990 and 2004 has shown. The differences are small between Switzerland, Austria, and Germany because all three countries use the same emission factors (SAEFL 2004a), whereas there are some differences when compared to France and Italy that use other emission factors (COPERT[10]). Nevertheless, the use of the mean Swiss emission factors seems to be the consistent approach.

Emission Factors

The emission factors for fossil CO_2 and other gases are country specific and based on measurements and analyses of fuel samples (see Table 3-3). Emission factors for the further gases are country specific derived from "emission functions" which are determined from a compilation of measurements from various European countries with programs using similar driving cycles (legislative as well as standardized real-world cycles, like "Common Artemis Driving Cycle" (CADC). The method has been developed in 1990-1995 and has been extended and updated in 2000, 2004 and 2010. These emission factors are compiled in a so called "Handbook of Emission Factors for Road Transport" (SAEFL 1995, 2004, 2004a, FOEN 2010i, INFRAS 2004, 2004a, 2010). The latest version (3.1) is presented and documented on the website http://www.hbefa.net/. Several reports may be downloaded from there:

- Documentation of the general emission factor methodology (INFRAS 2011; forthcoming in German),
- Emission Factors for Passenger Cars and Light Duty Vehicles Switzerland, Germany, Austria, Norway and Sweden (INFRAS 2010; in English),

The resulting emission factors are published on CD ROM ("Handbook of emission factors for Road Transport", INFRAS 2010). The underlying database contains a dynamic fleet compositions model simulating the release of new exhaust technologies and the fading out of

[10] see Euopean Environment Agency http://www.eea.europa.eu/publications/TEC05 [15.02.2011]

old technologies. Corrective factors are provided to account for future technologies. Further details are shown in Annex A3.1.5.

The following table gives a selection of mean emission factors. The CO_2 factors are constant over the whole period 1990–2010. The carbon content of the fuels has not changed. However, the increasing portion of biofuels to the fuels is encompassed by the data time series. See next chapter for the emission factors of biofuels. For the other gases, more or less pronounced decreases of the emission factors occur due to new emission regulations and subsequent new exhaust technologies (mandatory use of catalytic converters for gasoline cars and lower limits for sulphur content in diesel fuels). Early models of catalytic converters have been substantial sources of N_2O, leading to an emission increase until 1998. Recent converter technologies have overcome this problem resulting in a decrease of the (mean) emission factor. The N_2O emission factors vary between 1 and 4 kg/TJ for gasoline, and between 0.5 and 2 kg/TJ, which is higher than the IPCC default values (0.6 kg/TJ). The factors newly used in Switzerland are taken from Copert 4 model (EEA 2010). Note that the newly used emission factors are higher than the ones used until submission 2010. In contrast to the N_2O emission factors, the measurement sample for CH_4 emission factors remained the same. However, due to updates in the vehicles fleet composition, the implied emission factors changed eventually. Further detailed description of how the emission factors for CH_4 are estimated is provided in chapter 16.

Emission factors from the combustion of biofuels

In lieu of reviewed emission factors for biofuels the following assumption were made.

- Biodiesel and vegetable/waste oil: The implied emission factors 1A3b for fossil diesel are used. Values for 2010:
  - CO_2 73.6 t/TJ; CH_4 0.37 kg/TJ; N_2O 2.06 kg/TJ
- Bio ethanol: The implied emission factors 1A3b for gasoline are used. Values for 2010:
  - CO_2 73.9 t/TJ; CH_4 8.07 kg/TJ; N_2O 1.05 kg/TJ
- Biogas: The implied emission factors 1A3b for CNG are used. Values for 2010:
  - CO_2 55.0 t/TJ; CH_4 5.40 kg/TJ; N_2O 3 kg/TJ

Table 3-31 Mean emission factors for road transport for passenger cars and heavy duty vehicles (continued on next page). For more details see Annex A3.1.5.

Gas	Fuel	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Passenger Cars						t/TJ					
CO2	Gasonline	73.9	73.9	73.9	73.9	73.9	73.9	73.9	73.9	73.9	73.9
	Diesel	73.6	73.6	73.6	73.6	73.6	73.6	73.6	73.6	73.6	73.6
	CNG										
CH4	Gasonline	0.0279	0.0253	0.0229	0.0210	0.0190	0.0175	0.0162	0.0149	0.0138	0.0128
	Diesel	0.0015	0.0015	0.0013	0.0012	0.0013	0.0012	0.0011	0.0010	0.0009	0.0009
	CNG										
N2O	Gasoline	0.0029	0.0032	0.0034	0.0036	0.0038	0.0040	0.0042	0.0042	0.0041	0.0039
	Diesel	0.0002	0.0003	0.0004	0.0005	0.0007	0.0008	0.0009	0.0010	0.0012	0.0014
NOx	Gasonline	0.3758	0.3485	0.3174	0.2951	0.2809	0.2723	0.2631	0.2509	0.2390	0.2264
	Diesel	0.2524	0.2555	0.2459	0.2390	0.2451	0.2405	0.2395	0.2392	0.2409	0.2448
	CNG										
CO	Gasonline	3.4384	3.0624	2.6997	2.4135	2.1550	1.9628	1.7921	1.6424	1.5136	1.3998
	Diesel	0.3029	0.3051	0.2795	0.2617	0.2666	0.2493	0.2367	0.2189	0.2024	0.1865
	CNG										
NMVOC	Gasonline	0.5291	0.4740	0.4211	0.3791	0.3384	0.3071	0.2788	0.2540	0.2319	0.2122
	Diesel	0.0609	0.0618	0.0548	0.0505	0.0516	0.0470	0.0443	0.0408	0.0378	0.0351
	CNG										
SO2	Gasonline	0.0094	0.0094	0.0094	0.0094	0.0094	0.0094	0.0094	0.0094	0.0094	0.0094
	Diesel	0.0654	0.0607	0.0561	0.0467	0.0203	0.0159	0.0174	0.0165	0.0188	0.0207
	CNG										

Gas	Fuel	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Passenger Cars						t/TJ					
CO2	Gasonline	73.9	73.9	73.9	73.9	73.9	73.9	73.9	73.9	73.9	73.9
	Diesel	73.6	73.6	73.6	73.6	73.6	73.6	73.6	73.6	73.6	73.6
	CNG								59.0	59.0	59.0
CH4	Gasonline	0.0118	0.0110	0.0101	0.0094	0.0087	0.0083	0.0076	0.0073	0.0068	0.0065
	Diesel	0.0008	0.0007	0.0006	0.0006	0.0005	0.0005	0.0004	0.0004	0.0004	0.0003
	CNG								0.0061	0.0057	0.0056
N2O	Gasoline	0.0037	0.0035	0.0032	0.0029	0.0017	0.0016	0.0014	0.0013	0.0012	0.0011
	Diesel	0.0016	0.0017	0.0018	0.0019	0.0020	0.0020	0.0021	0.0021	0.0021	0.0021
NOx	Gasonline	0.2141	0.2006	0.1843	0.1705	0.1580	0.1484	0.1307	0.1230	0.1110	0.1024
	Diesel	0.2525	0.2627	0.2731	0.2843	0.2895	0.2879	0.2751	0.2658	0.2588	0.2540
	CNG								0.0223	0.0222	0.0223
CO	Gasonline	1.3025	1.2337	1.1587	1.0977	1.0426	1.0073	0.9371	0.9049	0.8587	0.8234
	Diesel	0.1698	0.1523	0.1334	0.1219	0.1116	0.1016	0.0888	0.0826	0.0761	0.0717
	CNG								0.1578	0.1586	0.1592
NMVOC	Gasonline	0.1938	0.1803	0.1652	0.1523	0.1416	0.1350	0.1238	0.1194	0.1120	0.1072
	Diesel	0.0323	0.0293	0.0261	0.0242	0.0223	0.0204	0.0177	0.0163	0.0149	0.0140
	CNG								0.0005	0.0005	0.0005
SO2	Gasonline	0.0067	0.0057	0.0048	0.0038	0.0004	0.0004	0.0004	0.0004	0.0004	0.0004
	Diesel	0.0127	0.0117	0.0110	0.0093	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005
	CNG								0.0000	0.0000	0.0000

Gas	Fuel	2010
Passenger Cars		t/TJ
CO2	Gasonline	73.9
	Diesel	73.6
	CNG	59.0
CH4	Gasonline	0.0062
	Diesel	0.0003
	CNG	0.0055
N2O	Gasoline	0.0010
	Diesel	0.0021
NOx	Gasonline	0.0946
	Diesel	0.2503
	CNG	0.0224
CO	Gasonline	0.7925
	Diesel	0.0679
	CNG	0.1578
NMVOC	Gasonline	0.1031
	Diesel	0.0133
	CNG	0.0005
SO2	Gasonline	0.0004
	Diesel	0.0005
	CNG	0.0000

Table 3-32 Mean emission factors for road transport for passenger cars and heavy duty vehicles (continued). For more details see Annex A3.1.5.

Gas	Fuel	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Heavy duty vehicles						t/TJ					
CO2	Diesel	73.6	73.6	73.6	73.6	73.6	73.6	73.6	73.6	73.6	73.6
CH4	Diesel	0.0018	0.0018	0.0018	0.0017	0.0016	0.0016	0.0016	0.0015	0.0014	0.0013
N2O	Diesel	0.0007	0.0007	0.0008	0.0008	0.0008	0.0008	0.0008	0.0009	0.0009	0.0009
NOx	Diesel	1.026	1.024	1.021	1.011	0.982	0.950	0.929	0.916	0.906	0.898
CO	Diesel	0.215	0.215	0.214	0.210	0.203	0.198	0.193	0.187	0.181	0.175
NMVOC	Diesel	0.074	0.073	0.073	0.071	0.067	0.065	0.064	0.060	0.058	0.055
SO2	Diesel	0.065	0.061	0.056	0.047	0.020	0.016	0.017	0.016	0.019	0.021

Gas	Fuel	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Heavy duty vehicles						t/TJ					
CO2	Diesel	73.6	73.6	73.6	73.6	73.6	73.6	73.6	73.6	73.6	73.6
CH4	Diesel	0.0013	0.0011	0.0010	0.0010	0.0009	0.0008	0.0008	0.0007	0.0005	0.0005
N2O	Diesel	0.0009	0.0009	0.0008	0.0008	0.0007	0.0007	0.0009	0.0013	0.0019	0.0022
NOx	Diesel	0.878	0.835	0.796	0.758	0.717	0.698	0.665	0.623	0.550	0.513
CO	Diesel	0.168	0.160	0.156	0.155	0.149	0.149	0.146	0.144	0.140	0.139
NMVOC	Diesel	0.051	0.045	0.042	0.039	0.035	0.034	0.031	0.027	0.022	0.019
SO2	Diesel	0.0127	0.0117	0.0110	0.0093	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005

Gas	Fuel	2010
Heavy duty vehicles		t/TJ
CO2	Diesel	73.6
CH4	Diesel	0.0004
N2O	Diesel	0.0025
NOx	Diesel	0.483
CO	Diesel	0.137
NMVOC	Diesel	0.017
SO2	Diesel	0.0005

Activity data

The amount of gasoline and diesel fuel sold in Switzerland serves as the activity data for the calculation of the CO_2 emissions: The Swiss overall energy statistics gives the amount of gasoline and diesel oil sold (SFOE 2011). From these numbers, the off-road consumption and the fugitive emissions from transmission, storage and fuelling of gasoline (reported under 1B2av Distribution of oil products) are subtracted. The result gives the inventory-relevant consumption for estimating the CO_2 emissions. It contains the fuel consumption due to the traffic model plus the amount of “tank tourism” (see above). The following table shows the details.

Table 3-33 Upper and middle part of table: Split of fuel sales into territorial on-road (model), off-road (model) and tank tourism (residual value to sales amounts) for gasoline and diesel oil in PJ. (Numbers may not add to totals due to rounding.)
Lower part of table: Consumption of biofuels for road transportation. Consumption starts in 1997. Note that the unit is TJ (not PJ like fossil fuels in the upper and middle part of the table) and that Vegetable/Waste oil is included in the numbers of Biodiesel as well as separately depicted. However no double counting occurs in the total sum and shares of total fuel consumption.

Activity data	**Source category**	**1990**	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**
		PJ									
Gasoline											
on-road consumption (model)	1A3b	137.2	140.7	139.0	135.7	138.7	141.8	143.2	143.6	144.5	145.8
"tank tourism"	1A3b	16.2	19.2	26.7	17.8	15.0	7.2	9.7	15.3	15.7	19.9
off-road consumption (models)	1A2fii;1A3aii,c,d,e;1A4aii,bii,cii;1A5	2.4	2.4	2.4	2.4	2.4	2.4	2.3	2.3	2.3	2.3
Gasoline sold in Switzerland		155.8	162.2	168.1	155.9	156.1	151.3	155.2	161.2	162.5	168.0
Diesel											
on-road consumption (model)	1A3b	36.6	37.6	38.5	38.3	39.2	40.0	39.8	40.2	41.3	42.9
"tank tourism"	1A3b	-1.5	-2.0	-4.7	-6.4	-4.8	-5.0	-7.9	-6.7	-6.0	-4.9
off-road consumption (models)	1A2fii;1A3aii,c,d,e;1A4aii,bii,cii;1A5	10.9	11.1	11.4	11.6	11.9	12.1	12.3	12.5	12.6	12.8
Diesel sold in Switzerland		46.0	46.7	45.2	43.5	46.2	47.2	44.2	46.0	48.0	50.9
Total											
on-road consumption (model)	1A3b	173.8	178.2	177.5	174.0	177.9	181.8	183.0	183.8	185.8	188.7
"tank tourism"	1A3b	14.7	17.2	22.1	11.5	10.2	2.2	1.8	8.6	9.7	15.0
off-road consumption (models)	1A2fii;1A3aii,c,d,e;1A4aii,bii,cii;1A5	13.3	13.5	13.8	14.0	14.2	14.5	14.6	14.8	15.0	15.1
Gasoline and Diesel sold in Switzerland		201.8	208.9	213.3	199.4	202.3	198.5	199.4	207.2	210.4	218.8

Activity data	**Source category**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**
		PJ									
Gasoline											
on-road consumption (model)	1A3b	147.3	145.8	144.7	142.0	138.9	135.7	131.5	128.3	125.3	122.7
"tank tourism"	1A3b	18.5	15.3	13.3	15.2	15.5	13.9	13.6	15.4	15.1	14.0
off-road consump. (models)	1A2fii;1A3aii,c,d,e;1A4aii,bii,cii;1A5	2.3	2.3	2.2	2.2	2.2	2.2	2.1	2.1	2.1	2.1
Gasoline sold in Switzerland		168.0	163.4	160.2	159.4	156.6	151.8	147.2	145.8	142.6	138.7
Diesel											
on-road consumption (model)	1A3b	45.0	46.0	47.7	50.8	54.3	57.8	61.4	65.6	68.5	71.6
"tank tourism"	1A3b	-3.7	-3.6	-3.3	-3.0	-2.0	0.5	2.9	4.4	10.0	8.4
off-road consump. (models)	1A2fii;1A3aii,c,d,e;1A4aii,bii,cii;1A5	13.0	13.1	13.1	13.2	13.3	13.3	13.3	13.4	13.4	13.4
Diesel sold in Switzerland		54.4	55.5	57.5	60.9	65.5	71.6	77.6	83.4	91.8	93.3
Total											
on-road consumption (model)	1A3b	192.3	191.8	192.3	192.8	193.2	193.5	192.9	193.8	193.8	194.3
"tank tourism"	1A3b	14.8	11.7	10.1	12.2	13.5	14.5	16.4	19.8	25.1	22.3
off-road consump. (models)	1A2fii;1A3aii,c,d,e;1A4aii,bii,cii;1A5	15.3	15.3	15.4	15.4	15.4	15.5	15.5	15.5	15.5	15.5
Gasoline and Diesel sold in Switzerland		222.4	218.9	217.7	220.4	222.2	223.5	224.8	229.1	234.4	232.1

Activity data	**Source category**	**2010**
		PJ
Gasoline		
on-road consumption (model)	1A3b	119.8
"tank tourism"	1A3b	12.1
off-road consump. (models)	1A2fii;1A3aii,c,d,e;1A4aii,bii,cii;1A5	2.1
Gasoline sold in Switzerland		133.9
Diesel		
on-road consumption (model)	1A3b	74.7
"tank tourism"	1A3b	8.9
off-road consump. (models)	1A2fii;1A3aii,c,d,e;1A4aii,bii,cii;1A5	13.4
Diesel sold in Switzerland		97.0
Total		
on-road consumption (model)	1A3b	194.5
"tank tourism"	1A3b	21.0
off-road consump. (models)	1A2fii;1A3aii,c,d,e;1A4aii,bii,cii;1A5	15.5
Gasoline and Diesel sold in Switzerland		231.0

Biofuels	1990-1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
	TJ														
Biodiesel	0	57	51	48	56	60.4	55.0	72.3	100.7	196.4	272.7	304.7	368.2	232.0	287.9
Bioethanol	0	0	0	0	0	0.0	0.0	0.0	0.0	19.0	22.3	67.1	69.2	31.2	54.6
Vegetable/Waste oil	0	0	0	0	0	0.0	2.0	5.0	10.8	18.3	29.2	63.9	34.8	77.0	62.9
Biogas	0	3	5	8	19	24.3	19.9	22.1	31.7	47.2	49.4	66.0	125.4	136.1	211.0
Sum	0	60.1	56.9	56.4	75.5	84.7	77.0	99.4	143.3	280.9	373.7	501.7	597.6	476.4	616.4
Share of total fuel consump. 1A3b	0	0.003	0.003	0.003	0.004	0.004	0.004	0.005	0.007	0.015	0.019	0.026	0.031	0.025	0.032

Further activity data needed for modelling the non-CO_2 emissions are the mileages (vehicle kilometres) per vehicle category in Table 3-34.

Table 3-34 Mileages in millions of vehicle kilometres. PC: passenger cars, LDV: light duty vehicles, HDV: heavy duty vehicles)

Veh. category	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
	million vehicle-km									
PC	42'650	43'745	43'178	42'259	43'280	44'639	45'567	46'138	47'056	48'166
LDV	2'758	2'742	2'867	2'632	2'669	2'746	2'767	2'786	2'831	2'903
HDV	1'992	2'015	2'036	2'025	2'109	2'107	2'055	2'072	2'126	2'200
Coaches	108	108	109	109	110	110	109	108	101	98
Urban Bus	174	186	188	190	190	192	188	188	192	195
2-Wheelers	2'025	1'947	1'866	1'792	1'717	1'744	1'756	1'823	1'872	1'941
Sum	49'707	50'743	50'244	49'007	50'074	51'538	52'443	53'115	54'178	55'503
(1990=100%)	100%	102%	101%	99%	101%	104%	106%	107%	109%	112%

Veh. category	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
	million vehicle-km									
PC	49'552	49'986	50'860	51'655	52'532	53'354	53'979	54'876	55'850	56'643
LDV	2'978	3'059	3'119	3'149	3'215	3'300	3'375	3'473	3'529	3'570
HDV	2'273	2'165	2'109	2'115	2'144	2'127	2'189	2'203	2'223	2'264
Coaches	99	95	93	95	98	106	118	120	114	120
Urban Bus	200	205	211	215	220	229	233	240	245	247
2-Wheelers	1'999	2'048	2'098	2'152	2'190	2'204	2'262	2'300	2'366	2'387
Sum	57'101	57'558	58'490	59'382	60'399	61'321	62'156	63'211	64'326	65'231
(1990=100%)	115%	116%	118%	119%	122%	123%	125%	127%	129%	131%

Veh. category	2010
	million vehicle-km
PC	57'419
LDV	3'607
HDV	2'304
Coaches	119
Urban Bus	250
2-Wheelers	2'409
Sum	66'108
(1990=100%)	133%

In 2010, 86.9% of total vehicle kilometres are driven by passenger cars, 5.5% and 3.5% by light and heavy duty vehicles, respectively. The mileages increased for all vehicle categories (except coaches), totalling +33% in the period 1990–2010. In the same period, fuel consumption increased less strongly, by 14.5%, indicating improved fuel efficiency. This effect is also reflected in Table 3-35 that depicts the specific fuel consumption per vehicle-km. For most vehicle categories, the specific consumption has decreased in the period 1990-2010 (between -3% and -22%). Consumption of light duty vehicles remained indifferent while two-wheelers (+20%) have increased their average specific consumption. Concerning the whole car fleet, a decrease of -16% in specific consumption has been reached between 1990 and 2010.

Table 3-35 Fuel consumption of road transport, not including "tank tourism" (PC: passenger cars, LDV: light duty vehicles, HDV: heavy duty vehicles).

Veh. cat.	Fuel	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
		MJ/veh-km									
PC	Gasoline	3.21	3.23	3.23	3.24	3.23	3.22	3.20	3.18	3.15	3.12
	Diesel	2.91	2.91	2.91	2.97	2.89	2.89	2.88	2.89	2.87	2.83
	CNG										
LDV	Gasoline	3.17	3.18	3.17	3.18	3.18	3.18	3.18	3.17	3.17	3.18
	Diesel	3.86	3.87	3.87	3.88	3.87	3.86	3.83	3.81	3.79	3.77
HDV	Diesel	10.99	11.04	11.07	11.02	11.07	10.93	10.79	10.65	10.53	10.46
Coach	Diesel	11.84	11.85	11.87	11.81	11.75	11.69	11.62	11.55	11.48	11.42
Urban Bus	Diesel	16.22	16.29	16.33	16.34	16.32	16.29	16.20	16.10	16.02	15.90
	CNG										
2-Wheeler	Gasoline	1.11	1.14	1.17	1.19	1.21	1.22	1.22	1.24	1.24	1.24
Average		**3.45**	**3.47**	**3.49**	**3.51**	**3.51**	**3.49**	**3.45**	**3.42**	**3.39**	**3.36**
		100%	**100%**	**101%**	**102%**	**102%**	**101%**	**100%**	**99%**	**98%**	**97%**

Veh. cat.	Fuel	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
		MJ/veh-km									
PC	Gasoline	3.09	3.06	3.04	3.01	2.97	2.94	2.89	2.86	2.82	2.78
	Diesel	2.77	2.69	2.62	2.54	2.47	2.40	2.36	2.34	2.30	2.28
	CNG								2.60	2.56	2.53
LDV	Gasoline	3.18	3.17	3.18	3.19	3.19	3.19	3.21	3.21	3.20	3.20
	Diesel	3.75	3.71	3.63	3.56	3.48	3.42	3.37	3.34	3.32	3.31
HDV	Diesel	10.38	10.66	10.71	10.74	10.73	10.91	10.85	10.86	10.78	10.72
Coach	Diesel	11.33	11.25	11.21	11.19	11.21	11.22	11.23	11.22	11.18	11.16
Urban Bus	Diesel	15.80	15.71	15.60	15.45	15.45	15.37	15.24	15.23	15.05	14.98
	CNG								20.95	21.02	20.95
2-Wheeler	Gasoline	1.25	1.25	1.24	1.25	1.27	1.28	1.29	1.31	1.33	1.34
Average		**3.32**	**3.29**	**3.24**	**3.20**	**3.15**	**3.11**	**3.06**	**3.02**	**2.96**	**2.93**
		96%	**95%**	**94%**	**93%**	**91%**	**90%**	**89%**	**87%**	**86%**	**85%**

Veh. cat.	Fuel	2010
		MJ/veh-km
PC	Gasoline	2.75
	Diesel	2.26
	CNG	2.51
LDV	Gasoline	3.19
	Diesel	3.31
HDV	Diesel	10.67
Coach	Diesel	11.16
Urban Bus	Diesel	14.93
	CNG	20.88
2-Wheeler	Gasoline	1.34
Average		**2.89**
		84%

For modelling of cold start and evaporative emissions of passenger cars and light duty vehicles, also vehicle stock and start numbers are used for activity data. The corresponding numbers are summarised in the next table. Vehicle stock figures correspond to registration data. The starts per vehicle are based on specific household surveys (ARE/SFSO 2005).

Table 3-36 Vehicle stock numbers and average number of starts per vehicle per day (PC: passenger cars, LDV: light duty vehicles).

Veh. Category	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
	stock in 1000 vehicles									
PC	2'985	3'058	3'091	3'110	3'165	3'229	3'268	3'323	3'383	3'467
LDV	221	228	229	228	232	238	241	243	247	254
2-Wheelers	764	747	729	720	708	704	699	709	718	728
	starts per vehicle per day									
PC	2.61	2.60	2.58	2.56	2.54	2.53	2.53	2.51	2.49	2.47
LDV	1.97	1.97	1.97	1.97	1.97	1.97	1.97	1.97	1.97	1.97
2-Wheelers	1.59	1.58	1.57	1.56	1.55	1.54	1.54	1.53	1.52	1.51

Veh. Category	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
	stock in 1000 vehicles									
PC	3'545	3'630	3'701	3'754	3'811	3'862	3'894	3'956	3'990	4'047
LDV	260	268	274	278	284	291	298	307	312	317
2-Wheelers	732	740	753	763	771	770	784	789	806	809
	starts per vehicle per day									
PC	2.46	2.45	2.44	2.43	2.41	2.40	2.39	2.38	2.37	2.35
LDV	1.96	1.96	1.96	1.96	1.96	1.96	1.96	1.96	1.96	1.96
2-Wheelers	1.50	1.51	1.52	1.52	1.53	1.54	1.54	1.55	1.56	1.56

Veh. Category	2010
	stock in 1000 vehicles
PC	4'102
LDV	321
2-Wheelers	813
	starts per vehicle per day
PC	2.34
LDV	1.96
2-Wheelers	1.57

c) Railways (1A3c)

The entire Swiss railway system is electrified. Electric locomotives are used in passenger as well as freight railway traffic. Diesel locomotives are used for shunting purposes in marshalling yards and for construction activities only.

The complete revision of the emissions of the whole off-road sector that began in 2005 was completed in 2008. The emissions of all off-road categories like railways, navigation etc. are modelled by the same approach. The emissions are calculated with a Tier 2 method. Some details of the emission modelling that hold for all off-road families are described in Annex A3.1.6 Off-road vehicles. Activity data and emission factors were updated and the emission calculation was carried out in a new database structured in analogy to the on-road database (INFRAS 2008). Emissions are calculated for the years 1990, 1995, 2000, 2005, 2010 etc. up to 2020. For the years in-between, the emissions are interpolated linearly.

Emission Factors

Only diesel oil is being used as fuel, therefore all emission factors refer to diesel oil.

- The emission factor for CO_2 is country specific and assumed to be constant in the period 1990-2010 with value 73.6 t/TJ (diesel oil, see Table 3-3, SFOE 2001).
- For SO_2 the emission factors are country specific. They are depicted in Table A - 11 in Annex A2.2, row diesel oil: Continuous decrease from 65.4 kg/TJ in 1990 to 12.7 kg/TJ in 2000 and to 0.47 kg/TJ in 2010.

- The emission factors for all other gases are country specific and are shown in Table A - 24 in Annex A3.1.6. Note that NMVOC is not modelled bottom-up. The NMVOC emissions are calculated as the difference of VOC and CH_4 emissions.
- For differences of the emission factors compared to IPCC default values, Table A - 20 in the Annex A3.1.6.

Note that emission factors in the unit of kg/h may be downloaded by query from the public part of the off-road database INFRAS (2008)[11].

Activity data

The fuel consumption is calculated by using the formula given above for the emission modelling. Instead of the emission factor, consumption factors are used (see Table A - 21). The operating hours depend on the number of vehicles per age and size class. In 2005 e.g., 1'260 vehicles were operating 0.77 million hours per year with an average number of 611 operating hours per year per vehicle (INFRAS 2008). The resulting fuel consumption is shown in Table 3-37.

Table 3-37 Activity data (diesel oil consumption) for railways.

Railways	Unit	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Diesel	TJ	390	400	410	420	430	441	444	447	449	452
1990=100%		100.0%	102.6%	105.2%	107.8%	110.4%	113.0%	113.8%	114.6%	115.3%	116.1%

Railways	Unit	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Diesel	TJ	455	461	467	473	478	484	490	496	502	507
1990=100%		116.8%	118.3%	119.8%	121.3%	122.7%	124.2%	125.7%	127.2%	128.7%	130.2%

Railways	Unit	2010
Diesel	TJ	513
1990=100%		131.6%

d) Navigation (1A3d)

The complete revision of the emissions of the whole off-road sector that began in 2005 was completed in 2008. The emissions of all off-road categories like railways, navigation etc. are modelled by the same approach. The emissions are calculated with a Tier 2 method. Some details of the emission modelling that hold for all off-road families are described in Annex A3.1.6 Off-road vehicles. Activity data and emission factors were updated and the emission calculation was carried out in a new database structured in analogy to the on-road database (INFRAS 2008).

There are passenger ships, dredgers, fishing boats, motor and sailing boats on the lakes of Switzerland and on the river Rhine. Every boat is registered at the cantonal authorities. The emissions are calculated for the years 1990, 1995, 2000, 2005, 2010 etc. up to 2020. For the years in-between, the emissions are interpolated linearly.

On the river Rhine as well as on the lakes Geneva and Constance, some of the boats cross the border and go abroad (Germany, France). Fuels bought in Switzerland will therefore become bunker fuel. The amount of bunker diesel oil is evaluated in Section 3.2.2.

[11] http://www.bafu.admin.ch/luft/00596/06906/offroad-daten/index.html?lang=en [24.01.2012]

Emission Factors

- The emission factor for CO_2 is country specific and is assumed to be constant in the period 1990-2010 with value 73.6 t/TJ for diesel oil, 73.9 t/TJ for gasoline and 73.7 t/TJ for gas oil (Table 3-3, SFOE 2001).
- For SO_2 the emission factors are country specific and are given in Table A - 11 in Annex A2.2 (diesel oil, gasoline, gas oil).
- The emission factors for all other gases are country specific and are shown in Table A - 25 to Table A - 28 in Annex A3.1.6. Note that NMVOC is not modelled bottom-up. The NMVOC emissions are calculated as the difference of VOC and CH_4 emissions.

Note that emission factors in the unit of kg/h may be downloaded by query from the public part of the off-road database INFRAS (2008), see footnote 11 on previous page.

Activity data

The numbers of vehicles and of operating hours are given in Annex A3.1.6 (INFRAS 2008). Table 3-38 shows the domestic fuel consumption. In 2010, the fuel-split was 52%, 38% and 10% for diesel oil, gasoline and gas oil.

Table 3-38 Fuel consumption of (domestic) navigation.

Navigation	Unit	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Diesel	TJ	705	703	701	698	696	694	708	723	738	753
Gasoline	TJ	701	692	682	673	664	654	647	639	631	623
Gas oil	TJ	110	116	122	127	133	139	141	142	144	145
Sum	TJ	1'517	1'511	1'505	1'499	1'493	1'487	1'496	1'504	1'513	1'521
1990 = 100%		100%	100%	99%	99%	98%	98%	99%	99%	100%	100%

Navigation	Unit	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Diesel	TJ	767	771	776	780	784	788	795	801	808	814
Gasoline	TJ	616	614	613	612	611	609	609	608	608	607
Gas oil	TJ	147	150	152	155	157	160	160	160	160	160
Sum	TJ	1'530	1'535	1'541	1'547	1'552	1'558	1'563	1'569	1'575	1'581
1990 = 100%		101%	101%	102%	102%	102%	103%	103%	103%	104%	104%

Navigation	Unit	2010
Diesel	TJ	821
Gasoline	TJ	606
Gas oil	TJ	160
Sum	TJ	1'587
1990 = 100%		105%

e) Pipeline Transportation (1A3e)

Source 1A3e includes emissions of CO_2, CH_4, N_2O, NO_x, CO, NMVOC and SO_2 from a compressor station located in Ruswil.

Emission Factors

The emission factors for 1A3e are calculated for each year separately based on expert judgement.

Activity data

The data on fuel consumption for the operation of the compressor station in Ruswil is based on the Swiss overall energy statistics (SFOE 2011; Table 13).

3.2.8.3 Uncertainties and Time-Series Consistency

a) General

For a general description of the uncertainty analysis and time series consistency of the Energy Sector see Chapter 3.2.6.3 a).

b) Specific: Uncertainty in CH_4 and N_2O emission factors for gasoline and diesel vehicles in 1A3b Road Transportation

Due to a study for the road transportation in Germany (IFEU/INFRAS 2009), where the same handbook of emission factors is used as in Switzerland, the uncertainties for the CH_4 and N_2O emission factors are adopted:

- CH_4: 37% (gasoline) and 20% (diesel),
- N_2O: 50% (gasoline) and 22% (diesel).

For the CH_4 emissions of CNG the qualitative uncertainty “medium” (30%) is taken (according to Table 1-3).

Consistency and Completeness in 1A3 Fuel Combustion

- Time series for 1A3 are all consistent.
- All estimates in the sector 1A3 are assumed to be complete.

3.2.8.4 Source-specific QA/QC and Verification

a) General

See Chapter 3.2.6.4.

The emission factors of category 1A3b for CO_2, CH_4 and N_2O used in the Swiss Inventory have been compared to the corresponding emission factors of other countries (UNFCCC http://unfccc.int/di/FlexibleQueries.do) and to the IPCC default value if available (INFRAS 2012). Switzerland’s diesel and gasoline CO_2 emission factor lie in the midfield of the other countries. Furthermore CH_4 and N_2O emission factors for gasoline are significantly lower. For further explanations see Sat. Pap in Chapter 16.

b) Specific: Civil Aviation (1A3a)

Emissions:

Total calculated emissions for domestic and international flights have been compared between different years. The development of total emissions with time is consistent with a fleet renewal of former Swissair in the early nineties, the technological improvements and changes in fleet composition.

Emission factors:

- From total fuel burn, total distance, number of passenger (without freight) per aircraft type, the fuel consumption per 100 passenger km has been calculated (backward calculation). The result of 2 to 10 kg fuel/100 passenger km is in line with expectations for 1990 passenger fleets.
- The implied emission factors were calculated for 2010 and compared with previous years.

Activity data:

- In an independent Tier 3b calculation, EUROCONTROL performed a fuel calculation for Switzerland’s international flights, based on collected flight plan data and single movements. The results for the years 2004, 2005 and 2007 matched the FOCA calculations by more than 97.4%. The FOCA results were generally 1% to 2% higher but included the total number of actual flight movements of all flights, including VFR (visual flight rules) and non-scheduled flights.
- Comparison between total movement numbers in the calculation and in the corresponding published statistics. Example: In 1990 calculation, FOCA considered all flights for which there was a form ‘Traffic report to the airport authorities’ filled in (total heavy aircraft). The total number of movements in 1990 is 266’487 (without Basel). The published number of movements for scheduled and charter flights in 1990 is: 263’952 (without Basel). The difference is due to pure cargo, post and rerouted flights, which are not considered as scheduled or charter movements.
- The bottom-up calculation of total fuel matches the total fuel sold within a few percents. The remaining difference can be attributed to fuelling.
- Real-world fuel consumption was compared with modelled consumption for selected aircrafts of four Swiss airlines. The difference between the two methods was smaller than 1%.

c) Specific: Road Transportation (1A3b)

The international project for the update of the emission factors for road vehicles is overseen by a group of external and international experts that guarantees an independent quality control. For the update of the modelling of Switzerland’s road transport emissions, which has been carried out between 2008 and 2010, several experts from the federal administration have conducted the project. The results have undergone large plausibility checks and comparisons with earlier estimates.

The emission factors CH_4 and N_2O used for the modelling of 1A3b Road Transportation are taken from the handbook of emission factors (INFRAS 2010), which is also applied in Germany, Austria, Netherlands, Sweden. The Swiss emission factors for CH_4 and N_2O used in 1A3b were additionally compared with those depicted in the CRF from Germany and a good match was found. Possible small differences might result from a varying fleet composition. For gasoline, the activity data is easily verified due to the fact, that 98.5% (2010) of the gasoline sold in Switzerland is consumed by 1A3b Road Transportation itself. Therefore the amount of gasoline reported in the Swiss overall energy statistics is a strong control and verification parameter for the activity data of 1A3b. For diesel, the same control is carried out and the amount of diesel consumed by 1A3b Road Transportation is 86.1% (2010) compared to the amount sold.

3.2.8.5 Source-Specific Recalculations

- 1A3b: following the update of the road traffic model in the last submission, a modification in the activity data calculation steps leads to a recalculation of the activity data for all GHG gases for the whole time series and all fuels.
- 1A3b: due to a correction of an error in data aggregation, activity data for all GHG gases related to the combustion of Biogas was recalculated for the year 2009.
- 1A3b: activity data for all GHG gases related to the combustion of gaseous fuels was recalculated for the years 2007-2009 due to changes in the Swiss overall energy statistic (SFOE 2011). This affected primarily use of gaseous fuels in tank tourism.

3.2.8.6 Source-Specific Planned Improvements

Civil Aviation (1A3a): For the years to come, efficiency improvements in the fuel consumption of large aircrafts will be considered in the modelling approach in order to avoid overestimation of consumption.

3.2.9 Source Category 1A4- Other Sectors (Commercial/ Institutional, Residential, Agriculture/ Forestry)

3.2.9.1 Source Category Description

Tier 1 Key categories 1A4

CO_2 from the combustion of Liquid Fuels in the Commercial/Institutional Sector (level and trend)
CO_2 from the combustion of Gaseous Fuels in the Commercial/Institutional Sector (level and trend)
CO_2 from the combustion of Liquid Fuels in the Residential Sector (level and trend)
CO_2 from the combustion of Gaseous Fuels in the Residential Sector (level and trend)
CO_2 from the combustion of Liquid Fuels in the Agriculture/Forestry Sector (level)

Tier 2 Key categories 1A4

CO_2 from the combustion of Liquid Fuels in the Commercial/Institutional Sector (level)
CO_2 from the combustion of Gaseous Fuels in the Commercial/Institutional Sector (level and trend)
CO_2 from the combustion of Liquid Fuels in the Residential Sector (level and trend)
CO_2 from the combustion of Gaseous Fuels in the Residential Sector (level and trend)
CH_4 from the combustion of Biomass in the Residential Sector (trend)

Table 3-39 Specification of source category 1A4 “Other sectors”.

1A4	Source	Specification	Data Source
1A4a	Commercial/ Institutional	Emission from fuel combustion in commercial and institutional buildings and from professional gardening off-road machinery and motorised equipment	AD: SFOE 2011, SFOE 2011b, Prognos/Basics, 2011, INFRAS 2008 EF: EMIS 2012/1A4 div., SAEFL 2000; SFOE 2001, IPCC 1997c, EMIS 2012/1 solid fuels/wood, INFRAS 2008
1A4b	Residential	Emissions from fuel combustion in households and from hobby gardening machinery and motorised equipment	AD: SFOE 2011, SFOE 2011b, INFRAS 2008 EF: EMIS 2012/1A4div., SAEFL 2000; SFOE 2001, IPCC 1997c, EMIS 2012/1A solid fuels/wood, INFRAS 2008
1A4c	Agriculture/ Forestry/ Fishing	Comprises fuel combustion for wood combustion in Agriculture and Forestry and grass drying and off-road machinery in agriculture/forestry	wood combustion: AD: SFOE 2011b EF EMIS 2012/1A solid fuels/wood AD, EF: EMIS 2012/1A4ci off-road machinery: AD, EF INFRAS 2008

3.2.9.2 Methodological Issues

a) Commercial/Institutional (1A4a) and Residential (1A4b)

For Fuel Combustion in Commercial and Institutional Buildings (1A4ai) and in Households (1A4bi), a country specific Tier 2 method is used. A top-down method based on aggregated fuel consumption data from the Swiss overall energy statistics is used to calculate emissions (SFOE 2011).

The wood fuel consumption is based on the Swiss wood energy statistics (SFOE 2011b). For the calculation of non-CO_2 emissions from the use of light fuel oil and natural gas the following sources are differentiated: (α) heat only boilers, (β) combined heat and power production in turbines and (γ) combined heat and power production in engines.

Emissions of GHGs are calculated by multiplying levels of activity by emission factors. An oxidation factor of 100% is assumed for all combustion processes and fuels (see sub-section on oxidation factors in the beginning of Section 3.2.5.1).

For mobile off-road sources (1A4aii and 1A4bii) the emissions are calculated by the same approach as all other off-road categories. The emissions are calculated with a Tier 2 method. Some details of the emission modelling that hold for all off-road families are described in Annex A3.1.6 Off-road vehicles. Activity data and emission factors were updated and the emission calculation was carried out in a new database structured in analogy to the on-road database (INFRAS 2008). The emission modelling is carried out for 1990, 1995, 2000, 2005, 2010. For the GHG inventory, the missing years in-between the modelling years are interpolated linearly by vehicle category. Diesel oil and gasoline are used as fuels only.

Emission Factors

The emission factors for CO_2 are country specific and based on measurements and analysis of fuel samples carried out by the Swiss Federal Laboratories for Materials Testing; Research EMPA and Intertek (EMPA 1999; Intertek 2008; carbon emission factor documented in SFOE 2001, Table 45: p. 51; net calorific values on p. 61. See also Annex A2.1.1).

The activity data on LFO use in the CRF includes LPG consumption. This is due to statistical reasons in the Swiss overall energy statistics (SFOE 2011). Therefore the LFO emission factor for CO_2 (see table below) is a mixed emission factor that results as a weighted average of the gas oil emission factor and LPG emission factor.

Emission factors for CH_4, NO_x, CO and NMVOC for heat only boilers are country specific based on comprehensive life cycle analysis of combustion boilers, turbines and engines in the residential, commercial institutional and agricultural sectors, documented in SAEFL 2000 (pp. 42-56) and EMIS. For NO_x emission factors, expert judgement has been used to estimate the fraction of low-NO_x burners. The emission factors for NO_x and CO for natural gas and light fuel oil have been recalculated for the entire time series based on a new study as documented in EMIS (EMIS 2012/1 Energy Model).

Emission factors for CH_4, NO_x, CO and NMVOC for combined heat and power generation in turbines and engines are country specific based on comprehensive measurements (EMIS 2012/1A4div. Energie). CH_4 emission factors have been recalculated for the time series.

For N_2O emissions the default emission factors from IPCC 1997c have been used.

The coal emission factor for CO_2 (see table below) is the emission factor for hard coal. Lignite consumption is accounted for exclusively in cement production in category 1A2f. For net calorific values see Annex A2.1.1.

Emission factors for biomass are based on SAEFL 2000 (pp. 26ff) and a new study on wood use (EMIS 2012/1A solid fuels/wood).

The following table presents the emission factors used in 1A4a and 1A4b:

Table 3-40 Emission Factors for 1A4a and 1A4b: Commercial/Institutional and Residential in “Other Sectors” for 2010.

Source/fuel	**CO_2**	**CO_2 biog.**	**CH_4**	**N_2O**	**NO_x**	**CO**	**NMVOC**	**SO_2**
	t/TJ		kg/TJ					
1A4 a Other Sectors: Commercial/Institutional								
LFO (weighted average)	73.5		0	0.6	36	7	6	24
LFO (heat only boilers)	73.5		1	0.6	36	7	6	24
LFO (turbines)	NO		NO	NO	NO	NO	NO	NO
LFO (engines)	73.5		0	0.6	40	30	8	24
Natural gas (weighted average)	55		1.4	0.1	27	14	2	0.5
NG (heat only boilers)	55		0	0.1	19	11	2	0.5
NG (turbines)	55		2	0.1	60	15	0	0.5
NG (engines)	55		20	0.1	128	61	1	0.5
Coal	NO		NO	NO	NO	NO	NO	NO
Biomass (weighted average)		89.5	33.7	1.5	119	824	78	19
Biomass (wood)		92	36	1.6	127	883	83	20
Biomass (biogas)		55	6	0.1	19	11	2	0.5
Gasoline (gardening professional)	73.9		95	2.1	152	23'155	2'518	0.4
1A4 b Other Sectors: Residential								
LFO (weighted average)	73.5		1	0.6	38	13	6	24
LFO (heat only boilers)	73.5		1	0.6	38	13	6	24
LFO (turbines)	NO		NO	NO	NO	NO	NO	NO
LFO (engines)	73.5		2	0.6	40	30	8	24
Natural gas (weighted average)	55		6.2	0.1	18	15	2	0.5
NG (heat only boilers)	55		6	0.1	18	14	2	0.5
NG (turbines)	55		2	0.1	60	15	0	0.5
NG (engines)	55		20	0.1	38	59	1	0.5
Coal	92.7		300	1.6	65	2'000	100	350
Biomass		92	92	1.6	92	1'983	214	20
Gasoline (gardening)	73.9		51	2.4	153	23'759	1'746	0.4

Remark: In the table above, the CO_2 emission factor of light fuel oil (73.52 t/TJ) is a weighted average emission factor including both gas oil (73.7 t/TJ) and LPG (65.5t/TJ) emissions, the same emission factor as in 1A1a and in 1A2 (see Section 3.2.6.2 and 3.2.7.2). The CO_2 emission factor for coal refers to the emission factor for hard coal (92.7 t/TJ), the same emission factor as for all 1A2 "top-down" sources except cement industry in 1A2f Other, in which also emissions from lignite occur (see section 3.2.7.2).

Emission factors for mobile off-road sources

- The emission factors for CO_2 are country specific and are assumed to be constant in the period 1990-2010 with values 73.6 t/TJ for diesel oil, 73.9 t/TJ for gasoline and 55.0 t/TJ for CNG (equal to natural gas). See Table 3-3.
- For SO_2 the emission factors are country specific and are given in Table A - 11 in Annex A2.2.
- The emission factors for all other gases are country specific and shown in Table A - 20 to Table A - 23 in the Annex A3.1.6 (INFRAS 2008) The NMVOC emissions are calculated as the difference of VOC and CH_4 emissions.

Note that emission factors in the unit of kg/h may be downloaded by query from the public part of the off-road database INFRAS (2008), see footnote 11 above.

Activity Data

Activity data on fuel consumption for Commercial/Institutional and Residential (1A4a and b) correspond to the consumption of light fuel oil (including LPG), natural gas, coal and biogas in the categories “Services” (for 1A4a) and “Households” (for 1A4b) of the Swiss overall energy statistics (SFOE 2011; Table 17).

Activity data for Biomass use (wood) in 1A4a and 1A4b correspond to a study based on the data of the Swiss wood energy statistics (SFOE 2011b), as documented in the EMIS database (EMIS 2012/1A solid fuels/wood).

The amount of light fuel oil and natural gas that is used for co-generation in turbines and engines is taken from Kaufmann (2008).

Table 3-41 Activity data in 1A4a Commercial/Institutional and 1A4b Residential.

Source/Fuel	Unit	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
1A4a Commercial/Institutional	TJ	79'653	89'650	88'492	87'772	80'048	84'149	90'345	85'187	87'526	86'058
Light fuel oil	TJ	60'023	67'133	65'695	63'628	57'125	58'741	63'115	59'585	61'044	60'172
LFO heat only boilers	TJ	60'000	67'082	65'636	63'572	57'004	58'566	62'884	59'297	60'746	59'845
LFO turbines	TJ	0	0	0	0	0	0	0	0	0	0
LFO engines	TJ	24	51	58	56	122	175	231	288	298	327
Natural gas	TJ	16'468	18'912	19'189	20'423	19'301	21'281	22'554	21'206	21'778	21'030
NG heat only boilers	TJ	16'192	18'477	18'629	19'797	18'478	20'110	21'143	19'741	20'176	19'320
NG turbines	TJ	85	114	109	106	107	78	21	5	12	4
NG engines	TJ	192	321	451	520	715	1'093	1'390	1'460	1'590	1'706
Coal	TJ	0	0	0	0	0	0	0	0	0	0
Biomass	TJ	2'953	3'385	3'376	3'477	3'367	3'861	4'399	4'108	4'405	4'547
Biomass (wood)	TJ	2'928	3'359	3'349	3'447	3'334	3'824	4'359	4'065	4'361	4'503
Biomass (biogas)	TJ	25	26	27	30	33	36	40	43	44	44
Gasoline (gardening professional)	TJ	208	220	232	243	255	266	277	288	299	309
1A4b Residential	TJ	186'575	198'896	198'533	189'729	178'783	192'834	200'469	186'011	192'191	189'004
Light fuel oil	TJ	138'916	145'507	145'175	136'252	128'901	137'597	139'992	131'915	136'508	131'838
LFO heat only boilers	TJ	138'915	145'506	145'173	136'251	128'900	137'593	139'961	131'877	136'459	131'785
LFO turbines	TJ	0	0	0	0	0	0	0	0	0	0
LFO engines	TJ	1	1	1	1	1	4	32	38	49	53
Natural gas	TJ	25'620	29'240	30'680	31'090	29'530	33'880	38'000	34'550	36'090	38'040
NG heat only boilers	TJ	25'560	29'138	30'536	30'922	29'326	33'622	37'693	34'237	35'740	37'635
NG turbines	TJ	0	0	0	0	0	0	0	0	0	0
NG engines	TJ	60	102	144	168	204	258	307	313	350	405
Coal	TJ	589	680	471	480	435	417	236	199	127	127
Biomass	TJ	21'451	23'470	22'207	21'907	19'917	20'940	22'241	19'346	19'466	18'999
Gasoline (gardening)	TJ	145	147	150	153	155	158	160	162	164	167

Source/Fuel	Unit	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
1A4a Commercial/Institutional	TJ	79'950	84'721	80'326	85'843	84'594	86'193	82'415	75'161	80'800	77'857
Light fuel oil	TJ	54'362	57'281	53'727	57'025	55'085	55'402	51'834	45'514	48'728	46'247
LFO heat only boilers	TJ	54'011	56'914	53'375	56'692	54'760	55'085	51'541	45'333	48'559	46'094
LFO turbines	TJ	0	0	0	0	0	0	0	0	0	0
LFO engines	TJ	351	367	352	333	326	318	293	181	169	154
Natural gas	TJ	20'932	22'413	21'697	23'480	24'062	25'184	24'335	23'564	25'392	24'612
NG heat only boilers	TJ	19'196	20'607	19'787	21'483	22'094	23'151	22'383	21'638	23'535	22'798
NG turbines	TJ	0	3	12	28	31	28	23	28	29	26
NG engines	TJ	1'737	1'803	1'899	1'968	1'937	2'004	1'929	1'898	1'829	1'787
Coal	TJ	0	0	0	0	0	0	0	0	0	0
Biomass	TJ	4'335	4'714	4'595	5'039	5'152	5'320	5'963	5'802	6'402	6'724
Biomass (wood)	TJ	4'289	4'660	4'535	4'970	5'070	5'207	5'782	5'514	6'045	6'324
Biomass (biogas)	TJ	46	54	60	68	83	113	181	288	357	400
Gasoline (gardening professional)	TJ	320	313	307	300	294	287	284	280	277	274
1A4b Residential	TJ	174'364	183'730	177'255	187'558	187'670	190'905	183'802	163'752	175'467	172'050
Light fuel oil	TJ	120'784	127'553	122'470	129'328	128'194	129'613	124'415	107'798	114'325	110'985
LFO heat only boilers	TJ	120'731	127'498	122'414	129'269	128'120	129'550	124'352	107'733	114'273	110'944
LFO turbines	TJ	0	0	0	0	0	0	0	0	0	0
LFO engines	TJ	53	55	56	58	74	63	63	65	52	42
Natural gas	TJ	36'290	38'000	37'790	40'330	41'660	42'790	41'080	39'320	42'550	42'630
NG heat only boilers	TJ	35'851	37'539	37'325	39'813	41'153	42'260	40'538	38'775	42'009	42'092
NG turbines	TJ	0	0	5	3	2	0	0	3	3	0
NG engines	TJ	439	461	460	514	505	530	542	542	537	538
Coal	TJ	118	118	118	118	362	362	362	362	362	362
Biomass	TJ	17'172	18'060	16'877	17'783	17'454	18'140	17'945	16'272	18'230	18'072
Gasoline (gardening)	TJ	169	167	164	162	160	158	155	153	151	149

Source/Fuel	Unit	2010
1A4a Commercial/Institutional	TJ	81'921
Light fuel oil	TJ	48'799
LFO heat only boilers	TJ	48'646
LFO turbines	TJ	0
LFO engines	TJ	154
Natural gas	TJ	25'620
NG heat only boilers	TJ	23'806
NG turbines	TJ	26
NG engines	TJ	1'787
Coal	TJ	0
Biomass	TJ	7'232
Biomass (wood)	TJ	6'743
Biomass (biogas)	TJ	489
Gasoline (gardening professional)	TJ	270
1A4b Residential	TJ	186'574
Light fuel oil	TJ	118'021
LFO heat only boilers	TJ	117'979
LFO turbines	TJ	0
LFO engines	TJ	42
Natural gas	TJ	48'390
NG heat only boilers	TJ	47'852
NG turbines	TJ	0
NG engines	TJ	538
Coal	TJ	362
Biomass	TJ	19'801
Gasoline (gardening)	TJ	146

The table above documents the net increase from 1990 and 2010 of Natural Gas consumption by 56% (1A4a) and 89% (1A4b), and the net decrease of liquid fuel consumption by -19% (1A4a) and -15% (1A4b), for the same period. This shift in fuel mix is the reason for CO_2 emissions from the use of natural gas and liquid fuels in category 1A4a and 1A4b being key categories regarding trend.

Underlying data for the activity data on mobile off-road sources (1A4aii and 1A4bii) like vehicle stock and operating hours are shown in Table A - 29 to Table A - 31 in Annex A3.1.6

b) Agriculture/Forestry (1A4c)

Emissions from all three sources are calculated bottom up. For grass drying, emission factors refer both to fuel consumption (in TJ) and production data (i.e. in tons of dried grass).

The emissions of all off-road categories like railways, navigation etc. are modelled by the same approach. The emissions are calculated with a Tier 2 method. Some details of the emission modelling that hold for all off-road families are described in Annex A3.1.6 Off-road Vehicles. Activity data and emission factors were updated and the emission calculation was carried out in a new database structured in analogy to the on-road database (INFRAS 2008). Emissions are calculated for the years 1990, 1995, 2000, 2005, 2010 etc. up to 2020. For the years in-between, the emissions are interpolated linearly.

An oxidation factor of 100% is assumed for all combustion processes and fuels (see sub-section on oxidation factors in Section 3.2.5.1).

For wood heating the emissions are calculated by multiplying the activity data by the emission factors.

Emission Factors drying of grass

The emission factors for CO_2 are country specific and based on measurements and analysis of fuel samples carried out by the Swiss Federal Laboratories for Materials Testing, Research EMPA and Intertek (EMPA 1999; Intertek 2008; carbon emission factor documented in SFOE 2001, Table 45: p. 51; net calorific values on p. 61). Emission factors for CH_4, N_2O, CO and NMVOC are country specific based on comprehensive life cycle analysis of a drying unit, documented in the EMIS database (EMIS 2012/1A4ci, see Section 4). Some of the emission factors have been updated based on expert judgement.

Emission Factors off-road machinery

- The emission factor for CO_2 is country specific and is assumed to be constant in the period 1990-2010 with value 73.6 t/TJ for diesel oil and 73.9 t/TJ for gasoline (Table 3-3, SFOE 2001).
- For SO_2 the emission factors are country specific and are given in Table A - 11 in Annex A2.2 (diesel oil, gasoline).
- The emission factors for all other gases are country specific and are shown in Table A - 20 to Table A - 23 in the Annex A3.1.6 (INFRAS 2008). Note that NMVOC is not modelled bottom-up. The NMVOC emissions are calculated as the difference of VOC and CH_4 emissions.

Note that emission factors in the unit of kg/h may be downloaded by query from the public part of the off-road database INFRAS (2008), see footnote 11 above.

Emission Factors wood heating

The emission factors are country specific and based on SAEFL 2000 (pp. 26ff) and a new study for wood combustion (EMIS 2012/1A solid fuels/wood).

Activity data

Drying of grass: Activity data on grass drying (in tons of dried grass) is extracted from the EMIS database (EMIS 2012/1A4ci).

Off-road machinery: Activity data is shown in Annex A3.1.6 (INFRAS 2008).

Activity data for wood heating in 1A4c have been recalculated for the whole time series according to a new study based on the data of the Swiss wood energy statistics (SFOE 2011b), as documented in the EMIS database (EMIS 2012/1A Holzfeuerungen).

Table 3-42 Activity data in 1A4c Agriculture/Forestry.

Source/Fuel	Unit	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
1A4c Agriculture/Forestry	TJ	8'447	8'472	8'416	8'392	8'334	8'337	8'361	8'268	8'260	8'237
Drying of Grass	TJ	1'895	1'828	1'748	1'683	1'620	1'544	1'482	1'409	1'349	1'291
light fuel oil	TJ	1'156	1'115	1'066	1'027	988	942	904	860	823	787
natural gas	TJ	739	713	682	657	632	602	578	550	526	503
Machinery (diesel, gasoline)	TJ	6'125	6'157	6'189	6'221	6'253	6'285	6'315	6'345	6'374	6'404
Biomass	TJ	427	487	478	488	461	508	564	514	536	542

Source/Fuel	Unit	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
1A4c Agriculture/Forestry	TJ	8'163	8'063	8'031	8'073	8'080	8'113	7'908	7'980	7'921	7'966
Drying of Grass	TJ	1'223	1'077	1'061	1'055	1'039	994	845	948	822	856
light fuel oil	TJ	746	657	647	644	634	607	516	579	502	522
natural gas	TJ	477	420	414	412	405	388	330	370	321	334
Machinery (diesel, gasoline)	TJ	6'434	6'440	6'446	6'452	6'458	6'464	6'467	6'471	6'474	6'477
Biomass	TJ	506	546	524	566	583	654	596	561	625	633

Source/Fuel	Unit	2010
1A4c Agriculture/Forestry	TJ	7'922
Drying of Grass	TJ	739
light fuel oil	TJ	451
natural gas	TJ	288
Machinery (diesel, gasoline)	TJ	6'480
Biomass	TJ	703

3.2.9.3 Uncertainties and Time-Series Consistency

The uncertainty of CO_2 emissions from fuel combustions is described in the uncertainty analysis of the Energy Industries (1A1) in Chapter 3.2.6.3. Uncertainty in emissions of other non-CO_2 gases are estimated to be medium: 30% for CH_4 and 80% for N_2O (see Table 1-13).

A general description of the time series consistency of the Energy Sector is provided in Chapter 3.2.6.3a).

3.2.9.4 Source-specific QA/QC and Verification

a) General

See Chapter 3.2.6.4.

b) Specific: Other sectors (1A4)

The time series have been compared between the current and the previous submission as well as available energy data. All activity data, implied emission factors and emissions undergo the triple check:

- the results for 2010 are compared with the results 2009 within the current CRF
- the CRF tables for the year 2009 are compared between the current CRF tables and the CRF tables of submission 2011.

- the CRF tables for the base year 1990 are compared between the current CRF tables and the CRF tables of submission 2011.

For A4ci grass drying: The fuel consumption was verified in 2003 by a statistical analysis of 20 typical grass drying plants (VSTB 2003).

The emission factor of category 1A4 used in the Swiss Inventory have been compared to the corresponding emission factors of other countries (UNFCCC http://unfccc.int/di/FlexibleQueries.do) and to the IPCC default value if available (INFRAS 2012). The values correspond to the emission factors of other countries or are in between the IPCC default values. The significantly low emission factor of CH_4 for Biomass will be further investigated and included in the next submission.

The emission factors for CH_4 emission of biomass combustion is significantly lower than the default emission factor and the emission factors of other Parties because the firing installation are of the best available technology. Further analyses on this issue will be realised and included in the next submission.

3.2.9.5 Source-Specific Recalculations

- 1A: The activity data of all fuels of the overall time series has been recalculated based on the new data from SFOE 2011.
- 1A: The activity data of wood consumption has been recalculated for the overall time series based on the new data from SFOE 2011b.

3.2.9.6 Source-Specific Planned Improvements

The uncertainty estimation of the energy statistics will be evaluated for the next submission.

The significantly low emission factor for Biomass will be further investigated and explained in the next submission.

3.2.10 Source Category 1A5b - Military

3.2.10.1 Source Category Description

Tier 1 Key categories 1A5
CO_2 from the combustion of Liquid Fuels (trend)

In Switzerland, the sub-sources are defined according to the next table. The IPCC category structure distinguishes stationary (1A5a) and mobile (1A5b) sources. All of the Swiss sub-categories refer to mobile sources.

Table 3-43 Specification of Swiss source category 1A5 “Other” (Military).

1A5	Source	Specification	Data Source
1A5a	Stationary	Not occurring in Switzerland (NO)	
1A5b	Mobile -Military off-road sources -Military Aviation	 Tanks and similar off-road vehicles. (emissions from military road vehicles are included in 1A3b Road Transportation)	 Method, AD, EF: INFRAS 2008 VTG 2011

3.2.10.2 Methodological Issues

a) Military off-road vehicles

The complete revision of the emissions of the whole off-road sector that began in 2005 was completed in 2008. The emissions of the military off-road categories (excluded aviation) are modelled by the same approach as railways, navigation etc. The emissions are calculated with a Tier 2 method. Some details of the emission modelling that hold for all off-road families are described in Annex A3.1.6 Off-road vehicles. Activity data and emission factors were updated and the emission calculation was carried out in a new database structured in analogy to the on-road database (INFRAS 2008).

The emission modelling is carried out for 1990, 1995, 2000, 2005 etc. For the GHG inventory the missing years 1991, 1992 etc. are interpolated linearly by vehicle category.

b) Military aviation

To calculate the emissions from military aviation, a Tier 1 method is used. The fuel consumption 1990–2010 is known on an annual basis (VTG 2011). A very small fraction of fuel is consumed for training abroad and might be allocated under “International Bunkers” (less than 3% of total military aviation consumption). Since the exact number is not known, it is not subtracted from the total consumption but included under national military aviation, as recommended by the IPCC Good Practice Guidance (IPCC 2000, chapter 2.5.1.3). Emissions of NO_x, CO and VOC have been modelled in detail by the Federal Office for Military Aviation (Bundesamt für Betriebe der Luftwaffe) for 1990 and 1995. From these inputs, FOEN determined average emission factors 1990 and 1995. For 1991-1994 the emission factors are linearly interpolated between 1990 and 1995. For 1996-2009, the factors for 1995 are used. The emissions are then calculated yearly by multiplying the average emission factors with the activity data.

The extension of the emission modelling to CO_2, CH_4, N_2O, NMVOC and SO_2 is also accomplished by FOEN.

Emission factors for military off-road vehicles

- The emission factors for CO_2 are country specific and are assumed to be constant in the period 1990-2010 with values 73.6 t/TJ for diesel oil, 73.9 t/TJ for gasoline and 55.0 t/TJ for CNG (equal to natural gas). See Table 3-3.
- For SO_2 the emission factors are country specific and are given in Table A - 11 in Annex A2.2.
- The emission factors for all other gases are country specific and shown in Table A - 20 to Table A - 23 in the Annex A3.1.6 (INFRAS 2008) The NMVOC emissions are calculated as the difference of VOC and CH_4 emissions.

Note that emission factors in the unit of kg/h may be downloaded by query from the public part of the off-road database INFRAS (2008), see footnote 11 above.

Emission factors for military aviation

- CO_2: The emission factor of 73.2 t/TJ is country specific and is based on measurements and analyses of fuel samples (see Table 3-3, SFOE 2001).
- NO_x, VOC, CO: Engine producer information is used (CORINAIR, for details see SAEFL 1996: p. 202) for calculation of the emission factors in 1990 and 1995. For 1991-1994 the values are linearly interpolated between 1990 and 1995. For 1996-2010, the values 1995 are used.

- CH_4, NMVOC: For VOC, aircraft-specific information used for calculation of the emission factors in 1990 and 1995. For 1991-1994 the values are linearly interpolated between 1990 and 1995. For 1996-2010, the values 1995 are used. The division of VOC into CH_4 and NMVOC is carried out by a constant split of 53%: 47% (country specific).
- N_2O: The IPCC default value 23 kg/TJ is used (IPCC 1997b) for the whole period 1990–2010.
- SO_2: The emission factor is taken from the IPCC Guidelines 1996, 23.3 kg/TJ, and is assumed to be constant over the period 1990–2010 (IPCC 1997c, Table 1-50)

Activity data for military off-road vehicles and military aviation

Fuel consumption data is shown in Table 3-44. The underlying data for military off-road such as vehicle stock and operating hours are shown in Table A - 29 to Table A - 31 in Annex A3.1.6.

Fuel consumption of military aviation is copied from the logbooks of the military aircrafts and summed up yearly (VTG 2011).

Table 3-44 Activity data (fuel consumption) for military off-road vehicles and military aviation

1A5	Fuel	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
		fuel consumption in TJ									
Military off-road	Diesel	48	48	48	48	49	49	49	49	50	50
Military off-road	Gasoline	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6
Military aviation	Jet kerosene	2'733	2'495	2'382	2'268	2'192	1'955	1'806	1'941	1'927	1'734

1A5	Fuel	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
		fuel consumption in TJ									
Military off-road	Diesel	50	50	49	49	49	48	48	47	47	47
Military off-road	Gasoline	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6
Military aviation	Jet kerosene	1'793	1'755	1'837	1'641	1'488	1'621	1'672	1'572	1'500	1'524

1A5	Fuel	2010
		f.c. TJ
Military off-road	Diesel	46
Military off-road	Gasoline	0.6
Military aviation	Jet kerosene	1'586

3.2.10.3 Uncertainties and Time-Series Consistency

a) General

For a general description of the uncertainty analysis and time series consistency of the Energy Sector see Chapter 3.2.6.3 a).

Source-specific QA/QC and Verification) General

See Chapter 3.2.6.4.

b) Specific

The time series have been compared between the current and the previous submission as well as available energy data. All activity data, implied emission factors and emissions undergo the triple check:

- the results for 2010 are compared with the results 2009 within the current CRF
- the CRF tables for the year 2009 are compared between the current CRF tables and the CRF tables of submission 2011.

- the CRF tables for the base year 1990 are compared between the current CRF tables and the CRF tables of submission 2011

The activity data of military aviation (kerosene consumption) are provided by the Federal Department of Defence, Civil Protection and Sport. For a compatibility check with the emission data base of civil aviation, they are sent to the FOCA (office of the Federal Department of the Environment, Transport, Energy and Communications). A further compatibility check is carried out by the NIR authors of the energy chapter. No peculiarities have been detected by the specialists in the time series of the kerosene consumption of military aviation.

3.2.10.4 Source-Specific Recalculations

No recalculations have been carried out.

3.2.10.5 Source-Specific Planned Improvements

There are no source-specific planned improvements.

3.3 Source Category 1B – Fugitive Emissions from Fuels

Fugitive emissions arise from the production, processing, transmission, storage and use of fuels. According to IPCC guidelines, emissions from flaring at oil and gas production facilities are included while emissions from vehicles are not included in 1B.

Source Category 1B “Fugitive Emissions from Fuels” comprises the following sub-categories:

- Solid fuels (1B1)
- Oil and Natural Gas (1B2)

3.3.1 Source Category 1B1 - Solid Fuels

Coal mining is not occurring in Switzerland.

3.3.2 Source Category 1B2 - Oil and Natural Gas

3.3.2.1 Source Category Description

Tier 1 Key categories 1B2
CH_4 from fugitive emissions of Oil and Natural Gas (trend)

Tier 2 Key categories 1B2

CH_4 from fugitive emissions of Oil and Natural Gas (level and trend)

In Switzerland, the fugitive emissions in the oil industry result from two refining companies and several fuel handling stations. In the natural gas industry, the fugitive emissions are from different distribution sites of natural gas.

Table 3-45 Specification of source category 1B2 “Fugitive Emissions from Oil and Natural Gas”.

1B2	Source	Specification	Data Source
1B2 a	Oil	Emissions from refining/storage of oil and	AD: SFOE 2011

1B2	Source	Specification	Data Source
		the distribution of oil products	EF: EMIS 2012/1B2aiv, 1B2av
1B2 b	Natural Gas	Emissions from gas pipelines	AD: SFOE 2011, SGWA 2005, SGIA 2011, Swissgas 2008 EF: Battelle 1994, Xinmin 2004, SGWA 2007
1B2 c	Venting / Flaring	The release/combustion of excess gas at the oil refinery	AD: SFOE 2011 EF: EMIS 2012/1B2c

3.3.2.2 Methodological Issues

For source 1B2a Oil, the emissions of CO_2, CH_4 and NMVOC are reported.

For source 1B2b Natural Gas, the emissions of CH_4 and NMVOC leakages from gas pipelines are calculated with a new country specific Tier 3 method. The method considers the length, type and pressure of the gas pipelines as well as the annual gas consumption. The distribution network components (regulators, shut off fittings and gas meters), the losses from maintenance and extension as well as the end user losses are separately taken into account.

For source category 1B2c Venting/Flaring (Oil), CO_2 as well as CH_4, NO_x, CO and NMVOC are considered.

The indirect CO_2 emissions from the decomposition of NMVOC in the atmosphere have been calculated from the average carbon contents of NMVOC emissions for the subcategory 1B2a and 1B2b.

The emissions from oil and venting/flaring (1B2a and 1B2c) are calculated based on annual production/consumption data which is consistent with the IPCC Tier 1 approach. Emissions of greenhouse gases are calculated by multiplying level of activity by emission factor.

Emission factors

1B2a and 1B2c: The emission factors for direct CO_2, CH_4 and NMVOC are based on data from the refining and gas industry and expert estimates.

The emission factors for gas distribution losses (source 1B2b) depend on the type and pressure of the natural gas pipeline (see Table 3-46; sources: Battelle 1994, Xinmin 2004, SGWA 2007). The CH_4-emissions due to gas meters are considered with the emission factor of 5.1 m^3 CH_4 per gas meter and year. The emission factors for 1B2b are calculated for each year separately.

Table 3-46 CH_4-Emission Factors for 1B2 "Fugitive Emissions from Oil and Natural Gas" (Battelle 1994, Xinmin 2004, SGWA 2007)

1B2 Fugitive Emissions from Oil and Natural Gas	< 100 mbar	100-1000 mbar	1- 5 bar	> 5 bar
	Emission factors in [m3/h/km]			
Cast iron	0.80000	1.20000	0.19200	-
Cast steel	0.08800	0.13200	0.00230	-
Steel normal	0.08800	0.01320	0.00062	-
Steel cath.	0.00800	0.01200	0.00002	0.028
HDPE (Polyethylene)	0.00800	0.01600	0.00062	-
other	0.00800	0.01600	0.00002	-

The indirect CO_2 emissions from the decomposition of NMVOC in the atmosphere have been calculated from the average carbon contents of NMVOC emissions from the EMIS database. Resulting emission factors are 3.15 Gg CO_2/Gg NMVOC for 1B2a (Oil) and 2.93 Gg CO_2/Gg NMVOC for 1B2b (Natural gas) (EMIS 2012/1B2a Raffinerie, Leckverluste iv, SGWA 2007).

Compared to other countries, the emission factors for CH_4 are significantly lower than in other countries or than the default values provided by IPCC. This is based on the fact that the oil transport in Switzerland is realised through underground pipelines. From the provided documentation of the Swiss refineries, it is not clear if leakages from the transport are included in their data or not. This issue will be further analysed and results will be presented in the next NIR submissions.

Activity data

The activity data for fugitive emissions such as the total annual gasoline consumption and gas imports are extracted from the Swiss overall energy statistics (SFOE 2011).

The activity data for methane of Natural Gas (source 1B2b) are provided by the Swiss gas and water industry association (SFOE 2011), but an extrapolation of data from 2005 is made based on aggregate increases in grid length in order to include the length of junction tubes (SFOE 2011, SGIA 2011, SGWA 2005, Swissgas 2007). Fugitive emissions from a high pressure natural gas transfer pipeline, crossing Switzerland from France to Italy, are included in the inventory.

3.3.2.3 Uncertainties and Time-Series Consistency

a) Uncertainty in fugitive CH_4 emissions from natural gas pipelines in 1B2
Following Good Practice Guidance (IPCC 2000: p. 2.92) overall uncertainty of bottom-up inventories of fugitive methane losses from gas activities are expected to result in errors of 25-50%. From this a conservative uncertainty of 50% is estimated for Switzerland.

b) Qualitative estimate of uncertainties of non-key category emissions in 1B2 Fugitive Emissions from Fuels
A preliminary uncertainty assessment of all other sources in source category 1B2 based on expert judgement results in medium confidence in the emissions estimate (see Table 1-13).

The time series is consistent.

3.3.2.4 Source-Specific QA/QC and Verification

The time series have been compared between the current and the previous submission as well as available energy data. All activity data, implied emission factors and emissions undergo the triple check:

- the results for 2010 are compared with the results 2009 within the current CRF
- the CRF tables for the year 2009 are compared between the current CRF tables and the CRF tables of submission 2011.
- the CRF tables for the base year 1990 are compared between the current CRF tables and the CRF tables of submission 2011.

The emission factor of category 1B2 used in the Swiss Inventory have been compared to the corresponding emission factors of other countries (UNFCCC http://unfccc.int/di/FlexibleQueries.do) and to the IPCC default value if available (INFRAS 2012). The values are significantly lower than the other countries and the IPCC default values. For further information, please see section 3.3.2.2.

3.3.2.5 Source-Specific Recalculations

No recalculations have been realised within this submission.

3.3.2.6 Source-Specific Planned Improvements

Gradual improvement of the data quality in co-operation with industry is on-going.

The question about the emissions resulting from the oil transport will be further investigated. For further information, please see section 3.3.2.2.

4 Industrial Processes

4.1 Overview

This chapter provides information on the estimation of the greenhouse gas emissions from sector 2 Industrial Processes. The following source categories are reported:

- 2A Mineral Products
- 2B Chemical Industry
- 2C Metal Production
- 2D Other Production
- *2E Production of Halocarbons and SF_6 is not occurring*
- 2F Consumption of Halocarbons and SF_6
- 2G Other

Emissions within this sector comprise greenhouse gas emissions as by-products from industrial processes and also emissions of F-gases during production, use and disposal. Emissions from fuel combustion in industry are reported under sector 1 Energy. Figure 4-1 shows the development of greenhouse gas emissions in source category 2 between 1990 and 2010.

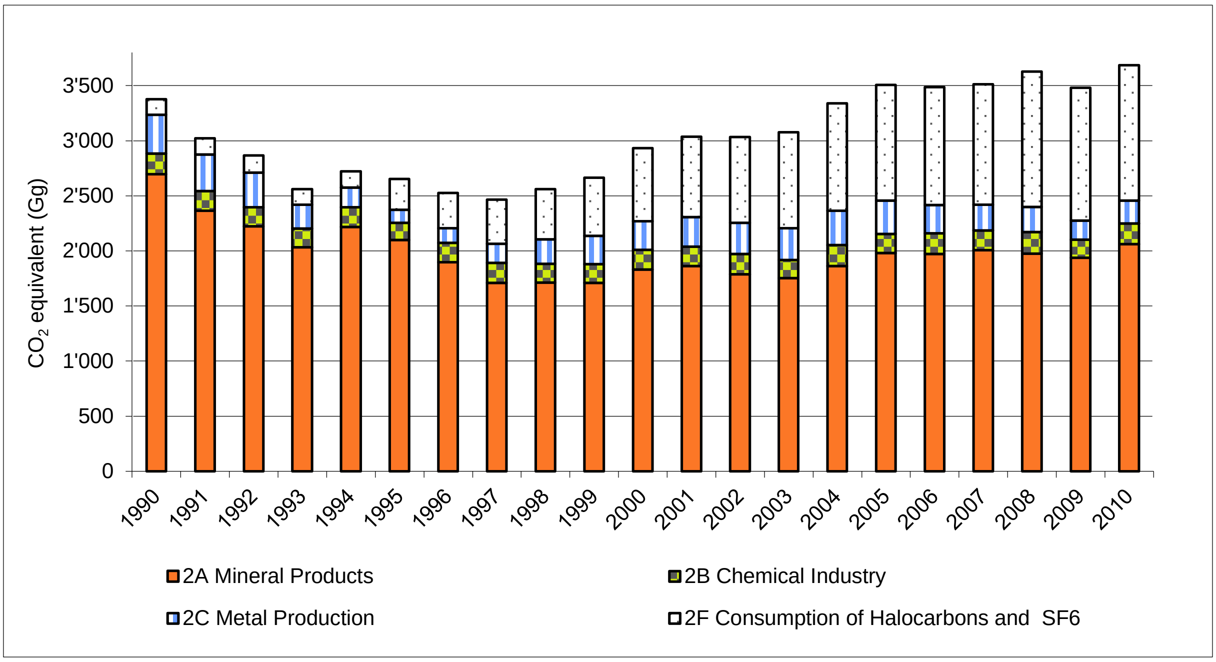

Figure 4-1 Switzerland's greenhouse gas emissions of source category 2 Industrial Processes 1990–2010. Source category 2D Other Production emits no direct greenhouse gas. The emissions of source category 2G Other are small (< 1 Gg CO_2 eq) and are therefore not visible in this figure.

2A Mineral Products remain the dominant source of sector 2 with a share of 55.9% of the greenhouse gas emissions in 2010 although they have decreased by 23.6% since 1990.-2010. 2B Chemical Industry accounts for 5.2% and has increased by 1.3% since 1990. 2C Metal Production has decreased by 41.2% and accounts for 5.6%. 2F Consumption of Halocarbons and SF_6 is of increasing importance: The emissions have increased by a factor of 8.6 since 1990 and are currently responsible for 33.3% of total greenhouse gas emissions in sector 2, This is primarily due to the replacement of HFC for CFC in many technical applications.

In Table 4-1 the development of greenhouse gas emissions are given by gases. The relative trend of these gases referring to the base year 1990 is shown in Figure 4-2 and 4-3.

Table 4-1 Greenhouse gas emissions of source category 2 Industrial Processes by gases in Gg CO_2 equivalent for the period 1990-2010.

Gas	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
	CO_2 equivalent (Gg)									
CO_2	3'059	2'721	2'581	2'332	2'492	2'294	2'125	1'958	1'961	2'003
CH_4	9.6	9.3	9.0	8.6	8.3	8.0	8.0	8.2	7.9	7.7
N_2O	68	62	54	52	61	60	58	51	54	55
Synth. gases	244	231	224	170	163	292	337	450	538	601
Sum	3'381	3'023	2'868	2'562	2'724	2'653	2'528	2'466	2'562	2'666

Gas	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
	CO_2 equivalent (Gg)									
CO_2	2'143	2'175	2'125	2'085	2'231	2'329	2'289	2'298	2'281	2'171
CH_4	7.9	8.1	8.0	8.0	8.6	8.6	8.3	8.5	8.7	7.9
N_2O	60	63	66	59	62	52	60	58	67	58
Synth. gases	724	793	838	928	1'041	1'119	1'133	1'148	1'273	1'245
Sum	2'935	3'039	3'036	3'080	3'342	3'509	3'490	3'514	3'630	3'482

Gas	2010
	CO_2 eq
CO_2	2'355
CH_4	8.4
N_2O	60
Synth. gases	1'265
Sum	3'689

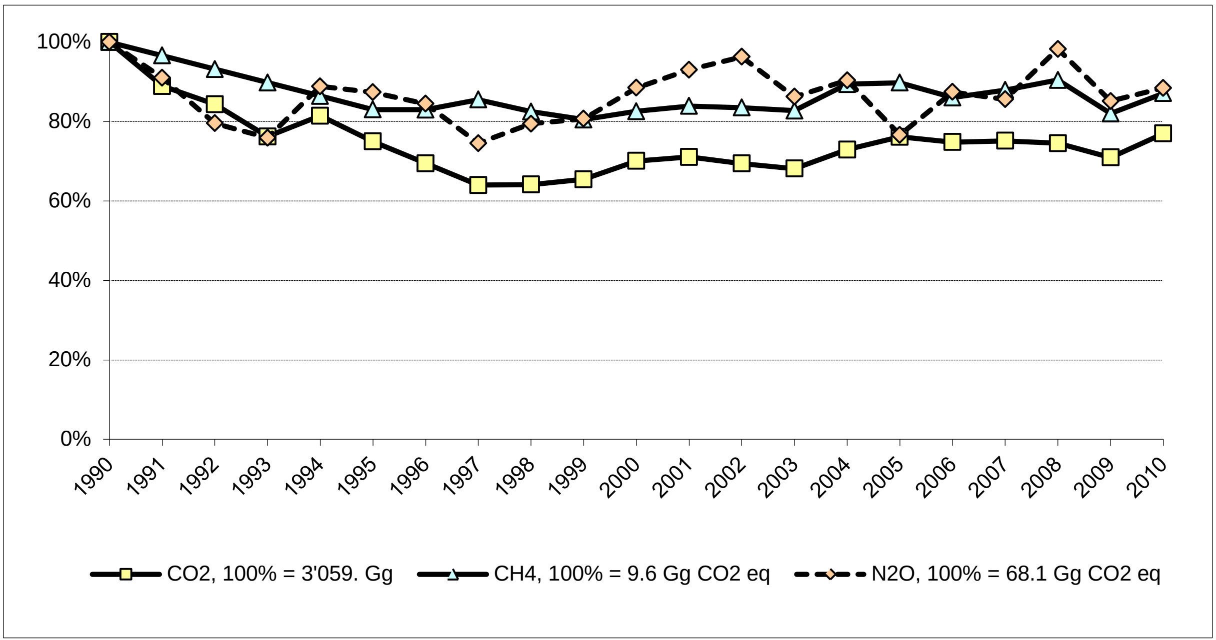

Figure 4-2 Relative trends of the greenhouse gases of source category 2 Industrial Processes in the period 1990-2010. The base year 1990 represents 100%.

Figure 4-2 shows that in the period 1990-2010 the emissions of CO_2, CH_4 and N_2O from sector 2 Industrial Processes have decreased to 77%, 87% and 88%, respectively compared to the base year 1990.

Figure 4-3 shows that the emissions of F-gases have increased to 519% compared to the year 1990.

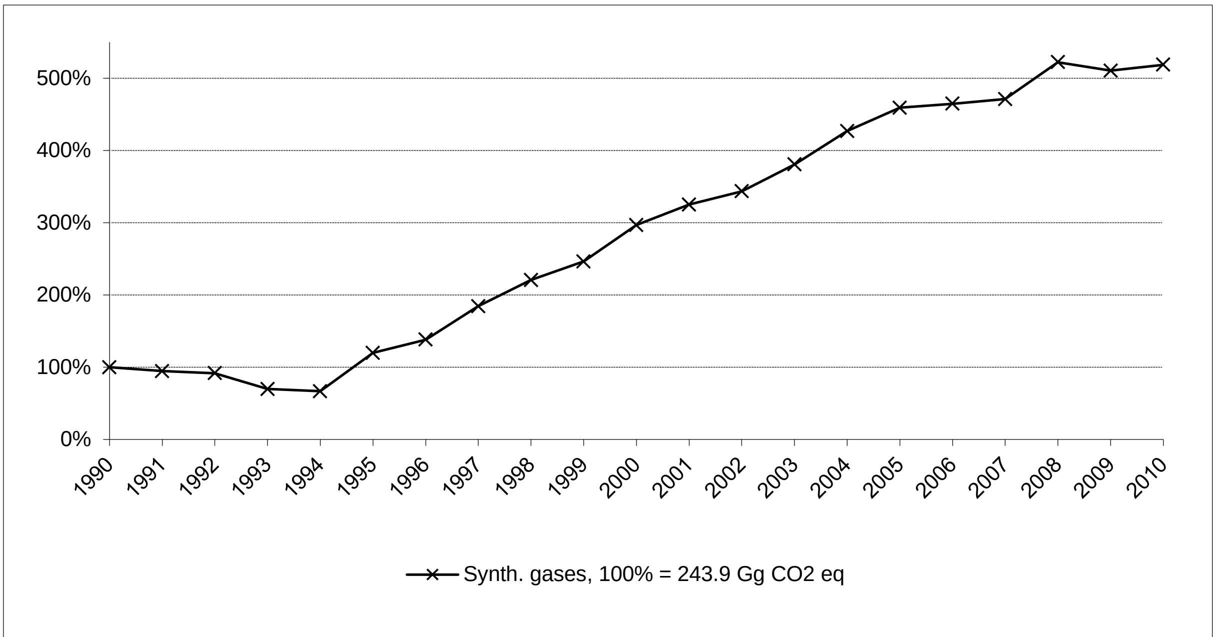

Figure 4-3 Relative trends of the F-gases of source category 2 Industrial Processes in the period 1990-2010. The base year 1990 represents 100%.

4.2 Source Category 2A – Mineral Products

4.2.1 Source Category Description

Tier 1 Key category 2A1
CO_2 emissions from Cement Production (level and trend).

Tier 2 Key category 2A1
CO_2 emissions from Cement Production (level and trend).

Source category 2A Mineral Products comprises process emissions from production of cement and lime, limestone and dolomite use, asphalt roofing, road paving with asphalt and from production of plaster and glass.

Table 4-2 Specification of source category 2A "Mineral Products".

2A	Source	Specification	Data Source
2A1	Cement Production	Geogenic CO_2 emissions from calcination process in cement production Emissions of CO_2, NO_x, CO, NMVOC and SO_2 from blasting operations	AD, EF: EMIS 2012/2A1 Zementwerke Rohmaterial AD, EF: EMIS 2012/2A1 Zementwerke übriger Betrieb
2A2	Lime Production	Geogenic CO_2 emissions from calcination process in lime production Emissions of CO_2, NO_x, CO, NMVOC and SO_2 from blasting operations	AD, EF: EMIS 2012/2A2 Kalkproduktion, Rohmaterial AD, EF: EMIS 2012/2A2 Kalkproduktion, übriger Betrieb
2A3	Limestone and Dolomite Use	Geogenic CO_2 emissions from fine ceramics, rock wool, and brick and tile production	EF: IPCC 2006, EMIS 2012/2A3 Ziegeleien AD: EMIS 2012/2A3 Feinkeramik Produktion, EMIS 2012/2A3 Steinwolle Produktion, EMIS 2012/2A3 Ziegeleien
2A4	Soda Ash Production and Use	Production is not occurring in Switzerland. Geogenic CO_2 emissions from the use of soda ash in fine ceramics and glass production is reported in 2A3 Limestone and Dolomite Use and 2A7 Other	
2A5	Asphalt Roofing	Emissions of CO and NMVOC from asphalt roofing	AD, EF: EMIS 2012/2A5 Dachpappenproduktion und Verlegung
2A6	Road Paving with Asphalt	Emissions of NMVOC from road paving	AD, EF: EMIS 2012/2A6 Strassenbelagsarbeiten
2A7	Other	Emissions of CO_2, NO_x, CO, NMVOC and SO_2 from the production of plaster Geogenic CO_2 emissions from production of container and tableware glass, and glass wool	AD, EF: EMIS 2012/2A7 Gips-Produktion übriger Betrieb AD, EF: EMIS 2012/2A7 Hohlglas Produktion, EMIS 2012/2A7 Glas übrige Produktion, EMIS 2012/2A7 Glaswolle Produktion Rohprodukt

4.2.2 Methodological Issues

4.2.2.1 Cement production (2A1)

Emissions of geogenic CO_2 occur during the production of clinker which is an intermediate component in the cement manufacturing process. During the production of clinker, limestone, which is mainly calcium carbonate ($CaCO_3$) is heated (calcined) to produce lime (CaO) and CO_2 as by-product. The CaO reacts subsequently with minerals in the raw materials and yields clinker. But during this reaction step no further CO_2 is emitted. Clinker is then mixed with other components such as gypsum to make cement.

In Switzerland there are six plants producing clinker and cement. The Swiss plants are rather small and do not exceed a capacity of 3'000 tonnes of clinker per day. All of them use modern dry process technology.

Blasting operations in the limestone quarries are another source of emissions for both CO_2 and indirect greenhouse gases such as NO_x, CO, NMVOC and SO_2.

a) Methodology

Calcination process: The geogenic CO_2 emissions from the calcination process in cement production are determined by a Tier 2 approach according to 2000 IPCC good practice guidance (IPCC 2000, chapter *3.1.1 Cement production*). For cement production in Switzerland this results in the following formula:

$$CO_2 \text{ Emissions} = M_{Clinker} \bullet EF_{Clinker} \bullet CDK_{Correction\ Faktor}$$

In Swiss cement plants no calcined cement kiln dust (CDK) is lost to the system; therefore the correction factor is 1.00.

Blasting operations: The emissions resulting from blasting operations during the digging of limestone are included following a country specific method. Emissions of GHGs related to blasting operations are calculated by multiplying the annual *cement* output by emission factors. Please note that the CO_2 emissions from "blasting" are related to the usage of the explosive itself and are not related to fuel consumption of e.g. bulldozers etc. The amount of used explosive is reported to be 0.16 kg/t cement (EMIS 2012/2A1 Zementwerke übriger Betrieb).

Total emissions reported for the production of cement are the sum of emissions from calcination process and blasting operations. The share of CO_2 emissions from blasting operations in limestone quarries is well below one tenth of a per cent of the geogenic CO_2 emissions from the calcinations process.

b) Emission Factors

Calcination process: The emission factor for CO_2 for calcination is a country specific value depending on the composition of the raw material. It amounts to 529 kg CO_2 per ton of *clinker* produced. The emission factor fluctuates somewhat over time but stays within the uncertainty range. The IPCC approach neglects CO_2 emissions from decomposition of $MgCO_3$, which are taken into account in this country-specific value.

Blasting operations: The emission factors are country specific based on measurements and data from industry and expert estimates as documented in EMIS 2012/2A1 Zementwerke übriger Betrieb. They are given per ton of *cement*.

Table 4-3 CO_2 emission factors for calcination process and blasting operations in kg/t clinker and g/t cement, respectively, and emission factors for NO_x, CO, NMVOC and SO_2 from blasting operations in g/t cement from source category 2A1 Cement Production(EMIS 2012/2A1 Zementwerke Rohmaterial and EMIS 2012/2A1 Zementwerke übriger Betrieb).

2A1 Cement production	Unit	CO_2	NO_X	CO	NMVOC	SO_2
Calcination	kg/t clinker	529	NA	NA	NA	NA
Blasting operations	g/t cement	96	3.7	22	9.6	0.16

c) Activity Data

Activity data on annual clinker and cement production is provided by industry and documented in EMIS 2012/2A1 Zementwerke Rohmaterial and EMIS 2012/2A1 Zementwerke übriger Betrieb. Please note that activity data for the year 2009 which were preliminary interpolated values in last year's submission have been replaced by official production data.

Table 4-4 Activity data of clinker and cement production in Switzerland for the period 1990-2010 in Gg (EMIS 2012/2A1 Zementwerke Rohmaterial and EMIS 2012/2A1 Zementwerke übriger Betrieb).

2A1 Cement production	Unit	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Cement production	Gg	5'117	4'683	4'268	4'043	4'432	3'994	3'648	3'485	3'371	3'540
Clinker production	Gg	4'808	4'189	3'927	3'564	3'930	3'706	3'337	2'994	2'995	2'992

2A1 Cement production	Unit	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Cement production	Gg	3'754	3'891	3'771	3'592	3'957	4'136	4'143	4'243	4'284	4'303
Clinker production	Gg	3'214	3'275	3'150	3'081	3'265	3'442	3'452	3'512	3'461	3'443

2A1 Cement production	Unit	2010
Cement production	Gg	4'553
Clinker production	Gg	3'642

4.2.2.2 Lime production (2A2)

During the production of lime calcium carbonate ($CaCO_3$) is heated (calcined) yielding burnt lime (CaO) and CO_2 as by-product. In Switzerland there is only one plant producing lime.

Blasting operations in quarry is another source of emissions for both CO_2 and indirect emissions such as NO_x, CO, NMVOC and SO_2.

a) Methodology

Calcination process: The geogenic CO_2 emissions from the calcination process in lime production are determined by a country specific approach according to 2000 IPCC good practice guidance (IPCC 2000, chapter *3.1.2 Lime production*). For lime production in Switzerland this results in the following formula:

CO_2 Emissions = $M_{Lime} \bullet EF_{Lime}$

Blasting operations: The emissions resulting from blasting operations during the digging of limestone are included following a country specific method. They are calculated by multiplying the annual *limestone* output by emission factors. Please note that the CO_2 emissions from "blasting" are related to the usage of the explosive itself and are not related to fuel consumption of e.g. bulldozers etc.

Total emissions reported for the production of lime are the sum of emissions from calcination process and blasting operations. The share of CO_2 emissions from blasting operations in the quarry is well below one tenth of a per cent of the geogenic CO_2 emissions from the calcinations process.

b) Emission Factors

Calcination process: The emission factor for CO_2 from calcination of limestone depends both on the purity of the limestone and the grade of calcination (i.e. amount of rest CO_2 remaining in the final lime). The country specific value has been calculated based on industry declaration and is assumed to be constant over time (EMIS 2012/2A2 Kalkproduktion, Rohmaterial). The value is considered confidential, however, available to reviewers.

Blasting operations: The emission factors are country specific based on measurements and data from industry and expert estimates as documented in EMIS 2012/2A1 Kalkproduktion, übriger Betrieb. The value is considered confidential, however, available to reviewers.

Table 4-5 CO_2 emission factor for calcination process and blasting operations in lime production in kg/t lime and emission factors for CO_2, NO_x, CO, NMVOC and SO_2 from blasting operations in g/t lime (EMIS 2012/2A2 Kalkproduktion, Rohmaterial and EMIS 2012/2A1 Kalkproduktion übriger Betrieb**)**.

2A2 Lime production	**Unit**	**CO_2**	**NO_X**	**CO**	**NMVOC**	**SO_2**
Calcination	kg/t	C	NA	NA	NA	NA
Blasting operations	g/t	C	C	C	C	C

c) Activity Data

Activity data on annual lime production is based on data from the one existing plant in Switzerland, documented in the EMIS database (EMIS 2012/2A2 Kalkproduktion, Rohmaterial and EMIS 2012/2A1 Kalkproduktion übriger Betrieb). Detailed activity data is not reported as it is considered confidential, however, available to reviewers.

4.2.2.3 Limestone and dolomite use (2A3)

In Switzerland limestone and dolomite are used as raw material in the production of

- fine ceramics,
- rock wool and
- bricks and tiles.

When using limestone and dolomite in such production processes geogenic CO_2 is released to the atmosphere. The three different production processes are discussed consecutively in the following.

The use of limestone and dolomite as raw materials in glass production is reported in source category 2A7 Glass Production.

Fine ceramics (2A3)

In Switzerland the main production of fine ceramics is sanitary ware. The carbonate containing raw materials limestone and dolomite are used in product glazes only. The glazes contain small amounts of soda ash (Na_2CO_3) as well. All information on the fine ceramics production is documented in EMIS 2012/2A3 Feinkeramik Produktion.

a) Methodology

The geogenic CO_2 emissions from fine ceramics production are determined by a Tier 2 approach according to 2006 IPCC guidelines (IPCC 2006, chapter *2.5 Other process uses of carbonates)*. For fine ceramics production in Switzerland this results in the following formula:

$$CO_2 \text{ Emissions} = (M_{Limestone} \bullet EF_{Limestone}) + (M_{Dolomite} \bullet EF_{Dolomite}) + (M_{Soda\ Ash} \bullet EF_{Soda\ Ash})$$

b) Emission Factors

For fine ceramics production in Switzerland the CO_2 emission factors of limestone, dolomite and soda ash are taken from IPCC 2006 (chapter *2.5 Other process uses of carbonates, Table 2.1*). As these emission factors are material properties they remain constant over time.

Table 4-6 Geogenic CO_2 emission factors used for fine ceramics, rock wool production and the production of brick and tile in g/t carbonate containing raw material and g/t product, respectively (IPPC 2006, EMIS 2012/2A3 Ziegeleien).

2A3 Soda ash use	Unit	CO_2 geogenic
fine ceramics and rock wool production		
limestone use	g/t limestone	439'710
dolomite use	g/t dolomite	477'320
soda use	g/t soda	414'920
brick and tile production	g/t	80'000

c) Activity Data

Activity data for carbonate containing raw materials, i.e. limestone, dolomite and soda ash used in the glazes of the fine ceramics production are extrapolated values based on industry data from the largest fine ceramics production plant in Switzerland. Detailed activity data of the carbonate containing raw materials are considered confidential; however, they are available to the reviewers.

Rock wool production (2A3)

In Switzerland there is one single producer of rock wool. The plant uses dolomite as raw material. No other carbonate containing raw material is used in the production process. All information of the rock wool production is documented in EMIS 2012/2A3 Steinwolle Produktion.

a) Methodology

The geogenic CO_2 emissions from rock wool production are determined by a Tier 2 approach according to IPCC 2006 (chapter *2.5 Other process uses of carbonates)*. For rock wool production in Switzerland this results in the following formula:

CO_2 Emissions = $M_{Dolomite} \bullet EF_{Dolomite}$

b) Emission Factors

For rock wool production in Switzerland the CO_2 emission factor of dolomite is taken from IPCC 2006 (chapter *2.5 Other process uses of carbonates, Table 2.1*). As the emission factor is a material property it remains constant over time (see Table 4-6).

c) Activity Data

Activity data are based on industry data from the single rock wool production plant in Switzerland.

Table 4-7 Activity data for the use of limestone and dolomite in fine ceramics and rock wool production and for the brick and tile production in Switzerland for the period 1990-2010 in Gg (EMIS 2012/2A3 Feinkeramik Produktion, EMIS 2012/2A3 Steinwolle Produktion, EMIS2012/2A3 Ziegeleien).

2A3 Soda ash use	Unit	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
fine ceramics production											
limestone use	Gg	C	C	C	C	C	C	C	C	C	C
dolomite use	Gg	C	C	C	C	C	C	C	C	C	C
soda use	Gg	C	C	C	C	C	C	C	C	C	C
rock wool production											
dolomite use	Gg	2.8	2.9	2.8	2.6	2.7	2.9	2.8	2.6	3.0	3.3
brick and tile production	Gg	1'271	1'240	1'208	1'177	1'146	1'115	1'084	1'052	1'021	990

2A3 Soda ash use	Unit	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
fine ceramics production											
limestone use	Gg	C	C	C	C	C	C	C	C	C	C
dolomite use	Gg	C	C	C	C	C	C	C	C	C	C
soda use	Gg	C	C	C	C	C	C	C	C	C	C
rock wool production											
dolomite use	Gg	3.7	2.7	4.9	5.6	4.9	1.7	0.3	3.7	4.7	4.7
brick and tile production	Gg	959	941	866	848	1'023	1'091	1'068	975	865	701

2A3 Soda ash use	Unit	2010
fine ceramics production		
limestone use	Gg	C
dolomite use	Gg	C
soda use	Gg	C
rock wool production		
dolomite use	Gg	5.9
brick and tile production	Gg	879

Brick and tile production (2A3)

In Switzerland there are about 20 plants producing bricks and tiles. The manufacturing process uses limestone containing clay as main raw material.

a) Methodology

Concerning the release of geogenic CO_2 emissions from brick and tile production there is no specific information on the employed raw materials available from Swiss industry. Requests to the Swiss association of brick and tile industry (Verband Schweizerische Ziegelindustrie VSZ) resulted in the following answer only:

“Due to the large range of variation of the carbonate content in the used raw materials we can only provide a rough estimate on the CO_2 emission resulting from the calcination process. We assume an amount of 4-12 mass-% of the produced amount of brick and tile to be released as CO_2”.

In order to estimate the geogenic CO_2 emission from brick and tile production in Switzerland the following formula was used:

CO_2 Emissions = $M_{\text{brick and tile}} \bullet EF_{\text{brick and tile}}$

b) Emission Factors

For estimating the geogenic CO_2 emissions from Swiss brick and tile production, a constant emission factor of 0.08 t CO_2/t brick and tile was assumed. This represents the mean value provided by the industry association as discussed above.

c) Activity Data

Activity Data are based on data from the Swiss association of brick and tile industry (see Table 4-7).

4.2.2.4 Soda ash production and use (2A4)

There is no soda ash production in Switzerland. The main use of soda ash is in the glass production which is reported separately in source category 2A7 Glass production. A very small amount of soda ash is also applied in glazes of fine ceramics and is thus included in source category 2A3.

4.2.2.5 Asphalt roofing (2A5)

This source category comprises emissions from production and use of asphalt roofing materials (saturated felt, roofing and siding shingles, roll roofing and sidings). These products are used in roofing and other building applications. From 2A5 Asphalt Roofing only indirect greenhouse gas emissions of CO and NMVOC arise. CO is emitted during the production process of asphalt roofing materials whereas NMVOC emissions are released during the entire production and laying processes (primers included).

Until the last submission also CH_4 emissions had been reported from the production of asphalt roofing materials. According to the Revised 1996 IPCC guidelines (IPCC 1996) no CH_4 emissions are released in the production process and therefore they are deleted in the current submission.

a) Methodology

Emissions of CO and NMVOC from asphalt roofing are calculated by multiplying the annual amounts of asphalt roofing products and primers produced and employed by the corresponding emission factors.

b) Emission Factors

The emission factors for CO and NMVOC emissions from asphalt roofing processes are country specific. They are based on measurements, industry data and expert estimates as documented in EMIS 2012/2A5 Dachpappenproduktion und Verlegung.

Table 4-8 Emission factors for CO and NMVOC in kg/t asphalt sealing sheeting and asphalt concrete from 2A5 Asphalt Roofing and 2A6 Road Paving with Asphalt, respectively (EMIS 2012/2A5 Dachpappenproduktion und Verlegung and EMIS 2012/2A6 Strassenbelagsarbeiten).

	Unit	CO	NMVOC
2A5 Asphalt roofing	kg/t asphalt sealing sheeting	118	25
2A6 Road paving	kg/t asphalt concrete	NA	0.78

c) Activity Data

Activity data on asphalt roofing products and primers produced is based on industry and expert estimates as documented in EMIS 2012/2A5 Dachpappen Produktion und Verlegung.

Table 4-9 Activity data for asphalt roofing and road paving with asphalt for the period 1990-2010 in Gg (EMIS 2012/2A5 Dachpappenproduktion und Verlegung and EMIS 2012/2A6 Strassenbelagsarbeiten).

	Unit	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
2A5 Asphalt roofing											
asphalt sealing sheeting	Gg	50	49	48	47	46	45	44	42	41	41
2A6 Road paving with asphalt											
asphalt concrete	Gg	5'500	5'360	5'220	5'080	4'940	4'800	4'763	4'727	4'690	5'070

	Unit	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
2A5 Asphalt roofing											
asphalt sealing sheeting	Gg	41	41	38	35	32	30	28	26	26	25
2A6 Road paving with asphalt											
asphalt concrete	Gg	5'170	4'860	4'770	4'860	4'840	4'780	5'400	5'100	5'160	5'200

	Unit	2010
2A5 Asphalt roofing		
asphalt sealing sheeting	Gg	25
2A6 Road paving with asphalt		
asphalt concrete	Gg	5'250

4.2.2.6 Road paving with asphalt (2A6)

Asphalt road surfaces are composed of compacted aggregate and asphalt binder. From road surfacing operations NMVOC emissions occur only.

a) Methodology

The NMVOC emissions are determined by a country specific method as documented in EMIS 2012/2A5 Strassenbelagsarbeiten and calculated by multiplying the annual amount of asphalt products used for road paving by the corresponding emission factor.

b) Emission Factors

The emission factor for NMVOC emissions from road paving with asphalt is country specific. It consists of a constant EF for the NMVOC emissions from the bitumen content of asphalt products and a variable EF from prime coatings. The values are based on industry data from 1998 and 2007. All other years are interpolated and complemented with expert estimates as documented in EMIS 2012/2A6 Strassenbelagsarbeiten (see Table 4-8).

c) Activity Data

Activity data on annual production of asphalt concrete is provided by the industry association on a yearly basis from 1998 on and for 1990 and 1995 (with expert estimates for the years in between) as documented in EMIS 2012/2A6 Strassenbelagsarbeiten (see Table 4-9).

4.2.2.7 Other (2A7)

Source category 2A7 Other comprises emissions from plaster production and from the production of container and table ware glass as well as glass wool.

Plaster Production (2A7)

a) Methodology

The emissions of CO_2, NO_x, CO, NMVOC and SO_2 from 2A7 Plaster Production refer to emissions from blasting operations during the mining of gypsum, i.e. the raw material for plaster production. The emissions are calculated by multiplying the annual amount of processed rock by the emission factors. There are two plaster production sites in Switzerland.

b) Emission Factors

As there are no specific emission factors for gypsum mining, the emission factors for cement raw material mining are taken instead. This approach is documented in EMIS 2012/2A7 Gips-Produktion übriger Betrieb.

Table 4-10 Emission factors for plaster production in g/t mined rocks (EMIS 2012/2A7 Gips-Produktion übriger Betrieb).

2A7 Plaster production	Unit	CO_2	NO_x	CO	NMVOC	SO_2
	g/t rocks	144	5.6	33	14.4	0.24

c) Activity Data

The activity data of the annual amount of rocks processed in the plaster production is based on industry data and expert estimates as documented in EMIS 2012/2A7 Gips-Produktion übriger Betrieb.

Table 4-11 Activity data for the mining of gypsum in Switzerland for the period 1990-2010 in Gg (EMIS 2012/2A7 Gips-Produktion übriger Betrieb).

2A7 Plaster production	Unit	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
rocks	Gg	319	316	313	310	307	304	300	297	294	291

2A7 Plaster production	Unit	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
rocks	Gg	288	285	290	296	301	327	323	314	295	293

2A7 Plaster production	Unit	2010
rocks	Gg	335

Glass production (2A7)

The carbonate containing raw materials in the glass production are soda ash, limestone and dolomite. In Switzerland the following three glass types are produced: container glass, tableware glass and glass wool. Today there is only one production plant for container glass and one for tableware glass in Switzerland after the other one closed in 2002 and 2006, respectively. Glass wool is produced in two plants.

a) Methodology

For determination of geogenic CO_2 emission from glass production a Tier 2 approach according to IPCC 2006 (chapter *2.4 Glass production)* is used. For glass production in Switzerland this results in the following formula:

$CO_2 \text{ Emissions} = M_{\text{Container glass}} \bullet EF_{\text{Container glass}} \bullet (1 - \text{cullet ratio})$

The cullet ratio describes the share of recycled glass material which is used in the production. The melting of cullet causes no geogenic CO_2 emissions.

b) Emission Factors

The emission factor for glass production in Switzerland is taken from IPCC 2006 (chapter *2.4 Glass production, Table 2.6*). For the production of container glass, tableware glass and glass wool the values for glass type *container*, *tableware* and *fibreglass* are taken, respectively. As the emission factors are material properties they remain constant over the time.

Table 4-12 Geogenic CO_2 emission factor for glass production in g/t glass (IPPC 2006).

2A7 Glass production	**Unit**	**CO_2 geogenic**
container glass	g/t	210'000
glass wool (fibre glass insulation)	g/t	250'000
glass (speciality tableware)	g/t	100'000

c) Activity Data

Activity data are based on industry data from Swiss glass producers. Detailed information on activity data for container glass production and tableware production is considered confidential as there is only one producing plant respectively. However, the detailed data is available to the reviewers. Activity data for glass wool production are based on industry data from the two glass wool production plants in Switzerland.

There has been an adjustment of the AD for glass wool production for the year 2006 due to an output correction of one plant. The cullet ratio for glass wool production has been adjusted for the whole time series according to new information from the plants.

Table 4-13 Glass production in Switzerland for the period 1990-2010 in Gg and cullet ratio in % (EMIS 2012/2A7 Hohlglas Produktion, EMIS 2012/2A7 Glas übrige Produktion and EMIS 2012/2A7 Glaswolle Produktion Rohprodukt).

2A7 Glass production	Unit	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
container glass											
production	Gg	C	C	C	C	C	C	C	C	C	C
cullet ratio	%	C	C	C	C	C	C	C	C	C	C
glass (speciality tableware)											
production	Gg	C	C	C	C	C	C	C	C	C	C
cullet ratio	%	C	C	C	C	C	C	C	C	C	C
glass wool											
production	Gg	24.3	22.5	22.9	20.9	24.0	23.0	18.9	24.3	26.0	30.9
cullet ratio	%	24	30	58	65	78	55	80	82	80	81

2A7 Glass production	Unit	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
container glass											
production	Gg	C	C	C	C	C	C	C	C	C	C
cullet ratio	%	C	C	C	C	C	C	C	C	C	C
glass (speciality tableware)											
production	Gg	C	C	C	C	C	C	C	C	C	C
cullet ratio	%	C	C	C	C	C	C	C	C	C	C
glass wool											
production	Gg	30.1	24.4	19.4	25.7	32.8	37.5	38.1	44.5	44.4	33.5
cullet ratio	%	84	85	88	85	84	84	84	81	80	82

2A7 Glass production	Unit	2010
container glass		
production	Gg	C
cullet ratio	%	C
glass (speciality tableware)		
production	Gg	C
cullet ratio	%	C
glass wool		
production	Gg	35.7
cullet ratio	%	85

4.2.3 Uncertainties and Time-Series Consistency

The uncertainty for CO_2 emissions in cement production (2A1) which is key category regarding level and trend amounts to 6.3%. The uncertainty of CO_2 emissions from clinker calcination was calculated following the steps in Table 3.2 in 2000 IPCC good practice guidance (IPCC 2000, p. 3.15). As CO_2 emissions are calculated based on plant level clinker production data (Tier 2), an activity data uncertainty of 2% is assumed. The uncertainty of the emission factor is based on the fact that an average CaO content of the clinker of 64.2% is assumed. According to the estimated default uncertainty values in the range of 4-8% in table 3.2 of the IPCC Good Practice Guidance a value of 6% is chosen for Switzerland.

For non-key categories, the NIR provides qualitative estimates of uncertainties only. The terms high, medium and low data quality is used and a quantitative relative uncertainty is assigned to every uncertainty category (see Table 1-13 Semi-quantitative uncertainties for non-key categories). The uncertainties for CO_2 emissions from source categories 2A2, 2A3 and 2A7 are estimated to be low and thus amount to 2%.

The time series is consistent.

4.2.4 Source-Specific QA/QC and Verification

The time series have been compared between the current and the previous submission. All activity data, implied emission factors and emissions undergo the triple check:

- the results for 2010 are compared with the results 2009 within the current CRF
- the CRF tables for the year 2009 are compared between the current CRF tables and the CRF tables of submission 2011.
- the CRF tables for the base year 1990 are compared between the current CRF tables and the CRF tables of submission 2011

The emission factor of category 2A1 used in the Swiss Inventory has been compared to the corresponding emission factors of other countries (UNFCCC http://unfccc.int/di/FlexibleQueries.do) and to the IPCC default value (INFRAS 2012). Switzerland's factor lies in the midfield of the other countries; see chpt. 4.2.2.1.

The emission factor of category 2A2 used in the Swiss Inventory has been compared to the corresponding emission factors of other countries (UNFCCC http://unfccc.int/di/FlexibleQueries.do) and to the IPCC default value (INFRAS 2012). Switzerland's factor lies in the midfield of the other countries, see chpt. 4.2.2.2.

The emission factor of category 2A3 used in the Swiss Inventory has been compared to the corresponding emission factors of other countries (UNFCCC http://unfccc.int/di/FlexibleQueries.do) and to the IPCC default value if available (INFRAS 2012). Switzerland's factor lies beyond the other countries. This is due to the fact, that the Swiss factor includes emissions from three different sources: fine ceramics, rock wool and brick and tile. The most dominant process in category 2A3 is brick and tile production. The emission factor amounts to 0.08 t CO_2/t brick and tile. Comparing this value to the German value which is 0.029 t CO_2/t bricks and tiles, shows that the Swiss value is rather high. The Swiss brick and tile industry has determined very recently the carbonate content of the clay raw material at several pits. A first comparison with the carbonate content of clay from pits in other European countries confirms that the Swiss values are indeed rather high.

Additionally, the CRF data was checked by doing spot-checks with activity data and emission factors from EMIS.

4.2.5 Source-Specific Recalculations

2A1 Cement Production: Activity data for clinker and cement production of 2009 which were preliminary interpolated values in last year's submission have been replaced by official production data.

2A5 Asphalt Roofing: Until the last submission also CH_4 emissions had been reported from the production of asphalt roofing materials. According to the Revised 1996 IPCC guidelines (IPCC 1996) no CH_4 emissions are released during the production process and therefore they are deleted in the current submission.

2A7 Glass Production: There has been an adjustment of the AD for glass wool production for the year 2006 due to an output correction of one plant. The cullet ratio for glass wool production has been adjusted for the whole time series according to new information from the plants.

4.2.6 Source-Specific Planned Improvements

2A3 Brick and tile production: Very recently Swiss brick and tile industry performed measurements on the release of geogenic CO_2 emissions from the brick and tile production. This data will be considered in the next year's submission and will result in a recalculation.

4.3 *Source Category 2B – Chemical Industry*

4.3.1 Source Category Description

Source category 2B Chemical Industry comprises process emissions from the production of ammonia, nitric acid, silicon carbide, ethylene, acetic acid and sulphuric acid.

Table 4-14 Specification of source category 2B “Chemical Industry”.

2B	Source	Specification	Data Source
2B1	Ammonia Production	Emissions of CO_2 and NMVOC are reported in 2B5 Ethylene production	AD, EF: EMIS 2012/2B1 Ammoniak-Produktion
2B2	Nitric Acid Production	Emissions of N_2O and NO_x from the production of nitric acid	AD, EF: EMIS 2012/2B2 Salpetersäure Produktion
2B3	Adipic Acid Production	Not occurring in Switzerland	
2B4	Carbide Production	Emissions of CO_2, CH_4 and SO_2 from the production of silicon carbide	EF: IPPC 2006, EMIS 2012/2B4 Graphit und Siliziumkarbid Produktion AD: EMIS 2012/2B4 Graphit und Siliziumkarbid Produktion
2B5	Other	Emissions of CO_2 and NMVOC from ethylene production Emissions of CH_4, CO and NMVOC from acetic acid production SO_2 emissions from sulphuric acid production	AD, EF: EMIS 2012/2B5 Ethen-Produktion AD, EF: EMIS 2012/2B5 Essigsäure-Produktion AD, EF: EMIS 2012/2B5 Schwefelsäure-Produktion

4.3.2 Methodological Issues

4.3.2.1 Ammonia production (2B1)

Ammonia (NH_3) is produced in one single plant in Switzerland by catalytic reaction of nitrogen and synthetic hydrogen (see Figure 4-4). Ammonia is not produced in an isolated reaction plant but is part of an integrated production chain (see Figure 4-5). The starting production process is the thermal cracking of liquefied petroleum gas (LPG) and light petroleum yielding ethylene (ethene, C_2H_4), and a series of by-products such as e.g. synthetic hydrogen and methane, which are used as educts for further production steps. According to the Swiss ammonia producer it is not possible to split and allocate the emissions of the cracking process (CO_2 and NMVOC) to every single product such as, e.g., ethylene, acetylene (ethene, C_2H_2), cyanic acid or ammonia. **Therefore, all CO_2 and NMVOC emissions of the cracking process are allocated to the *ethylene production*** and are reported under the category 2B5 Ethylene production. Thus, for source category 2B1 Ammonia production, CO_2 and NMVOC emissions are reported as included elsewhere (IE). All information on the ammonia production and the cracking process is documented in EMIS 2012/2B1 Ammoniak-Produktion and EMIS 2012/2B5 Ethen-Produktion, respectively.

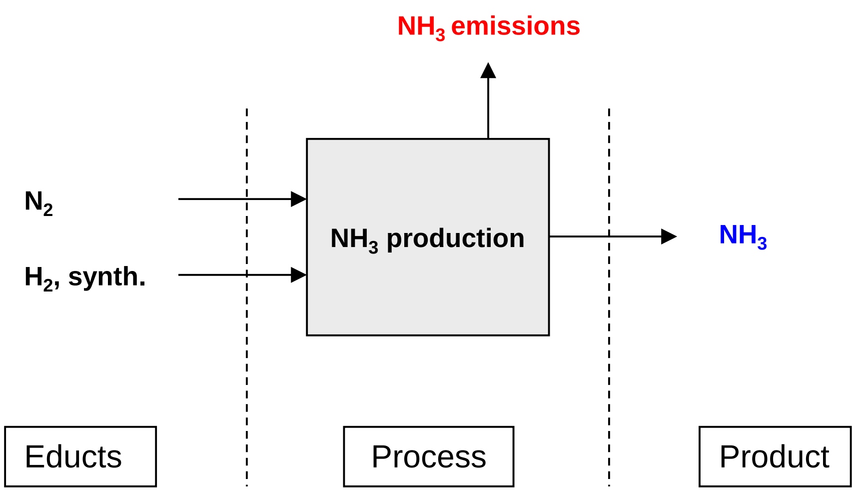

Figure 4-4 Process flow chart for the production of ammonia (NH_3) from nitrogen (N_2) and hydrogen (H_2, synth.). Hydrogen is derived from the thermal cracking process in the same plant (see Figure 4-5).

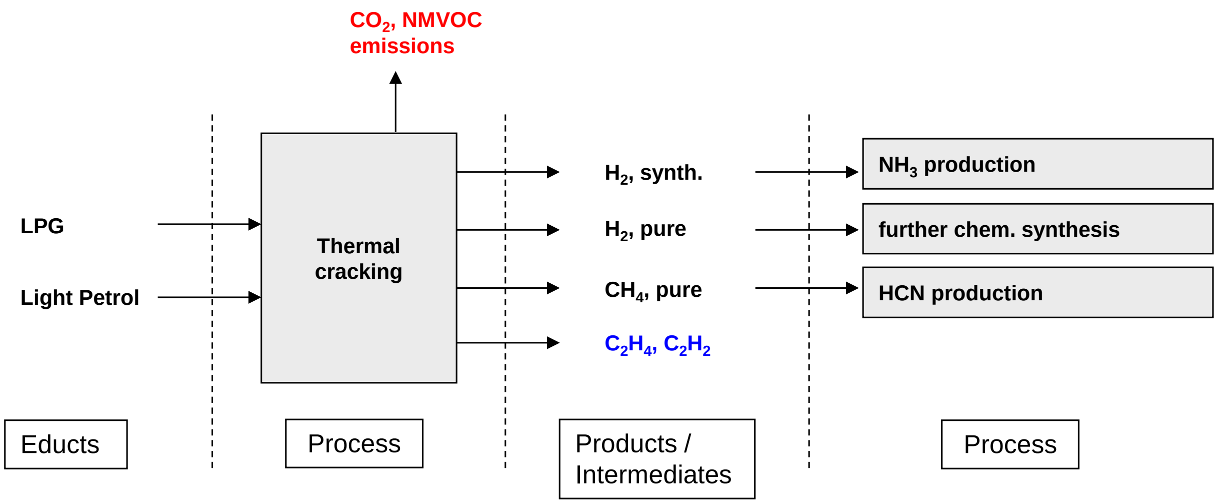

Figure 4-5 Process flow chart for the production of ethylene (C_2H_4) and acetylene (C_2H_2) by thermal cracking of liquefied petroleum gas (LPG) and light petrol. The intermediate product H_2, synth. is used as educt in the ammonia production in the same plant (see Figure 4-4)

4.3.2.2 Nitric acid production (2B2)

In Switzerland there is one single plant producing nitric acid (HNO_3). Nitric acid is produced by catalytic oxidation of ammonia (NH_3) with air. At temperatures of 800 °C nitric oxide (NO) is formed. During cooling, nitrogen monoxide reacts with excess oxygen to form nitrogen dioxide (NO_2). The nitrogen dioxide reacts with water to form 60% nitric acid (HNO_3). Today, two types of processes are used for nitric acid production: single pressure or dual pressure plants. In Switzerland, a dual pressure plant is installed.

During the process nitrous oxide (N_2O) can be formed as an unintended by-product. In addition, also some nitrogen oxide (NO_x) is produced. In the Swiss production plant abatement of NO_x is done by selective catalytic reduction (SCR) which reduces NO_x to N_2 and O_2 (the SCR in this plant is also used for treatment of other flue gases and was not installed for the HNO_3 production specially). No additional abatement technique is installed to destroy N_2O. A decomposition of N_2O occurs, to some extent, simultaneously in the NO_x reduction process. The production and abatement technology has essentially remained the same since 1990.

a) Methodology

The N_2O and NO_x emissions from nitric acid production are determined by a Tier 2 approach. The emissions are calculated by multiplying the annual nitric acid production output by the corresponding emission factors for N_2O and NO_x emissions respectively.

b) Emission Factors

The N_2O and NO_x emission factors for nitric acid production in Switzerland are based on measurements from the single nitric acid production plant. The values are documented in EMIS 2012/2B2 Salpetersäure Produktion. They are considered confidential, however, available to reviewers on request.

Table 4-15 Emission factors for N_2O and NO_x for nitric acid production in Switzerland in kg/t nitric acid. Data refers to 100% nitric acid (EMIS 2012/2B2 Salpetersäure Produktion).

2B2 Nitric acid production	Unit	N_2O	NO_x
	kg/t	C	C

c) Activity Data

Activity data on annual production of nitric acid is provided on a yearly basis by the Swiss production plant for the entire time period 1990-2010. The data is confidential but available for reviewers (see EMIS 2012/2B2 Salpetersäure Produktion).

4.3.2.3 Carbide production (2B4)

In Switzerland there is one single plant producing carbide. The plant produces silicon carbide which is used in abrasives, refractories, metallurgy and anti-skid flooring. The Swiss silicon carbide is produced in an electric furnace at temperatures above 2000 ºC using the Acheson process. The starting materials are quartz sand (SiO_2), petroleum coke and anthracite (C) which yield silicon carbide (SiC) and carbon monoxide (CO). The CO is converted to CO_2 in excess oxygen and released to the atmosphere. Petroleum coke and anthracite – although to a lower portion – may contain volatile organic compounds which can form methane (CH_4) as an unintended by-product. There is no abatement techniques installed which could capture the CO_2 or CH_4 emissions.

a) Methodology

The CO_2, CH_4 and SO_2 emissions from silicon carbide production are determined by a Tier 2 approach. The emissions are calculated by multiplying the annual silicon carbide production output by the corresponding emission factors for CO_2, CH_4 and SO_2 emissions respectively.

b) Emission Factors

The CO_2, CH_4 and SO_2 emission factors are considered confidential, however, available to reviewers on request. The values base partly on measurements and data from the single silicon carbide production plant and are documented in EMIS 2012/2B2 Graphit und Siliziumkarbid Produktion.

Table 4-16 Emission factors for CO_2, CH_4 and SO_2 for carbide production in Switzerland in kg/t silicon carbide respectively (EMIS 2012/2B4 Graphit und Siliziumkarbid Produktion).

2B4 Silicon carbide production	Unit	CO_2	CH_4	SO_2
	kg/t	C	C	C

c) Activity Data

Activity data on annual production of silicon carbide is provided on a yearly basis from 1997 onwards by the Swiss production plant. For the time period 1990-1996 activity data base on industry data for 1990 and 1995 and interpolated values in between. The data is confidential but available for reviewers (see EMIS 2012/2B4 Graphit und Siliziumkarbid Produktion).

4.3.2.4 Other (2B5)

Source category Other (2B5) comprises emissions from production of ethylene, acetic acid and sulphuric acid.

Ethylene production (2B5)

Ethylene (ethene, C_2H_4) is produced by a single plant in Switzerland by thermal cracking of liquefied petroleum gas (LPG) and light petrol. Ethylene is not produced in an isolated process but is co-processed together with several other products such as H_2, CH_4, and C_2H_2 (see flow chart in Figure 4-5 in section 4.3.2.1). From the thermal cracking process emissions of CO_2 and NMVOC are released. They are both allocated entirely to the production of ethylene which is the first product within the integrated production chain. CH_4 emissions to atmosphere do not occur since CH_4 is completely used as educt in the downstream production of cyanic acid (HCN) in the same facility (again, see Figure 4-5 and for further information see EMIS 2012/2B5 Ethen-Produktion). Therefore CH_4 emissions are reported as NA for ethylene production and only CO_2 and NMVOC emissions are reported.

a) Methodology

The CO_2 and NMVOC emissions from ethylene production are determined by country-specific approach. The emissions are calculated by multiplying the annual ethylene production output by the corresponding emission factors for CO_2 and NMVOC emissions respectively.

b) Emission Factors

The CO_2 and NMVOC emission factors for ethylene production are based on industry data from the single ethylene production plant in Switzerland. Emission data were only available from the year 2000 onwards. For the period 1990-1999, a constant value, i.e. the mean value of the years 2000-2009 was assumed. The emission factors for ethylene production are considered confidential; however, they are available to reviewers on request.

Table 4-17 Emission factors for CO_2 and NMVOC in ethylene production, CH_4, CO and NMVOC in acetic acid production and SO_2 in sulphuric acid production for the period 1990-2010 in kg/t product (EMIS 2012/2B5 Ethen-Produktion, EMIS 2012/2B5 Essigsäure-Produktion and EMIS 2012/2B5 Schwefelsäure-Produktion).

2B5 Chemical industry, other	Unit	CO_2	CH_4	CO	NMVOC	SO_2
ethylene production	kg/t	C	NA	NA	C	NA
acetic acid production	kg/t	NA	10	30	0.2	NA
sulphuric acid	kg/t	NA	NA	NA	NA	C

c) Activity Data

Activity data on the annual production of ethylene is provided on a yearly basis by the single ethylene production plant in Switzerland for the entire time period 1990-2010. The data is considered confidential but available for reviewers on request.

Table 4-18 Activity data for the production of ethylene, acetic acid and sulphuric acid in Switzerland for the period 1990-2010 in Gg (EMIS 2012/2B5 Ethen-Produktion, EMIS 2012/2B5 Essigsäure-Produktion and EMIS 2012/2B5 Schwefelsäure-Produktion).

2B5 Chemical industry, other	Unit	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
ethylene production	Gg	C	C	C	C	C	C	C	C	C	C
acetic acid	Gg	31	31	31	31	31	31	31	31	31	31
sulphuric acid	Gg	C	C	C	C	C	C	C	C	C	C

2B5 Chemical industry, other	Unit	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
ethylene production	Gg	C	C	C	C	C	C	C	C	C	C
acetic acid	Gg	31	31	31	31	31	31	30	30	30	30
sulphuric acid	Gg	C	C	C	C	C	C	C	C	C	C

2B5 Chemical industry, other	Unit	2010
ethylene production	Gg	C
acetic acid	Gg	30
sulphuric acid	Gg	C

Acetic and sulphuric acid production (2B5)

In Switzerland there are three plants producing acetic acid (CH_3COOH). From acetic acid production emissions of CH_4, CO and NMVOC occur. Sulphuric acid (H_2SO_4) is produced by one plant only in Switzerland. From this production process SO_2 is emitted.

a) Methodology

In order to determine emissions of CH_4, CO and NMVOC as well as of SO_2 emissions from acetic acid and sulphuric acid production, respectively, a country specific approach is used. The emissions are calculated by multiplying the annual production of acetic acid and sulphuric acid, respectively, by the corresponding emission factor.

b) Emission Factors

The emission factors for CH_4, CO and NMVOC from acetic acid production and for SO_2 from sulphuric acid production in Switzerland are country specific and base on measurements and data from industry and expert estimates documented in EMIS 2012/2B5 Essigsäure-Produktion and EMIS 2012/2B5 Schwefelsäure-Produktion (see Table 4-17). The data for sulphuric acid production is confidential but available for reviewers on request.

c) Activity Data

The annual amount of produced acetic acid and sulphuric acid base on data from industry and expert estimates documented in EMIS 2012/2B5 Essigsäure-Produktion and EMIS 2012/2B5 Schwefelsäure-Produktion (see Table 4-18). The data for sulphuric acid production is confidential but available for reviewers.

4.3.3 Uncertainties and Time-Series Consistency

For non-key categories, the NIR provides qualitative estimates of uncertainties only. The terms high, medium and low data quality are used and a quantitative relative uncertainty is assigned to every uncertainty category (see Table 1-13 Semi-quantitative uncertainties for non-key categories). The uncertainties for CO_2 and CH_4 and CO_2 emissions from source categories 2B4 Silicon Carbide Production and 2B5 Ethylene Production, respectively, are estimated to be medium, resulting in a relative uncertainty of 10% for CO_2 and of 30% for CH_4. For N_2O emissions from 2B2 Nitric Acid Production which has been a key category in previous submissions the uncertainty was calculated to be 41%.

The time series is consistent.

4.3.4 Source-Specific QA/QC and Verification

The time series have been compared between the current and the previous submission. All activity data, implied emission factors and emissions undergo the triple check:

- the results for 2010 are compared with the results 2009 within the current CRF
- the CRF tables for the year 2009 are compared between the current CRF tables and the CRF tables of submission 2011.
- the CRF tables for the base year 1990 are compared between the current CRF tables and the CRF tables of submission 2011

The N_2O emission factor of source category 2B2 Nitric Acid Production used in the Swiss Inventory has been compared to the corresponding emission factors of other countries (UNFCCC http://unfccc.int/di/FlexibleQueries.do) and to the IPCC default value (INFRAS 2012). Switzerland's factor lies in the midfield of the other countries; see chpt. 4.3.2.2.

Additionally, the CRF data was checked by doing spot-checks with activity data and emission factors from EMIS.

4.3.5 Source-Specific Recalculations

2B4 Carbide Production: Recalculations have been made due to more precise production data for the years 1997 to 2009.

2B5 Sulphuric Acid Production: Industry association was able to provide annual production data from 2000 onwards resulting in a recalculation in activity data between 1991 and 2009.

4.3.6 Source-Specific Planned Improvements

There are no source-specific planned improvements.

4.4 Source Category 2C – Metal Production

4.4.1 Source Category Description

Tier 2 Key category 2C1
CO_2 emissions from Iron and Steel Production (level and trend).

Source category 2C Metal Production comprises process emissions from the production of iron and steel, ferroalloys and aluminium, from the use of SF_6 in aluminium and magnesium foundries, as well as from battery recycling and non-ferrous metal foundries.

Table 4-19 Specification of source category 2C “Metal Production”.

2C	Source	Specification	Data Source
2C1	Iron and Steel Production	Emissions of CO_2, NO_x, CO, NMVOC and SO_2 from the production of iron and steel	AD, EF: EMIS 2012/2C1 Eisengiessereien Elektroschmelzofen/übriger Betrieb, EMIS 2012/2C1 Stahl-Produktion Elektroschmelzöfen/übriger Betrieb
2C2	Ferroalloys Production	Included in 2C1	
2C3	Aluminium Production	Emissions of PFC, CO_2, NO_x, CO, NMVOC and SO_2 from the production of aluminium (ceased in 2006)	AD: EMIS 2012/2C3 Aluminium Produktion EF for PFC: Industry Data EF other gases: EMIS 2012/2C3 Aluminium Produktion
2C4	Use of SF_6 in Aluminium and Magnesium Foundries	Emissions from use of SF_6 in aluminium and magnesium foundries	AD: Industry Data EF: IPCC 2006
2C5	Other	Emissions of CO_2, NO_x, CO and SO_2 from battery recycling Emissions of CO and NMVOC from non-ferrous metal foundries	AD, EF: EMIS 2012/2C5e Batterie-Recycling, AD, EF: EMIS 2012/2C5e Buntmetallgiessereien Elektroöfen

4.4.2 Methodological Issues

4.4.2.1 Iron and Steel production (2C1)

There is no primary iron and steel production in Switzerland. Only secondary steel production occurs, which is the steel production from recycled steel scrap. After closing down of two steel plants in 1994 there remain two plants in Switzerland. Both plants use electric arc furnaces (EAF) with a carbon electrode for melting the steel scrap. During this process CO_2 emissions occur due to consumption of the electrodes. Indirect emissions such as NO_x, CO, NMVOC and SO_2 occur as well.

In Switzerland no production of pig iron occurs but iron is processed in foundries only. 14 iron foundries exist in Switzerland today. About 70% of the iron is processed in induction furnaces and 30% in cupola furnaces. From induction furnaces only indirect emissions occur. From cupola furnaces also CO_2 emissions occur. Those CO_2 emissions are accounted for in category 1A2.

Most of the steel qualities produced in Switzerland are alloyed steels. Source category 2C2 Ferroalloys Production is therefore included in 2C1.

a) Methodology

For determination of CO_2 emission from steel production a Tier 1 approach according to IPCC 2006 (chapter 4.2 *Iron & steel and metallurgical coke production)* is used. For steel production in Switzerland this results in the following formula:

$E_{CO2, non-energy} = EAF \bullet EF_{EAF}$

whereas EAF is the quantity of EAF crude steel produced in tonnes and EF_{EAF} the emission factor in tonnes CO_2/tonne steel produced. The same formula is also applied to calculate indirect emissions for iron and steel production. No CH_4 emissions occur in the Swiss EAF process.

b) Emission Factors

The emission factors for iron and steel production in Switzerland are country specific and base on measurement data from industry and expert estimates documented in EMIS 2012/2C1 Eisengiessereien Elektroschmelzofen/übriger Betrieb, EMIS 2012/2C1 Stahl-Produktion Elektroschmelzöfen and EMIS 2012/2C1 Stahlwerke Walzwerke.

Table 4-20 Emission factors for NO_x, CO and NMVOC in iron production, for CO_2, NO_x, CO, NMVOC and SO_2 in steel production, for CO_2, NO_x, CO and SO_2 in battery recycling and for CO and NMVOC in non-ferrous metal production (EMIS 2012/2C1 Eisengiessereien Elektroschmelzofen/übriger Betrieb, EMIS 2012/2C1 Stahl-Produktion Elektroschmelzöfen and EMIS 2012/2C1 Stahlwerke Walzwerke, EMIS 2012/2C5e Batterie-Recycling and 2012/2C5e Buntmetallgiessereien Elektroöfen).

2C Metal production	Unit	CO_2	NO_x	CO	NMVOC	SO_2
2C1 Iron	kg/t	NA	0.01	4.1	5.4	NA
2C1 Steel	kg/t	140	0.19	0.8	0.1	0.017
2C5 Battery recycling	kg/t	560	0.88	1.2	NA	0.01
2C5 Non-ferrous metals	kg/t	NA	NA	0.24	0.05	NA

c) Activity Data

Activity data on annual production of iron and steel is provided on a yearly basis by the Swiss production plants and the foundry association. Data are given in the following table:

Table 4-21 Production of iron, steel, aluminium and non-ferrous metals as well as amount of batteries recycled in Switzerland for the period 1990-2010 in Gg (EMIS 2012/2C1 Eisengiessereien Elektroschmelzofen/ übriger Betrieb, EMIS 2012/2C1 Stahl-Produktion Elektroschmelzöfen, EMIS 2012/2C3 Aluminium Produktion, EMIS 2012/2C5e Batterie-Recycling and 2012/2C5e Buntmetallgiessereien Elektroöfen).

2C Metal production	Unit	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
2C1 Iron	Gg	170	140	136	110	115	130	111	114	123	122
2C1 Steel	Gg	1'108	1'155	1'245	1'276	1'230	716	738	789	880	918
2C3 Aluminium	Gg	87	82	75	36	24	21	27	27	32	34
2C5 Battery recycling	Gg	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0
2C5 Non-ferrous metals	Gg	55	56	57	58	59	60	65	66	68	69

2C Metal production	Unit	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
2C1 Iron	Gg	120	105	80	73	67	67	67	72	78	49
2C1 Steel	Gg	1'022	1'048	1'125	1'143	1'226	1'159	1'254	1'267	1'315	935
2C3 Aluminium	Gg	36	36	40	44	45	45	12	0	0	0
2C5 Battery recycling	Gg	3.0	3.0	3.0	2.9	3.3	2.8	2.4	2.4	2.5	3.4
2C5 Non-ferrous metals	Gg	70	60	49	43	38	33	30	28	21	15

2C Metal production	Unit	2010
2C1 Iron	Gg	53
2C1 Steel	Gg	1'218
2C3 Aluminium	Gg	0
2C5 Battery recycling	Gg	3
2C5 Non-ferrous metals	Gg	20

4.4.2.2 Aluminium Production (2C3)

a) Methodology

The last production site for aluminium in Switzerland closed down in April 2006. Both CO_2 and PFC emissions were based on a country specific approach. More specific for PFC emissions a Tier 3b approach according to 2000 IPCC good practice guidance (IPCC 2000) was used. Operating smelter emissions have been monitored periodically by the industry for selected years. The emissions were calculated by multiplying annual production by emission factors.

b) Emission Factors

The emission factor for CO_2 per ton of metal product is country specific. It is based on measurements and data from industry and expert estimates, documented in EMIS 2012/2C3 Aluminium Produktion. For CO_2 emissions from aluminium production, an emission factor of 1.6 ton CO_2 per ton of aluminium is used (EMIS 2012/2C3 Aluminium Produktion). This CO_2 stems from the oxidation of the anode in the electrolysis process. The value is based on an estimate of the amount of anode material used. In Switzerland only pre-backed processes are used. The emissions for CO_2 are calculated with 0.43 tons of anode per ton of aluminium; it is assumed that the anode consists completely of carbon and that it is fully oxidized during the process (value from Swiss foundries, value for 1990, assumed to be constant over the time series).

For PFC emissions from aluminium production, operating smelter EF have been monitored periodically by the industry for selected years. The only Swiss factory provided own measurements for 1990, 1999 and 2000 yielding smaller EFs than the European average (by factors of 3.9, 4.7 and 5.1, respectively) (Alcan 2003). The comparison with these data and data from IAI (2005) on global PFC emissions from aluminium production showed that the emissions from the smelter in Switzerland are lower by a factor of about 4. This seems to be plausible because they used point feed prebake (PFPB) technology and it is known that this technology has the lowest emissions per tonne of aluminium. Therefore a “general reduction factor” of 4.0 for both PFC gases (CF_4 and C_2F_6) is adopted based on the average European values as reported from the European Aluminium Association (Alcan 2002) for the years with no measured emission data available. The resulting emission factors for Switzerland are still within the uncertainty range according to IPCC GPG 2000. In order to calculate the emissions factors for the years 2001 to 2006 — without any measurements in Switzerland — the data has been interpolated from the European data. E.g. for the year 2006 a value of 0.035 kg_{PFC}/t_{AL}, results with a European average emission factor of 0.14 kg_{PFC}/t_{AL} and a correction factor of 0.25. For the ratio of CF_4 to C_2F_6 a value of 90% to 10% is applied. As it was not possible to perform industry independent measurements, and because of the fact that aluminium production was closed in 2006 it is not possible to redo any measurements or to collect any information about the process details retroactively. The emission factors have decreased by a factor of about 4.9 between 1990 and 2006 due to technical efforts to reduce emissions (Alcan 2003)..

The factors according to Table 4-22 are used. The large difference between the emission factors of the year 1999 and 2000 is based on measured data given by the company. For the time series of PFC emission factors see the inventory report for the year 2011 (FOEN 2011), Table 4-22

Table 4-22 PFC emissions factors for aluminium production in Switzerland.

Gas	Unit	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
CF_4	kg/t	0.1530	0.1373	0.1215	0.1058	0.0900	0.0833	0.0765	0.0698	0.0630	0.0540
C_2F_6	kg/t	0.0170	0.0153	0.0135	0.0118	0.0100	0.0093	0.0085	0.0078	0.0070	0.0060

Gas	Unit	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
CF_4	kg/t	0.0360	0.0360	0.0360	0.0360	0.0338	0.0315	0.0315	NO	NO	NO
C_2F_6	kg/t	0.0040	0.0040	0.0040	0.0040	0.0038	0.0035	0.0035	NO	NO	NO

c) Activity Data

In 2006 the last production site of aluminium in Switzerland was closed. Activity data on aluminium production from 1997 to 2006 is based on annual data published by the Swiss Aluminium Association. For earlier years, the data was provided directly by the aluminium industry.

Activity data for aluminium production in Switzerland is given in

Table 4-21.

4.4.2.3 Use of SF_6 in Aluminium and Magnesium Foundries (2C4)

a) Methodology

SF_6 is used in aluminium and magnesium foundries in the cleaning process as inert gas to fill casting forms. The Swiss Foundry Association (GVS) has not provided information on emission factors and hence a Tier 1 based approach is used. The inventory data on SF_6 used in aluminium and magnesium foundries (2C4) is based on the total imported amount of SF_6 according to the import statistic. It is assumed that the total imported amount is emitted within one year. For the inventory of any particular year the mean value of the imports in the present and the previous year is used to account for possible time lag between import and consumption (e.g. for 2010 inventory the mean value of 2009 and 2010 import data is used).

b) Emission Factors

For SF_6 used in aluminium and magnesium foundries (2C4) it is assumed that the total imported amount is emitted (IPCC 2006, default emission factor of 1000kg per ton of imported substance).

c) Activity Data

Activity data on SF6 used in aluminium and magnesium foundries (2C4) is based on import data. For the activity data of any particular year the mean value of the imports in the present and the previous year is used to account for possible time lag between import and consumption (e.g. for 2010 the mean value of 2009 and 2010 import data is used). SF6 is used in Swiss aluminium and magnesium foundries since 1997. There have been two magnesium foundries known to be using SF6. In 2007 one of them closed down production which led to a reduction in activity data for magnesium foundries by 25% from 2007 to 2008. The remaining magnesium foundry reported activity data for 2008 to 2010 to the SWISSMEM statistics. The fact that only one magnesium foundry uses SF6 was confirmed by a survey which has been carried out in 2011 within members of the Swiss Foundry Association (GVS). For 2010 the use of SF6 in Aluminium foundries was not confirmed. Regarding the activity data on SF_6 used in aluminium foundries a methodological change was introduced for the inventory report 2011 (FOEN 2011). So far the import amount for aluminium cleaning was extrapolated from an estimate value given in the year 2003 by an import company. Details on the imported amount are not available for later years. A steady decrease since 2003 is assumed for import of SF_6 used for aluminium cleaning. This assumption is based on the above mentioned survey and on information which was obtained on other applications within the category ‘others’ from FOEN import statistics which indicates that decreasing amounts of SF_6 are used for aluminum cleaning.

4.4.2.4 Other (2C5)

Battery recycling and non-ferrous metal foundries (2C5)

There is one plant recycling batteries in Switzerland. The recycling is done applying the Sumitomo-process. The batteries are first pyrolised at temperatures of 700 °C in reducing atmosphere in a shaft kiln. The gas with the carbonised components then goes to a post-combustion step where it is completely oxidised at temperatures of 1000 °C. The flue gas is then led to flue gas cleaning. The metal fraction from the pyrolysis goes to a melting furnace where it is reduced by addition of coal and magnesium oxide. As reducing agent coke and Carburit is used.

In Switzerland there are one large and several small plants operating non-ferrous metal foundries. During the melting process emissions of CO and NMVOC occur.

a) Methodology

To determine emissions of CO_2, NO_x, CO and SO_2 from battery recycling and of CO and NMVOC emissions from non-ferrous metal foundries, a country specific approach is used. The emissions are calculated by multiplying the annual amount of recycled batteries and produced non-ferrous metals by the corresponding emission factors.

b) Emission Factors

The emission factors of CO_2, NO_x, CO and SO_2 from battery recycling and of CO and NMVOC emissions from non-ferrous metal foundries in Switzerland are country specific and base on measurements from industry and expert estimates documented in EMIS 2012/2C5e Batterie-Recycling and 2012/2C5e Buntmetallgiessereien Elektroöfen (see Table 4-20).

c) Activity Data

The annual amount of recycled batteries and produced non-ferrous metals in Switzerland is reported from industry and foundry association as documented in EMIS 2012/2C5e Batterie-Recycling and 2011/2C5e Buntmetallgiessereien Elektroöfen (see Table 4-21).

4.4.3 Uncertainties and Time-Series Consistency

4.4.3.1 Uncertainty for key category 2C1 Iron and Steel Production

The uncertainty for CO_2 emissions in steel production amounts to 40.3 %. Production data of the steel industry has a high confidence and its uncertainty is estimated to 5% (EMIS 2012/2C1 Stahl-Produktion Elektroschmelzöfen). The uncertainty for the CO_2 emission factor is estimated to be 40% (EMIS 2012/2C1 Stahl-Produktion Elektroschmelzöfen).

4.4.3.2 Uncertainty for source category 2C4 Use of SF_6 in Aluminium and Magnesium Foundries

For the use of SF_6 in Aluminium and Magnesium Foundries, an uncertainty of 20% (with normal distribution) is assumed, which is a result of a Monte Carlo simulation of the emissions of F-gases (Carbotech 2012).

4.4.3.3 Qualitative estimate of uncertainties for non-key category 2C5 Other

For non-key categories, the NIR provides qualitative estimates of uncertainties. The terms high, medium and low data quality are used and a quantitative relative uncertainty is assigned to every uncertainty category (see Table 1-13, semi-quantitative uncertainties for non-key categories). The uncertainty for CO_2 emissions from source category 2C5 Battery recycling is rated medium and thus amounts to 10%.

The time series is consistent.

4.4.4 Source-Specific QA/QC and Verification

The time series have been compared between the current and the previous submission. All activity data, implied emission factors and emissions undergo the triple check:

- the results for 2010 are compared with the results 2009 within the current CRF
- the CRF tables for the year 2009 are compared between the current CRF tables and the CRF tables of submission 2011.
- the CRF tables for the base year 1990 are compared between the current CRF tables and the CRF tables of submission 2011

The CO_2 emission factor of source category 2C1 Steel Production used in the Swiss Inventory has been compared with the corresponding emission factors of other countries (UNFCCC http://unfccc.int/di/FlexibleQueries.do) and the IPCC default value (INFRAS 2012). Switzerland's factor lies in the lower end of the countries. This is due to the fact that in Switzerland only secondary steel making occurs; see chpt. 4.4.2.1.

For source category 2C4 Use of SF_6 in Aluminium and Magnesium Foundries the data received from SWISSMEM and import firms have been checked for double counting.

Additionally, the CRF data was checked by doing spot-checks with activity data and emission factors from EMIS.

4.4.5 Source-Specific Recalculations

Recalculations were made for source category 2C5 Battery Recycling for the years 2000-2005 and 2007-2009 as additional annual activity data was available from industry for the years 2000, 2003, 2004 and 2007-2009.

4.4.6 Source-Specific Planned Improvements

There are no source-specific planned improvements.

4.5 Source Category 2D – Other Production

4.5.1 Source Category Description

Source category 2D Other Production comprises process emissions of indirect greenhouse gases only from the production of pulp and paper including chipboard, fibreboard and cellulose, of food and drink as well as of charcoal.

Table 4-23 Specification of source category 2D “Other Production”.

2D	Source	Specification	Data Source
2D1	Pulp and Paper	Emissions from NMVOC from pulp and paper including chipboard-fibreboard and cellulose production (ceased in 2008)	AD, EF: EMIS 2012/2D1[12]
2D2	Food and Drink	Emissions of CO and NMVOC from production of food and drink	AD, EF: EMIS 2012/2D2
2D3	Wood Processing	Emissions of CO and NMVOC from production of charcoal	AD, EF: EMIS 2012/2D3

4.5.2 Methodological Issues

4.5.2.1 Pulp and paper production (2D1)

a) Methodology

To determine NMVOC emissions from pulp and paper production a country specific approach is used. The emissions are calculated by multiplying the annual amount of processed pulp and paper by the corresponding emission factors. Please note that the cellulose production in Switzerland closed down in 2008.

b) Emission Factors

The emission factors for NMVOC emissions from pulp and paper production in Switzerland are country specific and bases on measurements and data from industry and expert estimates documented in EMIS 2012/2D1.

Table 4-24 Emission factors for CO and NMVOC in pulp and paper production, food and drink production and charcoal production (EMIS 2012/2D1, EMIS 2012/2D2 and EMIS 2012/2D3).

2D Other production	Unit	CO	NMVOC
2D1 Pulp and paper	g/t	NA	640
2D2 Food and drink (exc. beer, wine, spirits)	g/t	250	1'310
2D2 Food and drink (beer, wine, spirits)	g/m3	NA	370
2D3 Charcoal production	kg/t	280	720

c) Activity Data

The annual amount of pulp and paper produced in Switzerland bases on data from industry and expert estimates documented in EMIS 2012/2D1. There has been a change in reporting the activity data for chipboard production. The data is now reported in tonnes instead of m^3. This has led to small rounding changes in activity data for pulp and paper where chipboard production is included.

[12] As far as no further specification is given, all EMIS documents under this source category are ment. If the text refers to a specific EMIS document the whole name is written out e.g. EMIS 2012/2D1 Spanplatten-Produktion.

Table 4-25 Production of pulp and paper, food and drink and charcoal in Switzerland for the period 1990-2010 in Gg (EMIS 2012/2D1, EMIS 2012/2D2 and EMIS 2012/2D3).

2D Other production	Unit	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
2D1 Pulp and paper	Gg	604	589	628	626	578	521	482	494	506	512
2D2 Food and drink (exc. beer, wine, spirits)	Gg	2'253	2'253	2'110	2'187	2'091	2'119	2'240	2'173	2'179	2'065
2D2 Food and drink (beer, wine, spirits)	m3	560'972	581'643	579'714	546'882	531'068	516'519	497'401	505'873	461'979	476'067
2D3 Charcoal production	Gg	0.04	0.05	0.04	0.05	0.05	0.05	0.06	0.08	0.06	0.06

2D Other production	Unit	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
2D1 Pulp and paper	Gg	506	496	473	438	457	447	466	489	469	334
2D2 Food and drink (exc. beer, wine, spirits)	Gg	2'304	2'084	2'279	1'905	1'949	1'992	2'037	2'081	2'105	2'148
2D2 Food and drink (beer, wine, spirits)	m3	492'208	481'114	466'112	461'071	478'687	454'179	456'980	462'185	479'293	465'753
2D3 Charcoal production	Gg	0.07	0.06	0.06	0.07	0.07	0.09	0.10	0.10	0.10	0.10

2D Other production	Unit	2010
2D1 Pulp and paper	Gg	338
2D2 Food and drink (exc. beer, wine, spirits)	Gg	2'162
2D2 Food and drink (beer, wine, spirits)	m3	464'645
2D3 Charcoal production	Gg	0.08

4.5.2.2 Food and drink production (2D2)

a) Methodology

To determine CO and NMVOC emissions from food and drink production a country specific approach is used. The emissions are calculated by multiplying the annual amount of produced food and drink by the corresponding emission factors.

b) Emission Factors

The emission factors for CO and NMVOC emissions from food and drink production in Switzerland are country specific and base on measurements and data from industry and expert estimates documented in EMIS 2012/2D2 (see Table 4-24).

c) Activity Data The annual amount of food and drink produced in Switzerland base on data from industry and expert estimates documented in EMIS 2012/2D2 (see Table 4-25).

4.5.2.3 Charcoal production (2D3)

a) Methodology

To determine CO and NMVOC emissions from charcoal production a country specific approach is used. The emissions are calculated by multiplying the annual amount of produced charcoal by the corresponding emission factors.

b) Emission Factors

The emission factor for CO and NMVOC emissions from charcoal production in Switzerland is country specific and base on measurements and data from industry and expert estimates documented in EMIS 2012/2D3 (see Table 4-24).

c) Activity Data

The annual amount of charcoal produced in Switzerland base on data from the industry association documented in EMIS 2012/2D3 (see Table 4-25).

4.5.3 Uncertainties and Time-Series Consistency

The time series is consistent.

4.5.4 Source-Specific QA/QC and Verification

The time series have been compared between the current and the previous submission. All activity data, implied emission factors and emissions undergo the triple check:

- the results for 2010 are compared with the results 2009 within the current CRF
- the CRF tables for the year 2009 are compared between the current CRF tables and the CRF tables of submission 2011.
- the CRF tables for the base year 1990 are compared between the current CRF tables and the CRF tables of submission 2011

Additionally, the CRF data was checked by doing spot-checks with activity data and emission factors from EMIS.

4.5.5 Source-Specific Recalculations

No recalculations have been made in category 2D in this year's submission.

4.5.6 Source-Specific Planned Improvements

There are no planned improvements.

4.6 Source Category 2E – Production of Halocarbons and SF_6

No emissions occurring in this sector within Switzerland. There is no production of HFC, PFC or SF_6 in Switzerland.

4.7 Source Category 2F – Consumption of Halocarbons and SF_6

4.7.1 Source Category Description

Tier 1 Key Category 2F1
HFC from the consumption of halocarbons and SF_6; Refrigeration and Air Conditioning Equipment (level and trend).

Tier 2 Key Category 2F1
HFC from the consumption of halocarbons and SF_6; Refrigeration and Air Conditioning Equipment (level and trend).

Tier 2 Key Categories 2F9
SF_6 from the consumption of halocarbons and SF_6; Other (trend).

HFC from the consumption of halocarbons and SF_6; Other (trend).

Source category 2F comprises HFC, PFC and SF_6 emissions from consumption of the applications listed below.

Table 4-26 Specification of source category 2F "Consumption of Halocarbons and SF_6". Data source: Carbotech (2012).

2F	Source	Specification	Data Source
2F1	Refrigeration and Air Conditioning Equipment	Emissions from Refrigeration and Air Conditioning Equipment	AD: Various national statistics[13] and industry data EF: Industry data and expert estimates
2F2	Foam Blowing	Emissions from Foam Blowing, incl. Polyurethane Spray	AD: Industry data EF: Expert estimates
2F3	Fire Extinguishers	Not occurring in Switzerland	
2F4	Aerosol / Metered Dose Inhalers	Emissions from use as aerosols, incl. metered dose inhalers	AD: Import statistics EF: IPCC default values
2F5	Solvents	Emissions from use as solvents	AD: Import statistics EF: IPCC default values
2F6	Other applications using ODS substitutes	Not occurring in Switzerland	
2F7	Semiconductor Manufacturing	Emissions from use in semiconductor manufacturing	AD: Import statistics and industry data[14] EF: IPCC default values and industry data
2F8	Electrical Equipment	Emissions from use in electrical equipment	AD: Industry data EF: Industry data
2F9	Other	Emissions of SF_6 which are not yet accounted for under 2F8. Emissions of different halocarbons not accounted in other source categories (i.e. for example research and laboratory use).	AD: Import statistics and Industry data EF: Industry data and estimates

The following graph shows emissions in source category 2F by sub-sector and by different groups of gases. Refrigeration and air conditioning equipment account by far for the highest

[13] e.g. statistics on registration of cars and trucks, import statistics on synthetic gases (Carbotech 2012).

[14] e.g. import amount of some substance for specific company with known application type.

emissions in this source category with a share of 83% of the total emissions in the source category 2F.

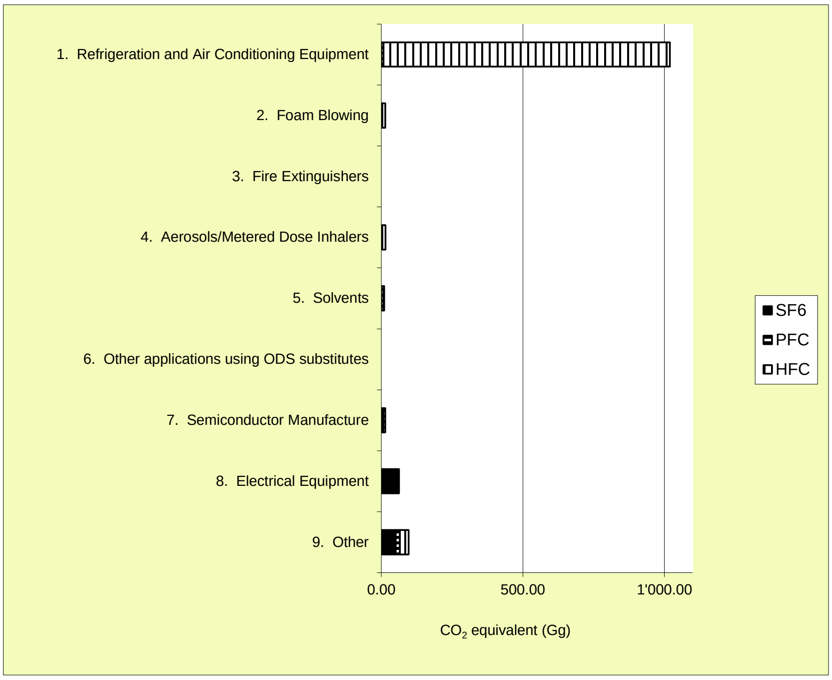

Figure 4-6 Distribution of emissions under source category 2F “Consumption of Halocarbons and SF_6“ (2010 data).

4.7.2 Methodological Issues

The data models used for source category 2F are complex and therefore a comprehensive documentation of all relevant model parameters is not possible within the framework of the NIR. Annex A3.2 shows an illustrative example of the model structure and parameters used for calculating emissions from mobile air-conditioning in cars. Where possible, the most important assumptions for the data model are documented (e.g. Table 4-27). Detailed documentation of the individual data models is available from Carbotech (2012) as well as related background documents. This information is FOEN internal due to confidentiality of data, but is open for consultation by reviewers.

4.7.2.1 2F1 Refrigeration and Air Conditioning Equipment

a) Methodology

The inventory under this sub-source category includes the following types of equipment: domestic refrigeration, commercial and industrial refrigeration, transport refrigeration, stationary air conditioning, mobile air conditioning, and heat pumps. For each of these types of equipment individual emission models are used for calculating actual emissions as per IPCC GPG Tier 2. In order to obtain the most reliable data for the calculations, two different approaches are applied to get the stock data needed for the model calculations: ‘top down’ using available statistics or estimations on the Swiss market from experts and associations and ‘bottom up’ through questionnaires sent to companies active in importation, production and service of appliances.

b) Emission Factors

Emission factors for manufacturing, product life and disposal as well as average product life times are established on the basis of expert judgement and literature. Direct monitoring of the product life emission factors is not done. The product life factors are used to make the allocation of imported F-gases to new products and maintenance activities. In 2008 a project was started to inventorise new equipments which are filled with more than 3kg of F-gases. The project is still under progress and gradual progress has been achieved. The available data is however not yet at a completeness level which would allow to directly draw the stock data or emission factors for the national inventory from this database. The data is therefore only used to check the proportional share of the F-gases for commercial refrigeration. Perhaps it will be possible in future to use the inventory to allocate the imported F-gases to the new installed equipment and so to monitor the product life emission factors. It is however not yet sure if this monitoring will become feasible because not all equipments are listed in the inventory. It is highly unlikely that this will be possible for the next annual inventory submission.

Table 4-27 displays the detailed model parameters used for the present inventory. For product life emission factors of some equipment types a dynamic model is applied which implies that emission losses improve linearly between 1995 and 2010 (respectively 2020 for some equipment types) due to better production technologies and the continuous sensitisation of service technicians. The start/end values are based on expert statements, UBA (2005, 2007) and Schwarz (2001, 2005).

Table 4-27 Typical values on life time, charge and emission factors used in model calculations for Refrigeration and Air Conditioning Equipment. Where values in brackets are provided, the first value shows the assumption for 1995 while the second value (in brackets) shows the assumption for 2010 respectively 2020. Data between 1995 and 2010 respectively 2020 is linearly interpolated.

Equipment type	Product life time [a]	Initial charge of new product [kg]	Manufacturing emission factor [% of initial charge]	Product life emission factor [% per annum]	Charge at end of life [% of initial charge of new product] *)	Disposal loss emission factor [% of remaining charge
Domestic Refrigeration	16	0.1	NO	0.5	92	19 **)
Commercial and Industrial Refrigeration	10	NR	0.5	12 (2020: 5)	100	15
Transport Refrigeration / Trucks	10	1.8 … 7.8	NO	15	100	20
Transport Refrigeration / Railway	12	NR	NO	10	100	10
Stationary Air Conditioning (direct / indirect cooling system)	15	NR	direct: 3 indirect: 1	direct: 10 (2010: 3) indirect: 6 (2010: 4)	100	direct: 28 indirect: 19
Heat Pumps	15	4.7 …7.5 till 1999 Going down to 2.8 …4.5 in 2010	3	2	100	10
Mobile Air Conditioning / Cars	15	0.7 (0.84) ***)	NO	8.5	58	100 until year 2005 50 since 2005****)
Mobile Air Conditioning / Trucks	12	1.1	NO	10 until year 2000 Going down to 8.5 in 2010	35	100 until year 2000 50 since 2001****)

Mobile Air Conditioning / Buses	12	7.5	NO	10 until year 2000 Going down to 8.5 in 2010	35	100 until year 2000 50 since 2001****)
Mobile Air Conditioning / Railway	13	20	NO	4	100	10

*) takes into account refill of losses during product life where applicable.

**) takes into account R134a content in foams, based on information from the national recycling organisation SENS.

***) Assumed constant since 2002. 0.84 kg in 1990. Linear interpolation between 1990 and 2002.

****) the value of 100% is based on expert assumptions. It however is not relevant for HFC emissions due to introduction of HFCs in MAC from 1991 only and 12 resp. 15 years lifetime (HFC disposal losses occur from 2003 onwards for Trucks/Buses resp. from 2006 for Cars). Value of 50% is based on UBA 2005 and expert assumptions on share of total refrigerant loss, e.g. due to road accident.

NA = not available
NR = not relevant as only aggregate data is used
NO = Not occurring (only import of charged units)

c) Activity Data

Activity data is taken from industry information and national statistics such as for admission of new cars and trucks. Stock data is modelled dynamically. Due to the large number of sub-models used for modelling the total emissions for sub-source category 2F1, no table on time series of activity data is provided here, despite 2F1 being a key category. For illustration, the detailed calculation model for car air-conditioning including the time series for the activity data for this particular sub-model can be seen from Annex A3.2. Mobile air-conditioning accounts for approx. 28% of the total emissions (CO_2 eq) of sub-source category 2F1 Refrigeration and Air Conditioning Equipment.

For this year’s inventory report a cross check has been performed for results from model calculation and FOEN statistics on disposal and recycling of HFCs. This has indicated a significant gap. Some of the gap is explained by the onsite reuse and recycling of refrigerants, which is not reflected by the FOEN statistics and with other factors as for example the not accounted export of refrigeration equipment (only export of vehicles with air-conditioning considered). The discrepancy however also led to errors in sub-model programming which were corrected.

4.7.2.2 2F2 Foam Blowing

a) Methodology

In Switzerland no production of open cell foam based on HFCs is reported by the industry. Therefore only closed cell PU and XPS foams, PU spray applications and sandwich elements are relevant under this source category.

The emission model (Tier 2) for foam blowing has been developed ‘top down’ based on import statistics for products, industry information and expert assumptions for market volumes and emission factors. Emissions for sandwich elements have been calculated as residual balance between SAEFL import statistics and consumption in PU spray, PU and XPS foams.

b) Emission Factors

For emission factors and lifetime of XPS and PU foam, expert estimates and general default values according to IPCC are being used (IPCC 2000: p. 3.95). For PU spray, expert estimates and specific default values according to IPCC are being used (IPCC 2000: p. 3.96).

Table 4-28 Typical values on life time, charge and emission factors used in model calculations for foam blowing.

		Product life time years	Charge of new product % of product weight	Manufacturing emission factor % of initial charge	Product life emission factor % per annum	Charge at end of life % charge of new product
PU foam		50	4.5	NR	NR	NR
XPS foam	HFC 134a HFC 152a	50	6.5	NO	10 / 0.7** 100 / 0**	64 0
PU spray		50	13.6 / 0 *	0.8	95 / 2.5 **	0
Sandwich Elements HFC 134a, HFC 227ea, HFC 365 mfc		50	3	10	0.7	64
HFC 152a				100	0	0

* Data for 1990 / since 2009
** Data for 1st year / following years
NA Not available from the model used
NR Not relevant, because no substances according to this protocol has been used, all emissions occur outside Switzerland during production
NO Not occurring, because XPS not produced in Switzerland

c) Activity Data

The export rate of PU spray from Swiss production is about 96.5% of total production volume. About one third of PU spray sold in Switzerland originates from local production, the rest is import. For PU rigid foams no HFCs are used as foam blowing agent (only Pentane and CO_2). From 2000 onwards there is no production of XPS in Switzerland with HFC. XPS foams are 100% imported.

Detailed activity data for this sub-source category is available at FOEN but not reported due to confidentiality.

4.7.2.3 2F3 Fire Extinguishers

No emissions occurring in this sector within Switzerland. The application of HFC, PFC and SF_6 in fire extinguishers is prohibited by law.

4.7.2.4 2F4 Aerosol / Metered Dose Inhalers

a) Methodology

The Tier 2 emission model for Aerosol / MDI is based on a 'top down' approach using import statistics for HFCs.

b) Emission Factors

A manufacturing emission factor of 1% is applied. For product life emission factor the model assumes that 50% of the remaining substance is emitted in the first year and 50% in the second year respectively, which is in line with IPCC GPG. To account for variations in imports and stocks, the average figure from imports for the actual year (t) and for the past year (t-1) is reported. This emission model can lead to implied product life emission factors of > 100% in case of decreasing imports.

c) Activity Data

In most aerosol applications, HFC has been replaced already in the past years. According to the information of companies filling aerosol bottles for use in households, e.g. cosmetics, cloth care and paint, no HFC is being used. For special technical applications - especially metered dose inhalers (MDI) - HFC is still in use. Compared to the total amount of aerosol applied, the HFC use for MDI is considered to be irrelevant.

Activity data is based on import statistics. The export and import of filled products is unknown and assumed to be in a similar range. Detailed activity data for this sub-source category is available at FOEN but not reported due to confidentiality.

4.7.2.5 2F5 Solvents

a) Methodology

HFC and PFC are used as solvents. Emissions are calculated according to Tier 1 method according to IPCC GPG on basis of a 'top down' approach using import statistics and industry information on allocation of the imported HFC and PFC amounts to different applications.

b) Emission Factors

An emission factor of 50% in the first and in the second year, respectively, is applied in line with IPCC GPG.

c) Activity Data

Activity data is based on import statistics. Detailed activity data for this sub-source category is available at FOEN but not reported due to confidentiality. For the present inventory report interviews have been made with industry to get in-depth information on allocation of imported HFC and PFC volumes to different applications. This resulted that most PFC import declared as "Solvents (2F7)" or "Other (2F9)" are related to the semiconductor manufacturing and thus the model for allocation of imported PFC volumes was adjusted accordingly.

4.7.2.6 2F6 Other applications using ODS substitutes

No emissions occurring in this sector within Switzerland.

4.7.2.7 2F7 Semiconductor Manufacturing

a) Methodology

A Tier 2 approach with process gas-specific parameters was used for emission calculations. General default values for gas-specific transformation rate and general values for exhaust treatment were applied.

Up to the inventory report 2010 (FOEN 2010), HFC, PFC and SF_6 emissions under 2F7 Semiconductor Manufacturing were calculated according to Tier 1 method according to IPCC GPG on basis of a 'top down' approach using import statistics. For the inventory report 2011 (FOEN 2011) interviews had been made with industry to get in-depth information on allocation of imported PFC volumes to different applications and to obtain process specific information from consumers. This resulted that most PFC import declared as "Solvents (2F7)" or "Other (2F9)" are related to the semiconductor manufacturing and thus the model for allocation of imported PFC volumes was adjusted accordingly which leads to increased emissions under source category 2F7 Semiconductor Manufacturing.

b) Emission Factors

Default emission factors as per IPCC GPG are used. For the present inventory the rate of exhaust treatment was assumed to be higher due to legislation under the “Act on risk-reduction concerning the use of chemicals” (ChemRRV) which limits emissions for industrial applications such as semiconductor manufacturing to 5%. For some large users the presence of exhaust treatment was confirmed in a survey. For the further industries it is assumed that 66% of applications do have emission control technologies.

c) Activity Data

Activity data is based on import statistics and industry information.

4.7.2.8 2F8 Electrical Equipment

a) Methodology

Under an agreement with FOEN, the industry association SWISSMEM is reporting actual emissions of SF_6 on basis of a mass balance approach (Tier 3a). The balance includes mainly data for the production, installation, operation and disposal of electrical equipment, but included in past years also small amounts of SF_6 for other applications (i. e. research, magnesium foundry). SWISSMEM is collecting data from its members and is cross-checking the reported SF_6 consumption data with data from importers of the SF_6. Installations in operation with electrical equipment containing SF_6 are periodically inspected for leakage and losses are refilled (topping up). The refilled quantities and any SF_6 charge required for during repair are reported as emissions at the time of filling. A product lifetime of 35 years is applied.

b) Emission Factors

Emission factors for this sub-source category are based on industry information and are calculated values based on the mass balance data. For 2010 the calculated product life emission factor is 0.20%. The calculated product life emission factor is varying between 0.77%/a (2005) and 0.20%/a (2010). The discontinuity in emission factor from 2005 to 2006 data is partly due to the inspection intervals.

c) Activity Data

Activity data is based on industry information. The wide annual fluctuation of SF_6 emissions from electrical equipment is related to the annual fluctuation of market volumes for such equipment as well as variations in inspection intervals and equipment break-down requiring topping up of SF_6 charge in the equipment. Also for the present inventory report the split factors for allocation of imported amounts to different applications were checked through industry interviews and in-depth analysis in order to eliminate double counting between SWISSMEM data and other import declarations.

4.7.2.9 2F9 Other

a) Methodology

The emissions reported under 2F9 relate to a small amount of unallocated SF_6 from the FOEN import statistics and since 2003 to further applications of halocarbons such as laboratory and research use. In the past years an increasing amount of CF_4 was registered to be used as trace gas. The unallocated difference for SF_6 between the FOEN import statistics and the SWISSMEM mass balance (see 2F8) have been assigned to cables and electrical control systems using a Tier 2 approach. Some imports of R134a were declared for medical use, and small import amount of HFC 23 was declared for electronics and refrigeration technology.

b) Emission Factors

For cables and electrical control systems the manufacturing emission factor is assumed at 4% and the product life emission factor at 1%. 1% of the remaining charge is emitted at time of disposal after 40 years lifetime. Because of the long life time the disposal emissions are not relevant for the given results.

According to the IPCC guidelines (IPCC 2000) the emission factors for HFC 134a (medical use) and for HFC 23 (electronics and refrigeration technology) were chosen as 50% in the first year and 50% in the second year.

For CF_4 a 50% lower emission factor was assumed considering a transformation and an exhaust treatment in some of the applications.

c) Activity Data

Activity data is based on import statistics and industry information. 80% of the production of cables and electrical control systems is exported. Also for the present inventory report the split factors for allocation of imported amounts to different applications was checked through industry interviews and in-depth analysis in order to eliminate double counting between SWISSMEM data and other import declarations. The quality check of import declarations and information obtained from import companies lead to a shift of SF_6 within different applications. Contrary to former obtained information no SF_6 was used for windows in 2009 and 2010. The split of SF_6 in different applications was adapted with new information obtained from import companies.

4.7.3 Uncertainties and Time-Series Consistency

For refrigeration equipment, air-conditioning equipment as well as for the foam blowing source category, a Monte Carlo analysis according to IPCC Good Practice Guidance for the evaluation of uncertainties of model calculations according to Tier 2 has been carried out. The Monte Carlo Analysis was performed on the inventory data of the current GHG inventory (submission April 2012). For the purpose of the Monte Carlo Analysis, uncertainty of all relevant parameters (e.g. initial appliance charge, product life emission factor, import and export volumes, etc.) used in the emission models for the applications as per

Table 4-30 below has been characterised by a statistical distribution. Frequently a triangular distribution was chosen, defined by the three parameters: minimum, maximum and most likely value. Some uniform distributions were chosen where the spectrum was assumed to have the same probability. In the other cases normal or Log normal distribution has been chosen. The analysis was carried out with 10'000 cycles. Some details on the distributions of parameters used (i.e. type of distribution, minimum, maximum, likeliest value) are documented in the report Carbotech (2012).

For the submission of 12 April 2006 the uncertainty for the import statistic data had been estimated for the first time. Discussions with the persons responsible for data collection in the years 1997–2010 led to the estimations given in Table 4-29.

Table 4-29 Estimated uncertainty for the data of the imported substances

Year	Minimal	Maximal	remarks
Up to 1999	- 10%	+30%	assumed that the data are not complete
2000 – 2003	-10%	+15%	data can be incomplete or possible double declaration
2004 – 2010	-10%	+10%	data can be incomplete or possible double declaration

The following table summarises the results for the application-specific emission models. The "value 2010" represents the actual emissions in Gg CO_2 equivalent for the specific application as used for calculating the 2010 CRF tables. The average, median, uncertainty, minimum and maximum values are output values of the Monte Carlo Analysis. The uncertainty of the resulting total emissions from the consumption of halocarbons and SF_6 is about 12%. Higher values result for the contributions of single applications.

Uncertainties of more than 20% have been calculated for the following applications:

- Stationary Air Conditioning
- Transport refrigeration
- Domestic Refrigeration
- Foam blowing
- Aerosols
- Semiconductors
- Others

Uncertainties of more 15% to 20% have been calculated for the following applications:

- Commercial/ Industrial Refrigeration
- Mobile Air-Conditioning

Low uncertainties of less than 15% have been calculated for the following applications:.

- Solvents.
- Electrical Equipment

For the model calculations of stocks, uncertainties result with a maximum of 36% for R134a in Commercial/ Industrial Refrigeration. For the model calculations of stocks in domestic refrigeration no uncertainties value is given due to very asymmetric distribution. Calculation of stocks is not reported in detail here because the uncertainties for stock and new filled refrigerant related to the split of refrigerant on different applications is of less relevance for the overall emissions. This is because different applications show similar characteristics for the building of stocks and related emissions. Detailed data is available with FOEN.

Relevant parameters for the building of stock in PU-foam are the PU-foam import and export rate and the PU-Spray first year emission factor. The data base for PU-Sprays has been significantly improved with effect from the 2007 submission (FOEN 2007). This is attributed to improved models which are elaborated by the main producer and its blowing agent import firm. However, the following three factors lead to a small amount remaining in the stock with a relative high uncertainty: high import and export rate of PU-Spray, incompleteness of information on import volumes of PU-Spray and about propellant used in import products and finally high emission factor of the first year.

Table 4-30 Summary of results for model parameter "emissions" from Monte Carlo Analysis for 2010 data on selected emission sources.

Application	Model para-meter	value 2010 Gg CO_2 eq.	Average Gg CO_2 eq.	Median Gg CO_2 eq.	min. Gg CO_2 eq.	max. Gg CO_2 eq.	Uncer-tainty %
Commercial / Industrial Refrigeration	Emissions in Gg CO_2 eq.	586	602	602	361	818	19.4
Mobile Air-Conditioning		286	289	289	205	392	19.8
Stationary Air-Conditioning		116	124	124	73	188	22.4
Transport Refrigeration		26.7	29	28.9	19.5	46.7	22
Domestic Refrigeration		4.56	7.7	4.83	0.24	40.5	*)
Total HFC from 2F1		1011.6	1051	1052	800	1310	11.8
2F2 Foam Blowing		14.1	17.3	16.8	6.5	44.3	48.6
2F4 Aerosol		14.7	14.7	14.7	5.3	26.5	40.8
2F5 Solvents		7.88	8.76	8.76	8.6	9	1.8
2F7 Semiconductors		12.6	13.8	13.7	4.36	26.8	40.2
2F8 Electrical equipment		62.5	62.5	62.5	48.8	75.3	10.2
2F9 Other		81.7	98.4	81.9	50.8	236	80.6
Total HFC from 2F without 2F1		52.4	55.5	55.2	39.7	83.3	18.8
Total HFC, PFC and SF_6 from 2F		1229	1281	1279	1005	1584	11.6

*) very asymmetric distribution, therefore no indication of a standard deviation.

The time series is consistent for all source categories, with exception of the sub-source category "Electrical Equipment" (2F8) where from 2000 onwards the data is based on a Tier 3a approach instead of model calculations according to Tier 2 as applied for data before 2000. Due to lack of basic information it is not possible to provide a consistent time series for category Electrical Equipment (2F8) retroactively.

4.7.4 Source-Specific QA/QC and Verification

The time series have been compared between the current and the previous submission. All activity data, implied emission factors and emissions undergo the triple check:

- the results for 2010 are compared with the results 2009 within the current CRF
- the CRF tables for the year 2009 are compared between the current CRF tables and the CRF tables of submission 2011.
- the CRF tables for the base year 1990 are compared between the current CRF tables and the CRF tables of submission 2011

Recalculations were identified and explained. Detailed controls of all modelling results produced by Carbotech (2012) have been carried out firstly by FOEN specialists and secondly by the author for the NIR chapters containing F-gases.

Efforts were undertaken for this inventory to better identify the reason for the discontinuity in emission factor of SF_6 in source category 2F8 Electrical equipment from 2005 to 2006 data. Due to change of personnel at the data supplier it was not possible to receive additional information.

The assumption of decreasing emissions factors for the different equipment types under sub-source category 2F1 Refrigeration and Air Conditioning Equipment have been cross-checked with the inventories of Austria and Germany and have found to be in line with the assumptions made for these inventories.

The emission factor of category 2F used in the Swiss Inventory has been compared to the corresponding emission factors of other countries (UNFCCC http://unfccc.int/di/FlexibleQueries.do) and to the IPCC default value if available (INFRAS 2012). Concerning the consumption of halocarbons and SF_6 the following sources of emissions are deemed relevant: HFC-125, HFC-134a and HFC-143a from stationary and commercial refrigeration as well as mobile air-conditioning. The product life factor is relevant, since there is no production of neither halocarbons or SF_6 in Switzerland. For all these sources Switzerland's emission factors lie in the midfield of the other countries except for the life factor in mobile air-conditioning. However when compared to neighbouring countries such as Germany, very similar values are used. The Swiss product life factors are often lower than the average for the following reasons. Since 2005 the ordinance on Chemical Risk Reduction (Swiss Confederation 2005) is in place that ensures the proper handling and disposal of halocarbons and SF_6. Furthermore the decommissioning sector is well organized by the SENS foundation and recycling is taxed in advance. Finally servicing staff is well trained to proper handling and disposal of respective appliances.

The FOEN supports a monitoring campaign at the high altitude research station Jungfraujoch, where various greenhouse gases are measured continuously. The location of the research station normally provides for analysis of tropospheric background concentrations. However, under special meteorological conditions, an estimate of Swiss emissions can be derived from the measurements. For HFC-134a, HFC-125 and HFC-152a, a comparison of the inventory data with the inferred emissions is presented in Annex A6.1. Further research is needed to refine the approach and apply it to other greenhouse gases.

4.7.5 Source-Specific Recalculations

Source-specific recalculations for the time series 1990 to 2010 are summarized in Table 4-31. The different improvements carried out in the present inventory are related to the sub-source categories with the highest emissions.

The recalculation of the emissions 2009 delivers about 15% higher total emissions under source category 2F than reported in the past submission.

Table 4-31 Summary of recalculations in source category 2F.

Source Category	Specification	AD/ EF	Years	Gas	Explication
2F1	Mobile Air Conditioning	AD/ EF	1991-2010	HFC 134a	General correction in the calculation of stocks of all vehicles (refilled amount added to stock). Specific correction in the calculation of vans (error in formula for calculation of stock). Elevation of the vehicle lifetime from 12 to 15 years for cars and from 10 to 12 years for vans and trucks. Due to statistics on vehicles delivered to the disposal. Adaptation of the emission factor for the disposal from 30% to 50%, due to the reported average amount recovered from equipment in cars (300-400 g if equipment not broken, about 30-40% of vehicles empty). New assumption for the recycling of R134. Recovered refrigerant has been reported to be reused after filtration (no information about quote available). 80% were assumed to be reused after filtration.
2F1	Stationary Air Conditioning	AD/ EF	1991-2010	HFC 32 HFC 125 HFC 134a HFC 143a	The quote of prefilled equipment is higher than assumed in former calculations. The factor for prefilled import was elevated: 95% instead of 55% for direct cooling equipment, 77% instead of 35% for indirect cooling equipment. Import companies report only about 10% of central equipment to be filled in Switzerland due to special dimensions (refrigerant content higher than average). Room air-conditioning equipment is generally prefilled abroad, some models need additional refrigerant depending from site specific conditions. Shift in distribution of R407C, use of R407C for the replacement of R22 and for other applications (commercial/industrial) Emission factor for operation of direct cooling equipment sinking 1995 to 2010 from 10% to 4% instead of 3%.
2F1	Commercial/Industrial refrigeration	AD/ EF	1991-2010	HFC 23 HFC 32 HFC 125 HFC 134a HFC 143a HFC 152a PFC 218	The import amount for commercial and industrial refrigeration is calculated from the total import amount minus the demand for other applications. The corrections in the stationary air-conditioning lead to a significant higher left amount for commercial and industrial applications. A recycling of R134a and the blend 404a has been reported during the present inventory and was included additionally in the calculations. Recycling leads to more refrigerant available for industrial/commercial applications (assumption about 15% recovered in the disposal of equipment). Higher emission factor for disposal 15% instead of 10% (Assumption 90% professional disposal with 0.5% emissions for recovery at site and 10% emissions for delivery of standalone equipment to treatment comparable to domestic refrigeration)
2F2	Foam blowing	AD	2002-2003	HFC 134a	Adaptation of HFC content in import products of PU-foam (literature values)
2F4 / 2F5	Aerosols / Solvents	AD	2009-2010	HFC 134a	Shift of R134a from aerosols to solvents (new calculation as solvent)
2F7 / 2F9	Semiconductors/ Other	AD	2009-2010	SF6	Shift in SF_6 distribution. Correction regarding the use of import amount by import company (no SF_6 for windows since 2009, import amount related to other applications as semiconductor industry)

4.7.6 Source-Specific Planned Improvements

Gradual improvement of the data quality in co-operation with industry is on-going. As in the past years, methodologies and emission models will be updated during the yearly process of F-gas inquiry. The focus will be on improvements of HFC-emission calculations from refrigeration and air-conditioning equipment.

It was intended for this submission to eliminate the existing double counting between the inventory reports of Switzerland and Liechtenstein. The double counting is on account of estimating emissions of F-gases in the GHG inventory of Liechtenstein on basis of a model which applies the rule of proportion on the Swiss emissions due to absence of separate import statistics for Liechtenstein. Due to delay in developing the methodological approach this will only be effected for the next submission.

4.8 Source Category 2G – Other

4.8.1 Source Category Description

Source category 2G Other comprises process emissions from blasting and shooting and Claus units in refineries.

Table 4-32 Specification of source category 2G "Other".

2G	Source	Specification	Data Source
2G	Other	Emissions of CO_2, NO_x, CO, NMVOC and SO_2 from blasting and shooting Emissions of SO_2 from Claus units in refineries	AD, EF: EMIS 2012/2G Sprengen und Schiessen AD, EF: SFOE 2011, expert estimates

4.8.2 Methodological Issues

4.8.2.1 Blasting and shooting and Claus units in refineries (2G)

a) Methodology

For determination of emissions of CO_2, NO_x, CO, NMVOC and SO_2 from blasting and shooting a country specific method is used as documented in EMIS 2012/2G Sprengen und Schiessen. The emissions are calculated by multiplying the annual amount of used explosive by the corresponding emission factors. The SO_2 emissions from Claus units are calculated by multiplying the annual amount of processed crude oil by the emission factor.

b) Emission Factors

The emission factors for CO_2, NO_x, CO, NMVOC and SO_2 from blasting and shooting activities in Switzerland and for SO_2 emissions from Claus units in refineries are country specific and base on measurements and data from industry and expert estimates documented in EMIS 2012/2G Sprengen und Schiessen.

Table 4-33 Emission factors for CO_2, NO_x, CO, NMVOC and SO_2 from blasting and shooting and SO_2 from Claus units in refineries (EMIS 2012/2G Sprengen und Schiessen).

2G Other	Unit	CO_2	NO_x	CO	NMVOC	SO_2
Blasting and shooting	kg/t	400	35	310	60	0.5
Claus units in refineries	g/t	NA	NA	NA	NA	38

c) Activity Data

The annual amount of used explosives and of processed crude oil in Clause units base on the Federal statistics on explosives as documented in EMIS 2012/2G Sprengen und Schiessen and the Swiss overall energy statistics (SFOE 2011), respectively.

Table 4-34 Amount of used explosives and processed crude oil in Switzerland for the period 1990-2010 in Gg (EMIS 2012/2G Sprengen und Schiessen and SFOE 2012).

2G Other	Unit	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
2G Blasting and shooting											
blasting agent and powder	Gg	2.6	2.3	2.1	1.8	1.6	1.3	0.5	0.8	1.1	1.6
2G Claus units in refineries											
crude oil	Gg	3'127	4'671	4'317	4'764	4'880	4'657	5'323	4'984	5'070	5'093

2G Other	Unit	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
2G Blasting and shooting											
blasting agent and powder	Gg	1.9	2.0	3.3	4.1	3.6	0.8	1.5	1.1	1.4	2.1
2G Claus units in refineries											
crude oil	Gg	4'649	4'846	4'848	4'567	5'146	4'810	5'497	4'662	5'067	4'778

2G Other	Unit	2010
2G Blasting and shooting		
blasting agent and powder	Gg	2.4
2G Claus units in refineries		
crude oil	Gg	4'491

4.8.3 Uncertainties and Time-Series Consistency

For non-key categories, the NIR provides qualitative estimates of uncertainties. The terms high, medium and low data quality are used and a quantitative relative uncertainty is assigned to every uncertainty category (see Table 1-13, semi-quantitative uncertainties for non-key categories). The uncertainty for CO_2 emissions from 2G Blasting and Shooting is rated medium and thus amounts to 10%.

The time series is consistent.

4.8.4 Source-Specific QA/QC and Verification

The time series have been compared between the current and the previous submission. All activity data, implied emission factors and emissions undergo the triple check:

- the results for 2010 are compared with the results 2009 within the current CRF
- the CRF tables for the year 2009 are compared between the current CRF tables and the CRF tables of submission 2011.
- the CRF tables for the base year 1990 are compared between the current CRF tables and the CRF tables of submission 2011

Additionally, the CRF data was checked by doing spot-checks with activity data and emission factors from EMIS.

4.8.5 Source-Specific Recalculations

2G Claus units in refineries: Due to changes in data for crude oil handling in Switzerland activity data for Claus units has been adapted for the years 1990-2009.

4.8.6 Source-Specific Planned Improvements

There are no planned improvements.

5 Solvent and Other Product Use

5.1 Overview

This chapter provides information on the calculation of the greenhouse gas emissions from solvent and other product use. The emissions contain NMVOC emissions from the use of solvents in different applications. Also, it includes direct CO_2 emissions resulting from post-combustion of NMVOC to reduce NMVOC in exhaust gases and indirect CO_2 emissions due to decomposition of NMVOC in the atmosphere. Further included are emissions of CO_2, NO_x, CO and SO_2 arising from the use of firework and N_2O emissions from medical and private use.

Emissions of biogenic CO_2 from the use of tobacco products are not reported. The disposal of solvents is reported in the waste sector (Chapter 8). Emissions from the use of halocarbons and sulphur hexafluoride are reported in the Industrial Processes Chapter under 2F.

Tier 1 Key category 3
CO_2 emissions from Solvent and Other Product Use (trend).

Tier 2 Key category 3
CO_2 emissions from Solvent and Other Product Use (level and trend).

N_2O emissions from Solvent and Other Product Use (trend).

5.1.1 Emissions of CO_2 and N_2O

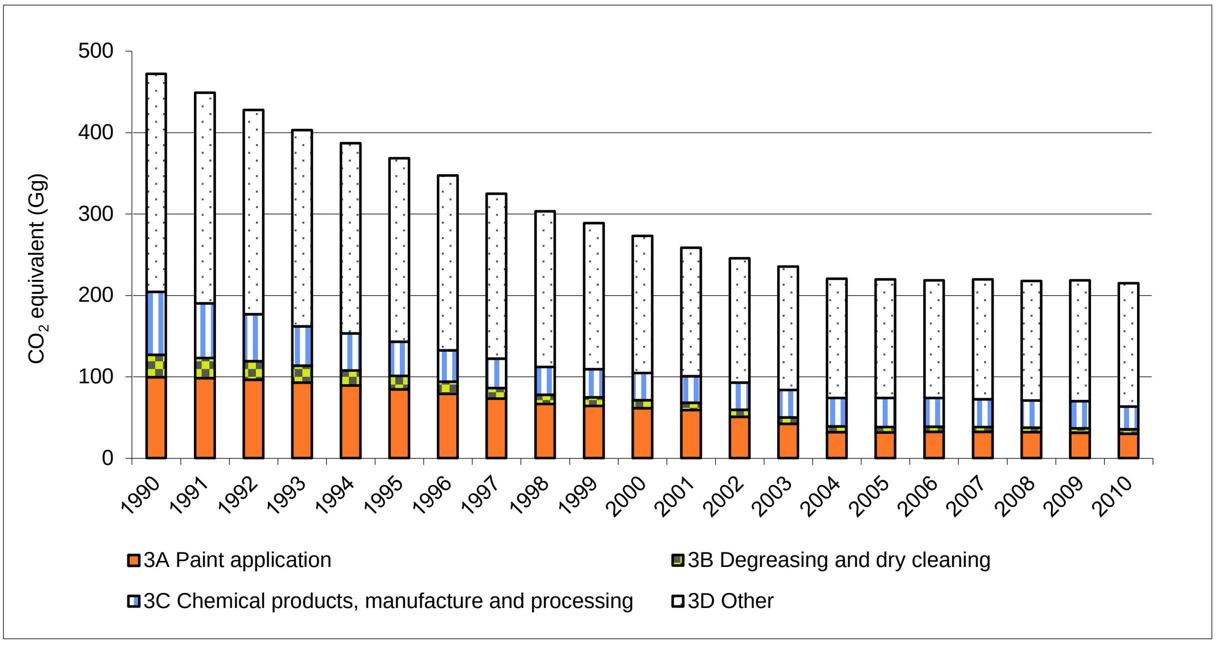

Figure 5-1 Switzerland's GHG emissions of source category "Solvent and Other Product Use" (3) 1990-2010 in Gg CO_2 eq.

In 2010 215 Gg of CO_2 eq emissions were released from source category "Solvent and Other Product Use" (3) as shown in Figure 5-1 and Table 5-1. This is a decline of 54% between 1990 and 2010. Source category "Other" (3D) remains the dominant source within the source category "Solvent and Other Product Use" (3) although its emissions have decreased by 43% since 1990. Source category "Paint Application" (3A) has decreased by

70% since 1990 and has now about the same importance as source category “Chemical Products” (3C) which has decreased by 64% in the same time-span. Source category “Degreasing and Dry Cleaning” (3B) has decreased by 77%.

Table 5-1 Emissions of source category “Solvent and Other Product Use” (3) 1990-2010 in Gg CO_2 eq.

Gas	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
	CO_2 equivalent (Gg)									
CO_2	362	343	326	306	295	282	266	249	233	224
N_2O	110	106	101	96	92	86	81	75	70	65
Sum	472	449	428	403	387	368	347	325	303	288

Gas	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
	CO_2 equivalent (Gg)									
CO_2	214	204	193	182	169	168	165	165	163	162
N_2O	59	54	52	53	51	52	53	54	55	56
Sum	273	258	245	235	220	219	218	219	218	218

Gas	2010
CO_2	157
N_2O	57
Sum	215

The relative trends of the emissions of CO_2 and N_2O are shown in Figure 5-2. The base year 1990 represents 100%.

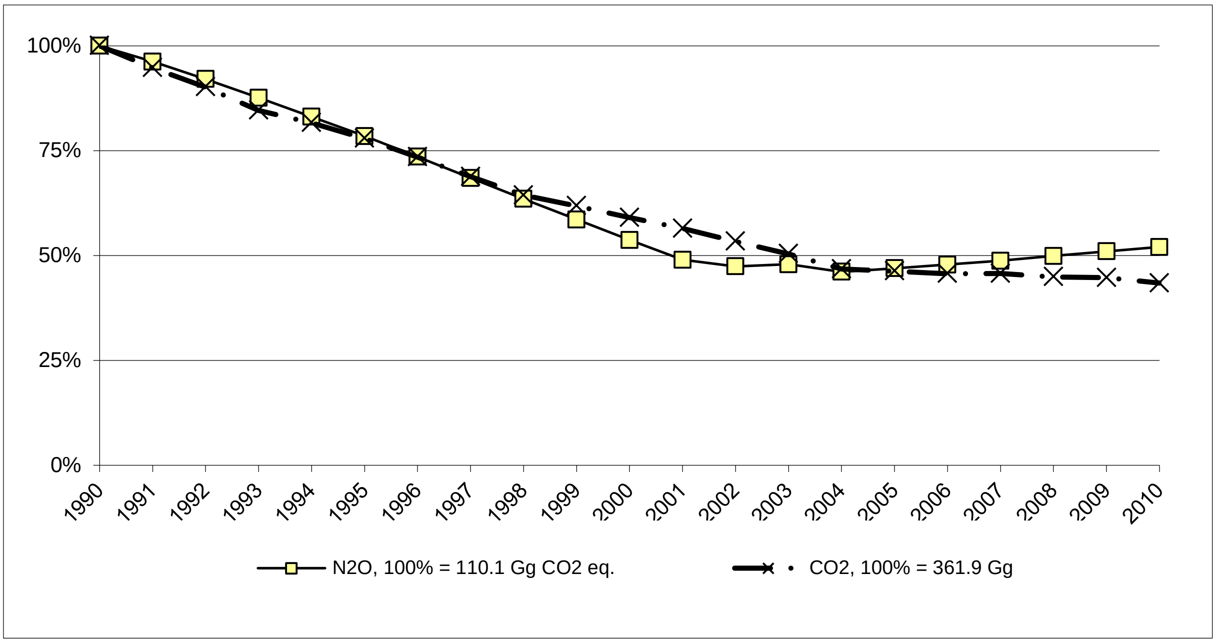

Figure 5-2 Relative trends of the greenhouse gases of source category “Solvent and Other Product Use” (3) in the period 1990-2010.

5.1.2 Emissions of NMVOC

Due to the importance of NMVOC emissions in source category “Solvent and Other Product Use” (3) they are shown separately in Table 5-2.

Table 5-2 Emissions of NMVOC in source category "Solvent and Other Product Use" (3) 1990-2010 in Gg.

NMVOC	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
	Gg									
3A Paint application	42	41	40	38	36	35	32	30	27	26
3B Degreasing and dry cleaning	12	11	10	9	8	7	7	6	5	5
3C Chemical products, manufacture and processing	28	23	18	14	12	10	9	8	7	6
3D Other	60	57	54	51	48	46	43	40	37	35
Sum	142	132	122	112	105	98	91	83	76	71

NMVOC	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
	Gg									
3A Paint application	25	23	20	16	12	12	12	12	11	11
3B Degreasing and dry cleaning	4	4	4	4	3	3	3	3	3	2
3C Chemical products, manufacture and processing	6	5	5	5	4	4	4	4	4	4
3D Other	32	29	28	26	25	24	24	24	24	24
Sum	66	62	56	51	45	43	42	42	42	41

NMVOC	2010
	Gg
3A Paint application	11
3B Degreasing and dry cleaning	2
3C Chemical products, manufacture and processing	4
3D Other	24
Sum	41

NMVOC emissions have diminished by 71 % between 1990 and 2010. This is mainly due to two reduction efforts: The introduction of NMVOC emission limit values by the ordinance on Air Pollution Control (Swiss Confederation 1985) and the introduction of the VOC-tax in 2000 (Swiss Confederation 1997).

5.2 Source Category 3A – Paint Application

5.2.1 Source Category Description

Source category "Paint Application" (3A) comprises NMVOC emissions from paints, lacquers, thinners and related materials used in coatings in industrial, commercial and household applications. Also, it includes direct CO_2 emissions resulting from post-combustion of NMVOC to reduce NMVOC in exhaust gases and indirect CO_2 emissions due to decomposition of NMVOC in the atmosphere.

Table 5-3 Specification of source category "Paint Application" (3A).

	Source	Specification	Data Source
3A	Paint Application	Paint application in households, industry and construction	AD, EF: EMIS 2012/3A1, 3A2 and 3A3[15]

5.2.2 Methodological Issues

5.2.2.1 Methodology

For determination of NMVOC emissions from paint application a country specific method based on the consumption of paint and its solvent content is used.

The indirect CO_2 emissions due to decomposition of NMVOC in the atmosphere are calculated from the average carbon contents of NMVOC emissions for source category "Paint Application" (3A) based on methodology and data from the Netherlands (RIVM 2005:

[15] As far as no further specification is given, all EMIS documents which are published under this source category are ment. If the text refers to a specific EMIS document the whole name is written out e.g. EMIS 2012/3A1 Farben-Anwendung Bau.

p. 5-2ff.), assuming that the type and characteristics of solvents used in Switzerland are roughly similar.

Also, several industrial plants use facilities and equipment to reduce NMVOC in exhaust gases and room ventilation output. Often, this implies the feeding of air with high NMVOC content into the burning chamber of boilers or other facilities to incinerate NMVOC. This leads to additional direct CO_2 emissions resulting from post-combustion of NMVOC. They are estimated based on industry data and expert estimates.

5.2.2.2 Emission Factors

Emission factors for NMVOC emissions base on data from Swiss industry and expert estimates, documented in the EMIS database (EMIS 2012/3A).

For paint application in construction, which is the most important NMVOC source in source category “Paint Application” (3A), the emission factor amounts to 58 kg NMVOC per ton of paint in 2010 (EMIS 2012/3A1 Farben-Anwendung Bau).

The emission factor for indirect CO_2 emissions from decomposition of NMVOC in the atmosphere is 2.35 Gg CO_2/Gg NMVOC for source category “Paint Application” (3A) (RIVM 2005: p. 5-2ff.).

5.2.2.3 Activity Data

Activity data correspond to the annual consumption of paints. Data on paint consumption is taken from Swiss industry and expert estimates, documented in the EMIS database (EMIS 2012/3A).

For paint application in construction, which is the most important NMVOC source in source category “Paint Application” (3A), the activity data equals the consumption of 43'846 t paint in 2010 (EMIS 2012/3A1 Farben-Anwendung Bau).

5.2.3 Uncertainties and Time-Series Consistency

The uncertainty assessment results in medium confidence in emissions estimates (EMIS 2012/3A).

The uncertainty of total CO_2 emissions from the entire source category “Solvent and Other Product Use” (3) is estimated to be 50% (expert estimate).

Time series is consistent.

5.2.4 Source-Specific QA/QC and Verification

The time series have been compared between the current and the previous submission. All activity data, implied emission factors and emissions undergo the triple check:

- the results for 2010 are compared with the results 2009 within the current CRF
- the CRF tables for the year 2009 are compared between the current CRF tables and the CRF tables of submission 2011.
- the CRF tables for the base year 1990 are compared between the current CRF tables and the CRF tables of submission 2011

Additionally, the CRF data was checked by doing spot-checks with activity data and emission factors from EMIS.

5.2.5 Source-Specific Recalculations

The reallocation of indirect CO_2 emissions from decomposition of NMVOC in the atmosphere that was reported in Submission 2011 (from NFR Sector 3 to 7 “Other”) has been undone in the review process. The recalculation took place in the Saturday Paper (see Chapter 16) and is therefore not a recalculation of Submission 2012.

No other recalculations beyond the mentioned shifting of the indirect CO_2 emissions from NMVOC decomposition have been made.

5.2.6 Source-Specific Planned Improvements

Gradual improvement of the data quality in co-operation with industry is on-going.

5.3 Source Category 3B – Degreasing and Dry Cleaning

5.3.1 Source Category Description

Source category “Degreasing and Dry Cleaning” (3B) comprises NMVOC emissions from degreasing, dry cleaning and cleaning in electronic industry. Also, it includes direct CO_2 emissions resulting from post-combustion of NMVOC to reduce NMVOC in exhaust gases and indirect CO_2 emissions due to decomposition of NMVOC in the atmosphere.

Table 5-4 Specification of source category “Degreasing and Dry Cleaning” (3B).

	Source	**Specification**	**Data Source**
3B	Degreasing and Dry Cleaning	Degreasing; dry cleaning; cleaning of electronic components; cleaning of parts in metal processing; other industrial cleaning	AD, EF: EMIS 2012/3B1 and 3B2

5.3.2 Methodological Issues

5.3.2.1 Methodology

For determination of NMVOC emissions from degreasing and dry cleaning a country specific method based on the consumption of solvents is used.

The indirect CO_2 emissions due to decomposition of NMVOC in the atmosphere are calculated from the average carbon contents of NMVOC emissions for source category “Degreasing and Dry Cleaning” (3B) based on methodology and data from the Netherlands (RIVM 2005: p. 5-2ff.), assuming that the type and characteristics of solvents used in Switzerland are roughly similar.

The direct CO_2 emissions resulting from post-combustion of NMVOC in exhaust gases is estimated based on industry data and expert estimates.

5.3.2.2 Emission Factors

Emission factors for NMVOC emissions are based on data from Swiss industry and expert estimates, documented in the EMIS database (EMIS 2012/3B).

For degreasing of metal, which is the most important NMVOC source in source category “Degreasing and Dry Cleaning” (3B), the emission factor amounts to 550 kg NMVOC per ton of solvent in 2010 (EMIS 2012/3B1 Metallreinigung).

The emission factor for the indirect CO_2 emissions from decomposition of NMVOC the atmosphere is 2.24 Gg CO_2/Gg NMVOC for source category “Degreasing and Dry Cleaning” (3B) (RIVM 2005: p. 5-2ff.).

5.3.2.3 Activity Data

Activity data correspond to the annual consumption of solvents for degreasing and dry cleaning. Data bases on industry data and expert estimates, documented in the EMIS database (EMIS 2012/3B).

For degreasing of metal, which is the most important NMVOC source in source category “Degreasing and Dry Cleaning” (3B), the activity data equals to 2'327 t solvent in 2010 (EMIS 2012/3B1 Metallreinigung).

5.3.3 Uncertainties and Time-Series Consistency

The uncertainty assessment results in medium confidence in emissions estimates (EMIS 2012/3B).

The uncertainty of total CO_2 emissions from the entire source category “Solvent and Other Product Use” (3) is estimated to be 50% (expert estimate).

The time series is consistent.

5.3.4 Source-Specific QA/QC and Verification

The time series have been compared between the current and the previous submission. All activity data, implied emission factors and emissions undergo the triple check:

- the results for 2010 are compared with the results 2009 within the current CRF
- the CRF tables of submission 2011 are compared between the current CRF tables and the CRF tables of submission 2010.
- the CRF tables for the base year 1990 are compared between the current CRF tables and the CRF tables of submission 2011.

Additionally, the CRF data was checked by doing spot-checks with activity data and emission factors from EMIS.

5.3.5 Source-Specific Recalculations

The reallocation of indirect CO_2 emissions from decomposition of NMVOC in the atmosphere that was reported in Submission 2011 (from NFR Sector 3 to 7 “Other”) has been undone in the review process. The recalculation took place in the Saturday Paper (see Chapter 16) and is therefore not a recalculation of Submission 2012.

No other recalculations beyond the mentioned shifting of the indirect CO_2 emissions from NMVOC decomposition have been made.

5.3.6 Source-Specific Planned Improvements

Gradual improvement of the data quality in co-operation with industry is on-going.

5.4 Source Category 3C – Chemical Products, Manufacture and Processing

5.4.1 Source Category Description

Source category “Chemical Products, Manufacture and Processing” (3C) comprises NMVOC emissions from manufacturing and processing chemical products. Also, it includes direct CO_2 emissions resulting from post-combustion of NMVOC to reduce NMVOC in exhaust gases and indirect CO_2 emissions due to decomposition of NMVOC in the atmosphere.

Table 5-5 Specification of source category “Chemical Products, Manufacture and Processing” (3C).

	Source	Specification	Data Source
3C	Chemical Products, Manufacture and Processing	Handling and storage of solvents; fine chemical production; production of pharmaceuticals; manufacturing of paint, inks, glues, adhesive tape, rubber; processing of PVC, polystyrene foam, polyurethane and polyester	AD, EF: EMIS 2012/3C

5.4.2 Methodological Issues

5.4.2.1 Methodology

For determination of NMVOC emissions from chemical products, manufacture and processing a country specific method is used. The emissions from fine chemical and pharmaceutical production are based on production data and expert estimates. The emissions of handling and storage of solvents are calculated based on the imported quantities. The emissions from manufacturing paint, glues, inks, adhesive tape, rubber and polyurethane as well as the processing of PVC are calculated based on production data. The emissions from processing of polystyrene foam and polyester are calculated based on consumption data.

The indirect CO_2 emissions due to decomposition of NMVOC in the atmosphere are calculated from the average carbon contents of NMVOC emissions for source category “Chemical Products, Manufacture and Processing” (3C) based on methodology and data from the Netherlands (RIVM 2005: p. 5-2ff.), assuming that the type and characteristics of solvents used in Switzerland are roughly similar.

Direct CO_2 emissions result from post-combustion of NMVOC. Those emissions are estimated based on industry data and expert estimates.

5.4.2.2 Emission Factors

Emission factors for NMVOC emissions base on data from Swiss industry and expert estimates, documented in the EMIS database (EMIS 2012/3C). Emission factors for handling and storage of solvents are estimated according to the solvent vapour pressure.

The emission factor for indirect CO_2 emissions from decomposition of NMVOC in the atmosphere is 2.31 Gg CO_2/Gg NMVOC for source category “Chemical Products, Manufacture and Processing” (3C) (RIVM 2005: p. 5-2ff.).

5.4.2.3 Activity Data

Activity data correspond to the annual consumption of solvents. They are based on data from industry and expert estimates, documented in the EMIS database (EMIS 2012/3C).

For fine chemical production, which is the most important NMVOC source in source category “Chemical Products, Manufacture and Processing” (3C), the NMVOC emissions equal to 1'200 t NMVOC in 2010 (EMIS 2012/3C Feinchemikalien-Produktion). Data for this source refers directly to the emissions without distinction between activity data and emission factor. It is planned to evaluate whether the methodology to determine emissions from this source can be improved.

5.4.3 Uncertainties and Time-Series Consistency

The uncertainty assessment results in medium confidence in emissions estimates (EMIS 2012/3C).

The uncertainty of total CO_2 emissions from the entire source category “Solvent and Other Product Use” (3) is estimated to be 50% (expert estimate).

Time series is consistent.

5.4.4 Source-Specific QA/QC and Verification

The time series have been compared between the current and the previous submission. All activity data, implied emission factors and emissions undergo the triple check:

- the results for 2010 are compared with the results 2009 within the current CRF
- the CRF tables for the year 2009 are compared between the current CRF tables and the CRF tables of submission 2011.
- the CRF tables for the base year 1990 are compared between the current CRF tables and the CRF tables of submission 2011

Additionally, the CRF data was checked by doing spot-checks with activity data and emission factors from EMIS.

5.4.5 Source-Specific Recalculations

The reallocation of indirect CO_2 emissions from decomposition of NMVOC in the atmosphere that was reported in Submission 2011 (from NFR Sector 3 to 7 “Other”) has been undone in the review process. The recalculation took place in the Saturday Paper (see Chapter 16) and is therefore not a recalculation of Submission 2012.

No other recalculations beyond the mentioned shifting of the indirect CO_2 emissions from NMVOC decomposition have been made.

5.4.6 Source-Specific Planned Improvements

Gradual improvement of the data quality in co-operation with industry is on-going.

5.5 Source Category 3D – Other

5.5.1 Source Category Description

Source category “Other” (3D) comprises emissions from many different solvent applications. Besides NMVOC also emissions of N_2O, NO_x, CO and SO_2 occur. Also, it includes direct

CO_2 emissions resulting from post-combustion of NMVOC to reduce NMVOC in exhaust gases and indirect CO_2 emissions due to decomposition of NMVOC in the atmosphere.

Direct emissions of greenhouse gases result from the application of N_2O in households and hospitals and from CO_2 emissions from the use of fireworks. Further included are emissions of CO_2, NO_x, CO and SO_2 arising from the use of firework.

Table 5-6 Specification of source category "Other" (3D).

	Source	Specification	Data Source
3D	Other	Use of spray cans in industry and households; domestic solvent use; print industry; application of glues and adhesives; use of concrete additives; removal of paint and lacquer; car underbody sealant; de-icing of airplanes; tanning of leather; impregnating of glass and mineral wool; use of cooling and other lubricants; extraction of oils and fats; use of pesticides; use of pharmaceutical products in households; house cleaning industry/craft/services; hairdressers; scientific laboratories; textile production; paper and paper board production; clothing production; cosmetic institutions; production and use of tobacco products; vehicles dewaxing; wood preservation; medical practitioners; other health care institutions; not attributable solvent emissions; use of N_2O in households and in hospitals; other use of gases; production of perfume /aroma and cosmetics; use of fireworks	AD, EF: EMIS 2012/3D1, 3D3 and 3D5

5.5.2 Methodological Issues

5.5.2.1 Methodology

For determination of direct and indirect emissions from source category "Other" (3D) a country specific method based on the production/consumption of the different solvent applications is used. The emissions from "Domestic solvent use", which is the most important emission source in source category "Other" (3D), is calculated proportional to the number of employees in Switzerland.

The indirect CO_2 emissions due to decomposition of NMVOC in the atmosphere are calculated from the average carbon contents of NMVOC emissions for source category "Other" (3D) based on methodology and data from the Netherlands (RIVM 2005: p. 5-2ff.), assuming that the type and characteristics of solvents used in Switzerland are roughly similar.

Direct CO_2 emissions result from post-combustion of NMVOC. Those emissions are estimated based on industry data and expert estimates.

5.5.2.2 Emission Factors

Emission factors for NMVOC emissions are based on data from Swiss industry and expert estimates, documented in the EMIS database (EMIS 2012/3D). Emission factors for N_2O, NO_x, CO and SO_2 are based on data from Swiss industry and expert estimates, documented in the EMIS database.

The emissions factor for indirect CO_2 emissions from decomposition of NMVOC in the atmosphere is 2.53 Gg CO_2/Gg NMVOC for source category "Other" (3D) (RIVM 2005: p. 5-2ff.).

For house cleaning, which is the most important emission source in source category "Other" (3D), the emission factor amounts to 477 g per employee in 2010 (EMIS 2012/3D5 Reinigung Gebäude IGD).

In Table 5-7 emission factors for the emission of N_2O is given for source category "Use of N_2O for anaesthesia" (3D1) and "N_2O from aerosol cans" (3D3).

Table 5-7 Emission factors for N_2O for category 3D1 and 3D3 in g/inhabitant (EMIS 2012/3D1 Lachgasanwendung Spitäler; EMIS 2012/3D3 Lachgasanwendung Haushalt).

3D Other	Unit	N_2O
3D1 Use of N_2O for anaesthesia	g/inhabitant	14
3D3 N_2O from aerosol cans	g/inhabitant	10

5.5.2.3 Activity Data

The activity data correspond to the annual production/consumption of solvents. Data bases on industry data and expert estimates, documented in the EMIS database (EMIS 2012/3D).

For house cleaning, which is the most important emission source in source category "Other" (3D), the activity data is the number of employees in Switzerland and amounts to 4'300'769 in 2010 (EMIS 2012/3D5 Reinigung Gebäude IGD).

5.5.3 Uncertainties and Time-Series Consistency

The uncertainty assessment results in medium confidence in emissions estimates (EMIS 2012/3D).

The uncertainty of total CO_2 emissions from the entire source category "Solvent and Other Product Use" (3) is estimated to be 50% (expert estimate).

The uncertainty of N_2O emissions which are key-category regarding trend, has been estimated with an expert estimates and was rated "medium". This results in an uncertainty of 80%.

Time series is consistent.

5.5.4 Source-Specific QA/QC and Verification

The time series have been compared between the current and the previous submission. All activity data, implied emission factors and emissions undergo the triple check:

- the results for 2010 are compared with the results 2009 within the current CRF
- the CRF tables for the year 2009 are compared between the current CRF tables and the CRF tables of submission 2011.

- the CRF tables for the base year 1990 are compared between the current CRF tables and the CRF tables of submission 2011

Additionally, the CRF data was checked by doing spot-checks with activity data and emission factors from EMIS.

5.5.5 Source-Specific Recalculations

The reallocation of indirect CO_2 emissions from decomposition of NMVOC in the atmosphere that was reported in Submission 2011 (from NFR Sector 3 to 7 “Other”) has been undone in the review process. The recalculation took place in the Saturday Paper (see Chapter 16) and is therefore not a recalculation of Submission 2012.

The determination of the emission factor for NMVOC of “Domestic solvent use” for 2010 on the same level as for 2007 caused slightly higher interpolated values for 2008 and 2009.

Activity data for glass wool impregnation for the year 2006 was slightly reduced according to corrected data by the respective industry.

5.5.6 Source-Specific Planned Improvements

Gradual improvement of the data quality in co-operation with industry is on-going.

6 Agriculture

6.1 Overview

This chapter provides information on the estimation of the greenhouse gas emissions from the sector Agriculture. The following source categories are reported:

- 4A Enteric Fermentation, CH_4 emissions from domestic livestock,
- 4B Manure Management, emissions of CH_4 and N_2O
- 4D Agricultural Soils, emissions of N_2O, NO_x and NMVOC ,
- 4F Field Burning of Agricultural Residues, emissions of CH_4, N_2O, NO_x, CO, NMVOC and SO_2.

Categories 4C Rice Cultivation and 4E Burning of Savannahs are not occurring and therefore not reported in Switzerland.

Total greenhouse gas emissions from agriculture in 2010 were 5’688 Gg CO_2 equivalents in total which is a contribution of 10.5% to the total of Swiss greenhouse gas emissions. Main agricultural sources of greenhouse gases in 2010 were enteric fermentation emitting 2’538 Gg CO_2 equivalents (45% of all agricultural greenhouse gases), followed by agricultural soils with 2’168 Gg CO_2 equivalents (38%) and Manure Management with 969 Gg CO_2 equivalents (17%). 4F is of minor importance with only 0.2% contribution to the agricultural greenhouse gases.

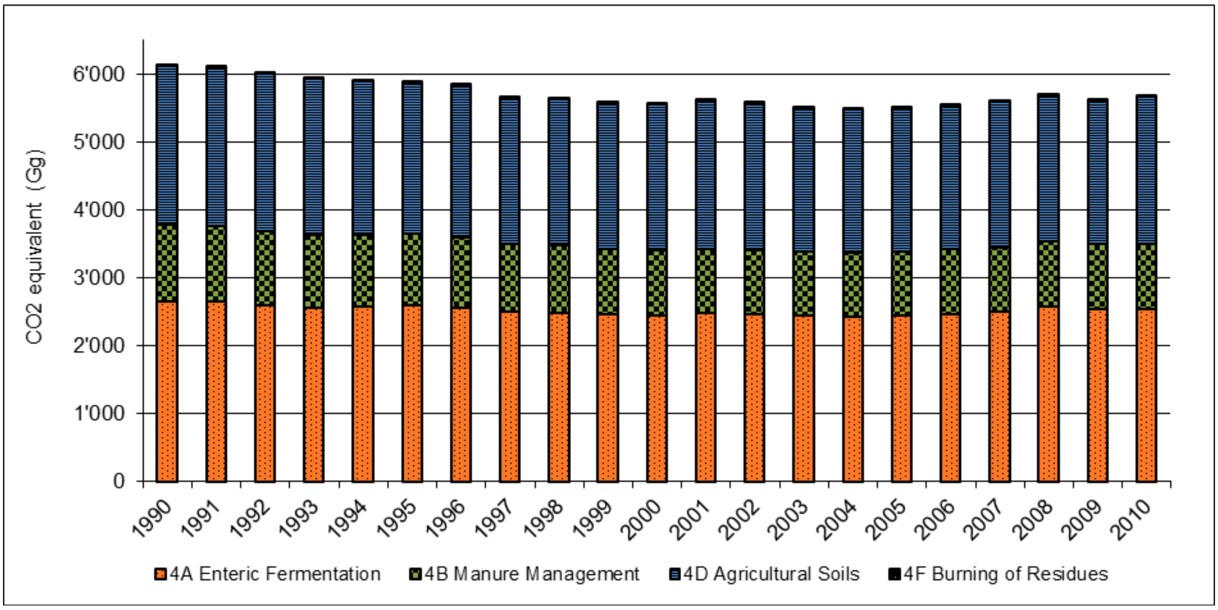

Figure 6-1 Greenhouse gas emissions of agriculture in Gg CO_2 equivalents 1990-2010.

Main greenhouse gases are CH_4 and N_2O. There are no CO_2 emissions reported in the agricultural sector. CO_2 emissions from soils are reported under Land Use, Land-use Change and Forestry. CO_2 emissions from energy use in agriculture are reported under 1A4c Energy; Others Sectors, Agriculture/Forestry/Fisheries.

Table 6-1 Greenhouse gas emissions in Gg CO_2 equivalents from agriculture 1990-2010.

Gas	**1990**	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**
	CO_2 equivalent (Gg)									
CO_2	0	0	0	0	0	0	0	0	0	0
CH_4	3'339	3'328	3'265	3'224	3'221	3'243	3'197	3'134	3'123	3'085
N_2O	2'799	2'785	2'756	2'715	2'685	2'657	2'652	2'541	2'530	2'499
Sum	6'138	6'113	6'021	5'940	5'906	5'900	5'849	5'675	5'653	5'583

Gas	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**
	CO_2 equivalent (Gg)									
CO_2	0	0	0	0	0	0	0	0	0	0
CH_4	3'078	3'112	3'102	3'074	3'062	3'091	3'117	3'146	3'233	3'199
N_2O	2'493	2'510	2'497	2'435	2'430	2'431	2'428	2'462	2'467	2'438
Sum	5'571	5'622	5'599	5'509	5'492	5'521	5'545	5'608	5'700	5'637

Gas	**2010**
CO_2	0
CH_4	3'193
N_2O	2'495
Sum	5'688

CH_4 and N_2O emissions were declining from 1990 until 2004. This general trend can be explained by a reduction of the number of cattle and a reduced input of mineral fertilisers due to the introduction of the “Required standard of Ecological Performance (REP)” (ART 2010a, Leifeld and Fuhrer 2005). From 2004 to 2008 CH_4 emissions increased again due to higher livestock numbers (mainly cattle). Since 2007 total emissions seem to be fluctuating on a rather stable level. Most emission factors did not change significantly.

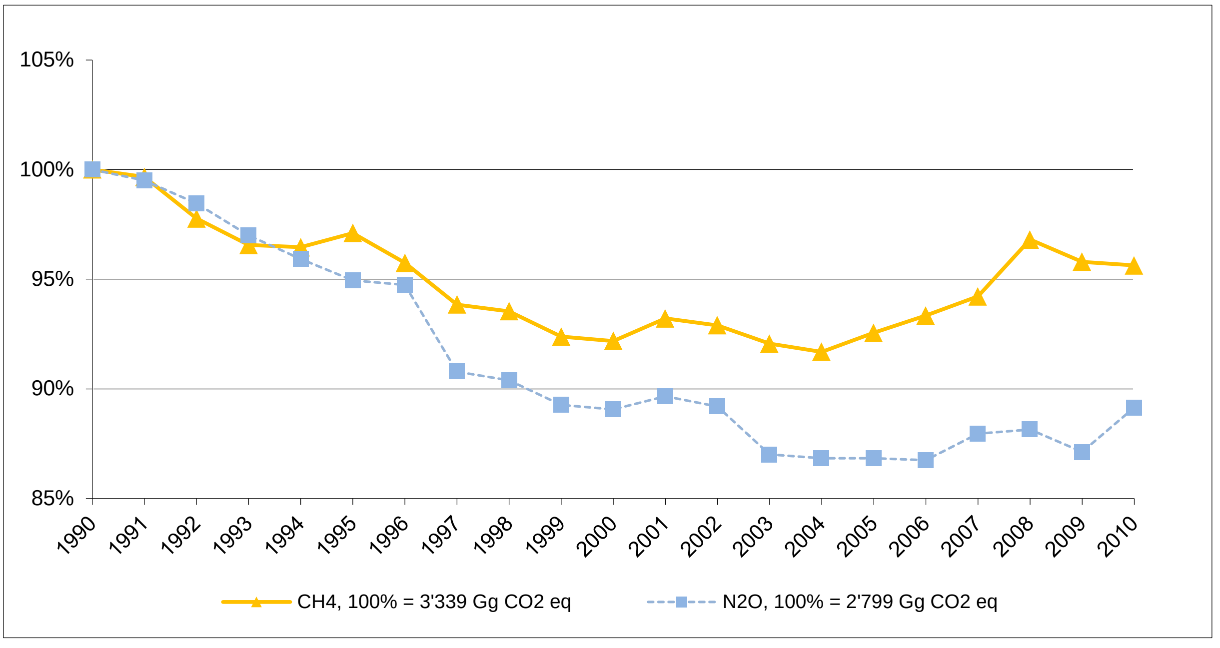

Figure 6-2 Trend of the greenhouse gases of the agricultural sector 1990-2010. The base year 1990 represents 100%.

Among the key categories of the Swiss inventory, six are out of the agricultural sector:

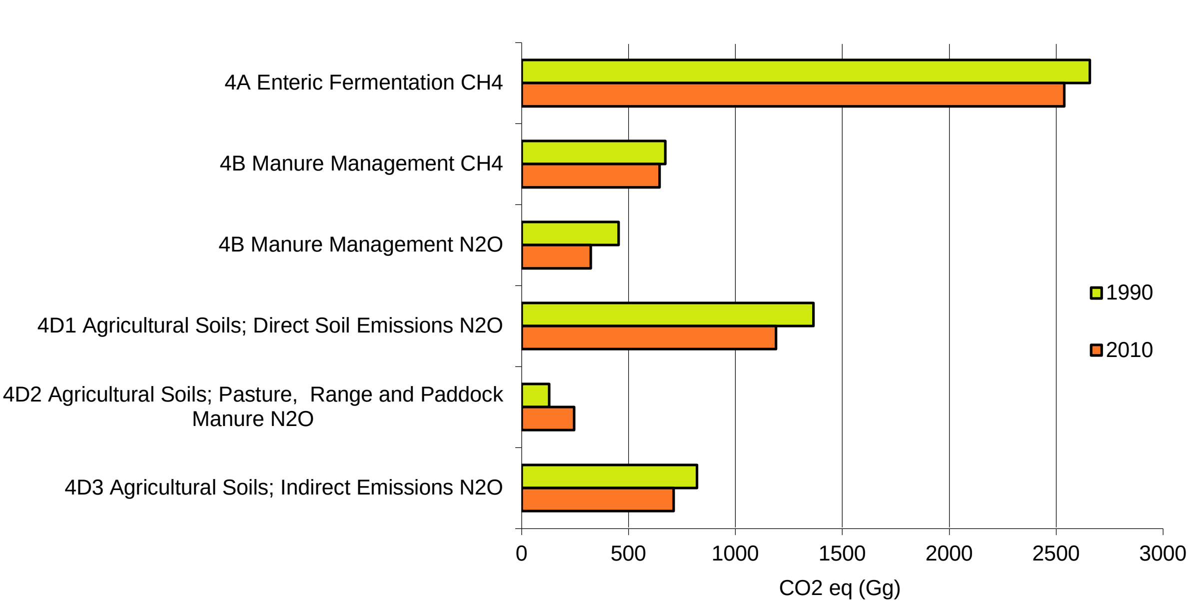

Figure 6-3 Key sources (Tier 1 and Tier 2) in Agriculture, emissions 1990 and 2010 in CO_2 equivalents (Gg).

6.2 Source Category 4A – Enteric Fermentation

6.2.1 Source Category Description

Tier 1 and Tier 2 Key category 4A
CH_4 emissions from Enteric Fermentation (level and trend)

The emission source is the domestic livestock population broken down into 3 cattle categories (mature dairy cattle, mature non-dairy cattle, young cattle), sheep, goats, horses, mules and asses, swine and poultry. Emissions from enteric fermentation were declining from 1990 until 2004, mainly due to a reduction of the number of cattle. However, between 2004 and 2008 cattle livestock numbers and subsequently CH_4 emissions were increasing again. 2009 and 2010 show a slight decrease in cattle numbers and CH_4 emissions. Emissions from cattle contribute to over 90% of the emissions from enteric fermentation.

Table 6-2 Specification of source category 4A "Enteric Fermentation". (AD: Activity data; EF: Emission factor).

4A	Source	Specification	Data Source
4A1	Cattle	Mature dairy cattle Mature non-dairy cattle Young cattle (fattening calves, pre-weaned calves, breeding cattle 1st year (breeding calves + breeding cattle 4-12 months), breeding cattle > 1 year, fattening cattle (fattening calves 0-4 months, fattening cattle 4-12 months)	AD: Livestock data from SBV 2011; ART/SHL 2012 Net energy and metabolisable energy (calves) from RAP 1999 EF: Soliva 2006
4A3 4A4	Sheep Goats		AD: Livestock data from SBV 2011 and ART/SHL 2012, and net energy data from SBV 2011 EF: Soliva 2006
4A6 4A7 4A8	Horses Mules and asses Swine		AD: Livestock data from SBV 2011 and ART/SHL 2012, and digestible energy data from SBV 2011

			EF: Soliva 2006
4A9	Poultry		AD: Livestock data from SBV 2011 and ART/SHL 2012, and metabolisable energy data from SBV 2011 EF: Hadorn and Wenk 1996 cited in Soliva 2006

6.2.2 Methodological Issues

6.2.2.1 Methodology

The calculation is based on methods described in the IPCC Good Practice Guidance (IPCC 2000, equation 4.14). CH_4 emissions from enteric fermentation of the livestock population have been estimated using Tier 2 methodology. This means that detailed country specific data on nutrient requirements, feed intake and CH_4 conversion rates for specific feed types are required.

For calculating the gross energy intake a country specific method based on available data on requirements of net energy (lactation, growth), digestible energy and metabolisable energy has been applied. Data on energy intake is based on RAP (1999) and SBV (2011). The method is described in detail in Soliva (2006) and is realised in ART (2012).

Different energy levels (Figure 6-4) are used to express the energy conversion from energy intake to the energy required for maintenance and performance.

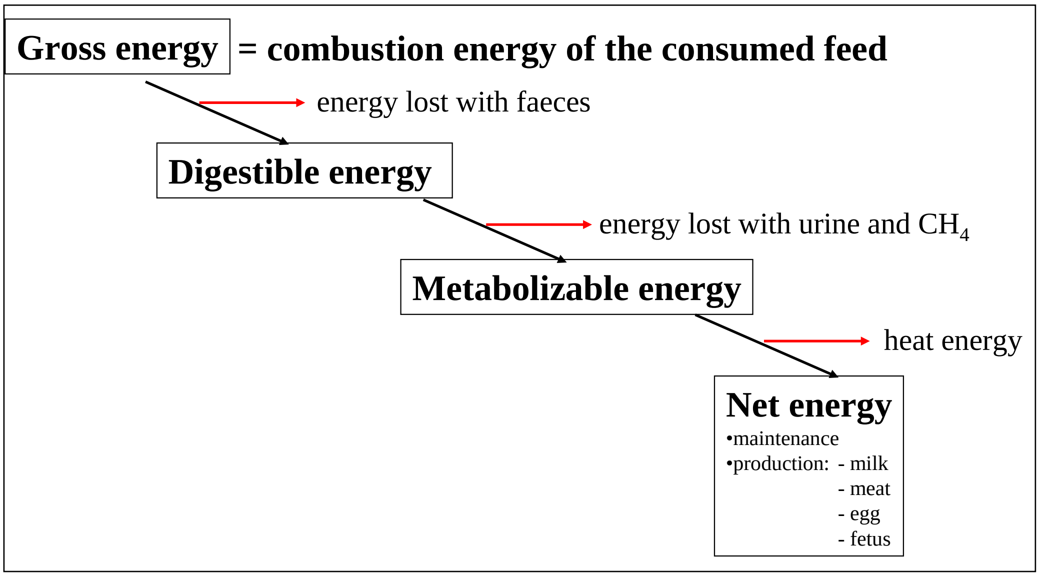

Figure 6-4 Levels of feed energy conversion. Reference: Soliva 2006.

Net energy (NE) is used to express the energy required by the ruminants such as cattle, sheep and goats. NE in cattle feeding is further sub-divided into NE for lactation (NEL) and NE for growth (NEV). For some of the young cattle categories NEL is used rather than NEV what would seem natural. However, cattle raising is often coupled with dairy cattle activities and therefore the same energy unit (NEL) is used in these cases (RAP 1999). Exceptions are the fattening calves (milk-fed calves), whose requirements for energy are expressed as metabolisable energy (ME). Horses, mules, asses and swine are fed on the basis of digestible energy (DE), whereas poultry are fed according to metabolisable energy (ME).

In the energy estimation also some feed energy losses are integrated. Feed losses are defined as the feed not eaten by the animal and therefore represent a loss of net energy.

For the cattle categories detailed estimations for NE requirements are necessary. As the Swiss Farmers Union (SBV) does not calculate the NE for detailed cattle sub-categories, NE data for each cattle subcategory was calculated individually according to the animal's requirements following the feeding recommendations of RAP (1999). These RAP recommendations are also used by the Swiss farmers as basis for their cattle feeding regime and for filling in application forms for subsidies for ecological services, and are therefore highly appropriate. In the calculation of the NE data, the animal's weight, daily growth rate, daily feed intake (dry matter), daily feed energy intake, and energy required for milk production for the respective sub-categories were considered (Soliva 2006).

For estimating the gross energy intake out of the available data on net energy, metabolisable energy and digestible energy, the following conversion factors were applied:

Table 6-3 Conversion factors used for calculation of energy requirements of individual livestock categories. Reference: Soliva 2006: p.3. GE: Gross energy; DE: Digestible Energy; ME: Metabolisable Energy; NEL: Net energy for lactation; NEV: Net energy for growth.

Livestock Category		Conversion factors	
Dairy cattle		NEL to GE	0.318
Mature non-dairy cattle		NEL to GE	0.275
Young cattle	Fattening calves	ME to GE	0.930
	Pre weaned calf	NEL to GE	0.291
	Breeding calf	NEL to GE	0.341
	Breeding cattle 1 (4-12 months)	NEL to GE	0.322
	Breeding cattle 2 (more than one year)	NEL to GE	0.313
	Fattening calf (0-4 months)	NEV to GE	0.350
	Fattening cattle (4-12 months)	NEV to GE	0.401
Sheep	Milksheep	NEL to GE	0.287
	Fattening Sheep	NEV to GE	0.350
Goats		NEL to GE	0.283
Horses		DE to GE	0.560
Mules & Asses		DE to GE	0.560
Swine		DE to GE	0.682
Poultry		ME to GE	0.700

6.2.2.2 Emission factors

All emission factors for enteric fermentation are country specific, based on IPCC equation 4.14 IPCC 2000: p. 4.26.

$$EF = \frac{GE * Y_m * 365\, days/y}{55.65\, MJ/kg\, CH_4}$$

GE = Gross energy intake (MJ/head/day)

Y_m = Methane conversion rate, which is the fraction of gross energy in feed converted to methane

55.65 MJ/kg = energy content of methane.

The following input data are used:

Table 6-4 Gross energy intake per head of different livestock groups. Calculation is based on the above mentioned parameters net energy, digestible energy, metabolisable energy according to the method described in Soliva (2006). Input data on net energy, digestible energy and metabolisable energy is taken from SBV (2011) and RAP (1999). All sub-categories displayed in italic.

Gross Energy Intake		**1990-1999**									
		1990	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**
		MJ/head/day									
Cattle											
Mature Dairy Cattle		258.0	260.3	260.6	263.9	263.6	266.4	265.4	269.6	273.7	277.2
Mature Non-Dairy Cattle		*205.1*	*205.1*	*205.1*	*205.1*	*205.1*	*205.1*	*205.1*	*205.1*	*205.1*	*205.1*
Young Cattle	Young Cattle Average (weighted)	93.6	93.5	93.6	93.4	93.8	94.3	93.7	94.1	93.1	92.1
	Fattening Calves	*47.6*	*47.6*	*47.6*	*47.6*	*47.6*	*47.6*	*47.6*	*47.6*	*47.6*	*47.6*
	Pre-Weaned Calves	*55.7*	*55.7*	*55.7*	*55.7*	*55.7*	*55.7*	*55.7*	*55.7*	*55.7*	*55.7*
	Breeding Calves	*26.9*	*26.9*	*26.9*	*26.9*	*26.9*	*26.9*	*26.9*	*26.9*	*26.9*	*26.9*
	Breeding Cattle (4-12 months)	*89.2*	*89.2*	*89.2*	*89.2*	*89.2*	*89.2*	*89.2*	*89.2*	*89.2*	*89.2*
	Breeding Cattle (> 1 year)	*129.1*	*129.1*	*129.1*	*129.1*	*129.1*	*129.1*	*129.1*	*129.1*	*129.1*	*129.1*
	Fattening Calves (0-4 months)	*55.6*	*55.6*	*55.6*	*55.6*	*55.6*	*55.6*	*55.6*	*55.6*	*55.6*	*55.6*
	Fattening Cattle (4-12 months)	*124.6*	*124.6*	*124.6*	*124.6*	*124.6*	*124.6*	*124.6*	*124.6*	*124.6*	*124.6*
Sheep		20.8	21.4	21.7	21.1	23.2	24.3	21.4	21.8	21.6	22.8
Goats		31.7	32.0	32.3	32.5	33.2	34.8	32.4	29.3	29.2	28.9
Horses		151.2	139.9	137.1	137.7	154.1	174.9	131.8	135.5	136.5	136.8
Mules and Asses		110.2	102.0	99.9	100.4	112.3	127.5	96.1	98.7	99.5	99.7
Swine		35.2	36.0	36.2	35.9	36.8	40.4	37.2	37.0	36.5	36.4
Poultry 1)		1.3	1.3	1.3	1.1	1.2	1.2	1.2	1.2	1.2	1.2

Gross Energy Intake		**2000-2009**									
		2000	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**
		MJ/head/day									
Cattle											
Mature Dairy Cattle		280.1	282.0	285.0	288.6	294.0	294.1	295.1	300.5	304.1	309.2
Mature Non-Dairy Cattle		205.1	205.1	205.1	205.1	205.1	205.1	205.1	205.1	205.1	205.1
Young Cattle	Young Cattle Average (weighted)	93.4	92.3	91.9	91.6	91.3	90.8	91.0	90.7	90.8	90.4
	Fattening Calves	*47.6*	*47.6*	*47.6*	*47.6*	*47.6*	*47.6*	*47.6*	*47.6*	*47.6*	*47.6*
	Pre-Weaned Calves	*55.7*	*55.7*	*55.7*	*55.7*	*55.7*	*55.7*	*55.7*	*55.7*	*55.7*	*55.7*
	Breeding Calves	*26.9*	*26.9*	*26.9*	*26.9*	*26.9*	*26.9*	*26.9*	*26.9*	*26.9*	*26.9*
	Breeding Cattle (4-12 months)	*89.2*	*89.2*	*89.2*	*89.2*	*89.2*	*89.2*	*89.2*	*89.2*	*89.2*	*89.2*
	Breeding Cattle (> 1 year)	*129.1*	*129.1*	*129.1*	*129.1*	*129.1*	*129.1*	*129.1*	*129.1*	*129.1*	*129.1*
	Fattening Calves (0-4 months)	*55.6*	*55.6*	*55.6*	*55.6*	*55.6*	*55.6*	*55.6*	*55.6*	*55.6*	*55.6*
	Fattening Cattle (4-12 months)	*124.6*	*124.6*	*124.6*	*124.6*	*124.6*	*124.6*	*124.6*	*124.6*	*124.6*	*124.6*
Sheep		22.1	22.8	22.6	22.3	23.0	22.5	21.7	21.3	21.4	21.6
Goats		31.9	31.9	30.9	31.4	30.9	30.7	30.5	30.9	31.0	31.1
Horses		138.2	138.8	136.7	136.7	136.8	137.2	137.5	139.0	139.6	139.1
Mules and Asses		100.7	101.2	99.7	99.6	99.7	100.0	100.2	101.3	101.8	101.8
Swine		35.2	35.2	35.0	35.0	35.0	34.3	34.2	34.8	34.5	32.9
Poultry 1)		1.2	1.2	1.2	1.2	1.1	1.1	1.1	1.1	1.2	1.1

Gross Energy Intake		
		2010
		MJ/h./d.
Cattle		
Mature Dairy Cattle		310.8
Mature Non-Dairy Cattle		205.1
Young Cattle	Young Cattle Average (weighted)	90.4
	Fattening Calves	*47.6*
	Pre-Weaned Calves	*55.7*
	Breeding Calves	*26.9*
	Breeding Cattle (4-12 months)	*89.2*
	Breeding Cattle (> 1 year)	*129.1*
	Fattening Calves (0-4 months)	*55.6*
	Fattening Cattle (4-12 months)	*124.6*
Sheep		21.8
Goats		31.2
Horses		139.1
Mules and Asses		101.8
Swine		34.0
Poultry 1)		1.1

1) Poultry data is not Gross Energy intake (GE) but Metabolizable Energy intake (ME)

The **gross energy intake** per head for some animal categories revealed some fluctuations during the inventory period. The value for mature dairy cattle increased which is mainly a result of higher milk production (Table 6-5). Milk production of mature dairy cattle increased from 4'900 kg per head and year in 1990 to 6'851 kg per head and year in 2010. Statistics of annual milk production are provided by the Swiss Farmers Union (SBV 2011). Milk production includes marketed milk, milk consumed by calves on farms and milk sold outside the commercial industry (MISTA 2011).

Table 6-5: Annual milk production in Switzerland

Milk Production Cattle		1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Population Size Mature Dairy Cattle	head	783'100	780'500	763'500	744'450	742'046	739'641	736'043	711'613	701'343	683'545
Lactation Period	day	305	305	305	305	305	305	305	305	305	305
Milk Yield Mature Dairy Cattle	kg/head/day	16.06	16.35	16.39	16.78	16.75	17.09	16.96	17.48	17.97	18.40
Milk Yield Mature Non-Dairy Cattle	kg/head/day	8.20	8.20	8.20	8.20	8.20	8.20	8.20	8.20	8.20	8.20

Milk Production Cattle		2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Population Size Mature Dairy Cattle	head	669'410	669'410	657'924	638'288	621'008	620'708	618'100	614'795	628'516	599'361
Lactation Period	day	305	305	305	305	305	305	305	305	305	305
Milk Yield Mature Dairy Cattle	kg/head/day	18.75	18.97	19.34	19.77	20.43	20.45	20.57	21.21	21.66	22.27
Milk Yield Mature Non-Dairy Cattle	kg/head/day	8.20	8.20	8.20	8.20	8.20	8.20	8.20	8.20	8.20	8.20

Milk Production Cattle		2010
Population Size Mature Dairy Cattle	head	589'024
Lactation Period	day	305
Milk Yield Mature Dairy Cattle	kg/head/day	22.46
Milk Yield Mature Non-Dairy Cattle	kg/head/day	8.20

The gross energy intake for mature non-dairy cattle is significantly higher than IPCC default values, since this category only comprehends mature cows to produce offspring for meat (so called suckler cows or mother cows). Milk production of mature non-dairy cattle is 2500kg per head and year and does not change over the inventory time period (RAP 1999).

The gross energy intake of young cattle was calculated separately for all sub-categories displayed in Table 6-4 (in italics) and subsequently averaged (weighted average). The values for all the 7 sub-categories summarized under young cattle are constant over time. Since the composition of the young cattle category is changing over time (e.g. more pre-weaned calves, less fattening calves, see Table 6-6) the average gross energy intake for young cattle is also slightly changing. To calculate an annual emission factor, the categories breeding calves and breeding cattle 4-12 months are combined in the category breeding cattle 1^{st} year (not shown in Table 6-4 and Table 6-6). Subsequently the respective animals have two separate gross energy intake values, i.e. 26.9 MJ/head/day for the first 4 month and 89.2 MJ/head/day for the later 8 months. The same procedure is applied for fattening calves 0-4 months and fattening cattle 4-12 months summing up to the category fattening cattle.

The gross energy intake for the horse categories showed higher values for 1994 and 1995. According to the Swiss Farmers Union data comparison of these years can be made only partially due to changes in livestock survey methods (SBV 1999, table 3.2 page 71).

For the **methane conversion rate Y_m** (%) only few country specific data exist. Therefore mainly default values recommended by the IPCC for developed countries in Western Europe were used (IPCC 1997b: Reference Manual: p. 4.32–4.35 and IPCC 2000: p. 4.27). For all juveniles consuming only milk (i.e. fattening calves) the CH_4 conversion rate is assumed to be zero (IPCC 2000). For poultry a country specific value ($Y_{poultry}$ = 0.1631% of metabolisable energy) was used since no default value is given by the IPCC. This value was evaluated in an in vivo trial with broilers (Hadorn and Wenk 1996).

6.2.2.3 Activity data

The activity data input has been obtained from statistics published by the Swiss Farmers Union (SBV 2011) and the Swiss Federal Statistical Office (SFSO). All activity data has been revised and harmonized during a joint effort of the Agroscope Reckenholz Tänikon Research Station (ART) and the Swiss College of Agriculture (SHL) in 2011 (ART/SHL 2012).

The following data were used:

Table 6-6 Activity data for calculating methane emissions from enteric fermentation (ART/SHL 2012).

Population Size		**1990-1999**									
		1990	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**
		1'000 head									
Cattle		1'855	1'829	1'783	1'745	1'746	1'748	1'747	1'673	1'641	1'609
Mature Dairy Cattle		783	781	764	744	742	740	736	712	701	684
Mature Non-Dairy Cattle		12	14	17	18	20	23	28	32	36	41
Young Cattle		1'060	1'034	1'002	983	984	986	983	929	904	884
	Fattening Calves	*112*	*111*	*110*	*111*	*106*	*102*	*112*	*106*	*108*	*116*
	Pre-Weaned Calves	*10*	*11*	*14*	*14*	*16*	*18*	*22*	*26*	*29*	*33*
	Breeding Calves	*214*	*204*	*197*	*184*	*175*	*166*	*155*	*139*	*136*	*72*
	Breeding Cattle (4-12 months)	*132*	*133*	*127*	*125*	*127*	*129*	*131*	*121*	*118*	*147*
	Breeding Cattle (> 1 year)	*404*	*400*	*397*	*381*	*379*	*378*	*383*	*372*	*350*	*305*
	Fattening Calves (0-4 months)	*88*	*79*	*71*	*76*	*79*	*82*	*75*	*68*	*66*	*48*
	Fattening Cattle (4-12 months)	*100*	*96*	*87*	*92*	*101*	*110*	*105*	*97*	*97*	*162*
Sheep		395	409	415	424	405	387	419	420	422	424
Goats		68	65	58	57	55	53	57	58	60	62
Horses		51	52	53	54	58	62	62	65	64	65
Mules and Asses		11	11	11	11	11	11	12	13	14	15
Swine		1'787	1'723	1'706	1'692	1'569	1'446	1'379	1'395	1'487	1'453
Poultry		5'938	5'647	5'502	6'410	6'330	6'251	6'440	6'553	6'740	6'908

Population Size		**2000-2009**									
		2000	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**
		1'000 head									
Cattle		1'588	1'611	1'594	1'570	1'545	1'555	1'567	1'572	1'604	1'597
Mature dairy cattle		669	669	658	638	621	621	618	615	629	599
Mature non-dairy cattle		45	51	58	65	70	78	87	94	98	108
Young cattle		874	891	878	867	854	856	861	863	877	890
	Fattening Calves	*103*	*115*	*114*	*114*	*111*	*106*	*101*	*100*	*95*	*101*
	Pre-Weaned Calves	*36*	*40*	*47*	*52*	*57*	*62*	*67*	*72*	*76*	*86*
	Breeding Calves	*76*	*78*	*76*	*73*	*71*	*75*	*77*	*76*	*80*	*77*
	Breeding Cattle (4-12 months)	*161*	*160*	*154*	*147*	*143*	*147*	*147*	*147*	*152*	*149*
	Breeding Cattle (> 1 year)	*352*	*350*	*345*	*337*	*326*	*318*	*320*	*320*	*322*	*331*
	Fattening Calves (0-4 months)	*43*	*40*	*38*	*39*	*36*	*35*	*35*	*34*	*36*	*35*
	Fattening Cattle (4-12 months)	*105*	*109*	*104*	*105*	*109*	*112*	*114*	*114*	*116*	*112*
Sheep		421	420	430	445	441	446	451	444	446	432
Goats		62	63	66	67	71	74	76	79	81	81
Horses		66	64	64	65	65	65	66	67	68	69
Mules and Asses		16	16	17	17	18	19	19	20	20	22
Swine		1'498	1'548	1'557	1'529	1'538	1'609	1'635	1'573	1'540	1'557
Poultry		6'983	6'939	7'339	7'587	8'061	8'260	7'670	8'228	8'543	8'809

Population Size		
		2010
		1'000 head
Cattle		1'591
Mature dairy cattle		589
Mature non-dairy cattle		111
Young cattle		891
	Fattening Calves	*99*
	Pre-Weaned Calves	*88*
	Breeding Calves	*77*
	Breeding Cattle (4-12 months)	*149*
	Breeding Cattle (> 1 year)	*332*
	Fattening Calves (0-4 months)	*34*
	Fattening Cattle (4-12 months)	*111*
Sheep		434
Goats		83
Horses		71
Mules and Asses		23
Swine		1'589
Poultry		9'025

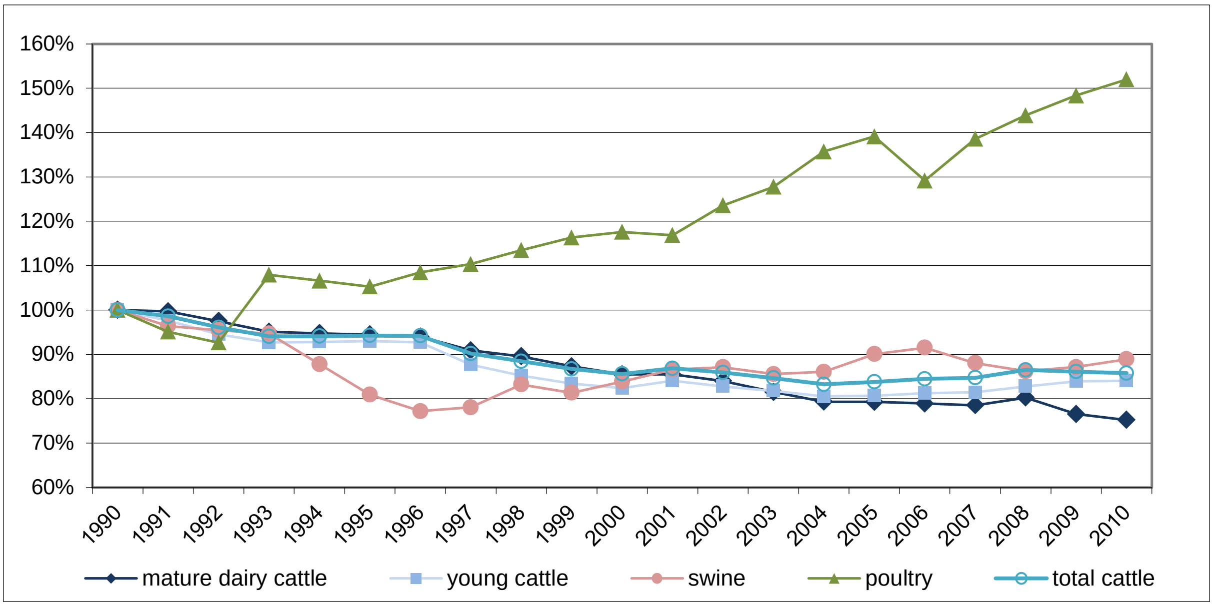

Figure 6-5 Relative development of main animal categories 1990-2010.

Emission estimation for cattle has been conducted at a more disaggregated level than the one displayed in the CRF. The category "Mature non-dairy cattle" only includes mature cows used to produce offspring for meat. The CRF livestock category "Young cattle" includes the sub-categories fattening calves, pre-weaned calves, breeding calves, breeding cattle 4-12 months, breeding cattle > 1 year, fattening calves 0-4 months and fattening cattle 4-12 months. Although not young cattle in the proper sense, bulls are contained in the categories "Breeding Cattle (> 1 year)" and "Fattening Cattle (4-12 months)" according to their purposes. This regrouping of the cattle category enhances the consistency and transparency of the emission estimation procedure from livestock activities (also refer to chapter 6.3).

The number of cattle was slightly declining until the year 2004, which is a result of an on-going process to a less intensive form of animal husbandry due to ecological and economic reasons. However, cattle livestock numbers were slightly increasing again between 2004 and 2010 mainly due to an increase of the number of young cattle.

After a decrease until 1996 the number of swine was increasing again until 2006 – a process that could be observed also in many other European countries (SBV 2004: p.69). Since then the number of swine decreased and increased again to the same level as 2006. The number of poultry shows a rapid increase between 1990 and 2010 with only a distinct dip between 2005 and 2006, a consequence of changed human consumption patterns as a result of the avian flu in 2006.

The numbers of goats and poultry are increasing since 1990.

6.2.3 Uncertainties and Time-Series Consistency

For the uncertainty analysis the input data from ART (2008a) was used. Therefore the arithmetic mean of the lower and upper bound uncertainty is used for activity data (6.4%) and for emission factors (17.2%), resulting in a combined uncertainty of 18.4%. For further results see Section 1.7. In the Tier 2 Uncertainty analysis also correlations between activity data or emission factors are considered (see Annex 7.2.2).

The time series 1990–2010 is generally consistent with three issues that should be considered:

1.) Between 1998 and 1999 the questionnaire for the collection of livestock data was modified. In some animal categories this led to minor ruptures in the time series. Consequences for overall emissions are, however, of minor importance. While the average absolute trend for the years 1990–2010 over all animal categories excluding mature non-dairy cattle was 3.3%, the average absolute trend for the years 1998-1999 was 3.8% (ART/SHL 2012).

2.) For the last two inventory years cattle population statistics were not available in the usual format. Data for 2009 and 2010 is based on the animal traffic database. Aggregation has been adapted to the format necessary for the AGRAMMON and greenhouse gas inventories by the Swiss College of Agriculture SHL (SHL 2010).

3.) The Swiss Farmers Union provides energy requirement estimates only for the years until 2006. For later years these statistics have been abandoned and replaced by a fodder balance calculation. Consequently gross energy intake for non-cattle animals in the years 2007-2010 had to be estimated by extrapolation using per capita fodder availability as driver.

6.2.4 Source-Specific QA/QC and Verification

All QA/QC activities are further described in a separate document (ART 2011c). General information on agricultural structures and policies is provided and eventual differences between national and (IPCC) standard values are being analysed and discussed. Furthermore, comparisons with data from other countries have been conducted and discussed where possible.

The documentation about the data set and calculation method assures transparency and traceability of the calculation methods (Soliva 2006). Additionally a document in German lists all the methodological differences between the former calculations and the current methodology (Soliva 2006a).

Livestock data was compared with the livestock data provided by the FAO and checked for plausibility. In all cases the new recalculated data according to ART/SHL (2012) is considered more reliable than the FAO data. Small inconsistencies (usually in the order of ± 2%) are due to data updates conducted by the Swiss Farmers Union that are not considered by the FAO. For horses, mules and asses disagreements are due to the different accounting of agricultural and non-agricultural horses. The Swiss inventory systems accounts for all animals no matter whether they are held on agricultural or non-agricultural enterprises. Moreover, the numbers of mules and asses is higher in the Swiss GHG-Inventory because unlike the FAO, Switzerland accounts also for ponies and lesser horses. The total number for poultry also shows some minor discrepancies due to different accounting of turkeys, geese, ducks and quails. Seasonal fluctuation of the cattle population has been analysed for the years 2005-2007 based on detailed information from the Swiss Farmers Union (SBV 2007a). Fluctuations are usually in the order of ±3% with census data (April) always slightly above the annual mean.

Total NE-intake of the cattle population as calculated in the Swiss GHG- Inventory is in accordance with an independent calculation of the Swiss farmers union (SBV 2007). In a check during the submission 2010 the average absolute difference for the time period 1990-2004 was ±1.2%.

IPCC tables with data for estimating emission factors for cattle (such as weight, weight gain, milk production) were filled in, checked for consistency and confidence and compared with IPCC default values (refer to Table A - 33 in Annex A3.3). Methane conversion rates (Y_m) and feed digestibilities were compared to literature values representative for Swiss conditions.

The emission factors of category 4A have been compared to the corresponding emission factors of other countries (UNFCCC http://unfccc.int/di/FlexibleQueries.do) and to the IPCC default value if available (INFRAS 2012). Implied emission factors for enteric fermentation in Switzerland are generally higher than IPCC default due to relatively high gross energy intake (ART 2011c). This can be explained by the high performance of animal livestock in Switzerland (weight, weight gain, milk production). In the case of young cattle, energy intake values are lower than when calculated with the IPCC default methodology. High feed quality together with high genetic standard i.e. high energy use efficiency of Swiss cattle might be a reason for the differences (ART 2011c). However, a straightforward comparison is difficult due to the inconsistent categorization of immature cattle.

During the years 2009-2012 the group of animal nutrition from the Swiss Federal Institute of Technology Zürich investigated the effect of different feeding and management strategies on methane and nitrous oxide emissions from enteric fermentation and manure management of cattle held under typical Swiss management conditions (Kreuzer 2012). Measured values of various parameters such as Y_m or MCF have been compared to IPCC default values and values in the Swiss greenhouse gas inventory. Preliminary analysis suggests that overall emissions are neither over- nor underestimated. Further investigations have to show to what extent the preliminary estimates will be confirmed to provide a basis for implementation in Switzerland’s GHG inventory.

The time series of activity data and emission factors have been compared between the current and the previous submission. All activity data, implied emission factors and emissions estimates undergo the following triple check:

- the results for 2010 are compared with the results for 2009 within the current CRF
- the CRF tables for the year 2009 are compared between the current CRF tables and the CRF tables of the submission 2011.
- the CRF tables for the base year 1990 are compared between the current CRF tables and the CRF tables of submission the 2011

Additionally an independent quality control was conducted by INFRAS by a countercheck of the data and calculation sheets elaborated by ART (ART 2012).

6.2.5 Source-Specific Recalculations

Time series-consistency of animal numbers (activity data) has been consolidated and improved, leading to minor recalculations. The most important changes concern the categories “Mature non-dairy cattle”, “pre-weaned claves”, “horses” and “mules and asses”. In official statistics the categories “Mature non-dairy cattle” and “pre weaned calves” are included under “Mature dairy cattle” and “fattening calves” for the years 1990-1999. Due to the increase of this more extensive production system (natura beef production) the respective categories have been split in 1999 and have been reported separately since then. This led to inconsistencies (e.g. 7.3% drop of the number of “Mature Dairy Cattle” between 1998 and 1999). The inconsistencies have been corrected in the GHG inventory by an independent estimate of the number of “Mature non-dairy cattle” and “pre weaned calves” for 1990-1998 (ART/SHL 2012). Additionally, non-agricultural horses and non-agricultural mules and asses are newly reported for the whole time-series, leading to an increase of emissions from 4A. Details of this recalculation are described in ART/SHL (2012).

A general recalculation for the years 2008 - 2009 has been carried out due to some data updates from the Swiss Farmers Union (SBV 2011). The respective changes are only of minor importance for total emission estimates.

6.2.6 Source-Specific Planned Improvements

A revision of energy intake estimates of non-cattle animals, particularly mules and asses, is aspired.

6.3 Source Category 4B – Manure Management

6.3.1 Source Category Description

Tier 1 and Tier2 Key categories 4B
CH_4 emissions from Manure Management (level), only trend Key Category in Tier 2 analysis
N_2O emissions from Manure Management (level and trend)

CH_4 and N_2O emissions from manure management are reported. The total emissions from manure management follow closely the development of the cattle population. Emissions have been declining from 1990 until 2004, and are since then increasing slightly again.

Table 6-7 Specification of source category 4B "Manure Management (CH_4)". (AD: Activity data; EF: Emission factor).

4B	Source	Specification	Data Source
4B1	Cattle	Mature dairy cattle Mature non-dairy cattle Young cattle	AD: SBV 2011; ART/SHL 2012 EF: IPCC 2000; IPCC 1997c; Flisch et al. 2009; Agrammon 2010; Soliva 2006
4B3 4B4 4B6 4B8	Sheep Goats Horses Swine		AD: SBV 2011; ART/SHL 2012 EF: IPCC 2000; IPCC 1997c; Flisch et al. 2009; Agrammon 2010; Soliva 2006
4B7	Mules and Asses		AD: SBV 2011; ART/SHL 2012 EF: IPCC 2000; IPCC 1997c; Flisch et al. 2009; Agrammon 2010; Soliva 2006
4B9	Poultry		AD: SBV 2011; ART/SHL 2012 EF: IPCC 2000; IPCC 1997c; Flisch et al. 2009; Agrammon 2010; Soliva 2006

Table 6-8 Specification of source category 4B "Manure Management" (N_2O).

4B	Source	Specification	Data Source
4B11 4B12	Liquid systems Solid storage and dry lot		AD: SBV 2011; ART/SHL 2012; Flisch et al. 2009; Agrammon 2010 EF: IPCC 1997c; IPCC 2000

6.3.2 Methodological Issues

For calculation of CH_4 and N_2O emissions slightly different livestock sub-categories are used. The livestock categories reported in the CRF tables are the same, but the respective sub-categories as a basis for the calculation are different. Nevertheless, there is no inconsistency in the total number of animals as they are the same both for CH_4 and N_2O emissions. The calculation of CH_4 and N_2O emissions is realised in ART (2012).

Calculation of CH_4 emissions is based on the domestic livestock populations mature dairy cattle, mature non-dairy cattle, young cattle (fattening calves, pre-weaned calves, breeding calves, breeding cattle 4-12 months, breeding cattle > 1 year, fattening calves 0-4 months, fattening cattle 4-12 months), sheep, goats, horses, mules and asses, swine and poultry as reported for enteric fermentation.

Calculation of N_2O emissions are based on a different livestock population break down:

- Cattle: Mature dairy cattle, mature non-dairy cattle and young cattle (fattening calves, pre-weaned calves, breeding cattle 1st year, breeding cattle 2nd year, breeding cattle 3rd year, fattening cattle). Although not young cattle in the proper sense, bulls are contained in the categories "Breeding cattle 3rd year" and "Fattening cattle" according to their purposes.
- Sheep: fattening sheep, milk sheep
- Goats: goat places
- Horses: horses < 3 years, horses > 3 years
- Mules and asses: mules, asses
- Swine: piglets, fattening pig over 25 kg, dry sows, nursing sows, boars
- Poultry: growers, layers, broilers, turkey, other poultry (geese, ducks, ostriches, quails)

This calculation is chosen because more detailed data on parameters such as N excretion or manure management system distribution for the particular animal categories are available (Flisch et al. 2009, Agrammon 2010). The nitrogen excretion rates are given on a yearly basis, considering replacement of animals (young cattle, swine and poultry) and including excretions from corresponding offspring and other associated animals (sheep, goats, swine) (ART/SHL 2012).

6.3.2.1 CH_4 Emissions

a) Methodology

Calculation of CH_4 emissions from manure management is based on IPCC Tier 2 (IPCC 2000: equation 4.17).

$$EF_i = VS_i \bullet 365\ days/year \bullet Bo_i \bullet 0.67\ kg/m^3 \bullet \sum_{ijk} MCF_{jk} \bullet MS_{ijk}$$

EF_i: annual emission factor for livestock population i
VS_i: daily volatile solids (VS) excreted for an animal within population i
Bo_i: maximum CH_4 producing capacity for manure produced by an animal within population i
MCF_{jk}: CH_4 conversion factors for each manure management system j by climate region k
MS_{ijk}: fraction of animal species / category i’s manure handled using manure system j in climate region k

b) Emission factor

Calculation of the emission factor is based on the parameters volatile solids excreted (VS), the maximum CH_4 producing capacity for manure (B_o) and the CH_4 conversion factors for each manure management system (MCF).

The **daily excretions of VS** for cattle sub-categories were estimated according to the IPCC Guidelines and GPG (2000: equation 4.16: p. 4.31). Gross energy intake is calculated according to the method described in Chapter 6.2.2. For the livestock categories swine, sheep, goats, horses, mules and asses, and poultry default values from IPCC (1997c: Reference Manual: p. 4.39 to 4.47) were taken.

The **ash content** of cattle manure is assumed to amount 8% on average (IPCC 1997c: Reference Manual: p. 4.47).

The **digestible energy** of the feed for cattle is assumed to be 60% on average, except for calves with 65% (IPCC 1997c: Reference Manual: p. 4.39).

For the Methane Producing Potential (**B_o**) default values are used (IPCC 1997c: Reference Manual: p. 4.39 to 4.47).

For the Methane Conversion Factor (**MCF**) IPCC default values are used (IPCC 2000, p. 4.36 and IPCC 1997c: Reference Manual: p. 4.25). In Switzerland mainly two manure management systems exist, solid storage and liquid/slurry storage. Fattening calves, sheep and goats are mainly kept in deep litter systems and there are also specific MCF values for pasture and poultry systems: The following MCF's were used:

Table 6-9 Manure management systems and Methane conversion factors (MCFs). References: IPCC 2000, p. 4.36 and IPCC 1997b: p. 4.25 (for liquid/slurry and deep litter).

Manure management system	Description	MCF
Solid manure	Dung and urine are excreted in a barn. The solids (with and without litter) are collected and stored in bulk for a long time (months) before disposal.	1%
Liquid/slurry	Combined storage of dung and urine under animal confinements for longer than 1 month.	10%
Pasture	Manure is allowed to lie as it is, and is not managed (distributed, etc.).	1%
Deep litter	Dung and urine is excreted in a barn with lots of litter and is not removed for a long time (months). This is applied for the cattle sub-categories of fattening calves, fattening calves 0-4 months, and for sheep and goats.	10%
Poultry system	Manure is excreted on the floor with or without bedding.	1.5%

For the MCF for deep litter the 2000 IPCC good practice guidance suggest a value of 39%. However, this would lead to a rather large overestimation of methane emissions from deep litter manure management systems in Switzerland. Since the 2000 IPCC good practice guidance state that the MCF's for cattle and swine deep litter are similar to liquid/slurry, the respective value from the 1996 IPCC guidelines (IPCC 1997b) has been adopted. The choice of a MCF of 10% for deep litter is supported by a number of studies representative for the country specific management conditions. For further details see FOEN 2011. The fraction of animal's manure handled using different manure management systems (**MS**) as well as the percentages of the grazing time was separately calculated for each livestock category. The fractions are based on Flisch et al. (2009) and calculated within the Swiss ammonium model AGRAMMON (Agrammon 2010). Input data for the AGRAMMON-model for the years 1990 and 1995 is based on expert judgement and literature whereas data for 2002 and 2007 is based on extensive farm surveys. Values in between the assessment years have been interpolated linearly (Table 6-10) while values beyond 2007 are kept constant until new survey results are available. The data clearly reflects the shift towards an increased use of pasture, range and paddocks and a decrease in solid storage.

Table 6-10 Manure management system distribution

MS Distribution		1990			1995			2002			2007-2010		
		%			%			%			%		
Cattle		Solid manure / Deep litter	Liquid/Slurry	Pasture range and paddock	Solid manure / Deep litter	Liquid/Slurry	Pasture range and paddock	Solid manure / Deep litter	Liquid/Slurry	Pasture range and paddock	Solid manure / Deep litter	Liquid/Slurry	Pasture range and paddock
Mature Dairy Cattle		27.70	64.04	8.26	24.54	65.88	9.59	16.07	65.71	18.22	13.90	67.80	18.30
Mature Non-Dairy Cattle		32.23	41.47	26.30	34.17	39.53	26.30	18.65	40.74	40.61	19.14	50.44	30.42
Young Cattle		36.13	48.09	15.78	35.42	48.68	15.90	29.31	42.98	27.72	27.47	46.28	26.24
	Fattening Calves	85.09	14.91	0.00	84.73	15.27	0.00	84.95	14.72	0.33	76.97	22.86	0.16
	Pre-Weaned Calves	32.23	41.47	26.30	34.17	39.53	26.30	19.29	42.16	38.55	17.38	50.96	31.67
	Breeding Cattle 1st Year	48.62	37.32	14.06	47.49	38.27	14.24	37.19	35.38	27.43	34.03	41.89	24.08
	Breeding Cattle 2nd Year	28.15	46.48	25.37	26.74	47.54	25.72	22.49	39.07	38.43	20.33	41.72	37.95
	Breeding Cattle 3rd Year	29.21	50.78	20.02	27.97	51.65	20.38	21.70	43.45	34.85	21.15	45.96	32.89
	Fattening Cattle	29.65	70.35	0.00	33.32	66.68	0.00	29.41	68.17	2.42	31.90	63.47	4.63
Sheep		69.90	0.00	30.10	69.73	0.00	30.27	66.46	0.00	33.54	60.78	0.00	39.22
	Fattening Sheep	69.32	0.00	30.68	69.32	0.00	30.68	65.67	0.00	34.33	59.84	0.00	40.16
	Milksheep	88.57	0.00	11.43	88.57	0.00	11.43	83.62	0.00	16.38	75.92	0.00	24.08
Goats		86.39	0.00	13.61	86.39	0.00	13.61	90.26	0.00	9.74	92.88	0.00	7.12
	Goat Places	86.39	0.00	13.61	86.39	0.00	13.61	90.26	0.00	9.74	92.88	0.00	7.12
Horses		93.15	0.00	6.85	93.15	0.00	6.85	74.66	0.00	25.34	78.18	0.00	21.82
	Horses <3 years	93.15	0.00	6.85	93.15	0.00	6.85	60.38	0.00	39.62	61.59	0.00	38.41
	Horses >3 years	93.15	0.00	6.85	93.15	0.00	6.85	77.77	0.00	22.23	81.36	0.00	18.64
Mules and Asses		93.15	0.00	6.85	93.15	0.00	6.85	80.34	0.00	19.66	73.66	0.00	26.34
	Mules	93.15	0.00	6.85	93.15	0.00	6.85	80.34	0.00	19.66	73.66	0.00	26.34
	Asses	93.15	0.00	6.85	93.15	0.00	6.85	80.34	0.00	19.66	73.66	0.00	26.34
Swine		0.00	100.00	0.00	0.00	100.00	0.00	0.46	99.42	0.12	0.19	98.61	1.20
	Piglets	0.00	100.00	0.00	0.00	100.00	0.00	1.13	98.87	0.00	0.93	98.71	0.36
	Fattening Pig over 25 kg	0.00	100.00	0.00	0.00	100.00	0.00	0.37	99.46	0.17	0.00	98.48	1.52
	Dry Sows	0.00	100.00	0.00	0.00	100.00	0.00	0.05	99.89	0.07	0.10	98.86	1.03
	Nursing Sows	0.00	100.00	0.00	0.00	100.00	0.00	0.94	99.06	0.00	0.74	98.92	0.34
	Boars	0.00	100.00	0.00	0.00	100.00	0.00	0.73	99.04	0.23	0.00	98.85	1.15
Poultry		100.00	0.00	0.00	99.50	0.00	0.50	97.43	0.00	2.57	96.34	0.00	3.66
	Growers	100.00	0.00	0.00	99.41	0.00	0.59	99.84	0.00	0.16	98.54	0.00	1.46
	Layers	100.00	0.00	0.00	99.41	0.00	0.59	94.88	0.00	5.12	92.69	0.00	7.31
	Broilers	100.00	0.00	0.00	99.61	0.00	0.39	99.39	0.00	0.61	98.84	0.00	1.16
	Turkey	100.00	0.00	0.00	99.61	0.00	0.39	96.94	0.00	3.06	96.93	0.00	3.07
	Other Poultry (Geese, Ducks, Ostriches, Quails)	100.00	0.00	0.00	100.00	0.00	0.00	98.88	0.00	1.12	96.94	0.00	3.06

c) Activity data

Activity data on all livestock categories is taken from SBV (2011) and the Swiss Federal Statistical Office (SFSO). All activity data has been revised and harmonized during a joint effort of the Agroscope Reckenholz Tänikon Research Station (ART) and the Swiss College of Agriculture (SHL) in 2011 (ART/SHL 2012) (refer to chapter 6.2.2.3 for details).

6.3.2.2 N_2O Emissions

a) Methodology

For the calculation of N_2O emissions from manure management a country specific method based on the Swiss ammonia model AGRAMMON is applied (Agrammon 2010). Basically the IPCC emission factors are used, but activity data is adjusted to the particular situation of Switzerland.

For calculation of emissions from manure management AGRAMMON applies other values for the nitrogen excretion per animal category than IPCC and differentiates the animal waste management systems Liquid systems and Solid storage. N_2O emissions from pasture, range and paddock appear under the category „D Agricultural soils, subcategory 2 animal production". IPCC categories „daily spread" and „other systems" are not occurring. The basic animal waste management systems are defined in Flisch et al. (2009) and Menzi et al. (1997).

b) Emission factors

IPCC default emission factors are used for the two animal waste management systems (IPCC 1997c: Reference Manual: p. 4.104).

Table 6-11 Emission factors for calculating N_2O emissions from manure management (IPCC 1997c: p. 4.104).

Source	Emission factor per animal waste management system (kg N_2O-N / kg N)
Liquid systems	0.001
Solid storage	0.020

c) Activity data

Livestock population data of all categories are taken from the Swiss Farmers Union (SBV 2011) and the Swiss Federal Statistical Office (SFSO). All activity data has been revised and harmonized during a joint effort of the Agroscope Reckenholz Tänikon Research Station (ART) and the Swiss College of Agriculture (SHL) in 2011 (ART/SHL 2012). Input data is subdivided into the following livestock categories:

Table 6-12 Activity data for calculating N_2O emissions from manure management (ART/SHL 2012).

Population Size		1990-1999									
		1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
		1000 head									
Cattle											
Mature Dairy Cattle		783.1	780.5	763.5	744.5	742.0	739.6	736.0	711.6	701.3	683.5
Mature Non-Dairy Cattle		12.0	14.0	17.0	18.0	20.0	23.0	28.0	32.0	36.0	41.2
Young Cattle		1060.1	1034.4	1002.1	982.6	983.7	985.6	983.0	929.3	903.5	884.0
	Fattening Calves	112.3	111.4	109.5	111.1	106.4	101.7	112.0	106.0	108.1	116.4
	Pre-Weaned Calves	9.6	11.2	13.6	14.4	16.0	18.4	22.4	25.6	28.8	33.2
	Breeding Cattle 1st Year	346.4	336.7	324.0	308.2	301.5	294.7	286.1	260.1	253.5	218.7
	Breeding Cattle 2nd Year	253.3	251.9	250.5	238.7	238.6	238.6	243.0	232.9	217.4	187.5
	Breeding Cattle 3rd Year	150.7	148.4	146.7	142.3	140.8	139.4	139.9	139.3	132.7	117.9
	Fattening Cattle	187.8	174.8	157.8	168.0	180.4	192.9	179.6	165.4	163.1	210.2
Sheep		395.2	409.4	414.7	424.0	405.4	386.7	418.6	420.4	422.3	423.5
	Fattening Sheep	190.6	200.8	201.0	211.1	201.2	191.4	207.6	208.0	208.7	221.7
	Milksheep	4.3	4.0	3.8	3.5	3.3	3.0	2.8	3.1	4.4	5.8
Goats		68.3	65.2	58.2	56.7	54.9	53.2	56.8	58.0	60.1	61.6
	Goat Places	44.8	43.1	38.4	37.3	35.9	34.6	37.1	37.7	39.8	40.8
Horses		51.2	52.2	53.2	54.3	58.0	61.6	62.4	64.7	63.8	65.3
	Horses <3 years	11.0	11.3	11.5	11.7	14.1	16.4	15.5	14.1	13.8	14.8
	Horses >3 years	40.2	41.0	41.8	42.6	43.9	45.2	46.9	50.7	50.1	50.5
Mules and Asses		10.7	10.9	11.1	11.3	11.3	11.2	12.3	13.3	13.7	15.2
	Mules	0.3	0.3	0.3	0.3	0.4	0.4	0.5	0.5	0.5	0.6
	Asses	10.4	10.6	10.8	11.0	10.9	10.8	11.8	12.8	13.2	14.6
Swine		1787.0	1722.6	1705.7	1691.8	1568.7	1445.6	1379.4	1394.9	1487.0	1453.3
	Piglets	299.4	282.5	290.8	299.6	287.2	274.8	240.9	252.2	261.8	281.0
	Fattening Pig over 25 kg	1024.6	989.6	972.8	943.0	855.5	767.9	778.7	779.6	837.4	734.4
	Dry Sows	129.3	126.0	124.9	125.3	117.1	108.9	98.8	104.3	110.9	101.2
	Nursing Sows	37.4	36.8	36.8	37.3	35.1	33.0	30.2	29.9	31.4	35.0
	Boars	8.4	8.1	8.0	8.2	7.7	7.1	6.3	6.4	6.4	6.2
Poultry		5938.2	5646.8	5501.6	6409.8	6330.3	6250.7	6440.5	6552.5	6739.6	6907.5
	Growers	718.9	664.2	709.6	719.2	716.8	714.4	732.1	732.9	793.5	760.9
	Layers	3083.0	2645.4	2535.8	2517.6	2317.9	2118.2	2226.0	2277.5	2270.1	2222.8
	Broilers	2019.9	2198.6	2095.5	2990.2	3110.6	3231.0	3293.2	3342.0	3502.3	3747.4
	Turkey	94.7	117.4	140.1	162.8	166.5	170.2	173.8	184.4	157.8	154.6
	Other Poultry (Geese, Ducks, Ostriches, Quails)	21.8	21.2	20.6	20.0	18.4	16.9	15.3	15.8	15.9	21.9

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Population Size		2000-2009									
		2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
		1000 head									
Cattle											
Mature Dairy Cattle		669.4	669.4	657.9	638.3	621.0	620.7	618.1	614.8	628.5	599.4
Mature Non-Dairy Cattle		44.9	50.6	58.1	65.1	70.0	78.5	87.3	93.5	98.4	108.4
Young Cattle		873.7	891.3	877.7	866.7	853.6	855.5	861.4	863.4	877.4	889.7
	Fattening Calves	103.3	114.7	114.4	113.9	111.3	105.6	101.2	100.5	95.0	100.5
	Pre-Weaned Calves	35.7	40.4	46.9	52.3	56.6	62.5	67.3	72.2	76.1	85.8
	Breeding Cattle 1st Year	236.0	238.1	229.5	219.8	214.7	222.0	223.2	223.3	232.4	225.7
	Breeding Cattle 2nd Year	221.9	219.3	219.1	212.7	205.4	204.7	210.2	210.5	212.7	212.2
	Breeding Cattle 3rd Year	129.8	130.4	126.0	124.0	120.9	113.3	110.1	109.1	109.6	118.8
	Fattening Cattle	147.1	148.5	141.7	144.1	144.7	147.5	149.4	148.0	151.6	146.6
Sheep		420.7	420.0	429.5	444.8	440.5	446.4	450.9	443.6	446.2	431.9
	Fattening Sheep	216.6	216.6	219.9	228.6	227.5	229.4	230.6	230.0	229.4	227.3
	Milksheep	6.7	7.0	7.2	8.0	8.1	8.9	13.0	10.2	10.7	11.7
Goats		62.5	63.0	66.0	67.4	70.6	74.0	76.3	79.1	81.4	81.2
	Goat Places	41.4	42.1	43.0	44.9	46.2	48.5	50.6	51.9	53.4	54.3
Horses		66.2	64.4	64.3	64.7	64.5	64.9	65.8	66.9	67.8	69.1
	Horses <3 years	13.3	12.5	12.0	11.5	11.3	11.0	11.1	11.2	11.0	10.4
	Horses >3 years	52.9	51.9	52.4	53.2	53.3	53.8	54.7	55.7	56.7	58.8
Mules and Asses		15.5	16.0	16.6	17.3	17.8	18.8	19.2	19.9	20.5	22.1
	Mules	0.5	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.5	0.9
	Asses	15.0	15.4	16.0	16.7	17.3	18.2	18.6	19.3	19.9	21.1
Swine		1498.2	1547.7	1556.7	1528.9	1537.5	1609.5	1634.8	1573.1	1540.1	1557.2
	Piglets	296.6	318.8	326.6	322.8	327.8	337.6	366.5	344.8	336.1	338.4
	Fattening Pig over 25 kg	750.9	762.5	767.9	751.7	753.2	796.7	786.1	766.9	763.2	779.5
	Dry Sows	104.8	108.0	108.6	105.3	107.9	112.7	115.2	105.7	105.4	104.7
	Nursing Sows	36.7	37.5	36.5	35.8	35.3	36.0	36.5	34.9	32.6	33.1
	Boars	6.2	6.1	5.8	5.3	5.2	5.1	4.9	4.2	4.0	3.8
Poultry		6983.0	6939.5	7338.6	7587.3	8060.7	8260.4	7670.3	8228.5	8542.8	8809.4
	Growers	831.7	745.3	753.9	809.0	853.1	867.7	888.4	901.8	919.0	966.7
	Layers	2150.3	2069.5	2154.1	2117.2	2088.8	2188.5	2147.3	2197.7	2254.9	2318.3
	Broilers	3807.8	3993.2	4298.2	4518.4	4970.8	5060.4	4481.3	5002.4	5300.4	5456.2
	Turkey	172.6	123.0	123.9	133.8	138.8	132.3	137.1	112.5	53.8	52.4
	Other Poultry (Geese, Ducks, Ostriches, Quails)	20.7	8.6	8.5	8.8	9.3	11.5	16.1	14.2	14.7	15.9

Population Size		
		2010
		1000 head
Cattle		
Mature Dairy Cattle		589.0
Mature Non-Dairy Cattle		111.3
Young Cattle		890.9
	Fattening Calves	99.4
	Pre-Weaned Calves	88.1
	Breeding Cattle 1st Year	226.4
	Breeding Cattle 2nd Year	212.8
	Breeding Cattle 3rd Year	119.2
	Fattening Cattle	145.1
Sheep		434.1
	Fattening Sheep	228.2
	Milksheep	12.4
Goats		82.8
	Goat Places	54.7
Horses		71.4
	Horses <3 years	10.0
	Horses >3 years	61.4
Mules and Asses		23.5
	Mules	1.1
	Asses	22.3
Swine		1589.0
	Piglets	350.9
	Fattening Pig over 25 kg	788.1
	Dry Sows	106.1
	Nursing Sows	33.5
	Boars	3.7
Poultry		9024.9
	Growers	925.5
	Layers	2438.1
	Broilers	5580.1
	Turkey	58.1
	Other Poultry (Geese, Ducks, Ostriches, Quails)	23.2

Data on nitrogen excretion per animal category (kg N/head/year) is taken from Agrammon (2010) (see Table 6-13). These values are based on Flisch et al. (2009) and adjusted according to the Swiss ammonia model AGRAMMON. Unlike IPCC, the age structure of the animals and the different use of the animals (e.g. fattening and breeding) are considered. Calculation of nitrogen excretion of dairy cattle is dependent on milk production and is therefore increasing from 1990 to 2010. Sheep in Switzerland are fed mainly according to a regime based on roughage from extensive pasture and meadows (Flisch et al. 2009) and are estimated to excrete approximately 8.0 kg N per head and year. This is considerably lower than IPCC default. However, nitrogen excretion is averaged over the whole population of which roughly 50% are lambs and other immature animals. Swine show a significant decrease in nitrogen excretion per head over almost the whole inventory time period which can be explained by the increasing use of protein reduced fodder.

The consideration of adopted nitrogen excretion values is one of the major advantages of the country specific method in Switzerland. The more disaggregated approach leads to considerable lower calculated nitrogen excretion rates compared to IPCC, which therefore also implies lower total N_2O emissions from manure management.

Table 6-13 Nitrogen excretion per animal category (kg N/head/year) 1990-2010 (Agrammon 2010)

Nitrogen Excretion		**1990-1999**									
		1990	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**
		kg N / head / year									
Cattle											
Mature Dairy Cattle		96.06	96.57	97.09	97.61	98.13	98.65	99.35	100.05	100.75	101.45
Mature Non-Dairy Cattle		80.00	80.00	80.00	80.00	80.00	80.00	80.00	80.00	80.00	80.00
Young Cattle		33.08	33.11	33.21	33.13	33.25	33.37	33.28	33.56	33.31	32.85
	Fattening Calves	13.00	13.00	13.00	13.00	13.00	13.00	13.00	13.00	13.00	13.00
	Pre-Weaned Calves	34.00	34.00	34.00	34.00	34.00	34.00	34.00	34.00	34.00	34.00
	Breeding Cattle 1st Year	25.00	25.00	25.00	25.00	25.00	25.00	25.00	25.00	25.00	25.00
	Breeding Cattle 2nd Year	40.00	40.00	40.00	40.00	40.00	40.00	40.00	40.00	40.00	40.00
	Breeding Cattle 3rd Year	55.00	55.00	55.00	55.00	55.00	55.00	55.00	55.00	55.00	55.00
	Fattening Cattle	33.00	33.00	33.00	33.00	33.00	33.00	33.00	33.00	33.00	33.00
Sheep		7.46	7.56	7.46	7.64	7.62	7.59	7.58	7.58	7.63	8.14
	Fattening Sheep	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00
	Milksheep	21.00	21.00	21.00	21.00	21.00	21.00	21.00	21.00	21.00	21.00
Goats		10.49	10.58	10.56	10.53	10.47	10.41	10.43	10.42	10.58	10.59
	Goat Places	16.00	16.00	16.00	16.00	16.00	16.00	16.00	16.00	16.00	16.00
Horses		43.57	43.57	43.57	43.57	43.51	43.47	43.50	43.56	43.57	43.55
	Horses <3 years	42.00	42.00	42.00	42.00	42.00	42.00	42.00	42.00	42.00	42.00
	Horses >3 years	44.00	44.00	44.00	44.00	44.00	44.00	44.00	44.00	44.00	44.00
Mules and Asses		15.70	15.70	15.70	15.70	15.70	15.70	15.70	15.70	15.70	15.70
	Mules	15.70	15.70	15.70	15.70	15.70	15.70	15.70	15.70	15.70	15.70
	Asses	15.70	15.70	15.70	15.70	15.70	15.70	15.70	15.70	15.70	15.70
Swine		13.40	13.41	13.36	13.19	13.02	12.83	12.81	12.44	12.10	11.01
	Piglets	4.60	4.60	4.60	4.60	4.60	4.60	4.60	4.61	4.61	4.62
	Fattening Pig over 25 kg	16.93	16.88	16.83	16.78	16.73	16.68	16.15	15.63	15.10	14.58
	Dry Sows	24.23	24.23	24.23	24.23	24.23	24.23	23.62	23.02	22.42	21.81
	Nursing Sows	51.26	51.26	51.26	51.26	51.26	51.26	50.42	49.57	48.73	47.89
	Boars	20.58	20.58	20.58	20.58	20.58	20.58	20.21	19.84	19.47	19.10
Poultry		0.57	0.56	0.56	0.54	0.53	0.53	0.53	0.53	0.52	0.52
	Growers	0.34	0.34	0.34	0.34	0.34	0.34	0.34	0.34	0.34	0.34
	Layers	0.71	0.71	0.71	0.71	0.71	0.71	0.71	0.71	0.71	0.71
	Broilers	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40
	Turkey	1.40	1.40	1.40	1.40	1.40	1.40	1.40	1.40	1.40	1.40
	Other Poultry (Geese, Ducks, Ostriches, Quails)	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56

Nitrogen Excretion		**2000-2009**									
		2000	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**
		kg N / head / year									
Cattle											
Mature Dairy Cattle		102.15	102.85	103.55	104.49	105.42	106.35	107.28	108.21	109.00	110.37
Mature Non-Dairy Cattle		80.00	80.00	80.00	80.00	80.00	80.00	80.00	80.00	80.00	80.00
Young Cattle		33.56	33.27	33.26	33.27	33.25	33.12	33.18	33.17	33.25	33.42
	Fattening Calves	13.00	13.00	13.00	13.00	13.00	13.00	13.00	13.00	13.00	13.00
	Pre-Weaned Calves	34.00	34.00	34.00	34.00	34.00	34.00	34.00	34.00	34.00	34.00
	Breeding Cattle 1st Year	25.00	25.00	25.00	25.00	25.00	25.00	25.00	25.00	25.00	25.00
	Breeding Cattle 2nd Year	40.00	40.00	40.00	40.00	40.00	40.00	40.00	40.00	40.00	40.00
	Breeding Cattle 3rd Year	55.00	55.00	55.00	55.00	55.00	55.00	55.00	55.00	55.00	55.00
	Fattening Cattle	33.00	33.00	33.00	33.00	33.00	33.00	33.00	33.00	33.00	33.00
Sheep		8.06	8.08	8.03	8.09	8.13	8.13	8.28	8.26	8.22	8.47
	Fattening Sheep	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00
	Milksheep	21.00	21.00	21.00	21.00	21.00	21.00	21.00	21.00	21.00	21.00
Goats		10.60	10.69	10.43	10.66	10.47	10.49	10.61	10.50	10.49	10.70
	Goat Places	16.00	16.00	16.00	16.00	16.00	16.00	16.00	16.00	16.00	16.00
Horses		43.60	43.61	43.63	43.64	43.65	43.66	43.66	43.67	43.67	43.70
	Horses <3 years	42.00	42.00	42.00	42.00	42.00	42.00	42.00	42.00	42.00	42.00
	Horses >3 years	44.00	44.00	44.00	44.00	44.00	44.00	44.00	44.00	44.00	44.00
Mules and Asses		15.70	15.70	15.70	15.70	15.70	15.70	15.70	15.70	15.70	15.70
	Mules	15.70	15.70	15.70	15.70	15.70	15.70	15.70	15.70	15.70	15.70
	Asses	15.70	15.70	15.70	15.70	15.70	15.70	15.70	15.70	15.70	15.70
Swine		10.67	10.25	9.91	9.74	9.59	9.47	9.23	9.07	9.15	9.18
	Piglets	4.62	4.62	4.63	4.57	4.51	4.46	4.40	4.35	4.35	4.35
	Fattening Pig over 25 kg	14.05	13.53	13.00	12.75	12.50	12.25	12.00	11.76	11.76	11.76
	Dry Sows	21.21	20.60	20.00	20.10	20.19	20.29	20.38	20.48	20.48	20.48
	Nursing Sows	47.05	46.20	45.36	45.00	44.65	44.29	43.93	43.58	43.58	43.58
	Boars	18.74	18.37	18.00	18.06	18.13	18.19	18.25	18.32	18.32	18.32
Poultry		0.51	0.50	0.50	0.51	0.51	0.52	0.54	0.54	0.54	0.54
	Growers	0.34	0.34	0.34	0.34	0.34	0.34	0.34	0.34	0.34	0.34
	Layers	0.71	0.71	0.71	0.73	0.75	0.76	0.78	0.80	0.80	0.80
	Broilers	0.40	0.40	0.40	0.41	0.42	0.43	0.44	0.45	0.45	0.45
	Turkey	1.40	1.40	1.40	1.40	1.40	1.40	1.40	1.40	1.40	1.40
	Other Poultry (Geese, Ducks, Ostriches, Quails)	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56

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Nitrogen Excretion		
		2010
		kg N / head / year
Cattle		
Mature Dairy Cattle		110.81
Mature Non-Dairy Cattle		80.00
Young Cattle		33.45
	Fattening Calves	13.00
	Pre-Weaned Calves	34.00
	Breeding Cattle 1st Year	25.00
	Breeding Cattle 2nd Year	40.00
	Breeding Cattle 3rd Year	55.00
	Fattening Cattle	33.00
Sheep		8.48
	Fattening Sheep	15.00
	Milksheep	21.00
Goats		10.57
	Goat Places	16.00
Horses		43.72
	Horses <3 years	42.00
	Horses >3 years	44.00
Mules and Asses		15.70
	Mules	15.70
	Asses	15.70
Swine		9.12
	Piglets	4.35
	Fattening Pig over 25 kg	11.76
	Dry Sows	20.48
	Nursing Sows	43.58
	Boars	18.32
Poultry		0.54
	Growers	0.34
	Layers	0.80
	Broilers	0.45
	Turkey	1.40
	Other Poultry (Geese, Ducks, Ostriches, Quails)	0.56

The split of nitrogen flows into the different animal waste management systems and its temporal dynamic is based on Agrammon (2010). The distribution is consistent with the allocation of volatile solids used for the calculation of CH_4 emissions (for further information refer to Chapter 6.3.2.1).

6.3.3 Uncertainties and Time-Series Consistency

For the uncertainty analysis the input data from ART (2008a) was used. The arithmetic mean of the lower and upper bound is used for activity data and for emission factors resulting in a combined uncertainty of 54.5% for CH_4 of 4B and 71.8% for N_2O from 4B. To aggregate liquid systems and solid storage (as required for input into Tier 1 and 2 analysis 4B/N_2O), the combined uncertainty of the emissions is determined by using Tier 1 error propagation for the sub-systems. For further results see Section 1.7. For Tier 2 uncertainty analysis correlations between emission factors or activity data are considered (see Annex 7.2.2).

Time series consistency of livestock population data and gross energy intake: See Chapter 6.2.3.)

Input data from the AGRAMMON-model are available for the years 1990 and 1995 (expert judgement and literature) as well as for 2002 and 2007 (extensive farm surveys). Values in between the assessment years were interpolated linearly while values beyond 2007 are mainly kept constant until new survey results are available. N_{ex} values for mature dairy cattle for the years after 2007 were extrapolated using average yearly milk production per dairy cow as driver.

6.3.4 Source-Specific QA/QC and Verification

All QA/QC activities are further described in a separate document (ART 2011c). General information on agricultural structures and policies is provided and eventual differences between national and (IPCC) standard values are being analysed and discussed.

For quality of livestock population data and animal energy intake please consult Chapter 6.2.4.

The time series of activity data and emission factors have been compared between the current and the previous submission. All activity data, implied emission factors and emissions undergo the following triple check:

- the results for 2010 are compared with the results for 2009 within the current CRF
- the results for 2009 are compared between the current CRF tables and the CRF tables of the submission 2011
- the results for the base year 1990 are compared between the current CRF tables and the CRF tables of the submission 2011.

Additionally an independent quality control was conducted by INFRAS by a countercheck of the data and calculation sheets elaborated by ART (ART 2012).

a) CH_4

For CH_4 the documentation about the data set and calculation method assures transparency and traceability of the calculation methods (Soliva 2006). Additionally a document in German lists all the methodological differences between the former calculations and the current methodology regarding CH_4 estimations (Soliva 2006a).

IPCC tables with data for estimating emission factors for all livestock categories (such as weight, feed digestibility, maximum CH_4 producing capacity (B_0) or daily excretion of volatile solids) were filled in, checked for consistency and confidence and compared with IPCC default values (refer to Table A - 34 in Annex A3.3). Factors for methane conversion (MCF) and manure management distribution (MS) were analysed considering the Swiss national agricultural context.

The emission factors of 4B CH_4 have been compared to the corresponding emission factors of other countries (UNFCCC http://unfccc.int/di/FlexibleQueries.do) and to the IPCC default value if available (ART 2011c, INFRAS 2012). Most implied emission factors for CH_4 emissions from manure management in Switzerland are considerably above IPCC default. Differences are mainly due to different allocations to manure management systems i.e., a higher share of manure stored in liquid systems and as deep litter.

Further the measurements conducted by Kreuzer (2012) show that the CH_4 building factors (Methane Producing Potential, B_0) used in this Inventory seem to represent reality well.

b) N_2O

N_2O estimation is based on the Swiss ammonium emission model AGRAMMON that is documented in Agrammon (2010).

All relevant data needed for the calculation of N_2O emissions such as nitrogen excretion, manure management system distribution and N_2O emission factors have been checked for consistency and have been compared to the corresponding values of other countries (UNFCCC http://unfccc.int/di/FlexibleQueries.do) and to the IPCC default value if available (ART 2011c). As one of the most important parameters, nitrogen excretion has been analysed in more detail. A comparison in 2011 revealed that bottom up calculations of total nitrogen excretion in the Swiss GHG inventory are only 5-8% below the values of an independent top down approach subtracting all nitrogen contained in animal products from the total amount of nitrogen in animal feedstuff produced in or imported to the country (Peter et al. 2006, Spiess 2005). Furthermore N_{ex} values for the most important animal categories (mature dairy cattle, mature non-dairy cattle and swine), being responsible for almost 70% of total nitrogen excretion, are very well in line with the alternative gross energy approach suggested in the 2006 IPCC guidelines.

During the years 2009-2012 the group of animal nutrition from the Swiss Federal Institute of Technology Zürich investigated the effect of different feeding and management strategies on methane and nitrous oxide emissions from enteric fermentation and manure management of cattle held under typical Swiss management conditions (Kreuzer 2012). Measured values of various parameters such as Y_m or MCF have been compared to IPCC default values and values in the Swiss greenhouse gas inventory. Preliminary analysis suggests that overall emissions are neither over- nor underestimated. Further investigations have to show to what extent the preliminary estimates will be confirmed to provide a basis for implementation in Switzerland's GHG inventory.

Source-Specific Recalculations Time series-consistency of animal numbers (activity data) has been consolidated and improved, leading to minor recalculations (ART/SHL 2012). For further details see Chapter 6.2.5.

A general recalculation for the year 2008 - 2009 has been carried out due to some data updates from the Swiss Farmers Union (SBV 2011). The respective changes are only of minor importance for total emission estimates.

6.3.5 Source-Specific Planned Improvements

New data from updated AGRAMMON projections were not yet available for estimating agricultural greenhouse gas emissions. Submissions under the UNECE and the UNFCCC are thus not overall consistent. However, updated AGRAMMON data will be implemented during the next annual submission.

A revision of energy intake estimates of non-cattle animals, particularly mules and asses, is aspired

Currently manure used for biogas production as reported under 1A1a and 6D is not subtracted from animal manure in sector 4B. It is planned to improve the respective cross sectoral reporting in future submissions to avoid double counting of emissions.

6.4 Source Category 4C – Rice Cultivation

Rice Cultivation is of minor importance in Switzerland. The agricultural land used for rice cultivation and the annual yield of rice are not estimated by the Swiss Farmers Union (SBV 2011). There is only some insignificant upland rice cultivation. CH_4 Emissions are assumed to be zero. They are therefore not considered in the emission calculation.

6.5 Source Category 4D – Agricultural Soils

6.5.1 Source Category Description

Tier 1 and Tier 2 Key category 4D:
4D1: N_2O emissions from Agricultural Soils; Direct Soil Emissions (level and trend)
4D2: N_2O emissions from Agric.Soils; Pasture, Range and Paddock Manure (level and trend)
4D3: N_2O emissions from Agricultural Soils; Indirect Soil Emissions (level and trend)

The source category 4D includes the following emissions: Direct N_2O emissions from soils and from animal production (emission from pasture, range and paddock), indirect N_2O emissions, other N_2O emissions from agricultural soils (application of sewage sludge and compost), NO_x emissions from soils and NMVOC emissions.

Direct and indirect N_2O emissions are decreasing since 1990 in almost all sub-categories. Contrarily N_2O emissions from animal production have been increasing due to a higher share of manure dropped on pasture, range and paddock. NO_x emissions declined by more than 13%.

The general trend can be explained by a reduction of the number of cattle and a reduced input of mineral fertilisers due to the introduction of the "Required standard of Ecological Performance (REP)" (ART 2011c, Leifeld and Fuhrer 2005). From 2004 on the cattle population increased again which lead to higher total animal manure nitrogen excretion.

Table 6-14 Specification of source category 4D "Agricultural Soils". (AD: Activity data; EF: Emission factor).

4D	Source	Specification	Data Source
4D1	Direct soil emissions	Includes emissions from synthetic fertilizer, animal manure, crop residues, N-fixing crops, organic soils, residues form meadows and pasture, N-fixation on meadows and pasture	AD: SBV 2011; ART/SHL 2012 ; Agricura 2010; FAL/RAC 2001; Flisch et al. 2009; Agrammon 2010; Leifeld et al. 2003; Schmid et al. 2000; Walther et al. 1994 EF: IPCC 1997c (N2O); IPCC 2000
4D2	Pasture, Range and Paddock Manure	Emissions from pasture, range and paddock	AD: SBV 2011; ART/SHL 2012 ; Flisch et al. 2009; Agrammon 2010 EF: IPCC 1997c
4D3	Indirect emissions	Leaching and run-off, N deposition air to soil	AD: SBV 2011; ART/SHL 2012 ; Flisch et al. 2009; Agrammon 2010; Prasuhn and Braun 1994; Braun et al. 1994; Schmid et al. 2000; EEA 2007 EF: IPCC 2000
4D4	Other (sewage sludge and compost used for fertilizing)		AD: SBV 2011; Agrammon 2010 EF: IPCC 1997c

6.5.2 Methodological Issues

Methodology

For calculation of N_2O emissions from agricultural soils the national method IULIA is applied. IULIA is an IPCC-derived method for the calculation of N_2O emissions from agriculture that basically uses the same emission factors, but adjusts the activity data to the particular situation of Switzerland (Schmid et al. 2000). According to Schmid et al. (2000) IULIA is better adapted to the conditions of Swiss agriculture, compared to the IPCC method.

IULIA has been updated with new parameters derived from the Swiss ammonium model AGRAMMON (Agrammon 2010). New values for nitrogen excretion, manure system distribution and ammonium emission factors have been adopted.

The modelling of the N_2O emissions is realised in ART (2012). The model structure is displayed in the following figure.

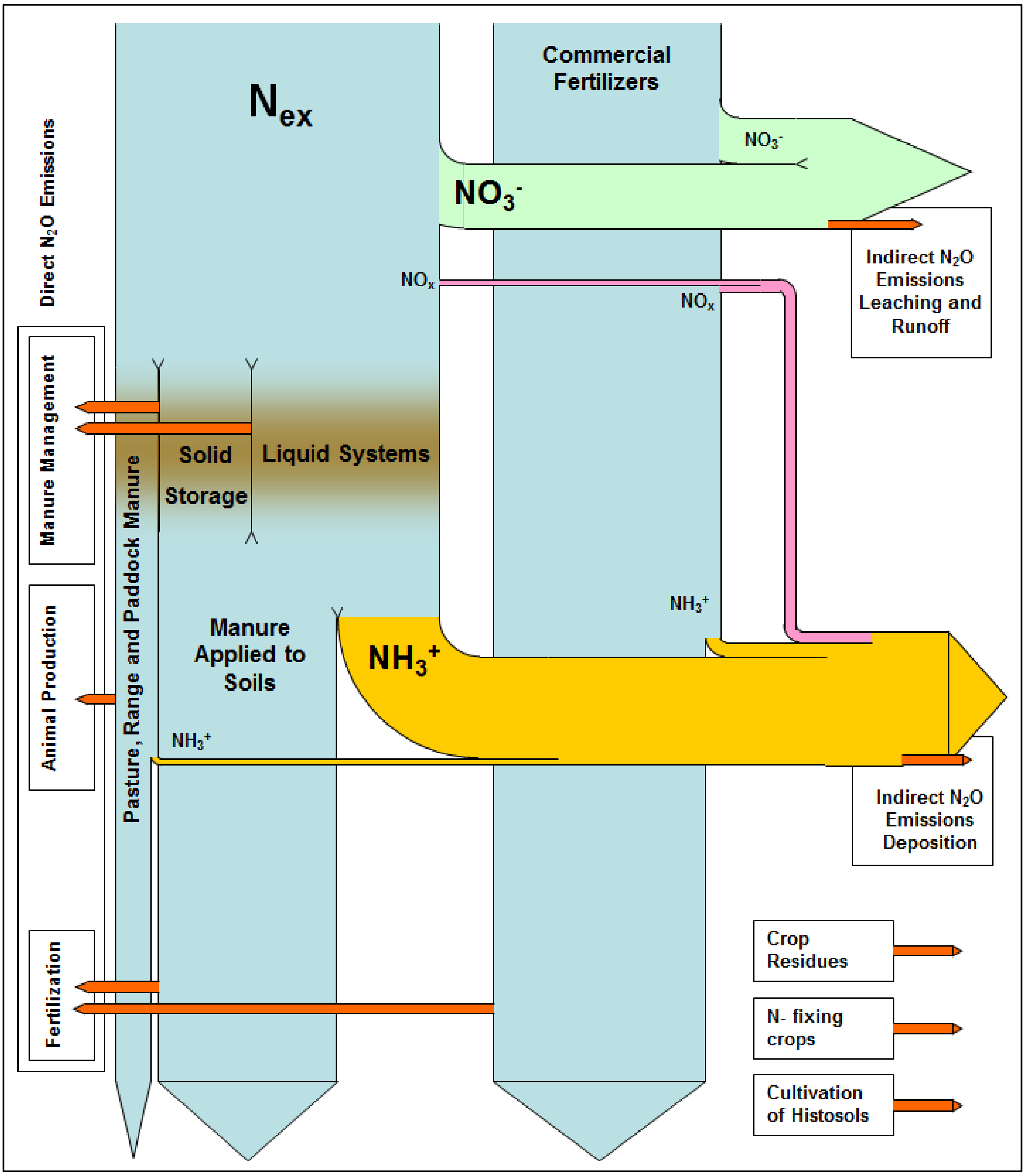

Figure 6-6 Diagram depicting the methodology of the approach to calculate the N_2O emissions in Agriculture. Note that the figure shows explicitly the methodology of the approach and not the physical nitrogen flow.

Main differences between the IULIA/AGRAMMON method and IPCC are (Schmid et al. 2000: p. 74):

- IULIA/AGRAMMON estimates lower nitrogen excretion per animal category, especially due to the lower excretions of young cattle (refer to chapter 6.3.2.2).
- The amount of losses to the atmosphere from the excreted nitrogen is more than 50% higher compared to IPCC.
- The amount of leaching (of nitrogen excreted and of synthetic fertilizers) is lower by 1/3 compared to IPCC.
- The share of solid storage out of the total manure is twofold; the share of excretion on pasture, range and paddock has been ½ of the suggested IPCC default value in 1990 and has almost doubled thereafter reaching the IPCC default value.
- The nitrogen inputs from biological fixation are higher by a factor of 30 since fixation on meadows and pastures are also considered. The consideration of nitrogen fixation from grassland is one of the major advantages of the method IULIA as the grassland accounts for the majority of nitrogen fixed in Swiss Agriculture.
- The nitrogen inputs from crop residues are only 25% higher although emissions from plant residue on grasslands are considered. This is explained by the fact that the emissions from plant residues returned to soils on cropland are estimated 50% below the IPCC defaults.

Despite the different assumptions of the two methods, differences at the level of the N_2O emissions are quite moderate. In a comparison of the 1996 N_2O inventory, IULIA estimations of the N_2O emissions from agriculture were approximately 15% lower than the IPCC estimations (Schmid et al. 2000: p. 75).

Direct emissions from soil (4D1)

Calculation of direct N_2O emissions from soil is based on IPCC 2000 Tier 1b.

- Emissions from **synthetic fertilizer** include urea and other mineral fertilizers (mainly ammonium-nitrate). The amount of nitrogen input due to these fertilizers is taken from SBV (2011), Agricura 2010 and Agrammon (2010). Fertilizer statistics is based on sales statistics by the compulsory storekeepers of fertilizers (Pflichtlagerhalter) and small importers. Agricura conducts plausibility checks with data received by the Directorate General of Customs (Oberzolldirektion). Fertilizer production in Switzerland is negligible. From the amount of nitrogen in fertilizer, losses to the atmosphere in form of NH_3 are subtracted and the rest is multiplied with the corresponding N_2O emission factor. According to AGRAMMON NH_3 losses to the atmosphere are 15% for urea and 2% for other synthetic fertilizers (Vanderweerden and Jarvis 1997) instead of the IPCC value of 10% for NH_3 and NO_x (see Table 6-16). For more information on ammonia volatilization from synthetic fertilizers see the paragraph on Indirect emissions (4D3). NO_x emissions are not subtracted since they occur mainly after the fertilizer application. Thus, the basis for N_2O-emissions is the synthetic fertilizer including the nitrogen that will be lost as NO_x later (Berthoud 2004).
- To model the emissions of **animal manure applied to soils**, nitrogen input from manure is calculated as the total N excretion minus N excreted on pasture, range and paddock minus ammonia volatilization from solid and liquid manure. The losses (to the atmosphere) as ammonia are specified for each animal category separately instead of using a fixed ratio of 20% (Agrammon 2010). For more information on ammonia volatilization from synthetic fertilizers see the paragraph on Indirect emissions (4D3). NO_x emissions are not subtracted since they occur after the application of animal wastes (Berthoud 2004). For details regarding the volatized N refer to Table 6-16.
- Emissions from **crop residues** are based on the amount of nitrogen in crop residues returned to soil. According to IULIA (Schmid et al. 2000: p. 68 and p. 100) the

calculation of nitrogen in crop residues is based on data reported on crop yields (SBV 2011), the standard values for arable crop yields (FAL/RAC 2001 and Walther et al. 1994) and standard amounts of nitrogen in crop residues returned to soils (FAL/RAC 2001 and Walther et al. 1994). The calculation of the amount of nitrogen in crop residues returned to soil according to IULIA is as follows (Schmid et al. 2000: p. 101):

$$F_{CR} = \sum_{Cr} (E_{Cr} * \frac{NR_{Cr}}{Y_{Cr}})$$

F_{CR}: Amount of nitrogen in crop residues returned to soils (t N)
E_{Cr}: Amount of crop yields for culture Cr (t)
Y_{Cr}: Standard values for arable crop yields for culture Cr (t/ha)
NR_{Cr}: Standard amount of nitrogen in crop residues returned to soils (t/ha)
From 2001 on updated standard values and amounts of nitrogen returned to soil are used. In addition to the N transfer from crop residues, IULIA also takes into account the plant residue returned to soils on meadows and pastures (Schmid et al.: 2000). Three quarters of the agricultural land use consists of grassland which underscores the importance of this source for Switzerland. Input data on the managed area of meadows and pastures are taken from SBV (2011). Estimated values of total crop production, nitrogen incorporated with crop residues $F_{(CR)}$, residue/crop ratio, dry matter (dm) fraction of residues and nitrogen content of residues are provided in Annex A3.3.

- For calculation of emissions from **N-fixing crops**, IULIA assumes that 60% of the nitrogen in leguminous crops is originates from biological nitrogen fixation (Schmid et al. 2000: p. 70). This is in line with the IPCC Guidelines that state that biological nitrogen fixation supplies 50-60 per cent of the nitrogen in grain legumes (IPCC 1997c, p. 4.89). The total amount of nitrogen is calculated according to the calculation of nitrogen in crop residues, additionally taking into account the nitrogen contained in the crop product. In addition, IULIA takes biological nitrogen fixation on meadows and pastures into account, assuming a nitrogen concentration of 3.5% in the dry matter from which 80% derives from biological nitrogen fixation. For the dry matter production of clover on pastures and meadows statistical data were used (Schmid et al. 2000: p. 70). The following table gives an overview of the calculation of emissions from N-fixing crops.

Table 6-15 Input values for calculation of emissions from N-fixing crops according to IULIA (Schmid et al. 2000: p. 70).

Fixation	Share of N caused by fixation	Share of N in Dry matter
Leguminous (N-fixing crops)	0.6	crop specific
Clover (Fixation on meadows and pastures)	0.8	0.035

- Estimates of total crop production and nitrogen fixed per kg crop dry matter are provided in Annex A3.3.
- Emissions from **cultivated organic soils** are based on estimations on the area of cultivated organic soils (17'000 ha for the whole time series, Leifeld et al. 2003) and the IPCC default emission factor for N_2O emissions from cultivated organic soils (IPCC 1997b).

Emissions from animal production (4D2)

Calculation of emissions from animal production is based on AGRAMMON (Agrammon 2010). IPCC equation 4.18, IPCC 2000: p. 4.42 is used, but national N excretion rates and manure system distribution fractions (MS) are used (refer to chapter 6.3.2). The relevant input data are based on Flisch et al. (2009) and calculated within the Swiss ammonium model AGRAMMON.

Only emissions of pasture, range and paddock are to be reported under agricultural soils. Other emissions from animal production are reported under Manure Management.

Indirect emissions (4D3)

Calculation of the indirect emissions is based on IPCC 2000 Tier 1b.

- For calculation of N_2O emissions from **leaching and run-off**, N from fertilizers and animal manure has to be estimated. The relevant input data is based on FAL/RAC 2001, Prasuhn and Braun (1994), Braun et al. (1994) and Prasuhn and Mohni (2003). $Frac_{Leach}$ is set as 0.2 instead of the IPCC default of 0.3. This country specific value is extrapolated from long-term monitoring and modelling studies from the canton of Berne (Prasuhn and Mohni 2003) while the default value is based on a global model which assumes that 30% of nitrogen from synthetic fertilizer and atmospheric deposition is reaching water bodies. According to Schmid et al. (2000: p.71) this later amount is not representative for N-excretion of livestock animals in Switzerland and would lead to a significant overestimation.
- N_2O emissions from **deposition** are based on NH_3 and NO_x emissions. NH_3-losses to the atmosphere are calculated according to the Swiss ammonium emission model AGRAMMON (Agrammon 2010). Input data for AGRAMMON for the years 1990 and 1995 are mainly based on expert judgements and literature studies whereas data for 2002 and 2007 include extensive farm surveys. Values in between the assessment years have been interpolated linearly while values beyond 2007 are kept constant until new survey results are available. For the calculation of NH_3 emissions changes of agricultural structures (changes to more animal friendly housing systems) and techniques (manure management, measures to reduce NH_3 emissions) are considered and explain temporal dynamics. For NH_3 emissions specific losses for all livestock categories are assumed. Ammonium volatilization of nitrogen in synthetic fertilizers is 15% for urea and 2% for other synthetic fertilizers. These estimates are based on a literature review by Van der Weerden and Jarvis (1997) who examined ammonia emission factors for ammonium nitrate and urea for grassland and cropland soils. The emission factors for all other applied synthetic nitrogen (as straight and compound fertilizers) were assumed to be similar to that for ammonium nitrate. Ammonia emission factors for recycling fertilizers (sewage sludge and compost) are between 5 and 18% depending on the relative share of the individual fertilizer types (Agrammon 2010). Total $Frac_{GASF}$ has declined considerably due to a change in the shares of the different components that contribute to $Frac_{GASF}$ (weighted mean): the use of urea and sewage sludge (which both have high NH_3 emission factors) has been declining since 1990. Furthermore, volatilization of 2.0 kg NH_3 -N/ha agricultural soil is assumed due to processes in the vegetation cover (Agrammon 2010). Details about the amount of volatized NH_3 are provided in the following table.

Table 6-16 Overview of Ammonia emission factors 1990–2010. Data source: Agrammon (2010)

Ammonia Emission Factor		1990	1995	2002	2007	2010
		%				
Cattle						
Mature Dairy Cattle		35.04	35.18	33.21	33.84	33.84
Mature Non-Dairy Cattle		31.16	31.77	28.48	34.46	34.46
Young Cattle		33.81	34.32	31.75	33.52	33.46
	Fattening Calves	39.57	40.01	38.16	41.11	41.11
	Pre-Weaned Calves	31.16	31.77	29.17	34.14	34.14
	Breeding Cattle 1st Year	33.98	34.53	31.84	34.05	34.05
	Breeding Cattle 2nd Year	30.01	30.44	27.90	29.53	29.53
	Breeding Cattle 3rd Year	31.74	32.18	29.35	31.31	31.31
	Fattening Cattle	41.31	41.51	41.22	40.18	40.18
Sheep		20.84	20.26	20.02	17.73	17.79
	Fattening Sheep	20.71	20.17	19.93	17.43	17.43
	Milksheep	24.91	24.21	21.81	22.56	22.56
Goats		24.38	23.70	24.48	17.90	17.90
	Goat Places	24.38	23.70	24.48	17.90	17.90
Horses		25.94	25.21	21.62	24.41	24.58
	Horses <3 years	25.94	25.21	18.43	19.20	19.20
	Horses >3 years	25.94	25.21	22.31	25.41	25.41
Mules and Asses		25.94	25.21	22.70	23.38	23.38
	Mules	25.94	25.21	22.70	23.38	23.38
	Asses	25.94	25.21	22.70	23.38	23.38
Swine		38.28	38.88	45.19	45.35	45.39
	Piglets	38.28	38.41	38.45	39.90	39.90
	Fattening Pig over 25 kg	38.28	38.97	46.98	46.61	46.61
	Dry Sows	38.28	39.00	46.34	47.43	47.43
	Nursing Sows	38.28	38.41	38.97	40.19	40.19
	Boars	38.28	38.41	46.56	47.74	47.74
Poultry		38.69	36.50	29.88	28.51	28.38
	Growers	44.89	42.25	32.44	31.22	31.22
	Layers	40.76	40.21	32.14	31.06	31.06
	Broilers	32.42	31.88	27.53	25.74	25.74
	Turkey	32.42	32.64	29.58	34.54	34.54
	Other Poultry (Geese, Ducks, Ostriches, Quails)	27.63	27.92	27.97	28.69	28.69
Fertilizer	Urea	15.00	15.00	15.00	15.00	15.00
	Other Mineral Fertilizers	2.00	2.00	2.00	2.00	2.00
	Recycling Fertilizers	15.82	16.49	16.31	8.09	4.99
	Agricultural Soils (kg/ha/year)	2.00	2.00	2.00	2.00	2.00

Other (sewage sludge and compost used for fertilizing) (4D4)

This source category covers N_2O emissions from sewage sludge and from compost used for fertilization. The calculation of the emissions corresponds to the one for synthetic fertilizer. Since 2003 the use of sewage sludge as fertilizer is prohibited in Switzerland. However, a transition period applies for some areas and the individual cantons could prolong this period until 2008 in individual cases (UVEK 2003).

Activity data is based on Agrammon (2010) and SBV (2011).

NO_x emissions

NO_x emissions are estimated to be 0.7% of total nitrogen from animal manure and synthetic fertilizer, sewage sludge and compost. This factor is based on the CORINAIR Emission Inventory Guidebook 2003 (EEA 2007). Data on N-excretion (kg N/head/yr) is based on Flisch et al. (2009) and calculated within AGRAMMON (Agrammon 2010). The amount of nitrogen from synthetic fertilizer, sewage sludge and compost is taken from Agrammon (2010) and SBV (2011).

NMVOC emissions

Estimation of NMVOC emissions of meadows and arable land is based on Spirig and Neftel (2002). VOC flows are estimated in Warneke et al. (2002) (for meadows) and König et al. (1995) (for arable land). Emissions were measured in a field trial in Austria (Karl et al. 2001).

6.5.2.1 Emission factors

The following IPCC default emission factors for calculating N_2O emissions from agricultural soils are used.

Table 6-17 Emission factors for calculating N_2O emissions from agricultural soils (IPCC 1997c: tables 4.18 (direct emissions), 4.22 (pasture, range and paddock) and 4.23 (indirect emissions); IPCC 2000: table 4.17 (organic soils).

Emission Source	Emission factor
Direct Emissions	
Synthetic fertilizer (kg N2O-N/kg)	0.0125
Animal manure nitrogen used as fertilizer (kg N2O-N/kg)	0.0125
Crop residue (kg N2O-N/kg)	0.0125
N-fixing crops (kg N2O-N/kg)	0.0125
Organic soils (kg N2O-N/ha)	8
Residues meadows and pasture (kg N2O-N/kg)	0.0125
N-fixing meadows and pasture (kg N2O-N/kg)	0.0125
Animal production	
Pasture, range and paddock (kg N2O-N/kg)	0.0200
Indirect emissions	
Leaching and run-off (kg N2O-N/kg)	0.0250
Deposition (kg N2O-N/kg)	0.01
Other	
Other (sewage sludge and compost used for fertilizing) (kg N2O-N/kg)	0.0125

6.5.2.2 Activity data

Activity data for calculation of direct soil emissions has been provided by SBV (2011) and ART/SHL (2012; animal livestock population), SBV (2011; use of synthetic fertilizer, sewage sludge, compost, crop yields, area of meadows and pasture), Agricura 2010 (use of synthetic fertilizer), FAL/RAC (2001: p. 48/49), Schmid et al. (2000), Walther et al. (1994), Flisch et al. (2009), Agrammon (2010) and Leifeld et al. (2003) (revised area of cultivated organic soils).

Use of synthetic fertilizers in public green areas, sports grounds and home gardens (domestic synthetic fertilizer use) is reported under 4D1.6 “Other direct emissions”.

The relevant activity data for calculating N_2O emissions from soils is displayed in the following table. Additional information is given in Table A - 35 and Table A - 36 in Annex A3.3.

Table 6-18 Activity data for calculating N_2O emissions from agricultural soils.

Related Activity Data		1990-1999									
		1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
		Value									
Direct Emissions											
Fertilizers (t N/yr)		70'726	71'807	71'437	66'366	62'897	64'245	62'167	54'836	55'366	57'662
	Mineral fertilizer (t N/yr)	66'096	66'877	66'721	61'959	58'276	58'316	56'213	48'855	49'207	51'521
	Sewage sludge (t N/yr)	3'360	3'565	3'451	3'338	2'737	3'499	3'333	3'169	3'156	3'143
	Compost (t N/yr)	1'270	1'365	1'265	1'068	1'885	2'431	2'622	2'812	3'003	2'998
	Nitrogen input from manure applied to soils (t N/yr)	81'744	80'624	78'945	77'631	76'432	75'283	73'840	70'823	69'353	66'482
N-fixing crops	N fixation peas, dry beans, soybeans and leguminous vegetables (t N/yr)	654	736	857	763	779	830	895	1'073	1'070	1'014
Crop residue	N from crop residues (t N/yr)	14'150	14'057	13'761	14'171	13'321	13'826	15'596	14'896	14'806	13'172
N-fixing meadows and pasture	N fixation meadows and pasture (t N/yr)	29'027	28'886	29'728	32'316	34'168	31'574	31'933	32'144	32'150	32'094
Residues meadows and pasture	N from residues meadows and pasture (t N/yr)	21'473	21'433	21'713	23'217	25'129	22'974	23'090	23'132	23'209	23'090
	Area of meadows and pasture (ha)	784'867	788'089	792'338	791'387	785'006	798'550	802'514	803'722	807'945	805'131
Organic soils	Area of cultivated organic soils (ha)	17'000	17'000	17'000	17'000	17'000	17'000	17'000	17'000	17'000	17'000
Animal production											
Pasture, range and paddock	N excretion on pasture range and paddock (t N/yr)	13'148	13'409	13'519	13'452	13'655	13'886	15'706	16'932	18'204	19'001
Indirect emissions											
	N excretion of all animals (t N/yr)	144'642	143'250	140'851	138'825	137'296	135'872	135'823	132'591	131'996	128'429
	Fertilizer (t N/yr)	75'200	75'800	75'400	70'200	66'500	68'100	65'900	58'000	58'400	60'800
Leaching and run-off	N from fertilizers and animal manure that is lost through leachin and run off (t N/yr)	43'968	43'810	43'250	41'805	40'759	40'794	40'345	38'118	38'079	37'846
Deposition	NH3 Emissions from fertilizers, animal manure and agricultural soils (tN/yr)	57'019	56'017	55'163	54'388	53'634	53'377	52'963	51'012	50'523	49'189
	NOx Emissions from fertilizers and animal manure (t N/yr)	1'539	1'533	1'514	1'463	1'427	1'428	1'412	1'334	1'333	1'325
	Area of agricultural soils (ha)	1'071'346	1'070'000	1'070'000	1'070'000	1'070'000	1'061'840	1'082'876	1'080'000	1'066'000	1'071'899
	Sum volatized N (NH3 and NOx) from fertilizers, animal manure and agricultural soils (t N/yr)	58'558	57'550	56'676	55'851	55'061	54'805	54'375	52'346	51'856	50'513

Related Activity Data		2000-2009									
		2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
		Value									
Direct Emissions											
Fertilizers (t N/yr)		56'878	60'855	59'438	55'771	55'264	54'253	53'765	56'013	53'051	49'933
	Mineral fertilizer (t N/yr)	50'903	54'896	53'496	51'217	51'458	50'454	49'559	51'694	48'886	46'220
	Sewage sludge (t N/yr)	2'982	2'969	2'957	1'479	739	739	665	591	444	0
	Compost (t N/yr)	2'994	2'989	2'985	3'075	3'067	3'060	3'540	3'728	3'721	3'713
	Nitrogen input from manure applied to soils (t N/yr)	64'668	63'887	62'222	61'383	60'742	61'587	61'862	61'860	63'200	62'790
N-fixing crops	N fixation peas, dry beans, soybeans and leguminous vegetables (t N/yr)	797	722	1'119	1'224	1'294	1'147	1'072	1'060	1'041	1'010
Crop residue	N from crop residues (t N/yr)	14'911	12'893	14'225	12'250	14'532	14'057	13'041	14'013	14'053	14'549
N-fixing meadows and pasture	N fixation meadows and pasture (t N/yr)	32'060	31'120	31'143	31'485	31'623	31'089	31'204	31'639	31'671	31'872
Residues meadows and pasture	N from residues meadows and pasture (t N/yr)	23'075	22'217	22'220	22'321	22'334	22'174	22'199	22'267	22'249	22'269
	Area of meadows and pasture (ha)	806'369	809'441	809'597	812'624	812'370	807'793	808'416	809'187	808'300	807'927
Organic soils	Area of cultivated organic soils (ha)	17'000	17'000	17'000	17'000	17'000	17'000	17'000	17'000	17'000	17'000
Animal production											
Pasture, range and paddock	N excretion on pasture range and paddock (t N/yr)	21'158	22'924	24'491	24'275	23'935	24'156	24'439	24'518	25'155	25'198
Indirect emissions											
	N excretion of all animals (t N/yr)	128'049	129'040	128'282	126'894	125'740	127'728	128'834	129'134	132'021	131'459
	Fertilizer (t N/yr)	60'100	64'200	62'800	58'400	57'800	56'600	56'000	58'600	55'300	51'800
Leaching and run-off	N from fertilizers and animal manure that is lost through leachin and run off (t N/yr)	37'630	38'648	38'216	37'059	36'708	36'866	36'967	37'547	37'464	36'652
Deposition	NH3 Emissions from fertilizers, animal manure and agricultural soils (tN/yr)	48'660	48'877	48'313	47'228	46'954	47'707	48'163	48'739	49'340	48'761
	NOx Emissions from fertilizers and animal manure (t N/yr)	1'317	1'353	1'338	1'297	1'285	1'290	1'294	1'314	1'311	1'283
	Area of agricultural soils (ha)	1'072'492	1'071'346	1'069'770	1'063'595	1'064'574	1'065'118	1'065'200	1'060'278	1'058'134	1'055'684
	Sum volatized N (NH3 and NOx) from fertilizers, animal manure and agricultural soils (t N/yr)	49'977	50'230	49'650	48'525	48'239	48'998	49'457	50'053	50'651	50'044

Related Activity Data		
		2010
		Value
Direct Emissions		
Fertilizers (t N/yr)		57'130
	Mineral fertilizer (t N/yr)	53'425
	Sewage sludge (t N/yr)	0
	Compost (t N/yr)	3'705
	Nitrogen input from manure applied to soils (t N/yr)	62'756
N-fixing crops	N fixation peas, dry beans, soybeans and leguminous vegetables (t N/yr)	1'013
Crop residue	N from crop residues (t N/yr)	12'973
N-fixing meadows and pasture	N fixation meadows and pasture (t N/yr)	31'983
Residues meadows and pasture	N from residues meadows and pasture (t N/yr)	22'266
	Area of meadows and pasture (ha)	807'226
Organic soils	Area of cultivated organic soils (ha)	17'000
Animal production		
Pasture, range and paddock	N excretion on pasture range and paddock (t N/yr)	25'187
Indirect emissions		
	N excretion of all animals (t N/yr)	131'381
	Fertilizer (t N/yr)	59'400
Leaching and run-off	N from fertilizers and animal manure that is lost through leachin and run off (t N/yr)	38'156
Deposition	NH3 Emissions from fertilizers, animal manure and agricultural soils (tN/yr)	49'126
	NOx Emissions from fertilizers and animal manure (t N/yr)	1'335
	Area of agricultural soils (ha)	1'051'747
	Sum volatized N (NH3 and NOx) from fertilizers, animal manure and agricultural soils (t N/yr)	50'461

6.5.3 Uncertainties and Time-Series Consistency

For the uncertainty analysis the input data from ART (2008a) was used. The arithmetic mean of the lower and upper bound uncertainty is used for activity data and for emission factors, resulting in the following combined uncertainties for Tier 1 analysis: 4D1: 76.5%, 4D2: 84.8%, 4D3: 158.8% and 4D4 80.4%. To aggregate fertilizer and organic soils to a single category 4D1 and atmospheric deposition, leaching and run-off to 4D3 (as required for input into Tier 1 analysis), the combined uncertainty of the emissions is determined by using Tier 1 error propagation for the sub-systems. For further results see Section 1.7.

For Tier 2 uncertainty analysis correlations between emission factors or activity data are considered. Furthermore, asymmetric distributions of the EF uncertainties in 4D2 and 4D3 are considered (see Annex 7.2.2)

For some crops input parameters for the calculation of nitrogen input from crop residues and biological fixation changed between 2000 and 2001 due to the publication of the new "Principles of fertilization in crop and feed production" (FAL/RAC 2001) that replaced the older version (Walther et al. 1994).

For further details on time-series consistency see Chapter 6.2.3 and 6.3.3.

6.5.4 Source-Specific QA/QC and Verification

All QA/QC activities are further described in a separate document (ART 2011c). General information on agricultural structures and policies is provided and eventual differences between national and (IPCC) standard values are being analysed and discussed.

For quality of livestock population data consult Chapter 6.2.4.

An internal documentation of the Agroscope Reckenholz-Tänikon Research Station (ART) about the calculation of the greenhouse gas emissions in agriculture assures transparency and traceability of the calculation methods (Berthoud 2004). IULIA is described in Schmid et al. (2000) and the Swiss ammonium emission model AGRAMMON is documented in Agrammon (2010).

All relevant data needed for the calculation of direct and indirect nitrogen inputs to agricultural soils (e.g. F_{SN}, MS-distribution, $Frac_{GASF}$, N_{ex}, $Frac_{GASM}$, F_{BN}, F_{CR}) have been checked for consistency and confidence and have been compared (where possible) to IPCC default values, values of other countries as well as literature values. As one of the most important parameters, nitrogen excretion has been analysed in more detail as described in Chapter 6.3.4.

The implied emission factors have been compared to the corresponding emission factors of other countries (UNFCCC http://unfccc.int/di/FlexibleQueries.do) (INFRAS 2012). Additionally, N_2O emission factors have been compared to literature values to assure plausibility. Implied emission factors are generally in line with measurements representative for Swiss conditions (ART 2011c).

The estimate for cultivated histosols in the agricultural sector is based on a literature study conducted by Leifeld et al. (2003) and is thus different from the estimate of organic soils under cropland and grassland in the LULUCF sector. The estimate from Leifeld et al. (2003) is used in the agricultural sector because i) it will not fluctuate between one submission and the other due to statistical effects of the land use projections, ii) it is close to the values reported in the LULUCF sector and therefore considered consistent and iii) it is considered robust because it relies on additional independent assessments. Given that all remaining intact peatlands are protected by law and that the agricultural area in Switzerland is limited, it is unlikely that the area of cultivated organic soils would increase or decrease considerably.

The time series of activity data and emission factors have been compared between the current and the previous submission. All activity data, implied emission factors and emissions undergo the following triple check:

- the results for 2010 are compared with the results for 2009 within the current CRF
- the CRF tables for the year 2009 are compared between the current CRF tables and the CRF tables of the submission 2011.
- the CRF tables for the base year 1990 are compared between the current CRF tables and the CRF tables of the submission 2011

Additionally an independent quality control was conducted by INFRAS by a countercheck of the data and calculation sheets elaborated by ART (ART 2012).

6.5.5 Source-Specific Recalculations

Time series-consistency of animal numbers (activity data) has been consolidated and improved, leading to minor recalculations (ART/SHL 2012). For further details see Chapter 6.2.5

A general recalculation for the year 2008 - 2009 has been carried out due to some data updates from the Swiss Farmers Union (SBV 2011). The respective changes are only of minor importance for total emission estimates.

6.5.6 Source-Specific Planned Improvements

New data from updated AGRAMMON projections were not yet available for estimating agricultural greenhouse gas emissions. Submissions under the UNECE and the UNFCCC are thus not overall consistent. However, updated AGRAMMON data will be implemented during the next annual submission.

The possibility of adopting new values for standard crop yield as well as crop nitrogen- and dry matter contents provided in Flisch et al. (2009) will be examined.

6.6 Source Category 4E – Burning of savannahs

Burning of savannahs does not occur (NO) in Switzerland.

6.7 Source Category 4F – Field Burning of Agricultural Residues

6.7.1 Source Category Description

Source category 4F “Field Burning of Agricultural Residues” is **not a key category**. Emissions from this source occur from open burning of branches in agriculture and forestry. The source category includes CH_4, N_2O, NO_x, CO and NMVOC emissions. Burning of other residues than branches is not occurring. Therefore, emissions from field burning of agricultural residues are of minor importance in Switzerland.

6.7.2 Methodological Issues

6.7.2.1 Methodology

The emissions are calculated by multiplying the annual estimate of branches burned (in Gg of wood equivalent) by emission factors (IPCC default method).

6.7.2.2 Emissions factors

The emission factors are taken from EMEP/CORINAIR (EEA 2007). See also EMIS 2012/4F.

Table 6-19 Emission factors for calculating emissions from burning of branches in agriculture and forestry (EEA 2007).

Emissions from burning of branches in agriculture and forestry	Emission factor kg/t dry matter
CH_4	6.8
N_2O	0.18
NOx	3.6
CO	104.0
NMVOC	9.5
SO_2	0.7

6.7.2.3 Activity data

The annual amount of branches burnt in agriculture and forestry is based on expert judgement from the EMIS experts and kept constant for the whole time series.

Burning of other residues than branches is not occurring in Switzerland. However information on total crop production, residue / crop ratio, dry matter (dm) fraction of residues and nitrogen content of residues is provided in Annex A.3.3. These values were assessed in order to calculate direct N_2O emissions from agricultural soils (see chapter 6.5.2).

Table 6-20 Activity data for calculating emissions from burning of branches in agriculture and forestry (EMIS 2012/4F).

4F Field Burning		1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Field Burning	t wood	70'000	70'000	70'000	70'000	70'000	70'000	70'000	70'000	70'000	70'000

4F Field Burning		2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Field Burning	t wood	70'000	70'000	70'000	70'000	70'000	70'000	70'000	70'000	70'000	70'000

4F Field Burning		2010
Field Burning	t wood	70'000

6.7.3 Uncertainties and Time-Series Consistency

Uncertainty is estimated to be high for CH_4 (60%) and N_2O (150%). Time series is consistent as it is constant.

6.7.4 Source-Specific QA/QC and Verification

The time series of activity data and emission factors have been compared between the current and the previous submission. All activity data, implied emission factors and emissions undergo the following triple check:

- the results for 2010 are compared with the results for 2009 within the current CRF
- the CRF tables for the year 2009 are compared between the current CRF tables and the CRF tables of the submission 2011.
- the CRF tables for the base year 1990 are compared between the current CRF tables and the CRF tables of the submission 2011

6.7.5 Source-Specific Recalculations

Activity data has been recalculated for the whole time series. The AD for 4F has been set to 70’000t for the whole time-series.

6.7.6 Source-Specific Planned Improvements

There are no planned improvements.

7 LULUCF

7.1 Overview of LULUCF

7.1.1 Methodology

Chapter 7 presents information about the estimate of greenhouse gas emissions by sources and removals by sinks from land use, land-use change and forestry (LULUCF). Data acquisition and calculations are based on the Good Practice Guidance for Land Use, Land-Use Change and Forestry (IPCC 2003) and are completed by country specific methodologies.

The land areas in the period 1990-2010 are represented by geographically explicit land-use data with a resolution of one hectare (following approach 3 for representing land areas; IPCC 2003). Direct and repeated assessment of land use with full spatial coverage also enables to calculate spatially explicit land-use change matrices. In 2004 the new Swiss land-use statistics has been launched (referred to as AREA). Simultaneously, aerial photos from two earlier Swiss land-use statistics (1979/85 and 1992/97) are being re-evaluated, applying the same approach. At the editorial deadline the interpretation of 72% of the Swiss territory was completed for all three time slices. A full coverage is expected in 2013. To estimate the land use and land-use change for each year in the period 1990-2010, a spatial extrapolation based on the presently available AREA data in combination with both earlier land-use statistics had to be performed.

The six main land categories required by IPCC (2003) are: A. Forest Land, B. Cropland, C. Grassland, D. Wetlands, E. Settlements and F. Other Land. These categories were divided in 18 sub-divisions of land use. A further spatial stratification reflects the criteria “altitude” (3 zones),”geomorphologic and climatic conditions” (adopting the five production regions of the National Forest Inventory; NFI) and ”soil type” (mineral, organic).

Country specific emission factors and carbon stock values for forests were derived from three Swiss National Forest Inventories (NFI 1 – NFI 3), which had been finalised in 1985, 1995 and 2006, respectively. The inventories comprehend 6'000 (1995, 2006) or 12'000 (1985) terrestrial sampling plots, where biomass stock, growth, harvesting and mortality had been measured.

For other land use categories, carbon stock values and GHG emissions/removals were derived from particular research activities, surveys and measurements in the fields of agriculture (cropland, grassland) and nature conservation (wetlands). Partially, also IPCC default values and expert estimates have been used.

7.1.2 Emissions and Removals

Table 7-1 and Figure 7-1 summarize the CO_2 emissions and removals in consequence of carbon losses and gains for the years 1990-2010. The total net emissions and removals of CO_2 from 1990 to 2010 vary between -5'792 Gg (1994) and 706 Gg (2001).

In Table 7-1 and Figure 7-1, four components of the CO_2 balance are differentiated:

- Gains in carbon stock of living biomass on forest land (three-year average): growth of biomass on forest land remaining forest land; it represents the largest sink of carbon.
- Losses in carbon stock of living biomass on forest land (three-year average): decrease of carbon in living biomass (by harvest and mortality) on forest land remaining forest land; it represents the largest source of carbon.

- Net carbon stock changes in dead organic matter (DOM) on forest land remaining forest land as well as on forest land converted to non-forest land (three-year average): it represents a small sink of carbon in all years.
- Land use and land-use change: balance of carbon emissions and removals in soils and in living biomass (1) due to the use of soils (especially of organic soils), (2) due to agricultural lime application, and (3) due to land-use changes (including afforestation and deforestation). In the period under investigation this accumulative component persistently represents a source of carbon.

In forests, growth of biomass exceeds the harvesting and mortality rate and the dead organic matter increases in most years. Compared to CO_2 fluxes involved in forest biomass dynamics, the net CO_2 emissions arising from the use of soils, from agricultural lime application, and from all land-use changes are relatively small (see Figure 7-1). As a result, the LULUCF sector was a sink of -2'249 Gg CO_2 on the average between 1990 and 2010. However, the forestal carbon sink trends to diminish since the mid-nineties, because wood harvesting has generally increased and the growth of living biomass has slightly decreased (see Table 7-1 and Figure 7-2).

Table 7-1 Switzerland's CO_2 emissions and removals (Gg) of category 5 Land Use, Land-Use Change and Forestry 1990-2010. Positive values refer to emissions; negative values refer to removals. In this data set, emissions of CH_4 and N_2O are not included. Land-use changes include afforestation and deforestation.

LULUCF	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
	Gg CO_2									
Gains of living biomass in forest	-13'807	-13'829	-13'850	-13'859	-13'867	-13'645	-13'424	-13'201	-13'202	-13'206
Losses of living biomass in forest	10'206	10'332	10'331	9'149	9'136	10'500	10'255	10'101	10'312	10'840
Net change in dead organic matter	-998	-939	-373	-902	-1'789	-2'230	-2'035	-871	-902	-249
Net change in soil and living biomass (by land use & land-use change)	732	705	702	707	727	732	723	753	726	717
Total Sector 5: LULUCF	-3'867	-3'731	-3'190	-4'904	-5'792	-4'643	-4'481	-3'218	-3'066	-1'899

LULUCF	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
	Gg CO_2									
Gains of living biomass in forest	-13'207	-13'208	-13'208	-13'209	-13'209	-13'225	-13'235	-13'243	-13'227	-13'248
Losses of living biomass in forest	13'958	14'417	14'267	11'620	11'249	11'673	12'099	12'626	12'667	12'362
Net change in dead organic matter	-1'219	-1'216	-1'322	-1'427	-339	-1'024	-147	-881	-909	-889
Net change in soil and living biomass (by land use & land-use change)	715	713	721	722	707	711	713	719	698	672
Total Sector 5: LULUCF	248	706	458	-2'293	-1'591	-1'865	-570	-779	-772	-1'104

LULUCF	2010	Mean
	Gg CO_2	
Gains of living biomass in forest	-13'297	-13'400
Losses of living biomass in forest	12'098	11'438
Net change in dead organic matter	-358	-1'001
Net change in soil and living biomass (by land use & land-use change)	672	714
Total Sector 5: LULUCF	-885	-2'249

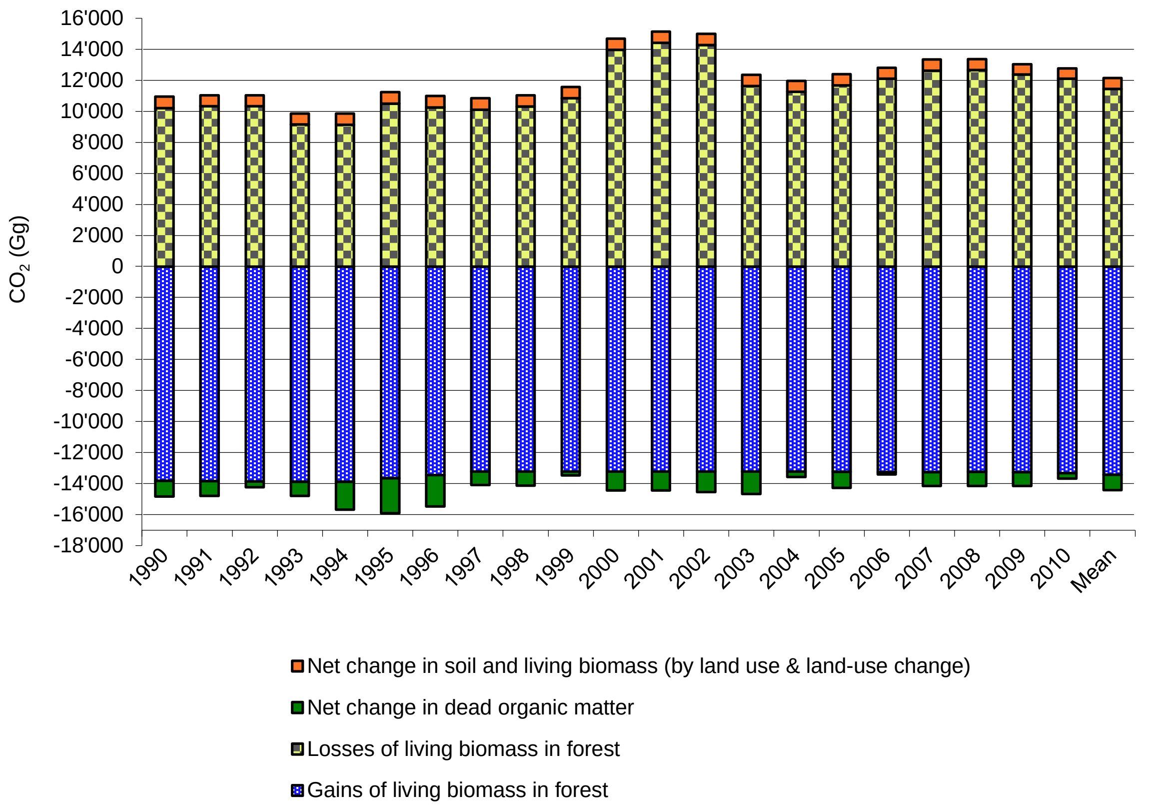

Figure 7-1 (i) CO_2 removals due to the gain (growth) of living biomass on forest land, (ii) CO_2 emissions due to the loss (harvest and mortality) of living biomass on forest land, (iii) net CO_2 emissions and removals due to changes in dead organic matter, and (iv) net CO_2 emissions from soils and living biomass due to land use and land-use changes, 1990–2010.

The non-CO_2 emissions associated with land use, land-use change and forestry are very small. Between 1990 and 2010 annual CH_4 emissions add up to less than 0.53 Gg, and N_2O emissions equal at maximum 0.04 Gg. Those emissions arise from soil disturbance associated with land-conversion to cropland (N_2O; CRF Table 5(III)) and wildfires on forest land (CH_4 and N_2O; CRF Table 5(V)). The calculation methods are based on default procedures of IPCC (2003; Chapter 3) and are summarized in Chapters 7.3.4.12 and 7.4.4.4, respectively.

Figure 7-2 shows the resulting net GHG balances of LULUCF 1990–2010 including all CO_2 and non-CO_2 fluxes. Further representations of LULUCF CO_2 eq data can be found in Chapter 2 “Trends in Greenhouse Gas Emissions and Removals”.

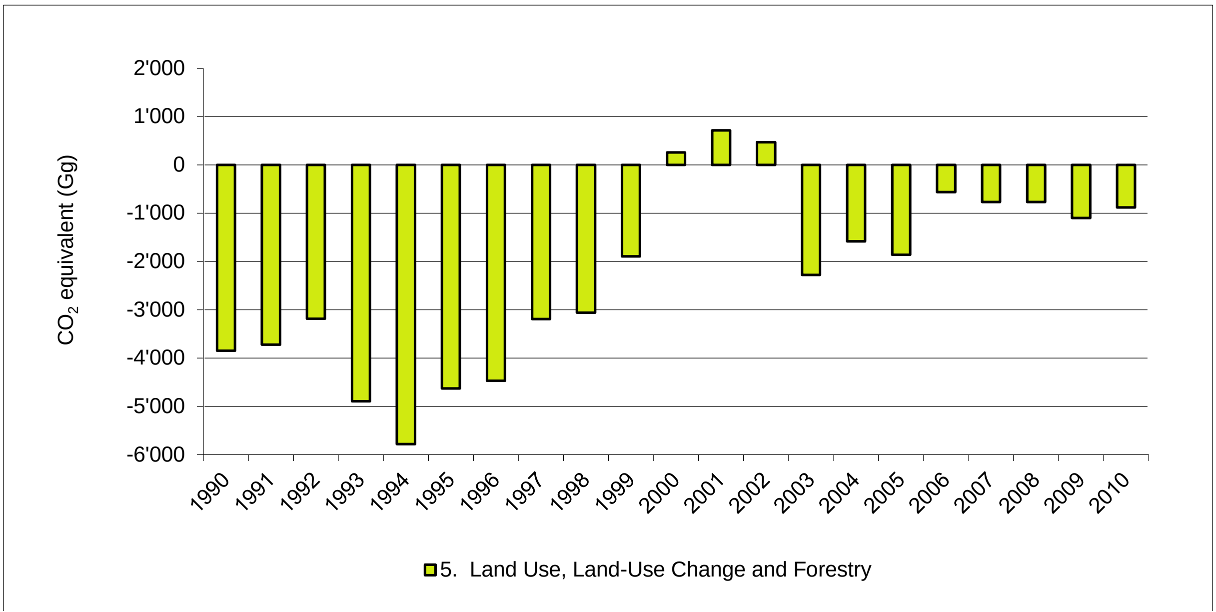

Figure 7-2 Switzerland's net GHG balance of category 5 Land Use, Land-Use Change and Forestry 1990–2010 (in Gg CO_2 eq). Positive values refer to emissions, negative values refer to removals.

7.1.3 Approach for Calculating Carbon Emissions and Removals

7.1.3.1 Work Steps

The selected procedure for calculating carbon emissions and removals in the LULUCF sector corresponds to a Tier 2 approach as described in IPCC (2003; Chapter 3). It can be summarised as follows:

- Define land use categories and sub-divisions with respect to available land-use data (see Table 7-2). For the present study, so-called combination categories (CC) were defined on the basis of the AREA land-use and land-cover categories (FOEN 2007f; SFSO 2006a).
- Define criteria and collect data for the spatial stratification of the land-use categories.
- Measure or estimate the carbon stocks and carbon stock changes for each spatial stratum of the land-use categories.
- Calculate the land use and the land-use change matrix in each spatial stratum.
- Calculate the carbon stock changes in living biomass ($deltaC_l$), in dead organic matter ($deltaC_d$) and in soil ($deltaC_s$) for all cells of the land-use change matrix.
- Finally, aggregate the results by summarising the carbon stock changes over land-use categories and strata according to the level of disaggregation displayed in the CRF tables.

Table 7-2 Land-use categories used in this report (so-called combination categories CC): 6 main land-use categories and 18 sub-divisions. Additionally, descriptive remarks, abbreviations used in the CRF tables, and CC codes are given. For a detailed definition of the CC see FOEN (2007f) and SFSO (2006a).

CC Main category	CC Sub-division	Remarks	Terminology in CRF tables	CC code
A. Forest Land	Afforestations	areas converted to forest by active measures, e.g. planting	afforestation	11
	Productive Forest	dense and open forest meeting the criteria of forest land	productive	12
	Unproductive Forest	brush forest and forest on unproductive areas meeting the criteria of forest land	unproductive	13
B. Cropland		arable and tillage land (annual crops and leys in arable rotations)		21
C. Grassland	Permanent Grassland	meadows, pastures (low-land and alpine)	permanent	31
	Shrub Vegetation	agricultural and unproductive areas predominantly covered by shrubs	woody, shrub	32
	Vineyards, Low-Stem Orchards, Tree Nurseries	perennial agricultural plants with woody biomass (no trees)	woody, vine	33
	Copse	agricultural and unproductive areas covered by perennial woody biomass including trees	woody, copse	34
	Orchards	permanent grassland with fruit trees	woody, orchard	35
	Stony Grassland	grass, herbs and shrubs on stony surfaces	unproductive, stony	36
	Unproductive Grassland	unmanaged grass vegetation	unproductive	37
D. Wetlands	Surface Waters	lakes and rivers	surface	41
	Unproductive Wetland	reed, unmanaged wetland	unproductive	42
E. Settlements	Buildings and Constructions	areas without vegetation such as houses, roads, construction sites, dumps	building	51
	Herbaceous Biomass in Settlements	areas with low vegetation, e.g. lawns	herb	52
	Shrubs in Settlements	areas with perennial woody biomass (no trees)	shrub	53
	Trees in Settlements	areas with perennial woody biomass including trees	tree	54
F. Other Land		areas without soil and vegetation: rocks, sand, scree, glaciers		61

7.1.3.2 Calculating Carbon Stock Changes

For calculating carbon stock changes, the following input parameters (mean values per hectare) must be quantified for all combination categories (CC) and spatial strata (i):

$stockC_{l,i,CC}$ carbon stock in living biomass (t C ha^{-1})
$stockC_{d,i,CC}$ carbon stock in dead organic matter (t C ha^{-1})
$stockC_{s,i,CC}$ carbon stock in soil (t C ha^{-1})
$gainC_{l,i,CC}$ annual gain (growth) of carbon in living biomass (t C ha^{-1} yr^{-1})
$lossC_{l,i,CC}$ annual loss (harvesting and mortality) of carbon in living biomass (t C ha^{-1} yr^{-1})
$changeC_{d,i,CC}$ annual net carbon stock change in dead organic matter (t C ha^{-1} yr^{-1})
$changeC_{s,i,CC}$ annual net carbon stock change in soil (t C ha^{-1} yr^{-1})

On this basis, the total carbon fluxes (t C yr^{-1}) in living biomass ($deltaC_l$), in dead organic matter ($deltaC_d$) and in soil ($deltaC_s$) are calculated for all cells of the land-use change matrix. Each cell is characterized by a land-use category before the conversion (b), a land-use category after the conversion (a), and the area of converted land within the spatial stratum (i). Equations 7.1.-7.3 show the general approach of calculating C emissions and removals taking into account the net carbon stock changes in living biomass, dead organic matter and soils as well as the stock changes due to conversion of land use (difference of the stocks before and after the conversion):

$$deltaC_{l,i,ba} = [\ gainC_{l,i,a} - lossC_{l,i,a} + (stockC_{l,i,a} - stockC_{l,i,b})\ ] * A_{i,ba} \quad (7.1)$$

$$deltaC_{d,i,ba} = [\ changeC_{d,i,a} + (stockC_{d,i,a} - stockC_{d,i,b}\ )\ ] * A_{i,ba} \quad (7.2)$$

$$deltaC_{s,i,ba} = [\ changeC_{s,i,a} + W_{s,ba} * (stockC_{s,i,a} - stockC_{s,i,b}\ )\ ] * A_{i,ba} \quad (7.3)$$

where:

$_a$:	land-use category after conversion (CC = a)
$_b$:	land-use category before conversion (CC = b)
$_{ba}$:	land use conversion from b to a
$_i$:	spatial stratum
$A_{i,ba}$:	area of land converted from b to a in the spatial stratum i (activity data from the land-use change matrix)
$W_{s,ba}$:	weighting factor for soil, depending on b and a.

The following values for $W_{s,ba}$ have been chosen:

- If "Buildings and Constructions" are involved in the conversion (a = 51 or b = 51) the factor for soils is set to: $W_{s,ba}$ = 0.5.
- In all other cases the factor is 1, i.e. the differences of the C stocks before and after the conversion are taken fully into account: $W_{s,ba}$ = 1.

If a land-use change involves "buildings and constructions" it is assumed that only 50% of the soil carbon is emitted because the humus layer is re-used on green spaces of construction sites (see also Chapter 7.7.4.2).

7.1.3.3 Displaying Results in the Common Reporting Format (CRF)

In the CRF tables 5A to 5F, a part of the combination categories (CC) and associated spatial strata are shown at an aggregated level for optimal documentation and overview. The values of deltaC are accordingly summarised. Positive values of $deltaC_{l,i,ba}$ are inserted in the column "Gains" and negative values in the column "Losses", respectively. The values of $deltaC_{d,i,ba}$ and $deltaC_{s,i,ba}$ are inserted in column "Net carbon stock change in dead organic matter" and "Net carbon stock change in soils", respectively.

The CRF tables 5A to 5F are subdivided in two parts: (1) X Land remaining X Land and (2) Land converted to X Land. Unchanged areas as well as changes occurring from one combination category to another belonging to the same land-use category are reported in the first part of the CRF. For example, the area of "shrub vegetation" (CC32) converted to "permanent grassland" (CC31) is reported in CRF Table 5C1 in the sub-division "permanent" in the respective altitude zone. As CC31 and CC32 do have different carbon stocks in soil and biomass, a carbon stock change is calculated according to the equations presented in Chapter 7.1.3.2.

7.1.3.4 Considering the Conversion Delay Time

Changes in the soil carbon stock – this is also true for the increase of woody biomass – as a result of land-use changes are slow processes that might take decades. Therefore, IPCC (2003) suggests implementing a conversion time (T). Following the IPCC default value (T =

20 years), the carbon emission or removal due to a soil carbon stock difference ($stockC_{s,i,a}$ – $stockC_{s,i,b}$) does not occur in one year but is distributed evenly over the 20 years following the land-use conversion.

A conversion time of 20 years has been applied to all soil carbon stock changes (except land converted to surface water). Accordingly, the CRF tables 5A2, 5B2, 5C2, 5D2, 5E2 and 5F2 contain the cumulative area remaining in the respective category in the reporting year.

In addition, the default conversion time of 20 years has been assumed for carbon stock changes in biomass (living and dead) for land converted to forest land including changes between productive and unproductive forest land.

The land-use category “afforestations" (CC11) is inherently a transitional category by definition in the land-use survey. Areas converted to afforestations are reported in the CRF Table 5A2 with the same conversion time as for other forest sub-categories (20 years). However, afforestations remaining afforestations (according to the land-use survey) are reported in CRF Table 5A1 and are merged with subcategory “productive forest” (CC12) after having been reported 20 years under land converted to forest land.

Table 7-3 summarises the conversion times applied to carbon stock changes in living biomass, in dead organic matter, and in soils for all types of land-use transitions.

Table 7-3 Conversion time periods applied for different land-use transitions and carbon pools.

	Conversion time T [years]		
Land-Use Categories	**living biomass**	**dead organic matter**	**soil**
5A2. Land converted to Forest Land (including afforestations)	20	20	20
5B2. Land converted to Cropland	1	1	20
5C2. Land converted to Grassland	1	1	20
5D2. Land converted to Wetlands	1	1	20
5D2. Land converted to Surface Water	1	1	1
5E2. Land converted to Settlements	1	1	20
5F2. Land converted to Other Land	1	1	20

There is no consistent data on land-use changes before 1990, but it is well known (ARE/SAEFL 2001, FOEN 2011e) that the main trends of the Swiss land-use dynamics (e.g. increase of forests and settlements) did arise before 1970. Therefore, it was assumed that between 1971 and 1989 the annual rate of all land-use changes was the same as in 1990. Based on this assumption it has been possible to produce the land-use data required for the consideration of the conversion time in that period.

7.1.4 Carbon Stocks, Emission Factors, and Net Changes at a Glance

Table 7-4 lists all values of carbon stocks, gains, losses and net changes of carbon specified for combination category (CC) and associated spatial strata for the year 1990. These values remain constant during the period 1990-2010 with two exceptions:

- The carbon stock, gain and loss of living biomass and carbon stock and net change in dead organic matter of productive forest (CC12): The deduction of the annually changing data of CC12 – according to harvest statistics and natural disturbances (like wind throw) – is described in Chapter 7.3.4. The resulting annual data are given in Table 7-5.
- The carbon stock of living biomass of cropland (CC21): The annual data of CC21 are listed in Table 7-30 (see Chapter 7.4.4.1 for further explanations).

While the carbon data for forests are derived from monitoring data of National Forest Inventories NFI 1, NFI 2 and NFI 3, the data for agriculture, grassland and settlements are based on experiments, field studies, literature and expert estimates. For wetlands and other land, expert estimates or default values are available. The deduction of the individual values (carbon stocks in biomass and soils; growth and harvesting of living biomass, net changes in dead organic matter and in soils) is explained in detail in the Chapters 7.3 to 7.8.

The carbon stock changes resulting from individual land-use changes are broken down in Meteotest (2012a).

Table 7-4 Carbon stocks and changes in living biomass, in dead organic matter and in soils for the combination categories (CC), disaggregated for altitude, NFI region, and soil type. The values are valid for the whole period 1990-2010 with the exception of the values in the highlighted cells, which change annually (numbers given here are for the year 1990); cf.text.

land-use code CC	NFI region	altitude zone z	carbon stock in living biomass (stockCl,i)	carbon stock in dead org. matter (stockCd,i)	carbon stock in mineral soil (stockCs,i)	carbon stock in organic soil (stockCs,i)	gain of living biomass (gainCl,i)	loss of living biomass (lossCl,i)	net change in dead org. matter (changeCd,i)	net change in mineral soil (changeCs,i)	net change in organic soil (changeCs,i)
	Strata		t C ha^{-1}				t C ha^{-1} yr^{-1}				
11 Afforestations	1	1	7.84	0	75.00	240	1.63	0	0	0	-0.68
	1	2	4.30	0	75.00	240	1.09	0	0	0	-0.68
	1	3	1.61	0	75.00	240	0.57	0	0	0	-0.68
	2	1	7.84	0	62.60	240	1.63	0	0	0	-0.68
	2	2	4.30	0	62.60	240	1.09	0	0	0	-0.68
	2	3	1.61	0	62.60	240	0.57	0	0	0	-0.68
	3	1	7.84	0	75.30	240	1.63	0	0	0	-0.68
	3	2	4.30	0	75.30	240	1.09	0	0	0	-0.68
	3	3	1.61	0	75.30	240	0.57	0	0	0	-0.68
	4	1	7.84	0	72.10	240	1.63	0	0	0	-0.68
	4	2	4.30	0	72.10	240	1.09	0	0	0	-0.68
	4	3	1.61	0	72.10	240	0.57	0	0	0	-0.68
	5	1	7.84	0	109.00	240	1.63	0	0	0	-0.68
	5	2	4.30	0	109.00	240	1.09	0	0	0	-0.68
	5	3	1.61	0	109.00	240	0.57	0	0	0	-0.68
12 Productive forest	1	1	130.22	12.31	75.00	240	3.56	-2.40	0.19	0	-0.68
	1	2	130.81	12.64	75.00	240	3.23	-2.38	0.21	0	-0.68
	1	3	84.98	10.86	75.00	240	1.96	-1.48	0.08	0	-0.68
	2	1	138.14	10.35	62.60	240	4.89	-4.30	0.06	0	-0.68
	2	2	151.12	10.82	62.60	240	4.97	-4.00	0.09	0	-0.68
	2	3	112.14	22.50	62.60	240	1.62	-0.95	0.93	0	-0.68
	3	1	145.99	17.82	75.30	240	4.30	-2.93	0.03	0	-0.68
	3	2	153.76	19.29	75.30	240	4.15	-3.04	0.13	0	-0.68
	3	3	121.31	20.76	75.30	240	2.57	-2.08	0.24	0	-0.68
	4	1	97.07	34.86	72.10	240	3.18	-2.55	0.10	0	-0.68
	4	2	104.19	37.30	72.10	240	2.54	-1.81	0.28	0	-0.68
	4	3	100.74	37.28	72.10	240	2.02	-1.76	0.28	0	-0.68
	5	1	70.93	24.68	109.00	240	2.05	-0.97	0.17	0	-0.68
	5	2	73.92	23.72	109.00	240	2.16	-0.84	0.10	0	-0.68
	5	3	81.02	24.41	109.00	240	1.77	-0.52	0.15	0	-0.68
13 Unproductive forest	1	1	45.90	9.7	75.00	240	0	0	0	0	-0.68
	1	2	48.20	9.7	75.00	240	0	0	0	0	-0.68
	1	3	48.03	9.7	75.00	240	0	0	0	0	-0.68
	2	1	46.64	9.5	62.60	240	0	0	0	0	-0.68
	2	2	45.90	9.5	62.60	240	0	0	0	0	-0.68
	2	3	12.86	9.5	62.60	240	0	0	0	0	-0.68
	3	1	45.90	17.4	75.30	240	0	0	0	0	-0.68
	3	2	47.68	17.4	75.30	240	0	0	0	0	-0.68
	3	3	29.08	17.4	75.30	240	0	0	0	0	-0.68
	4	1	40.47	33.4	72.10	240	0	0	0	0	-0.68
	4	2	38.37	33.4	72.10	240	0	0	0	0	-0.68
	4	3	18.58	33.4	72.10	240	0	0	0	0	-0.68
	5	1	38.59	22.3	109.00	240	0	0	0	0	-0.68
	5	2	33.46	22.3	109.00	240	0	0	0	0	-0.68
	5	3	21.14	22.3	109.00	240	0	0	0	0	-0.68

(Table continued)

21 Cropland	n.s.	n.s.	4.34	0	53.40	240	0	0	0	0	-9.52
31 Permanent Grassland	n.s.	1	7.08	0	62.02	240	0	0	0	0	-9.52
	n.s.	2	6.00	0	67.50	240	0	0	0	0	-9.52
	n.s.	3	7.95	0	75.18	240	0	0	0	0	-9.52
32 Shrub Vegetation	n.s.	1	12.90	0	68.23	240	0	0	0	0	-5.3
	n.s.	2	12.90	0	68.23	240	0	0	0	0	-5.3
	n.s.	3	12.90	0	68.23	240	0	0	0	0	-5.3
33 Vineyards et al.	n.s.	n.s.	3.74	0	53.40	240	0	0	0	0	-9.52
34 Copse	n.s.	1	12.90	0	68.23	240	0	0	0	0	-5.3
	n.s.	2	12.90	0	68.23	240	0	0	0	0	-5.3
	n.s.	3	12.90	0	68.23	240	0	0	0	0	-5.3
35 Orchards	n.s.	n.s.	24.63	0	64.76	240	0	0	0	0	-9.52
36 Stony Grassland	n.s.	n.s.	4.52	0	26.31	240	0	0	0	0	-5.3
37 Unproductive Grassland	n.s.	n.s.	6.05	0	68.23	240	0	0	0	0	-5.3
41 Surface Waters	n.s.	n.s.	0	0	0	240	0	0	0	0	0
42 Unproductive Wetland	n.s.	n.s.	6.50	0	68.23	240	0	0	0	0	-5.3
51 Buildings, Constructions	n.s.	n.s.	0	0	0	0	0	0	0	0	0
52 Herbaceous Biomass in S.	n.s.	n.s.	9.54	0	53.40	240	0	0	0	0	0
53 Shrubs in Settlements	n.s.	n.s.	15.43	0	53.40	240	0	0	0	0	0
54 Trees in Settlements	n.s.	n.s.	20.72	0	53.40	240	0	0	0	0	0
61 Other Land	n.s.	n.s.	0	0	0	0	0	0	0	0	0

Legend

altitude zones:		*NFI-regions:*		
1	< 601 m	1	Jura	n.s. = no stratification
2	601 - 1200 m	2	Central Plateau	annually changing data
3	> 1200 m	3	Pre-Alps	
		4	Alps	
		5	Southern Alps	

Table 7-5 Annual carbon data for productive forest (CC12) disaggregated for NFI region (NFI) and altitude zone (Alt.), 1990-2010, three-year-averages. Highlighted data for 1990 as displayed in Table 7-4.

NFI	Alt.	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
		CC12: carbon stock in living biomass (stockCl,i) [t C ha^{-1}]									
1	1	130.22	131.39	132.63	133.92	135.24	136.44	135.63	134.67	133.56	132.45
1	2	130.81	131.66	132.64	133.71	134.86	135.88	136.48	137.05	137.57	138.12
1	3	84.98	85.46	86.05	86.72	87.49	88.16	88.95	89.66	90.28	90.92
2	1	138.14	138.74	139.50	140.31	141.46	142.42	142.82	143.17	143.41	143.62
2	2	151.12	152.09	153.22	154.38	155.91	157.25	157.97	158.61	159.11	159.60
2	3	112.14	112.81	113.52	114.23	115.06	115.84	116.03	115.94	115.55	115.17
3	1	145.99	147.36	148.77	150.20	151.91	153.63	155.15	156.57	157.89	159.14
3	2	153.76	154.88	156.01	157.15	158.74	160.38	161.45	162.60	163.82	164.96
3	3	121.31	121.81	122.29	122.78	123.66	124.59	125.46	126.35	127.25	128.11
4	1	97.07	97.71	98.18	98.55	99.10	99.77	100.88	102.20	103.73	104.92
4	2	104.19	104.91	105.38	105.78	106.54	107.50	108.30	109.22	110.24	111.09
4	3	100.74	101.01	100.97	100.87	101.21	101.78	102.20	102.69	103.22	103.70
5	1	70.93	72.01	73.09	74.10	74.98	75.75	76.68	77.59	78.49	79.30
5	2	73.92	75.24	76.59	77.89	79.06	80.15	81.74	83.35	84.96	86.53
5	3	81.02	82.27	83.61	84.93	86.16	87.33	88.52	89.68	90.76	91.83

NFI	Alt.	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
		CC12: carbon stock in living biomass (stockCl,i) [t C ha^{-1}]									
1	1	131.23	129.73	128.55	127.66	127.28	126.81	126.11	125.06	123.61	121.88
1	2	138.59	138.73	139.09	139.64	140.61	141.44	142.07	142.47	142.65	142.70
1	3	91.52	91.95	92.47	93.08	93.89	94.62	95.25	95.79	96.23	96.63
2	1	143.57	141.33	138.68	136.15	135.55	135.19	134.44	133.43	132.33	131.46
2	2	159.84	157.80	155.28	152.83	152.33	152.06	151.41	150.56	149.71	149.16
2	3	114.72	113.55	112.22	110.89	110.15	109.48	108.69	107.87	107.07	106.39
3	1	160.22	160.36	160.21	160.08	160.72	161.52	162.17	162.53	162.63	162.55
3	2	165.88	165.11	163.66	161.99	161.55	161.48	161.43	161.31	161.07	160.75
3	3	128.84	128.51	127.72	126.75	126.53	126.56	126.65	126.77	126.87	126.96
4	1	106.01	107.22	108.78	110.42	111.94	113.42	114.86	116.18	117.36	118.39
4	2	111.86	112.74	113.83	114.98	116.01	117.04	118.06	119.03	119.89	120.62
4	3	104.10	104.61	105.25	105.93	106.50	107.09	107.68	108.28	108.78	109.16
5	1	80.10	80.97	81.91	82.88	83.86	84.83	85.83	86.67	87.42	88.04
5	2	88.11	89.73	91.41	93.11	94.80	96.48	98.17	99.79	101.35	102.84
5	3	92.92	94.16	95.50	96.90	98.24	99.55	100.85	102.12	103.25	104.32

NFI	Alt.	2010									
		CC12: carbon stock in living biomass (stockCl,i) [t C ha^{-1}]									
1	1	120.13									
1	2	142.80									
1	3	97.07									
2	1	130.99									
2	2	149.06									
2	3	105.87									
3	1	162.61									
3	2	160.69									
3	3	127.22									
4	1	119.32									
4	2	121.27									
4	3	109.45									
5	1	88.74									
5	2	104.35									
5	3	105.34									

(Table continued)

NFI	Alt.	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
		CC12: gain of living biomass (gainCl,i) [t C ha^{-1} yr^{-1}]									
1	1	3.56	3.56	3.56	3.56	3.56	3.40	3.24	3.08	3.08	3.08
1	2	3.23	3.23	3.23	3.23	3.23	3.17	3.11	3.06	3.06	3.06
1	3	1.96	1.96	1.96	1.96	1.96	1.87	1.77	1.68	1.68	1.68
2	1	4.89	4.89	4.89	4.89	4.89	4.77	4.64	4.51	4.51	4.51
2	2	4.97	4.97	4.97	4.97	4.97	4.79	4.61	4.43	4.43	4.43
2	3	1.62	1.62	1.62	1.62	1.62	1.31	0.99	0.67	0.67	0.67
3	1	4.30	4.30	4.30	4.30	4.30	4.24	4.18	4.12	4.12	4.12
3	2	4.15	4.15	4.15	4.15	4.15	4.20	4.24	4.28	4.28	4.28
3	3	2.57	2.57	2.57	2.57	2.57	2.54	2.52	2.49	2.49	2.49
4	1	3.18	3.18	3.18	3.18	3.18	3.29	3.40	3.51	3.51	3.51
4	2	2.54	2.54	2.54	2.54	2.54	2.55	2.55	2.56	2.56	2.56
4	3	2.02	2.02	2.02	2.02	2.02	1.97	1.91	1.86	1.86	1.86
5	1	2.05	2.05	2.05	2.05	2.05	2.11	2.17	2.23	2.23	2.23
5	2	2.16	2.16	2.16	2.16	2.16	2.21	2.26	2.31	2.31	2.31
5	3	1.77	1.77	1.77	1.77	1.77	1.77	1.76	1.75	1.75	1.75

NFI	Alt.	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
		CC12: gain of living biomass (gainCl,i) [t C ha^{-1} yr^{-1}]									
1	1	3.08	3.08	3.08	3.08	3.08	3.08	3.08	3.08	3.08	3.08
1	2	3.06	3.06	3.06	3.06	3.06	3.06	3.06	3.06	3.06	3.06
1	3	1.68	1.68	1.68	1.68	1.68	1.68	1.68	1.68	1.68	1.68
2	1	4.51	4.51	4.51	4.51	4.51	4.51	4.51	4.51	4.51	4.51
2	2	4.43	4.43	4.43	4.43	4.43	4.43	4.43	4.43	4.43	4.43
2	3	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67
3	1	4.12	4.12	4.12	4.12	4.12	4.12	4.12	4.12	4.12	4.12
3	2	4.28	4.28	4.28	4.28	4.28	4.28	4.28	4.28	4.28	4.28
3	3	2.49	2.49	2.49	2.49	2.49	2.49	2.49	2.49	2.49	2.49
4	1	3.51	3.51	3.51	3.51	3.51	3.51	3.51	3.51	3.51	3.51
4	2	2.56	2.56	2.56	2.56	2.56	2.56	2.56	2.56	2.56	2.56
4	3	1.86	1.86	1.86	1.86	1.86	1.86	1.86	1.86	1.86	1.86
5	1	2.23	2.23	2.23	2.23	2.23	2.23	2.23	2.23	2.23	2.23
5	2	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31
5	3	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75

NFI	Alt.	2010
		CC12: gain of living biomass (gainCl,i) [t C ha^{-1} yr^{-1}]
1	1	3.08
1	2	3.06
1	3	1.68
2	1	4.51
2	2	4.43
2	3	0.67
3	1	4.12
3	2	4.28
3	3	2.49
4	1	3.51
4	2	2.56
4	3	1.86
5	1	2.23
5	2	2.31
5	3	1.75

(Table continued)

NFI	Alt.	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
		CC12: loss of living biomass (lossCl,i) [t C ha^{-1} yr^{-1}]									
1	1	-2.40	-2.32	-2.27	-2.24	-2.36	-4.21	-4.21	-4.19	-4.19	-4.30
1	2	-2.38	-2.25	-2.16	-2.07	-2.21	-2.57	-2.55	-2.53	-2.51	-2.59
1	3	-1.48	-1.37	-1.28	-1.19	-1.30	-1.07	-1.06	-1.05	-1.04	-1.08
2	1	-4.30	-4.13	-4.09	-3.74	-3.93	-4.37	-4.29	-4.27	-4.30	-4.56
2	2	-4.00	-3.84	-3.80	-3.44	-3.62	-4.07	-3.97	-3.93	-3.93	-4.19
2	3	-0.95	-0.92	-0.91	-0.79	-0.84	-1.12	-1.08	-1.06	-1.05	-1.13
3	1	-2.93	-2.89	-2.87	-2.60	-2.58	-2.72	-2.76	-2.80	-2.87	-3.03
3	2	-3.04	-3.03	-3.01	-2.56	-2.51	-3.13	-3.09	-3.06	-3.14	-3.36
3	3	-2.08	-2.09	-2.08	-1.69	-1.63	-1.67	-1.63	-1.59	-1.63	-1.76
4	1	-2.55	-2.71	-2.82	-2.63	-2.52	-2.19	-2.08	-1.98	-2.32	-2.42
4	2	-1.81	-2.07	-2.14	-1.78	-1.58	-1.74	-1.64	-1.54	-1.70	-1.78
4	3	-1.76	-2.06	-2.12	-1.69	-1.46	-1.54	-1.43	-1.32	-1.39	-1.46
5	1	-0.97	-0.96	-1.03	-1.17	-1.27	-1.18	-1.25	-1.33	-1.42	-1.42
5	2	-0.84	-0.81	-0.87	-0.99	-1.08	-0.62	-0.65	-0.70	-0.74	-0.74
5	3	-0.52	-0.44	-0.45	-0.54	-0.61	-0.57	-0.60	-0.68	-0.68	-0.67

NFI	Alt.	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
		CC12: loss of living biomass (lossCl,i) [t C ha^{-1} yr^{-1}]									
1	1	-4.59	-4.26	-3.97	-3.46	-3.55	-3.78	-4.14	-4.53	-4.81	-4.84
1	2	-2.91	-2.70	-2.51	-2.08	-2.23	-2.43	-2.66	-2.88	-3.02	-2.95
1	3	-1.25	-1.16	-1.07	-0.86	-0.95	-1.05	-1.14	-1.23	-1.28	-1.24
2	1	-6.75	-7.16	-7.04	-5.11	-4.87	-5.26	-5.52	-5.60	-5.38	-4.98
2	2	-6.46	-6.94	-6.88	-4.93	-4.69	-5.07	-5.28	-5.28	-4.97	-4.52
2	3	-1.84	-2.01	-2.01	-1.41	-1.35	-1.46	-1.50	-1.47	-1.35	-1.20
3	1	-3.98	-4.27	-4.24	-3.47	-3.32	-3.46	-3.76	-4.02	-4.19	-4.06
3	2	-5.06	-5.73	-5.95	-4.72	-4.35	-4.33	-4.39	-4.52	-4.60	-4.34
3	3	-2.82	-3.27	-3.46	-2.71	-2.46	-2.41	-2.36	-2.39	-2.40	-2.23
4	1	-2.30	-1.94	-1.87	-1.99	-2.04	-2.07	-2.18	-2.33	-2.48	-2.58
4	2	-1.68	-1.46	-1.41	-1.52	-1.53	-1.54	-1.58	-1.70	-1.82	-1.91
4	3	-1.35	-1.22	-1.17	-1.29	-1.28	-1.27	-1.26	-1.36	-1.48	-1.56
5	1	-1.36	-1.29	-1.25	-1.26	-1.25	-1.23	-1.38	-1.48	-1.60	-1.53
5	2	-0.68	-0.63	-0.61	-0.62	-0.63	-0.62	-0.69	-0.75	-0.82	-0.80
5	3	-0.52	-0.41	-0.35	-0.41	-0.44	-0.46	-0.49	-0.62	-0.69	-0.73

NFI	Alt.	2010									
		CC12: loss of living biomass (lossCl,i) [t C ha^{-1} yr^{-1}]									
1	1	-4.89									
1	2	-2.89									
1	3	-1.19									
2	1	-4.69									
2	2	-4.18									
2	3	-1.08									
3	1	-4.05									
3	2	-4.21									
3	3	-2.13									
4	1	-2.73									
4	2	-2.02									
4	3	-1.64									
5	1	-1.63									
5	2	-0.84									
5	3	-0.73									

(Table continued)

NFI	Alt.	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
		CC12: carbon stock in dead organic matter (stockCd,i) [t C ha^{-1}]									
1	1	12.31	12.48	12.51	12.66	13.05	13.49	13.85	13.89	13.98	13.91
1	2	12.64	12.84	12.86	13.04	13.48	13.98	14.38	14.43	14.53	14.45
1	3	10.86	10.94	10.95	11.02	11.19	11.39	11.59	11.69	11.85	11.95
2	1	10.35	10.40	10.41	10.46	10.59	10.74	10.92	11.05	11.25	11.40
2	2	10.82	10.90	10.92	11.00	11.19	11.44	11.72	11.88	12.12	12.27
2	3	22.50	23.35	23.47	24.26	26.19	28.66	30.39	30.23	29.60	28.16
3	1	17.82	17.85	17.85	17.88	17.94	18.02	18.20	18.43	18.78	19.10
3	2	19.29	19.41	19.43	19.54	19.82	20.17	20.54	20.74	21.02	21.18
3	3	20.76	20.98	21.01	21.21	21.71	22.31	22.90	23.17	23.57	23.77
4	1	34.86	34.96	34.97	35.06	35.28	35.55	35.82	35.94	36.10	36.17
4	2	37.30	37.56	37.59	37.83	38.41	39.25	39.94	40.13	40.17	39.96
4	3	37.28	37.54	37.57	37.81	38.39	39.18	39.84	40.01	40.08	39.90
5	1	24.68	24.84	24.86	25.00	25.36	25.81	26.25	26.43	26.64	26.70
5	2	23.72	23.81	23.82	23.91	24.12	24.39	24.64	24.75	24.88	24.92
5	3	24.41	24.55	24.57	24.70	25.02	25.41	25.78	25.91	26.06	26.08

NFI	Alt.	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
		CC12: carbon stock in dead organic matter (stockCd,i) [t C ha^{-1}]									
1	1	14.06	14.21	14.37	14.54	14.49	14.56	14.48	14.58	14.71	14.85
1	2	14.63	14.79	14.98	15.18	15.12	15.20	15.11	15.23	15.38	15.53
1	3	12.16	12.39	12.64	12.92	13.04	13.27	13.34	13.47	13.58	13.68
2	1	11.65	11.93	12.22	12.55	12.74	13.03	13.14	13.30	13.41	13.51
2	2	12.57	12.89	13.25	13.64	13.83	14.17	14.28	14.47	14.60	14.74
2	3	27.67	26.99	26.33	25.52	23.90	22.58	21.29	21.04	21.35	21.67
3	1	19.53	19.99	20.49	21.06	21.45	21.99	22.24	22.51	22.65	22.79
3	2	21.55	21.94	22.36	22.84	23.05	23.44	23.55	23.79	23.96	24.13
3	3	24.32	24.89	25.51	26.21	26.49	27.04	27.16	27.52	27.79	28.07
4	1	36.39	36.63	36.88	37.16	37.26	37.48	37.52	37.67	37.78	37.90
4	2	40.09	40.20	40.33	40.46	40.25	40.21	40.00	40.10	40.28	40.47
4	3	40.06	40.20	40.37	40.54	40.36	40.37	40.19	40.30	40.49	40.68
5	1	27.00	27.31	27.65	28.03	28.13	28.41	28.43	28.63	28.80	28.97
5	2	25.10	25.28	25.49	25.71	25.77	25.94	25.96	26.07	26.18	26.28
5	3	26.31	26.53	26.79	27.06	27.11	27.30	27.30	27.44	27.58	27.72

NFI	Alt.	2010									
		CC12: carbon stock in dead organic matter (stockCd,i) [t C ha^{-1}]									
1	1	14.87									
1	2	15.56									
1	3	13.70									
2	1	13.53									
2	2	14.76									
2	3	21.72									
3	1	22.81									
3	2	24.16									
3	3	28.12									
4	1	37.92									
4	2	40.50									
4	3	40.71									
5	1	29.00									
5	2	26.30									
5	3	27.75									

(Table continued)

NFI	Alt.	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
		CC12: net change in dead organic matter (changeCd,i) [t C ha^{-1} yr^{-1}]									
1	1	0.19	0.17	0.02	0.16	0.39	0.44	0.36	0.05	0.09	-0.07
1	2	0.21	0.19	0.03	0.18	0.44	0.49	0.40	0.05	0.10	-0.08
1	3	0.08	0.08	0.01	0.07	0.17	0.20	0.20	0.10	0.16	0.09
2	1	0.06	0.06	0.01	0.05	0.13	0.15	0.18	0.13	0.20	0.15
2	2	0.09	0.09	0.01	0.08	0.20	0.25	0.27	0.17	0.23	0.15
2	3	0.93	0.85	0.12	0.79	1.93	2.47	1.73	-0.16	-0.63	-1.44
3	1	0.03	0.03	0.00	0.03	0.06	0.08	0.18	0.23	0.35	0.32
3	2	0.13	0.12	0.02	0.12	0.28	0.35	0.37	0.20	0.28	0.16
3	3	0.24	0.22	0.03	0.21	0.50	0.59	0.59	0.27	0.41	0.20
4	1	0.10	0.10	0.01	0.09	0.22	0.27	0.27	0.12	0.16	0.07
4	2	0.28	0.25	0.04	0.24	0.58	0.83	0.70	0.19	0.04	-0.21
4	3	0.28	0.25	0.04	0.24	0.58	0.79	0.66	0.17	0.07	-0.18
5	1	0.17	0.16	0.02	0.15	0.35	0.46	0.43	0.18	0.21	0.06
5	2	0.10	0.09	0.01	0.09	0.21	0.27	0.26	0.11	0.13	0.04
5	3	0.15	0.14	0.02	0.13	0.31	0.40	0.36	0.13	0.15	0.02

NFI	Alt.	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
		CC12: net change in dead organic matter (changeCd,i) [t C ha^{-1} yr^{-1}]									
1	1	0.15	0.14	0.16	0.18	-0.06	0.07	-0.08	0.11	0.13	0.13
1	2	0.17	0.16	0.19	0.20	-0.06	0.08	-0.09	0.12	0.15	0.15
1	3	0.22	0.23	0.25	0.28	0.12	0.23	0.06	0.14	0.10	0.10
2	1	0.25	0.27	0.29	0.33	0.19	0.29	0.11	0.16	0.10	0.10
2	2	0.30	0.32	0.35	0.39	0.20	0.34	0.11	0.19	0.14	0.14
2	3	-0.49	-0.67	-0.67	-0.81	-1.61	-1.33	-1.28	-0.25	0.31	0.31
3	1	0.42	0.46	0.50	0.57	0.39	0.54	0.25	0.27	0.14	0.14
3	2	0.37	0.39	0.42	0.47	0.21	0.39	0.11	0.24	0.17	0.17
3	3	0.55	0.57	0.62	0.70	0.28	0.56	0.12	0.35	0.28	0.28
4	1	0.22	0.23	0.25	0.28	0.10	0.22	0.04	0.14	0.12	0.12
4	2	0.13	0.11	0.13	0.13	-0.21	-0.04	-0.21	0.10	0.18	0.18
4	3	0.16	0.14	0.16	0.17	-0.18	0.01	-0.18	0.12	0.19	0.19
5	1	0.30	0.31	0.34	0.38	0.10	0.28	0.02	0.20	0.17	0.17
5	2	0.18	0.19	0.20	0.23	0.06	0.17	0.02	0.12	0.10	0.10
5	3	0.22	0.23	0.25	0.28	0.05	0.19	-0.01	0.15	0.14	0.14

NFI	Alt.	2010									
		CC12: net change in dead organic matter (changeCd,i) [t C ha^{-1} yr^{-1}]									
1	1	0.02									
1	2	0.03									
1	3	0.02									
2	1	0.02									
2	2	0.02									
2	3	0.05									
3	1	0.02									
3	2	0.03									
3	3	0.05									
4	1	0.02									
4	2	0.03									
4	3	0.03									
5	1	0.03									
5	2	0.02									
5	3	0.02									

7.1.5 Uncertainty Estimates

Table 7-6 gives an overview of uncertainty estimates of activity data (AD) and of emission factors (EF). In most cases (highlighted in yellow; reasons for exceptions are indicated in column "Remark"), the uncertainty of AD depends on the quality of the AREA survey data.

In general, AD uncertainty is lower than EF uncertainty, because AD are based on a systematic survey with high spatial resolution (see Chapter 7.2), while EF include parameters that are difficult to measure or model such as carbon stocks in biomass, growth rates and other biological processes.

Uncertainty estimates of AD are presented in Chapter 7.2.5, while uncertainty estimates of EF are presented in detail in the respective chapters (7.X.5) of the LULUCF subcategories.

Table 7-6 Uncertainty estimates in the LULUCF sector, expressed as half of the 95% confidence intervals.

IPCC category		Gas	Activity data uncertainty	Emission factor uncertainty	Remark
			%	%	
5A1	1. Forest Land remaining Forest Land	CO2	5	36	
5A2	2. Land converted to Forest Land	CO2	24	36	
5A1	1. Forest Land remaining Forest Land	CH4	10	70	wildfire
5A1	1. Forest Land remaining Forest Land	N2O	10	70	wildfire
5B1	1. Cropland remaining Cropland	CO2	30	25	organic soil
5B2	2. Land converted to Cropland	CO2	10	50	
5B2	2. Land converted to Cropland	N2O	10	90	
5C1	1. Grassland remaining Grassland	CO2	10	50	
5C2	2. Land converted to Grassland	CO2	11	50	
5D1	1. Wetlands remaining Wetlands	CO2	30	100	organic soil
5D2	2. Land converted to Wetlands	CO2	8	50	
5E1	1. Settlements remaining Settlements	CO2	11	50	
5E2	2. Land converted to Settlements	CO2	11	50	
5F2	2. Land converted to Other Land	CO2	13	50	
5(IV)	Agricultural lime application	CO2	40	25	

7.2 Activity Data – Land Areas

7.2.1 Description

Chapter 7.2 presents information related to activity data that is valid for all LULUCF categories, including information on land-use databases, approaches used for representing land areas, classification systems, uncertainties of land-use data as well as land-use related QA/QC, recalculations and planned improvements. The chapter, hence, is structured in a similar way as the subsequent category-specific Chapters 7.3 – 7.8.

7.2.2 Information on Approaches Used for Representing Land Areas and on Land-use Databases Used for Inventory Preparation

7.2.2.1 Swiss Land Use Statistics (AREA)

Data of the Swiss Land Use Statistics (AREA) evaluated by the Swiss Federal Statistical Office (SFSO 2011) are the basis of activity data. In the course of the AREA surveys, every hectare of Switzerland's territory (4'128 kha) will be assigned to one of 46 land-use categories and to one of 27 land-cover categories by means of stereographic interpretation of aerial photos (SFSO 2006a). The AREA surveys were launched in 2004 and are on-going. They are expected to be completed in 2013.

For the reconstruction of the land use conditions in Switzerland during the period 1990-2010 three datasets are used:

- Land Use Statistics "1979/85" (AREA1)
- Land Use Statistics "1992/97" (AREA2)
- Land Use Statistics "2004/09" (AREA3)

The aerial photos for AREA1 and AREA2 were taken 1977-1986 and 1990-1998, respectively, and used for two earlier Swiss land-use statistics (ASCH1 and ASCH2). They are now simultaneously being re-evaluated according to the newly designed AREA set of land-use and land-cover categories (SFSO 2006a) as shown in Figure 7-3.

The new nomenclature of AREA (NOAS04) is not compatible with the former nomenclature NOAS92 used in ASCH. Nevertheless, ASCH2 is used as auxiliary data in making projections of AREA for the whole territory as long as the AREA surveys are not yet completed (see Chapter 7.2.4). Presently, coherently interpreted data of 72% of the Swiss territory are available for all three time slices: AREA1, AREA2 and AREA3 (SFSO 2011). In the previous submission (FOEN 2011), coverage has been restricted to 59%.

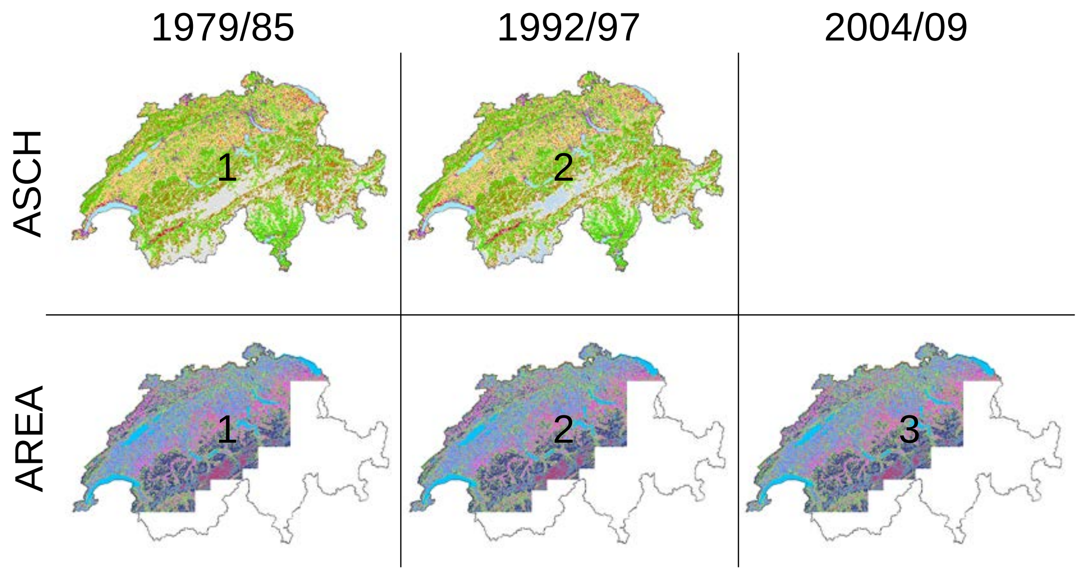

Figure 7-3 The land-use surveys ASCH and AREA. At present, only the old ASCH surveys cover the whole territory. In the course of the on-going AREA survey the earlier ASCH aerial photos are gradually re-evaluated according to the AREA nomenclature.

The inter-survey period is not the same throughout the Swiss territory, but varies regionally. It averages approximately 12 years. This methodical characteristic needs to be considered when reconstructing the annual country-wide status of land use or when calculating annual rates of land-use change.

7.2.2.2 Combination Categories (CC) as derived from AREA Land Use Statistics

The 46 land-use categories and 27 land-cover categories of AREA were aggregated to 18 combination categories (CC; FOEN 2007f), thus implementing the main categories proposed by IPCC as well as country specific sub-divisions (see Table 7-2). The sub-divisions were defined with respect to optimal distinction of biomass densities, carbon turnover, and soil carbon contents.

The first digit of the CC code represents the land-use category according to IPCC, whereas the second digit stands for sub-divisions of the land-use categories.

7.2.2.3 Interpolation of the Status for each Year

The exact dates of aerial photo shootings are known for each hectare. However, the exact occurrence date (year) of a land-use change on a specific hectare is unknown. The actual change can have taken place in any year between two AREA surveys. In this study, it is assumed that the probability of a land-use change from AREA1 to AREA2 and from AREA2 to AREA3 is uniformly distributed over the respective interim period between two surveys. Therefore, the land-use change of each hectare has to be equally distributed over its specific interim period.

Thus, the land-use status for the years between two data collection dates can be calculated by linear interpolation. Dates of aerial photo shootings (i.e. starting and ending year of the inter-survey period) and the land-use categories of AREA1, AREA2 and AREA3 for every hectare are used for these calculations. An example is shown in Figure 7-4: A hectare has been assigned to the land-use category “Cropland” in AREA1 (aerial photo in 1980). A land-use change to “Surrounding of Buildings” has been discovered 10 years later (1990) in AREA2.

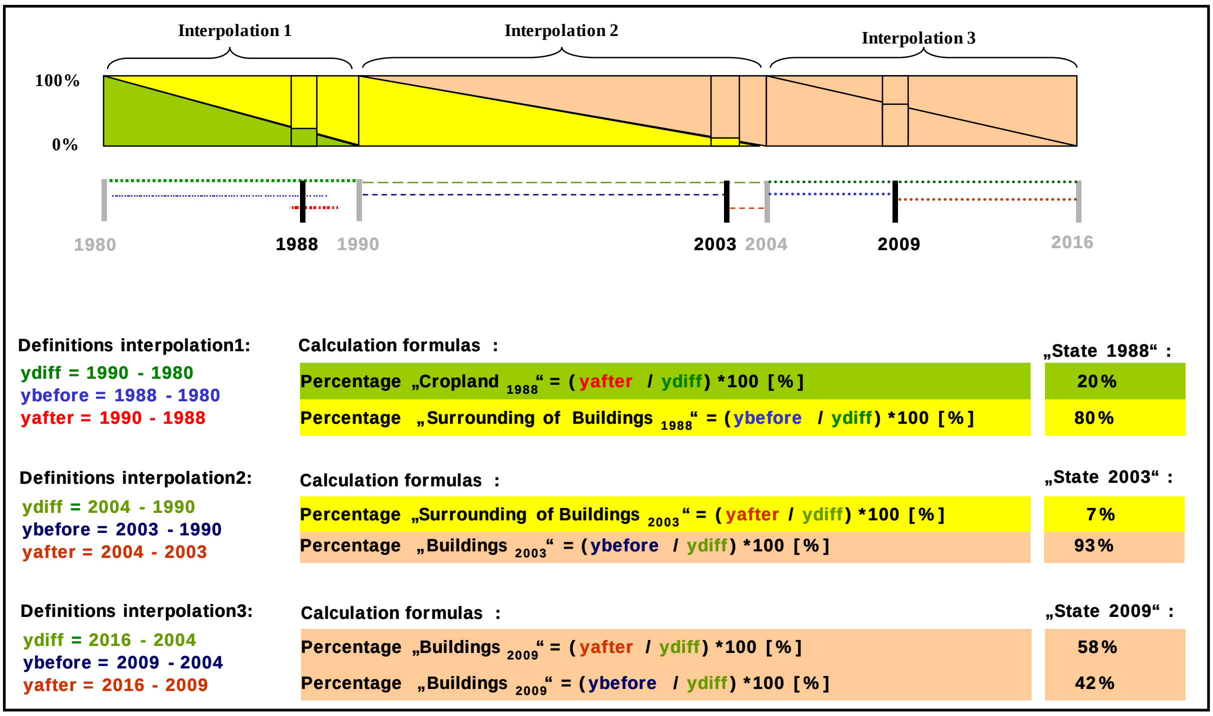

Figure 7-4 Hypothetical linear development of land-use changes between AREA1, AREA2 and AREA3 considering as example a hectare changing from “Cropland” to “Surrounding of Buildings” and then from "Surrounding of Buildings" to "Buildings". For 2009, a linear interpolation has been carried out between AREA3 and a virtual fourth survey modelled for the year 2016 (here resulting in no change of land use).

The “status 1988” of that hectare is determined by calculating the fractions of the two land-use categories for the year 1988. A linear development from “Cropland” to “Surrounding of Buildings” during the whole interim period is assumed. Thus, in 1988 the hectare is split up in two fractions: 80% is “Surrounding of Buildings” and 20% is “Cropland”. The same procedure can be applied for two survey dates between AREA2 and AREA3 (here exemplarily shown for the period 1990-2004, highlighting “status 2003”).

At present, AREA3 comprehends aerial photos from five years (2004-2008). More recent photos have not been interpreted yet. Therefore, the land-use changes occurring after AREA3 are calculated from the linear development detected between AREA3 and a virtual fourth survey, AREA4 (see Figure 7-4: example “status 2009”). AREA4 was modelled by randomly assigning a land-use type to each hectare, thereby maintaining the same transition probabilities as observed between AREA2 and AREA3 within each spatial stratum (Sigmaplan 2012).

The status for each individual year in the period 1990-2010 for the whole Swiss territory results from the summation of the fractions of all hectares per CC, additionally considering the spatial strata where appropriate.

7.2.3 Land-use Definitions and the Classification Systems Used and their Correspondence to the LULUCF Categories

7.2.3.1 Spatial Stratification

In order to quantify carbon stocks and GHG emissions by sources and removals by sinks in the LULUCF sector as accurately as possible, Switzerland’s territory was stratified by means of three site criteria: soil type (mineral or organic), altitude and forest production region.

Most soils in Switzerland are mineral soil types. For mapping the occurrence of organic soils, two datasets were used: (i) the digital soil map “BEK” (SFSO 2000a) and (ii) the Inventory of Raised Bogs of National Importance (Appendix to Swiss Confederation 1991a).

Two units of the digital soil map contain mainly organic soils (Figure 7-5): The codes F1 and Q3, representing Histosols in the Central Plateau and in Alpine valleys, respectively, are good indicators for organic soils in the lowlands. As the soil map has no appropriate unit for organic soils in mountainous areas the maps of the Inventory of Raised Bogs (with a scale of 1:25'000) were used in addition. All areas covered by this inventory were assumed to have organic soils (see Figure 7-5).

For Forest Land and – in part – Grassland, three altitudinal belts were differentiated: <601 m a.s.l. (meters above sea level), 601-1200 m a.s.l., and >1200 m a.s.l. (Figure 7-5). Altitude data are available on a hectare-grid from the Swiss Federal Statistical Office (SFSO 1997).

Forest Land was furthermore differentiated into the five production regions of the National Forest Inventory (EAFV/BFL 1988; Brassel and Brändli 1999; Brändli 2010). These regions were adopted from EAFV/BFL (1988) as shown in Figure 7-5:

1. Jura
2. Central Plateau
3. Pre-Alps
4. Alps
5. Southern Alps.

Applying all spatial stratifications, 30 different strata (referred to as subscript i in Chapter 7.1.3.2) would be theoretically possible. Not all of them, but altogether 28 have been actually realised and applied for the calculation of LULUCF-associated carbon emissions and removals.

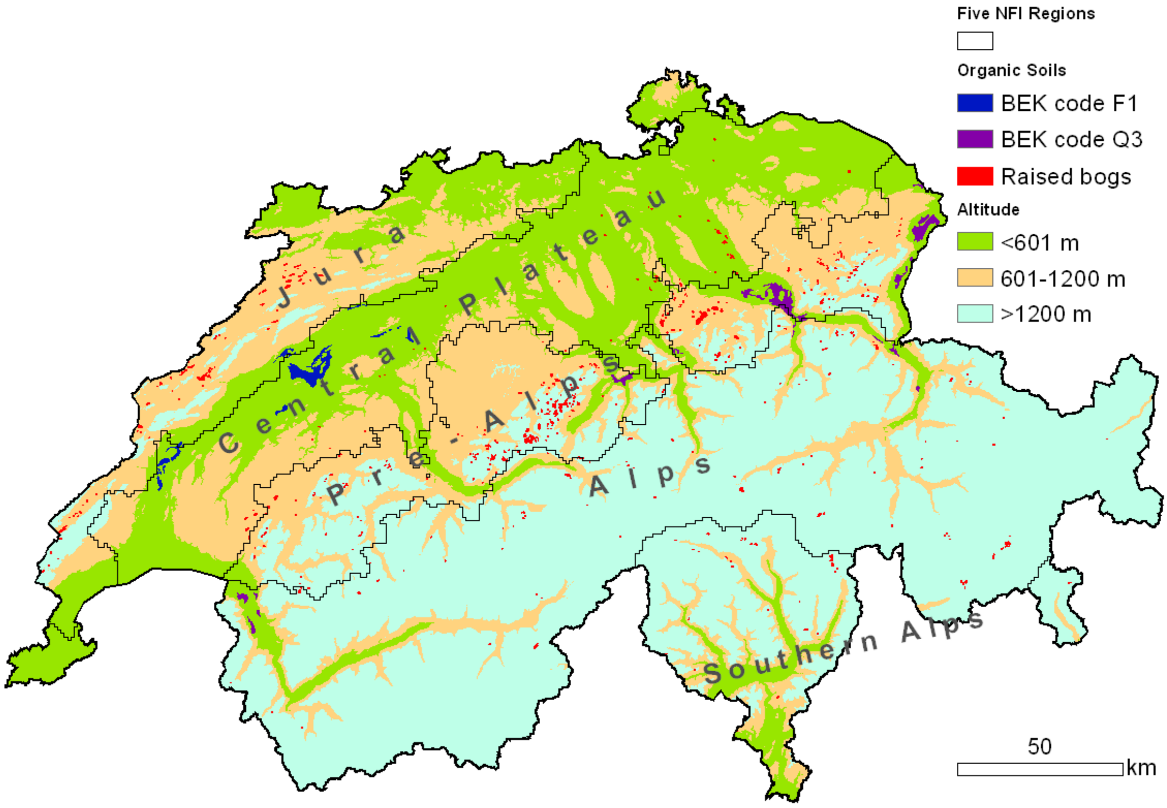

Figure 7-5 Map showing the spatial stratification according to NFI region, altitude, and soil type.

7.2.3.2 The Land-use Tables and Change Matrices

In Table 7-7 the land-use statistics resulting from spatial stratification (Chapter 7.2.3.1), interpolation in time (Chapter 7.2.2.3) and spatial extrapolation (Chapter 7.2.4) are exemplarily shown for the year 1990. This table gives also an overview of the size of the individual spatial strata. The combination codes (CC) have been introduced in Table 7-2.

Table 7-7 Land use (CC) projection by the end of 1990, stratified separately for altitude (3 zones), soil type (mineral or organic) and NFI-region (1-5), in kha.

CC:	11	12	13	21	31	32	33	34	35	36	37	41	42	51	52	53	54	61	Sum
Altitude																			
<601	1.1	208.3	0.8	307.2	154.6	1.5	21.9	36.9	1.3	0.3	2.7	132.7	5.2	112.3	45.6	2.4	17.5	1.2	1053.4
601-1200	1.5	460.3	6.1	135.5	368.5	5.5	4.8	38.9	0.4	1.7	1.5	10.3	5.7	48.6	17.7	1.0	5.5	7.7	1121.1
>1200	1.4	394.2	86.0	0.4	429.8	137.7	0.0	30.4	0.0	160.1	59.6	15.2	15.8	12.0	3.5	0.2	1.1	606.4	1953.9
	4.0	1062.7	93.0	443.0	953.0	144.7	26.7	106.1	1.6	162.2	63.7	158.2	26.7	172.9	66.7	3.6	24.1	615.3	4128.4
Soil																			
mineral	4.0	1059.3	92.9	430.9	947.4	144.6	26.6	105.6	1.6	162.1	63.4	157.6	23.4	171.0	66.0	3.5	23.9	615.3	4099.4
organic	0.0	3.4	0.1	12.1	5.7	0.1	0.1	0.5	0.0	0.1	0.3	0.5	3.3	1.8	0.7	0.1	0.1	0.0	29.0
	4.0	1062.7	93.0	443.0	953.0	144.7	26.7	106.1	1.6	162.2	63.7	158.2	26.7	172.9	66.7	3.6	24.1	615.3	4128.4
NFI-region																			
1	0.7	202.7	5.5	78.6	125.3	0.9	4.5	15.2	0.3	0.2	0.6	24.2	1.3	28.0	11.4	0.5	4.9	0.6	505.6
2	0.8	232.7	0.4	314.7	159.4	0.9	10.4	32.1	1.0	0.2	1.6	71.2	4.3	86.8	35.4	1.6	12.8	0.7	967.4
3	1.1	220.7	9.3	32.5	266.0	10.4	0.8	22.3	0.1	8.6	7.2	31.6	12.6	27.5	9.3	0.5	2.9	15.0	678.2
4	1.3	337.8	57.6	12.8	369.8	107.5	10.9	32.4	0.2	120.8	46.6	27.9	7.9	28.0	9.5	0.8	3.1	538.9	1713.9
5	0.1	68.8	20.2	4.4	32.4	25.0	0.0	4.2	0.0	32.3	7.7	3.2	0.7	2.6	1.1	0.2	0.4	60.2	263.3
	4.0	1062.7	93.0	443.0	953.0	144.7	26.7	106.1	1.6	162.2	63.7	158.2	26.7	172.9	66.7	3.6	24.1	615.3	4128.4

Table 7-8 shows the overall trends of land-use changes between 1990 and 2010. For example, the area of afforestations (CC11) decreased by 76% during this period, while the area of unproductive forests (CC13) increased by 9%. CC11 is decreasing because the area of new afforestations has been decreasing during this period and because most of the afforestation areas develop to productive forests after a certain time period.

Table 7-8 Statistics of land use (CC) for the period 1990-2010 (in kha) and relative change (%) between 1990 and 2010.

CC:	11	12	13	21	31	32	33	34	35	36	37	41	42	51	52	53	54	61	Sum
Year:																			
1990	4.0	1062.7	93.0	443.0	953.0	144.7	26.7	106.1	1.6	162.2	63.7	158.2	26.7	172.9	66.7	3.6	24.1	615.3	4128.4
1991	3.9	1064.8	93.5	442.2	951.1	144.5	26.8	104.9	1.6	161.9	63.6	158.2	26.7	174.5	67.2	3.7	24.4	614.9	4128.4
1992	3.8	1066.8	94.0	441.4	949.3	144.2	26.8	103.7	1.5	161.6	63.4	158.2	26.7	176.2	67.8	3.7	24.8	614.5	4128.4
1993	3.7	1068.8	94.5	440.6	947.7	144.0	26.8	102.6	1.5	161.3	63.3	158.2	26.7	177.7	68.3	3.8	25.0	614.2	4128.4
1994	3.5	1070.5	94.9	439.3	946.7	143.7	26.7	101.4	1.4	161.2	63.1	158.2	26.7	179.3	68.8	3.8	25.2	613.9	4128.4
1995	3.3	1072.2	95.3	437.7	946.5	143.2	26.7	100.4	1.4	161.0	63.0	158.2	26.7	180.8	69.4	3.8	25.2	613.6	4128.4
1996	3.1	1073.7	95.8	436.0	946.2	142.7	26.6	99.4	1.3	160.9	62.9	158.2	26.7	182.3	70.1	3.8	25.2	613.3	4128.4
1997	2.9	1075.2	96.2	434.2	946.2	142.3	26.5	98.4	1.3	160.7	62.8	158.3	26.7	183.8	70.9	3.8	25.0	613.0	4128.4
1998	2.6	1076.5	96.6	432.5	946.2	142.0	26.4	97.4	1.3	160.7	62.7	158.3	26.7	185.3	71.6	3.8	24.9	612.8	4128.4
1999	2.4	1077.8	97.0	430.7	946.3	141.6	26.3	96.4	1.2	160.6	62.6	158.3	26.7	186.8	72.4	3.9	24.8	612.6	4128.4
2000	2.2	1079.2	97.4	428.9	946.3	141.3	26.2	95.4	1.2	160.5	62.5	158.3	26.8	188.3	73.2	3.9	24.6	612.3	4128.4
2001	1.9	1080.5	97.8	427.1	946.3	141.0	26.1	94.4	1.2	160.4	62.4	158.3	26.8	189.9	73.9	3.9	24.5	612.1	4128.4
2002	1.7	1081.8	98.2	425.4	946.3	140.7	26.0	93.3	1.1	160.3	62.3	158.3	26.8	191.4	74.7	3.9	24.3	611.9	4128.4
2003	1.5	1083.2	98.6	423.6	946.3	140.3	25.9	92.3	1.1	160.2	62.1	158.3	26.8	192.9	75.5	3.9	24.2	611.6	4128.4
2004	1.3	1084.5	99.0	421.8	946.4	140.0	25.8	91.3	1.1	160.1	62.0	158.4	26.8	194.4	76.2	3.9	24.1	611.4	4128.4
2005	1.1	1086.7	99.7	421.3	946.8	139.1	25.5	89.5	1.0	160.0	61.8	158.4	26.8	195.7	76.6	3.8	23.5	610.8	4128.4
2006	1.0	1088.7	100.3	421.2	946.9	138.5	25.3	87.8	1.0	159.9	61.5	158.5	26.8	197.0	76.9	3.7	23.0	610.3	4128.4
2007	1.0	1090.3	100.8	421.3	946.6	138.2	25.0	86.4	1.0	159.8	61.3	158.5	26.7	198.0	77.2	3.7	22.6	609.9	4128.4
2008	1.0	1091.8	101.1	421.5	946.4	137.9	24.8	85.4	0.9	159.7	61.2	158.6	26.7	198.8	77.3	3.6	22.2	609.5	4128.4
2009	1.0	1092.9	101.4	419.9	946.2	137.6	24.7	84.6	0.9	159.6	61.1	158.6	26.7	200.2	77.9	3.6	22.2	609.3	4128.4
2010	1.0	1093.9	101.7	418.3	946.0	137.3	24.6	83.8	0.9	159.5	61.0	158.6	26.7	201.7	78.6	3.6	22.1	609.1	4128.4
Change:	-76	3	9	-6	-1	-5	-8	-21	-45	-2	-4	0	0	17	18	0	-8	-1	0

The annual rates of change in the entire territory of Switzerland (change-matrices) are achieved by adding up the annual change rates of all hectares per combination category (CC). Each land-use change involves a decreasing (“from”) and an increasing (“to”) change. Because the respective areas may be spatially extrapolated by different area expansion factors (see Chapter 7.2.4), the resulting decreasing area may not be equal to the resulting increasing area for a specific land-use transition. The deviations between both values will diminish once the interpretation of AREA has been terminated. Meanwhile, the change matrices are established by calculating the mean of the increasing area and of the decreasing area for each land-use transition, as shown in Table 7-9.

For calculating the carbon stock changes, fully stratified (up to 28 strata, cf. Chapter 7.2.3.1) land-use change tables are used for each year (Meteotest 2012).

Table 7-9 Annual rates of land-use change in 1990 and in 2010 (change matrices). Units: ha/year, rounded values. Empty cells indicate no change has occurred.

1990	change to CC																	
change from CC	11	12	13	21	31	32	33	34	35	36	37	41	42	51	52	53	54	61	decrease
11		359	2	0	1	0		0						0	0	0		0	363
12			158	6	126	108	5	89		14	19	9	7	109	22	9	14	52	747
13		593			153	49	0	50		5	1	1	2	7	0		1	12	874
21	8	1			661	5	179	40	1	4	3	4	4	634	315	20	18	22	1920
31	145	163	264	723		1038	116	542	5	51	50	9	11	877	486	22	42	74	4620
32	21	943	800	2	138		8	286		13	14	5	0	24	7	3	2	31	2298
33	1	0		130	61	2		31	3	0	1	0		50	25	3	3	6	316
34	29	605	38	155	1116	60	40		11	12	25	4	4	207	111	7	53	15	2491
35		0		9	14	0	5	50						5	3	0	1	0	86
36	2	23	29	2	169	279	1	38			98	4	0	10	1	0		48	704
37	5	24	6	1	10	265	1	64		9		3	0	7	2		0	14	410
41	0	4	0	1	2	4	0	4		3	1		17	10	2	1	0	84	134
42	5	27	7	1	3	3	0	3			0	6		4	1	0	0	1	60
51	38	18	0	86	162	10	5	10		4	5	6	4		263	57	46	6	721
52	6	3		16	31	3	1	2		0	1	1	2	342		68	382	0	859
53	4	8	0	5	7	1	0	1			0	0	2	40	24		44	0	137
54	2	5		1	1	0	0	3			0	0	1	72	140	6		0	232
61	5	37	13	17	72	91	10	26		299	41	93	2	13	1	0	0		720
increase	271	2816	1318	1155	2726	1919	373	1241	20	414	258	147	56	2411	1402	196	606	365	17692

2010	change to CC																	
change from CC	11	12	13	21	31	32	33	34	35	36	37	41	42	51	52	53	54	61	decrease
11		67												0					68
12			238	1	177	160	1	102		26	21	15	12	79	21	11	8	73	944
13		610			198	60		28		5	2	1	2	3	1	0	1	10	920
21	2	0			1300	5	133	17	0	4	11	7	9	500	285	13	5	12	2304
31	16	80	218	446		602	67	321	2	74	28	6	9	778	399	13	9	90	3159
32	3	686	632	1	124		1	261		17	11	4	0	12	3	1	1	31	1787
33	0	1		141	91	3		19	1	1	0		0	33	21	1	2	7	321
34	3	480	32	54	782	61	14		4	10	22	6	1	125	69	2	21	19	1705
35				1	6		2	17						1	0				27
36	0	15	27	3	85	210	1	44			56	5		4	0			43	494
37	1	14	3	1	3	183	0	44		12		3	1	4	1			11	282
41	0	3	0	0	1	4		1		3	3		9	5	1	0		104	134
42	0	18	5		0	0		2		0		7		2	0			1	36
51	17	8	1	65	146	8	3	5		6	7	6	2		276	51	20	5	625
52	5	3	1	16	40	3	1	3		1	2	1	1	403		47	210	0	737
53	2	9		3	10	2	0	1			0	0	0	45	33		38	0	143
54	1	3		0	1	0		1			0		0	92	285	16			400
61	1	25	11	16	48	66	5	24		250	18	101	1	5	1	0			572
increase	51	2022	1168	750	3013	1367	228	891	7	410	182	160	49	2091	1395	155	314	407	14659

It is worth noting that in general the numbers given in the tables above cannot be directly compared with the numbers reported in the CRF tables: The CRF tables 5A2–5F2 contain the cumulative area remaining in the respective category in the reporting year. As described in Chapter 7.1.3.4, a conversion time of 20 years is applied to those land-use transitions and during the conversion time, the converted areas are reported under CRF tables 5X2. In contrast, the change matrices present the land-use changes occurring in the specified year alone.

7.2.4 Methodological Issues – Spatial Extrapolation of AREA

The land-use surveys AREA1, AREA2 and AREA3 were launched in 2004 (see Chapter 7.2.2.1). Presently, a sample region covering 72% of the Swiss territory has been evaluated (see Figure 7-6). For the rest of the Swiss territory data availability is currently restricted to the LUcode classification (Table 7-10; see FOEN 2006b for details), i.e. a land-use classification that has been developed on the basis of the nomenclature used in ASCH1 and ASCH2 (SFSO 2005).

Figure 7-6 Map showing the regions (dark gray) that have already been evaluated in the land-use survey AREA3 (as of June 2011), including some unverified provisional data (light gray).

A spatial extrapolation of the AREA-derived CC data in the sample region (72%) to the total Swiss territory has been carried out, using ASCH2 as a reference basis. First, the CC data in the sample region ($AREA_{samp}$) were interpolated in time for each year (see Figure 7-4), and then the spatial extrapolation of the respective land-use categories was calculated. In the same way the land-use changes detected in the sample region were extrapolated.

The LUcode classification included the 6 main categories and 13 sub-divisions (LUcode), which are an aggregation of the 74 ASCH-codes (FOEN 2006b). The CC classification is built of 6 main categories and 18 sub-divisions (Table 7-10). A direct correspondence of all LUcode and CC sub-divisions is not given. Therefore, an auxiliary categorisation, called ”excat” (extrapolation category) is introduced. Excat includes 11 sub-divisions. Each LUcode category and CC, respectively, can be definitely assigned to one excat code. The relation between LUcodes categories, CC and ”excat” is shown in Table 7-10.

Table 7-10 Relation between different land-use categorisations: IPCC main categories (IPCC 2003), LUcode sub-divisions, LUcode (aggregated ASCH code; FOEN 2006b), ASCH code and description (SFSO 2005), Excat code (extrapolation category; this report), combination category (CC), and CC code (FOEN 2007f).

Main Category	LUcode Sub-division	LUcode	ASCH-code	ASCH-description	Excat code	Combination Category (CC)	CC code
Forest Land	Afforestations	11	9	Afforestations	11	Afforestations	11
	Productive Forest	12	10	Damaged forest areas	12	Productive Forest	12
			11	Normal dense forest	12		
			13	Open forest (on agricultural areas)	12		
			14	Forest stripes, edges	12		
	Unproductive Forest	13	12	Forest on unproductive areas	13	Unproductive Forest	13
			15	Brush forest	13		
Cropland		20	52	Garden allotments	21		
			71	Regular vineyards	30		
			72	"Pergola" vineyards	30		
			73	Extensive vines	30		
			78	Horticulture	21		
			81	Favourable arable land and meadows	21		
					21	Cropland	21
Grassland	Permanent Grassland	31	32	Green motorway environs	31	Permanent Grassland	31
			38	Airfields, green airport environs	31		
			54	Golf courses	50		
			67	Green railway environs	31		
			68	Green road environs	31		
			82	Other arable land and meadows	31		
			83	Farm pastures	31		
			85	Mountain meadows	31		
			87	Remote and steep alpine	31		
			88	Favourable alpine pastures	31		
			89	Rocky alpine pastures	31		
	Grass with Perennial Woody Biomass	32	16	Scrub vegetation	30	Shrub Vegetation	32
			17	Groves, hedges	30		
			18	Clusters of trees (on agricultural areas)	30		
			19	Other woods	30		
			75	Intensive orchards	30		
			76	Rows of fruit trees	30		
			77	Scattered fruit trees	30		
			84	Brush meadows and farm pastures	30		
			86	Brush alpine pastures	30		
	Unproductive Grassland	33	97	Unproductive grass and shrubs	30		
					30	Vineyards, Low-Stem Orchards, Tree nurseries	33
					30	Copse	34
					30	Orchards	35
					30	Stony Grassland	36
					30	Unproductive Grassland	37
Wetlands	Surface Waters	41	91	Lakes	41	Surface Waters	41
			92	Rivers	41		
	Unproductive Wetland	42	95	Wetlands	42	Unproductive Wetland	42
			96	Water shore vegetation	42		
Settlements	Buildings/Constructions	51	20	Ruins	51	Buildings and Constructions	51
			21	Industrial buildings	51		
			23	Buildings in recreational areas	51		
			24	Buildings in special urban areas	51		
			25	One- and two-family houses	51		
			26	Terraced houses	51		
			27	Blocks of flats	51		
			28	Agricultural buildings	51		
			29	Unspecified buildings	51		
			31	Motorways	51		
			33	Roads and paths	51		
			34	Parking areas	51		
			35	Railway station grounds	51		
			36	Railway lines	51		
			37	Airports	51		
			51	Sport grounds	51		
			53	Camping, caravan sites	51		
			61	Other supply or waste treatment plants	51		
			62	Energy supply plants	51		
			63	Waste water treatment plants	51		
			64	Quarries, mines	51		
			65	Dumps	51		
			66	Construction sites	51		
	Surrounding of Buildings	52	41	Industrial grounds	50	Herbaceaus Biomass in Settlement	52
			45	Surroundings of one- and two-family	50		
			46	Surroundings of terraced houses	50		
			47	Surroundings of blocks of flats	50		
			48	Surroundings of agricultural buildings	50		
			49	Surroundings of unspecified buildings	50		
	Parks	53	56	Cemeteries	50	Shrubs in Settlements	53
			59	Public parks	50		
					50	Trees in Settlements	54
Other Land		60	69	River shores	61		
			90	Glaciers, perpetual snow	61		
			93	Flood protection structures	61		
			98	Avalanche protection structures	61		
			99	Rocks, sand, screes	61		
					61	Other Land	61

In the spatial extrapolation approach the whole Swiss territory is divided into three main sub-regions (see Figure 7-7):

- Sample region (samp): CC data are available on hectare-basis for AREA1, AREA2 and AREA3. Coverage: 72% of Swiss territory.
- Extrapolation region (extrapol): Land use can be quantified by extrapolating CC data in the sample region using excat. Coverage: 99.8% of Swiss territory (including the sample region).
- Substitution region (subst): This is the remaining area for which no or too little CC data in the sample region are available. Extrapolation of CC data is impossible and land-use data from ASCH2 survey (LUcode categories) is used instead. Coverage: 0.2% of Swiss territory. Changes in land use are neglected in the substitution region.

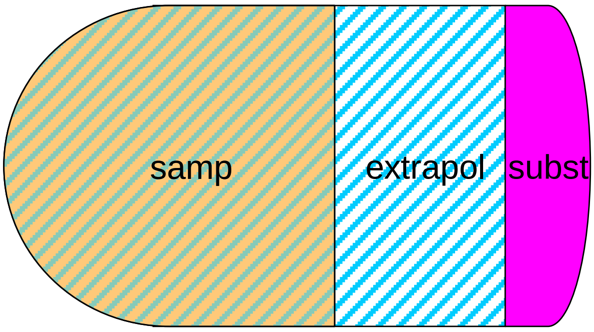

Figure 7-7 Scheme showing the three sub-regions of Switzerland used for the extrapolation: sampling region of AREA (samp), extrapolation region (extrapol, diagonal shading) and substitution region (subst).

As the spatial stratification is needed for the computation of CO_2 equivalent emissions/ removals the land use and land-use changes must be quantified for each stratum. The basic idea is to extrapolate the CC data of a certain stratum by applying a stratum-specific area expansion factor (AEF). As CC datasets are not available in ASCH2, excat is used instead. The AEF for a certain excat in stratum i(z,nfi,soil) can be formulated as:

$$AEF(excat,i) = ASCH2_{extrapol}(excat,i) \,/\, ASCH2_{samp}(excat,i) \qquad (7.4)$$

where:

$ASCH2_{extrapol}(excat,i)$: Number of hectares in the ASCH2 dataset covered by land-use type excat situated in stratum i for the whole extrapolation region

$ASCH2_{sample}(excat,i)$: Number of hectares in the ASCH2 dataset covered by land-use type excat situated in stratum i in the sample region

i: Spatial strata defined by a combination of z (altitude zone), nfi (NFI region) and soil (organic, mineral); i = i(z,nfi,soil).

To avoid arbitrary results caused by very small and unrepresentative areas in the sample region, a "decision cascade" is introduced (see Figure 7-8). The idea is to apply a less differentiated AEF if the size of the sub-sample does not reach a specific threshold (T). The threshold of the most differentiated case (level A in Figure 7-8) is calculated as follows:

$$T(excat,i) = 10\% * ASCH2_{extrapol}(excat,i) \qquad (7.5)$$

In FOEN (2006), thresholds were empirically tested and it was decided to successively adjust the calculation of thresholds in later submissions to match approximately the half of the relative size of the sample region. The sample region exceeds 20% since the April 2008 submission (FOEN 2008). The thresholds are calculated with a (maximal) factor of 10% since then.

description	threshold	availability	number of categories
level A: excat, i	T (excat,i)	90%	271 (max. 504)
level B1: excat	T (excat)	96%	28 (max. 30)
level B2: i	T (i)	100%	11
level C: main category	T (main category)	100%	6
level D: general	-	100%	1

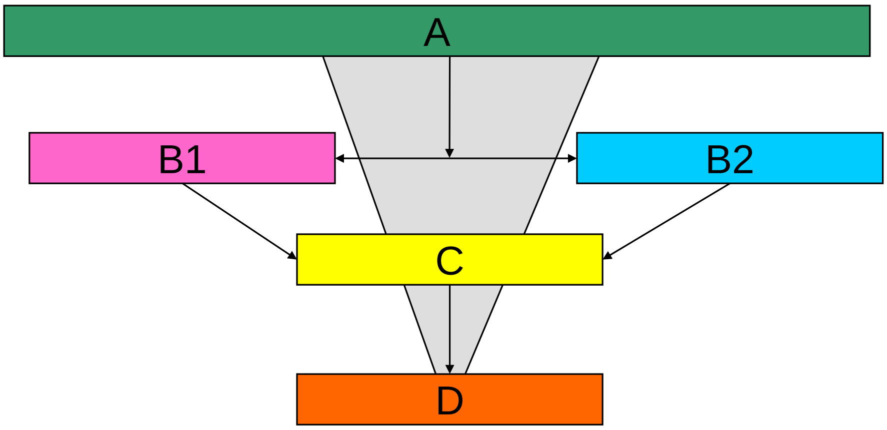

Figure 7-8 Extrapolation cascade for calculating area expansion factors (AEF) at different levels of differentiation.

If the size of the sub-sample $AREA_{samp}$(excat(CC),i,yr) is greater than the threshold T(excat,i), then the extrapolated area $AREA_{extrapol}$(CC,i,yr) is calculated by the most differentiated AEF (see Equation 7.4). This corresponds to level A in Figure 7-8. With these AEF values, the extrapolated area of the combination category CC in the stratum i in the year yr is calculated as follows:

$$AREA_{extrapol}(CC,i,yr) = AEF(excat(CC),i) * AREA_{samp}(CC,i,yr) \qquad (7.6)$$

where:

$AREA_{samp}$(CC,i,yr): Number of all hectares in the AREA data sample (interpolated to the year yr) covered by land-use type CC situated in stratum i.

excat(CC): Stands for the excat to which the respective CC is assigned (see Table 7-10).

If the threshold is not reached at level A, then the threshold values of level B1 (T(excat)) and B2 (T(i)) are calculated (with an appropriately simplified version of Equation 7.5) and compared. The AEF of the level with the higher value for T is calculated (only if threshold is exceeded):

$$AEF(excat) = ASCH2_{extrapol}(excat) / ASCH2_{samp}(excat) \qquad (7.7a)$$
$$AEF(i) = ASCH2_{extrapol}(i) / ASCH2_{samp}(i) \qquad (7.7b)$$

where:

$ASCH2_{extrapol}$(excat): Number of all hectares in the ASCH2 dataset covered by land-use type excat within the extrapolation region, regardless of the stratum i.

$ASCH2_{samp}$(excat): Number of all hectares in the ASCH2 dataset covered by land-use type excat within the sample region, regardless of the stratum i.

$ASCH2_{extrapol}$(i): Number of all hectares in the ASCH2 dataset lying in the spatial stratum i within the extrapolation region, regardless of the land-use category.

$ASCH2_{samp}$(i): Number of all hectares in the ASCH2 dataset lying in the spatial stratum i within sample region, regardless of the land-use category.

If the size of the sub-sample size does not reach the thresholds T(excat) and T(i), the threshold of the main category T(maincat) is evaluated and the AEF(maincat) is used (level C in Figure 7-8). "Maincat" denotes the main land-use category according to Table 7-10:

$$AEF(maincat) = ASCH2_{extrapol}(maincat) / ASCH2_{samp}(maincat) \quad (7.8)$$

If also T(maincat) is not reached by the size of the generalised sub-sample, then the most general area expansion factor AEF(general) is used (level D in Figure 7-8), which is the ratio of the extrapolation region to the sample region:

$$AEF(general) = ASCH2_{extrapol} / ASCH2_{samp} \quad (7.9)$$

By applying area expansion factors of different accuracy levels, slight discrepancies in the total area result. Therefore, a calibration factor F is calculated *a posteriori* to adjust the sum of the calculated areas to the real total area of the extrapolation region:

$$F(yr) = ASCH2_{extrapol} / [\Sigma AREA_{extrapol}(CC,i,yr)] \quad (7.10)$$

With the presently available sample data, the values of F(yr) are 1.023.

In the substitution region only ASCH data are available (i.e. $AREA_{samp}(CC,i,yr) = 0$). ASCH2 data are chosen as a surrogate for AREA. They are converted by means of the excat classification to the CC by the function "part", which corresponds to the fraction of CC in excat:

$$AREA_{subst}(CC,i,yr) = ASCH2_{subst}(excat(CC),i) * part(CC,yr) \quad (7.11)$$

$$part(CC,yr) = AREA_{samp}(CC,yr) / AREA_{samp}(excat(CC),yr) \quad (7.12)$$

where:

$ASCH2_{subst}$(excat(CC),i): Number of all hectares in the ASCH dataset covered by land-use excat and situated in stratum i in the substitution region.

$AREA_{samp}$(CC,yr): Number of all hectares in the AREA dataset covered by land-use CC.

$AREA_{samp}$(excat(CC),yr): Number of all hectares in the AREA dataset covered by land-use excat.

The total stratified area of the CC in Switzerland is the sum of the calibrated area in the extrapolation region and of the area in the substitution region:

$$AREA_{Switzerland}(CC,i,yr) = F(yr) * AREA_{extrapol}(CC,i,yr) + AREA_{subst}(CC,i,yr) \quad (7.13)$$

7.2.5 Uncertainties and Time-series Consistency of Activity Data

An overview of uncertainty estimates for activity data (AD) and emission factors (or biomass parameters) has been shown in Table 7-6. Details related to uncertainties of AD are presented in this chapter, while uncertainties of the emission factors are presented in the respective chapters (7.X.5) of the LULUCF subcategories.

In most cases (as highlighted in yellow in Table 7-6), the uncertainty of AD depends on the quality of the AREA survey data. Five exceptions are:

- (1) CH_4 emissions and (2) N_2O emissions from category 5A1 (Forest land remaining forest land) are due to wildfires. The burnt area is surveyed by cantonal authorities. A relatively small uncertainty of 10% is assumed as it is a complete survey and not a sampling approach.
- (3) CO_2 emissions of category 5B1 (Cropland remaining cropland) are due to net carbon stock changes in organic soils. The uncertainty of the area of organic soils is around 30% according to Leifeld et al. (2003: 61).
- (4) CO_2 emissions of category 5D1 (Wetland remaining wetland) are due to net carbon stock losses in organic soils. The uncertainty of the area of organic soils is around 30% according to Leifeld et al. (2003: 61).
- (5) CO_2 emissions of category 5(IV): agricultural lime application. The amount of lime was estimated based on a poll among the main producers in Switzerland (ART 2009; see Chapter 7.4.4.5).

The uncertainty of AREA-based activity data has four main sources (Table 7-11). They have been quantified on the basis of the AREA data available by August 2011 (SFSO 2011) as follows:

1) Interpretation error: In the AREA survey, the interpretation of the aerial photos is checked by a second independent interpreter. The portion of sampling points with a mismatch of the first and the second interpretation is used as the uncertainty of the interpretation. While it is clear that this is rather an estimate of the maximum potential interpretation error than of the actual interpretation error, it is reported hereafter unless more accurate information is available.

2) Statistical sampling error: In the AREA survey, the land-use types are interpreted on points situated on a regular 100x100 m grid. Thus, the uncertainty of the surface area covered by a certain land-use type or land-use change decreases with increasing numbers of sampling points. Assuming a binomial distribution of the errors, this uncertainty is calculated as

$$U_{sampling} = 100 * 1.96 * (\text{number of points})^{-0.5}$$

The number of sampling points lies between 1'678 (for 5D2) and 951'198 (for 5C1) leading to values of $U_{sampling}$ between 4.8% and 0.2%.

3) Extrapolation error: Remaining and converted land-use types in the sampling region may have a frequency that differs from the whole of Switzerland leading to a bias in the extrapolated areas. With the increase of the sampling region, the extrapolation error will converge to zero in the future. For quantifying this error, the relative change of proportions of the land-use types (5A1 to 5F2) between the AREA sample of the last year (59% of Switzerland; FOEN 2011) and the present sample (72% of Switzerland) was used. The values are between 2.7% and 31.7%.

4) Substitution error: The spatial strata that are not covered by the sample of the AREA survey are called substitution region, because the AREA data are substituted here by ASCH2 data. In the substitution region land-use changes are neglected. In order to quantify the uncertainty caused by this simplification, the land-use activities (5A1 to 5F2) taking place between AREA2 and AREA3 were compared with the activities observed between AREA1 and AREA2. The relative change among these two transitions (AREA1-AREA2 and AREA2-AREA3), weighted with the relative size of the substitution region, is used as an indicator for the uncertainty U_{subst} in the rate of change within the substitution area (see Table 7-11). It is obvious that the conversion activities have a higher substitution uncertainty than the “remaining” categories.

The overall uncertainty was calculated as:

$$U_{overall} = (U_{interpret}^2 + U_{sampling}^2 + U_{extrapol}^2)^{0.5} + U_{subst}$$

As U_{subst} contains systematic components it was added linearly to the other uncertainties. Finally, conservatively rounded values of the calculated overall uncertainties were chosen for further processing in the uncertainty analysis.

Table 7-11 Three sources of AD uncertainty and overall uncertainties in the area calculations, expressed as half of the 95% confidence intervals. Exceptions for subcategory 5B1 and 5D1 are mentioned in the text above. Calculations are based on AREA data from SFSO (2011).

IPCC	Description	Interpretation uncertainty	Sampling uncertainty	Extrapolation uncertainty	Substitution uncertainty	Overall uncertainty, calculated value	Overall uncertainty, rounded value
5A1	Forest Land remaining Forest Land	1.1	0.2	4.2	0.0	4.42	5
5A2	Land converted to Forest Land	1.1	1.7	22.4	1.1	23.54	24
5B1	Cropland remaining Cropland	4.9	0.3	15.7	0.1	16.51	17
5B2	Land converted to Cropland	4.9	2.1	7.1	1.1	9.91	10
5C1	Grassland remaining Grassland	5.2	0.2	8.4	0.1	9.96	10
5C2	Land converted to Grassland	5.2	1.1	7.2	1.1	10.08	11
5D1	Wetlands remaining Wetlands	0.9	0.5	2.7	0.0	2.90	3
5D2	Land converted to Wetlands	0.9	4.8	5.6	0.5	7.85	8
5E1	Settlements remaining Settlements	4.4	0.4	9.1	0.4	10.54	11
5E2	Land converted to Settlements	4.4	1.2	8.5	0.6	10.23	11
5F1	Other Land remaining Other Land	1.4	0.4	31.7	0.0	31.71	NA
5F2	Land converted to Other Land	1.4	3.5	11.1	0.4	12.15	13

7.2.6 QA/QC and Verification of Activity Data

The AREA survey is a well-defined and controlled, long-term process in the responsibility of the Swiss Federal Statistical Office (SFSO 2006a). The data supplied by SFSO (2011) have been checked for suitability and consistency (Sigmaplan 2012).

The extrapolation of the AREA sample is quite a complex procedure, whose internal consistency is checked systematically as described in Sigmaplan (2012). Further checks (interannual comparisons, plausibility) are carried out after producing the land-use change tables presented in Chapter 7.2.3.2.

The occurrence of decreasing areas of several land-use categories (e.g. Other Land) found in the last submission (FOEN 2011: 250) has been mitigated as the sample sizes in the strata of NFI region 5 (Southern Alps) have further risen in this submission (details are given in Sigmaplan 2012).

7.2.7 Recalculations of Activity Data

The increment of available AREA activity data (SFSO 2011), currently reaching a coverage of 72% of Swiss territory in comparison to 59% that had been available in the previous submission (FOEN 2011), has led to a recalculation in the LULUCF sector.

The geographic delineation of organic soils has been improved by including the Inventory of Raised Bogs of National Importance as criterion of demarcation. The total area of organic soils has thereby increased by approximately 25% and the number of actually realised spatial strata increased from 20 to 28.

7.2.8 Planned Improvements for Activity Data

Switzerland will further reduce the uncertainty of its activity data for land areas by gradually increasing the AREA sample size. Full coverage is expected in 2013. By this improvement, it is expected that, while both extrapolation and substitution errors will converge to zero (the spatial extrapolation becomes redundant), the statistical sampling error will decrease by 20–50% depending on the category concerned.

7.3 Category 5A – Forest Land

7.3.1 Description

Tier 2 Key category 5A1 CO_2 from Forest Land remaining Forest Land (2010: level and trend) **Tier 2 Key category 5A2** CO_2 from Land converted to Forest Land (2010: level and trend)

Only temperate forests are occurring in Switzerland. Forest is defined as a minimum area of land of 0.0625 ha with crown cover of at least 20% and a minimum width of 25 m. The minimum height of the dominant trees must be 3 m or have the potential to reach 3 m at maturity in situ (FOEN 2006h). The following forest areas are not subject of the criteria of minimum stand height and minimum crown cover, but must have the potential to achieve it: afforested, regenerated, as well as burned, cut or damaged areas. Although orchards, parks, camping grounds, open tree formations in settlements, gardens, cemeteries, sports and parking fields may fulfil the (quantitative) forest definition, they are not considered as forests (FOEN 2006h).

For reporting in the CRF tables, the different forest types are allocated to afforestations (CC11), productive forest (CC12) and unproductive forest (CC13) based on AREA categories (see Table 7-2; FOEN 2007f; SFSO 2006a).

7.3.2 Information on Approaches Used for Representing Land Areas and on Land-use Databases Used for the Inventory Preparation

See Chapter 7.2.

7.3.3 Land-use Definitions and the Classification Systems Used and their Correspondence to the LULUCF Categories

See Chapter 7.2.

7.3.4 Methodological Issues

7.3.4.1 Choice of Method and National Forest Inventories

For calculating annual changes in carbon stocks changes, the general approach was used (see IPCC 2003 Eq. 3.1.1).

Data for growing stock, gross growth, cut (harvesting) and mortality and stock of dead wood were derived from the first, second and third Swiss National Forest Inventories (NFI, see Table 7-12). A description of NFI 1 and NFI 2 methodologies can be found in EAFV/BFL (1988) and in Brassel and Brändli (1999). Data and methodology of NFI 3 are described in Brändli (2010). These inventories are based on full surveys that were repeated in intervals of approximately 10 years. Since 2009, the inventory interval has been changed: a continuous survey is being conducted (NFI 4, 2009-2017). This means that a rotating subsample of approximately 12% will be surveyed and evaluated every year. The first NFI 4 data will be implemented in the next submission in April 2013.

Table 7-12 Characteristics of the National Forest Inventories I, II and III.

	NFI 1	NFI 2	NFI 3
Inventory cycle	1983-1985	1993-1995	2004-2006
Grid size	1 x 1 km	1.4 x 1.4 km	1.4 x 1.4 km
Terrestrial sample plots	~12'000	~6'000	~6'000
Measured single trees	~130'000	~70'000	~70'000

7.3.4.2 Three-year averaging of forest carbon pools

The Revised 1996 IPCC Guidelines (IPCC 1997a) recommend working with three-year averages to report carbon changes in “Forest and Other Woody Biomass Stocks”. Further, the 2003 IPCC GPG (IPCC 2003) describes how to deal with interannual variability and states that “it is good practice to consistently report emissions using longer-term averages of environmental conditions or actual annual estimates of emissions when estimating stock changes”.

Changes in the carbon pools reported for the Swiss forest sector reflect annual fluctuations in management, weather conditions and natural disturbances. Therefore, three-year moving averages are calculated for all changes in forest carbon pools in order to smooth out high interannual fluctuations.

Three-year moving averages for the inventory year X are calculated as the average of the years X, X-1 and X-2. For example, the value for the inventory year 2004 is the average value of the years 2002-2004.This “backward-averaging” was used instead of calculating the arithmetic mean (mean of the years X-1, X, X+1), because

- if X is the most recent inventory year, X+1 data generally are not available in time (for submission in year X+2);
- we argue, that growth of living biomass, cut and mortality and the amount of dead wood is more influenced by the previous years than by the following year.

This “backward-averaging” introduces a certain time-lag in the calculated values and can complicate the interpretation of the resulting CO_2 emissions and removals.

7.3.4.3 Stratification

Spatial strata

Forests in Switzerland reveal a high heterogeneity in terms of elevation, growth conditions, tree species composition, and inter-annual growth variability. We therefore stratified Switzerland to reduce the variance of following variables: gross growth, biomass conversion and expansion factors, tree species, and inter-annual growth variability.

To find explanatory variables that significantly reduce the variance of gross growth and biomass expansion factors an analysis of variance was done (Thürig et al. 2005a). The explanatory variables considered in this study are:

- the five NFI production regions
  (1. Jura, 2. Central Plateau, 3. Pre-Alps, 4. Alps, 5. Southern Alps)
- altitude (<601 m, 601-1200 m, >1200 m)

- tree species (coniferous and deciduous species).

The analysis of variance indicated that production region, elevation, and tree species all significantly explain differences in gross growth and biomass conversion and expansion factors (Table 7-13). Therefore, values for growing stock, gross growth, harvesting, mortality and biomass conversion and expansion factors were calculated and applied for each of these 30 strata.

Table 7-13 Analysis of variance of gross growth and biomass expansion factors. Explanatory variables: Tree species, production region, and altitude (Thürig et al. 2005a).

	Gross growth		Biomass expansion factor	
	F-value	p-value	F-value	p-value
Coniferous/Deciduous	421	<0.0001	18'832	<0.0001
Production region	45	<0.0001	2'434	<0.0001
Altitude	34	<0.0001	103	<0.0001

Separating mixed forests into coniferous and deciduous sites

In Switzerland, most forests are mixed stands. However, the forest area derived by the Swiss land use statistics does not allow separating coniferous and deciduous sites.

To derive species specific measures for growing stock, gross growth, harvesting, mortality and biomass conversion and expansion factors, the total forest area has to be divided according to the species mixture. The emission factor per stratum is then calculated as the weighted mean of both species. The weights were derived from the single tree NFI data. It was assumed that the space asserted by a single tree is highly correlated with its basal area. The required ratio of coniferous forest area (R_c) per spatial stratum was calculated by dividing the sum of the basal area of the conifers (BA_c) over the sum of the basal area of all trees (BA).

$R_{ci} = BA_{ci} / BA_i$ i = spatial strata

As both species add up to 1 (or 100%) the rate of deciduous forest area (R_d) is:

$R_{di} = 1 - R_{ci}$ i = spatial strata

The weights for each spatial stratum are displayed in Table 7-14.

Table 7-14 Ratio of coniferous and deciduous species for 1985-1994 (derived from NFI 1 and NFI 2; source: Brassel and Brändli 1999) and for 1995-2005 (derived from NFI 2 and NFI 3 data; source: Brändli 2010).

		1985 - 1994		1995 – 2005	
NFI region	**Altitude [m]**	**Coniferous**	**Deciduous**	**Coniferous**	**Deciduous**
1	<601	0.35	0.65	0.34	0.67
	601-1200	0.58	0.42	0.58	0.43
	>1200	0.75	0.25	0.75	0.25
2	<601	0.56	0.44	0.51	0.49
	601-1200	0.65	0.35	0.59	0.41
	>1200	0.90	0.10	0.85	0.15
3	<601	0.40	0.61	0.39	0.61
	601-1200	0.71	0.29	0.68	0.32
	>1200	0.93	0.08	0.91	0.09
4	<601	0.37	0.63	0.31	0.69
	601-1200	0.65	0.35	0.63	0.37
	>1200	0.96	0.04	0.94	0.06
5	<601	0.06	0.94	0.06	0.94
	601-1200	0.15	0.85	0.15	0.85
	>1200	0.81	0.19	0.80	0.20

Additional stratification: eastern and western Alps

In the Swiss Alps below an altitude of 1200 m, climate between the eastern and the western part differs substantially. We therefore included an additional stratification for the eastern and the western part of the Alps below 1200 m (Alps < 601 m east, Alps < 601 m west, Alps 601-1200 m east, Alps 601-1200 m west; see Thürig et al. 2005a for details). This additional stratification resulted in very small datasets per stratum.

To limit the stratification of the forest area derived from the Swiss land use statistics to a manageable amount, the same procedure as aforementioned under the subject of separating mixed forests into coniferous and deciduous sites was applied. Growth parameters were estimated for the eastern and western Alps separately. The emission factors for the Alps below 1200 m were then calculated as a weighted mean of the percentage of forest area situated in the western and in the eastern Alps. The weights for the pooled emission factors derived from the NFI 2 and NFI 3 are listed in Table 7-15.

Table 7-15 Ratio of forest area in the eastern and western Alps (NFI production region 4) for the time periods 1985-1994 and 1995-2005, respectively, as derived from NFI data (Brändli 2010).

	1985 - 1994		1995 – 2005	
Altitude [m]	**NFI 2 Eastern**	**NFI 2 Western**	**NFI 3 Eastern**	**NFI 3 Western**
<601	0.43	0.57	0.5	0.5
601-1200	0.56	0.44	0.6	0.4

7.3.4.4 Biomass Conversion and Expansion Factors

In the Swiss NFI, growing stock, gross growth, cut and mortality and stock of dead wood are expressed as stem-wood over bark including the above-ground part of the stock. Stem-wood over bark including stock was expanded to total biomass as described in Thürig et al. (2005a) and by applying allometric single-tree functions to all trees measured at the NFI 3. Functions for twigs (diameter < 7 cm) and branches (diameter > 7 cm) were parameterized based on measurements from approximately 12'000 trees (Kaufmann 2001). Foliages were estimated using functions based on samples from 400 trees (Perruchoud et al. 1999). Coarse roots were estimated with functions from Wirth et al. (2004a) for coniferous trees and from Wutzler et al. (2008) for deciduous trees.

Values of stem-wood over bark including stock and branches, delivered in volume units (m^3 ha^{-1}) were converted into mass units ($t\ ha^{-1}$) by multiplying with species specific wood densities (Assmann 1961). Values for twigs, foliages and coarse roots are already given in mass units ($t\ ha^{-1}$).

A biomass conversion and expansion factor (BCEF; IPCC 2006) combines the conversion of volume-units into mass-values and the expansion into total biomass. BCEF is calculated as the ratio between stem-wood over bark including stock ($m^3\ ha^{-1}$) and the total above- and below-ground biomass ($t\ ha^{-1}$). BCEF has the dimension ($t\ m^{-3}$) and transforms by means of one single multiplication growing stock, net annual increment, or wood removals (m^3) directly into total living biomass, total biomass growth, or total biomass removals (t). Multiplication with species specific wood densities to convert volume-based forest inventory data into mass-based values is no longer needed. Biomass conversion and expansion factors were calculated for each spatial stratum and are listed in Table 7-16.

Table 7-16 Biomass conversion and expansion factors to convert stem-wood over bark including stock (m^3 ha^{-1}) to total biomass (t ha^{-1}) for conifers and deciduous species, respectively. The factors are derived from NFI 3 data (Brändli 2010). In the Alps (NFI production region 4) below 1200 m, BCEFs are additionally separated for eastern and western Alps.

NFI region	Altitude [m]	BCEF conifers [t m^{-3}]	BCEF deciduous species [t m^{-3}]
1	<601	0.60	0.81
	601-1200	0.63	0.8
	>1200	0.67	0.83
2	<601	0.6	0.86
	601-1200	0.61	0.86
	>1200	0.72	0.82
3	<600	0.61	0.82
	601-1200	0.61	0.79
	>1200	0.66	0.83
4 east	<601	0.61	0.87
4 west	<601	0.59	0.81
4 east	601-1200	0.62	0.81
4 west	601-1200	0.64	0.81
4	>1200	0.68	0.83
5	<601	0.69	0.81
	601-1200	0.66	0.9
	>1200	0.72	0.84

The weighted mean BCEF for conifers amounts to 0.64 and for deciduous species 0.83.

For comparison, BCEF values were calculated from typical values for BEF, wood density and root-shoot ratio, which are listed in the 2003 IPCC GPG (IPCC 2003). Based on the IPCC tables, a mean BCEF of 0.84 was calculated for conifers and a mean BCEF of 0.99 for deciduous tree species. Thus, the BCEF values derived from IPCC defaults are in general higher than the values calculated for Swiss forests.

7.3.4.5 Carbon Content

The IPCC default carbon content of solid wood of 50% was applied (IPCC 2003; p. 3.25).

7.3.4.6 Growing Stock, Gross Growth and Cut & Mortality in Productive Forests (CC12)

The calculation of emission factors for productive forests is described in detail in Thürig and Schmid (2008).

Values for growing stock, gross growth, cut and mortality for productive forests (CC12, without afforestations) were derived from 5’425 common sample plots measured during NFI 1 and NFI 2 (Kaufmann 2001) and 5’581 samples measured during NFI 2 and NFI 3 (Brändli 2010). All values derived from the national inventories are related to stem-wood over bark with the above-ground part of the stock and are available in volume units (m^3 ha^{-1}) per spatial stratum (Table 7-17 and

Table 7-18 for coniferous and deciduous trees, respectively).

Table 7-17 Growing stock, gross growth, cut and mortality for coniferous trees (related to coniferous forest area). In the Alps (NFI production region 4) below 1200 m, data are additionally separated for eastern and western Alps. Data sources: Brassel and Brändli (1999), Brändli (2010).

NFI region	Altitude [m]	Growing stock 1985 [m^3 ha^{-1}]	Growing stock 1995 [m^3 ha^{-1}]	Growing stock 2005 [m^3 ha^{-1}]	Gross growth [m3 ha-1 yr^{-1}] NFI 1-2	Cut and mortality [m3 ha^{-1} yr-1] NFI 1-2	Gross growth [m^3 ha^{-1} yr^{-1}] NFI 2-3	Cut and mortality [m^3 ha^{-1} yr^{-1}] NFI 2-3
1	<601	354.12	410.93	364.82	9.70	6.97	10.55	14.07
	601-1200	372.10	399.64	413.97	9.45	7.36	8.92	8.28
	>1200	255.32	255.82	275.99	5.79	4.91	5.01	3.11
2	<601	414.90	472.53	391.10	13.99	12.95	14.36	21.39
	601-1200	458.41	521.17	441.76	14.11	12.21	13.97	20.39
	>1200	282.75	329.91	300.27	3.23	2.44	0.87	4.03
3	<601	473.58	526.98	478.89	12.73	9.53	12.80	12.97
	601-1200	482.43	548.33	515.12	13.14	9.79	13.80	16.45
	>1200	356.09	372.58	379.68	7.61	5.96	7.53	7.45
4 east	<601	346.60	412.49	413.83	5.34	4.76	16.21	13.32
4 west	<601	171.38	225.11	241.79	7.59	4.49	7.94	7.12
4 east	601-1200	370.39	390.00	423.15	8.51	6.98	9.16	6.07
4 west	601-1200	260.16	290.12	298.37	7.16	5.56	5.61	5.12
4	>1200	295.36	296.92	319.95	5.72	4.80	5.40	4.01
5	<601	234.46	232.53	240.97	1.82	1.58	0.32	0.49
	601-1200	245.82	282.02	325.97	4.72	2.97	4.97	1.64
	>1200	229.02	245.93	282.54	4.38	1.42	4.45	1.56

Table 7-18 Growing stock, gross growth, cut and mortality for deciduous trees (related to deciduous forest area). In the Alps (NFI production region 4) below 1200 m, data are additionally separated for eastern and western Alps. Data sources: Brassel and Brändli (1999); Brändli (2010).

NFI region	Altitude [m]	Growing stock 1985 [m^3 ha^{-1}]	Growing stock 1995 [m^3 ha^{-1}]	Growing stock 2005 [m^3 ha^{-1}]	Gross growth [m3 ha-1 yr^{-1}] NFI 1-2	Cut and mortality [m3 ha^{-1} yr-1] NFI 1-2	Gross growth [m^3 ha^{-1} yr^{-1}] NFI 2-3	Cut and mortality [m^3 ha^{-1} yr^{-1}] NFI 2-3
1	<601	322.29	351.65	334.88	9.61	6.12	7.51	9.85
	601-1200	318.04	361.61	392.04	8.93	5.41	8.51	5.96
	>1200	196.67	217.30	240.49	4.81	1.17	3.99	2.64
2	<601	342.05	341.68	357.23	13.05	9.61	10.96	9.47
	601-1200	370.66	373.17	407.98	13.66	8.52	10.75	7.52
	>1200	144.81	158.68	285.81	10.33	2.04	6.65	2.89
3	<601	379.93	419.41	417.42	11.13	6.59	10.36	7.25
	601-1200	374.75	381.12	429.69	11.23	6.02	11.15	6.01
	>1200	257.27	270.39	316.99	7.23	1.79	5.70	1.59
4 east	<601	382.98	316.64	365.78	10.91	11.86	7.44	4.62
4 west	<601	156.46	176.68	235.31	7.88	4.58	8.54	3.54
4 east	601-1200	249.86	282.71	319.42	8.39	3.50	7.01	3.59
4 west	601-1200	193.29	210.57	262.76	4.68	2.30	6.72	2.79
4	>1200	168.69	158.14	192.39	8.25	2.47	5.51	2.21
5	<601	152.10	176.19	208.48	5.26	2.84	5.82	3.36
	601-1200	134.02	163.75	210.28	5.04	2.12	5.39	1.51
	>1200	142.14	157.41	222.40	6.16	1.66	5.69	0.96

Annual gross growth

Annual values of gross growth have been derived from the NFI1 and NFI2 datasets for the period 1985-1994 and from the NFI2 and NFI3 datasets for the period 1995-2009. Annual values of gross growth are constant in the intersurvey period of NFI1-NFI2 and of NFI2-NFI3, respectively. These annual values are averaged over 3 years (see Chapter 7.3.4.2), thereby affecting the values of gross growth of the years 1995 and 1996.

Annual cut and mortality

An average value for cut and mortality (CM) is derived from the NFI 1 and NFI 2 dataset for the period 1985-1994 and from the NFI 2 and NFI 3 datasets for the period 1995-2005. To calculate annual values of cut and mortality (CMy) for the years 1985 to1994 and 1995 to 2005, respectively, the average amount of cut and mortality was weighted by the percentage of the annual harvesting amounts taken from the forest statistics (Table 7-19; SFSO 2011b; FOEN 2011e, and former editions 1985-2010). Moving three-year averages of the harvesting amounts from the forest statistics were calculated in order to level out extreme events (see Chapter 7.3.4.2) such as storm Vivian in 1990 and storm Lothar in 1999.

Table 7-19 Annual harvesting amount in m^3 merchantable timber specified for NFI production region as well as for coniferous and deciduous tree species for the period 1990-2010 as derived from forest statistics (SFSO 2011b; FOEN 2011e, and former editions 1985-2010). All values were averaged over three years to compensate for extreme events.

Year	1. Jura		2. Central plateau		3. Pre-Alps		4. Alps		5. Southern Alps	
	Conif.	Dec.	Conif.	Dec.	Conif.	Dec.	Conif.	Dec.	Conif.	Dec.
	[m^3]	[m^3]	[m^3]	[m^3]	[m^3]	[m^3]	[m^3]	[m^3]	[m^3]	[m^3]
1990	669'756	364'296	1'400'390	582'340	963'683	138'833	851'765	65'707	38'790	24'026
1991	616'629	360'660	1'348'951	557'776	967'684	135'699	1'002'608	68'221	31'210	24'093
1992	573'269	361'633	1'328'880	556'023	966'390	133'405	1'034'064	71'000	31'106	25'943
1993	527'672	366'516	1'141'041	541'195	779'032	131'588	816'939	68'958	38'085	29'386
1994	575'928	379'505	1'225'395	554'916	752'565	132'571	701'336	67'181	43'628	31'723
1995	607'611	391'128	1'288'507	554'563	765'351	140'962	652'879	62'517	45'047	33'467
1996	597'544	393'817	1'241'999	556'409	742'348	147'125	604'935	61'095	46'972	35'501
1997	590'296	394'443	1'210'678	571'579	723'808	152'997	557'039	60'013	53'658	37'649
1998	575'006	399'476	1'191'359	590'606	744'730	156'410	579'223	77'391	53'319	40'188
1999	602'445	405'237	1'283'404	614'399	801'259	163'971	608'468	80'428	52'075	40'285
2000	733'872	402'682	2'196'853	733'718	1'300'811	184'017	562'665	78'246	38'806	38'572
2001	680'175	374'861	2'426'715	722'713	1'514'372	181'804	513'772	62'014	29'343	36'651
2002	626'798	351'805	2'448'000	674'298	1'603'283	168'724	491'872	60'187	24'903	35'522
2003	481'195	327'776	1'698'975	535'598	1'254'485	144'789	542'312	62'065	30'195	35'667
2004	551'910	316'752	1'617'068	509'352	1'135'069	147'134	534'976	65'377	32'781	35'617
2005	622'087	326'862	1'751'762	549'665	1'108'437	162'449	530'563	67'811	34'189	34'890
2006	681'354	357'113	1'788'551	606'050	1'082'363	191'691	524'433	75'116	36'300	39'261
2007	727'255	397'149	1'726'102	667'116	1'090'739	213'537	568'604	79'224	47'235	41'950
2008	744'843	430'545	1'549'750	704'695	1'093'245	228'233	618'331	83'231	53'102	45'453
2009	699'189	448'946	1'339'493	709'282	1'013'811	226'469	654'511	85'013	57'413	43'359
2010	650'428	471'929	1'173'993	717'138	963'166	232'425	687'652	90'799	56'610	46'159

For inventory years after 2005, no NFI data are available. Therefore, CM_y for these years are calculated on the basis of the annual harvesting amounts derived from the annual forest statistics and corrected for the amount of total losses as observed in the NFI (e.g. natural mortality, harvesting damage). The correction factor (Table 7-20) was derived for all production regions and both tree species by building the ratio between total cut and mortality in the period 1995-2005 and the sum of the annual harvesting amount reported in the forest statistics from 1995 to 2005:

$$\text{Correction factor}_i = [\, \Sigma_a\, CM_a * 11]_i \,/\, [\, \Sigma_y \text{ Harvesting amount forest statistics}_y\,]_i$$

i = 1-10 (five NFI production regions and two tree species)

a = 1-3 (three zones of altitude: <601 m, 601-1200 m, >1200 m)

y = 1995-2005

Table 7-20 Correction factors to convert annual harvesting amounts from the forest statistics (SFSO 2011b) into total amount of cut and mortality for inventory years after 2005.

NFI region	Tree	Correction
1	coniferous	1.459
1	deciduous	1.819
2	coniferous	1.537
2	deciduous	1.528
3	coniferous	1.889
3	deciduous	1.888
4	coniferous	2.225
4	deciduous	2.507
5	coniferous	2.222
5	deciduous	3.798

Growing stock: Calculation of time series

In order to develop a consistent time series, annual growing stocks (GS) are calculated backward or forward starting from the growing stock 2005, determined from NFI 3.

A backward calculation is used for the time period 1985-2004, meaning that the annual growing stock equals the growing stock 2005 minus the cumulated gains of the annual gross growths and plus the cumulated annual amounts of cut and mortality (CM_y).

Growing stocks for inventory years after 2005 are determined using a forward calculation, i.e. adding the cumulated annual gross growths to the growing stock 2005, and subtracting the cumulated annual amounts of cut and mortality (CM_y).

$$GS_{iy} = GS2005 - \Sigma_y \text{ [annual gross growth}_y\text{]} + \Sigma_y \text{ [CM}_y\text{]} \quad \text{for iy < 2005}$$

$$GS_{iy} = GS2005 \quad \text{for iy = 2005}$$

$$GS_{iy} = GS2005 + \Sigma_y \text{ [annual gross growth}_y\text{]} - \Sigma_y \text{ [CM}_y\text{]} \quad \text{for iy > 2005}$$

where the “iy” indicates the inventory year and “y” refers to the years between 2005 and the inventory year.

These values, given in stem-wood over bark including stock [m^3 ha^{-1}], were converted to carbon in living biomass [t C ha^{-1}] as follows:

$$\text{[C in living biomass]}_s = \Sigma_t \text{ [stem-wood over bark incl. stock]}_{s,t} * BCEF_{s,t} * \text{C-content} * \text{[percentage of tree species]}_{s,t}$$

where “s” refers to the 15 spatial strata and “t” the two tree species classes (coniferous and deciduous trees).

An overview of the values of gross growth, cut & mortality and calculated growing stock for the period 1990 to 2010 specified for all spatial strata are displayed in Table 7-5.

All work steps, data and Excel files required to reproduce the calculation of the CC12 emission factors in the period 1990-2010 are summarized in FOEN (2012c).

7.3.4.7 Growing Stock, Gross Growth and Cut and Mortality in Unproductive Forests (CC13)

Brush forest

Brush forests in Switzerland mainly consist of *Alnus viridis* and horizontal *Pinus mugo var. prostrata*. No NFI data are available to derive their growing stock. Therefore, following assumptions were met to describe the stocks: 4'000 trees per ha, average height of 2.5 m and an average diameter at 1.3 m of 10 cm. Hence, an average growing stock (> 7 cm diameter) of 40 m^3 ha^{-1} was estimated. Multiplied by the mean BCEF for coniferous trees of 0.64, an average biomass for brush forest of 25.7 t ha^{-1}, which translates to 12.9 t C ha^{-1} (using the IPCC default carbon content of 50%) was estimated.

Forest on unproductive areas

Forest on unproductive areas in Switzerland is mainly located in the Alps and the Southern Alps. In those forests, no NFI data are available to derive growing stocks. As those forests are assumed to grow preferably on bad site conditions, an average growing stock (> 7 cm diameter) of 150 m^3 ha^{-1} was estimated. Multiplied by the mean BCEF for coniferous trees of 0.64, an average biomass for forest on unproductive areas of 96.4 t ha^{-1} was estimated, which translates to 48.2 t C ha^{-1} (using the IPCC default carbon content of 50%).

Carbon content of unproductive forests (CC13): Weighted means

The carbon content of unproductive forest was calculated as a weighted average of brush forest and forest on unproductive areas per spatial stratum:

$[\text{weighted C content}]_i = RS_i * CS + (1- RS_i) * CI$

where RS_i is the rate of the brush forest per spatial stratum i,

CS is the carbon content of brush forest (12.9 t C ha^{-1}),

CI is the carbon content of forest on unproductive areas (48.2 t C ha^{-1}).

Table 7-21 shows the carbon content per spatial stratum in t C ha^{-1}.

Table 7-21 Rate of brush forest and forest on unproductive areas and the resulting weighted carbon content in t C ha^{-1} of Swiss unproductive forests (CC13) specified for all spatial strata. The area of forest on unproductive sites is derived from NFI 2 (Brassel and Brändli 1999).

NFI region	Altitude [m]	Brush forest [ha]	Forest on unproductive area(*) [ha]	Total unproductive forest [ha]	Rate of brush forest	Weighted C content [t C ha^{-1}]
1	<601	25	356	381	0.07	45.90
	601-1200	1	1780	1781	0.00	48.20
	>1200	1	178	179	0.01	48.03
2	<601	25	534	559	0.05	46.64
	601-1200	25	356	381	0.07	45.90
	>1200	1	0	1	1.00	12.86
3	<601	25	356	381	0.07	45.90
	601-1200	50	3204	3254	0.02	47.68
	>1200	2100	1780	3880	0.54	29.08
4	<601	100	356	456	0.22	40.47
	601-1200	1925	4984	6909	0.28	38.37
	>1200	36925	7120	44045	0.84	18.58
5	<601	200	534	734	0.27	38.59
	601-1200	2550	3560	6110	0.42	33.46
	>1200	16875	5162	22037	0.77	21.14

Gross growth and cut and mortality of unproductive forests (CC13)

As no harvesting is conducted in unproductive forests, gross growth and cut and mortality of unproductive forest are assumed to be in balance.

7.3.4.8 Dead Organic Matter

Stock of dead wood pool

The influence of wood decay on wood density and on carbon content of dead wood has been investigated by Dobbertin and Jüngling (2009) for two dominant tree species in Swiss forests: Norway spruce (*Picea abies*) and beech (*Fagus sylvatica*). They found a significant decrease in relative wood density with increasing decay degree for Norway spruce (30%) and beech (60%) compared to fresh wood. Only small differences in carbon content in dry matter were found between tree species and between fresh wood and dead wood (1.2 - 1.4%), but carbon content remained stable for dead wood across the four decay classes for each species

The total amount of carbon in the dead wood pool (TDW) in Switzerland consists of three components:

TDW = CWD + LIS + DRoots

where CWD (coarse woody debris) contains all wood of dead trees with a diameter of at least 12 cm, LIS contains lying small diameter dead wood with a diameter of at least 7 cm determined with the **l**ine **i**nter**s**ect method and DRoots consist of **d**ead coarse **root**s. DRoots were estimated by applying biomass functions of roots of living trees. The volume of CWD was calculated by applying biomass functions of living trees including bark, tree-top and stump and, according to the degree of decay, the volume of the branches ≥ 7 cm (see Cioldi et al. 2010: 109-112).

In the NFI 3 dataset CWD is classified into 5 decay classes (Keller 2005). Based on this data, the volume of CWD per decay class was converted to CWD biomass by multiplying it with a decay class specific, modelled value for CWD density for coniferous or deciduous wood (see models 1 to 8 below). The density for decay class 1-4 for coniferous wood ($D_{1-4,C}$) and for deciduous wood ($D_{1-4,D}$) was modelled using local, climatic information with EvJune|EvJuly = potential evapotranspiration in June|July (mm day^{-1}); Temp = average annual temperature (°C); Rain = sum annual rainfall (mm); DroJune|DroJuly = sum rainfall June|July (mm) – daily potential evapotranspiration (mm day^{-1})*30:

- Model 1: $D_{1,C}$ = exp (-0.526 - 2.5901 (EvJune)+ 2.2930 (EvJuly) - 0.00185 (Rain) + 0.0625 (Temp))
- Model 2: $D_{2,C}$ = 0.51211 - 0.01998 (EvJune) - 0.00095158 (Rain)
- Model 3: $D_{3,C}$ = exp (-0.9409 - 0.00256 (Rain))
- Model 4: $D_{4,C}$ = 0.28018 + 0.31860 (EvJune) - 0.31326 (EvJuly)
- Model 5: $D_{1,D}$ = 0.52
- Model 6: $D_{2,D}$ = exp (-1.0975-0.00129 (DroJune))
- Model 7: $D_{3,D}$ = 0.24
- Model 8: $D_{4,D}$ = exp (-1.4590 - 0.00161 (DroJuly))

These models were established on the basis of measurements of spruce and beech dead wood density for decay class 1 to 4 at 34 sites in Switzerland (Weggler et al. 2012; Dobbertin and Jüngling 2009). Models for spruce were used for coniferous CWD and models for beech were used for deciduous CWD. To convert CWD biomass into CWD carbon the C concentration of 48.3% and 46.8% was used for coniferous and deciduous CWD biomass, respectively.

Additionally, during NFI 3, the amount of lying dead wood of at least 7 cm was measured by the line intersect method enabling the estimation for LIS (all dead wood ≥ 7, except stem and branches ≥ 12 cm that where already included in the CWD). The volume of LIS_{NFI3} was converted to carbon by applying the wood densities of living trees and a C concentration of 50%.

As CWD based on decay classes and LIS could only be estimated for the NFI 3 dataset, TDW per spatial stratum was also only estimated for the NFI 3 dataset (TDW_{NFI3}). TDW for the NFI 2 (TDW_{NFI2}) for the same strata was approximated as follows:

$TDW_{NFI\ 2,\ s} = TDW_{NFI\ 3,\ s} * (DWV_{2,\ \geq 12,\ s} / DWV_{3,\ \geq 12,\ s})$

where DWV (dead wood volume) is the volume of dead wood with a diameter of at least 12 cm that can be estimated identically for NFI 2 and NFI 3 and s indicates the 15 spatial strata.

The resulting estimates of TDW in Swiss productive forests (CC12) for the NFI2 and NFI3 are shown in Table 7-22, differentiated for 15 spatial strata.

Table 7-22 Dead wood stock in Swiss productive forests (CC12) per spatial stratum in t C ha^{-1} in 1995, as assessed from NFI 2 and NFI 3, diameter>7 cm (Brassel and Brändli 1999, Brändli 2010) and in 2005 as derived from NFI 3, diameter >7cm (Cioldi et al. 2010).

NFI region	Altitude [m]	Carbon in dead wood stock > 7 cm in 1995 [t C ha^{-1}]	Carbon in dead wood stock > 7 cm in 2005 [t C ha^{-1}]
1	<601	4.05	4.95
	601-1200	4.57	5.61
	>1200	1.81	3.83
2	<601	1.34	3.85
	601-1200	2.13	5.04
	>1200	21.02	11.70
3	<601	0.69	5.18
	601-1200	3.03	6.47
	>1200	5.30	10.26
4	<601	2.35	4.33
	601-1200	6.59	6.79
	>1200	6.45	7.00
5	<601	3.87	6.41
	601-1200	2.29	3.83
	>1200	3.41	5.21

Annual changes in dead wood pool

By analysing the difference in dead wood with a diameter larger than 7 cm between the NFI 2 and NFI 3, temporal changes of the dead wood pool were calculated.

Weighted annual changes in the dead wood pool in Swiss forests were calculated using additional data from the Sanasilva-monitoring network (Brang 1998, Dobbertin et al. 2001). The Sanasilva network provides annual data on the relative basal area of lying and standing trees. A statistical regression was calculated between the dead wood stock, provided by the NFI, and the relative basal area, found in the Sanasilva database. Based on this regression, annual values of dead wood stock were calculated for the period 1990-2010 (see Figure 7-9). For the inter-survey period 1995-2005, the difference in the dead wood pool between the two national forest inventories was weighted by the relative share of the basal area. For the time period 1990-1995 and for the years after 2005, annual values were calculated by extrapolating the dependency found between the relative basal area and the amount of dead wood for the period 1995-2005. Finally, all annual changes were averaged over a moving three-year period. Annual values of stocks changes in the dead wood pool are displayed in Table 7-5.

All work steps, data and Excel files required to reproduce the calculation of annual changes in dead wood stock in the period 1990-2010 are summarized in FOEN (2012c).

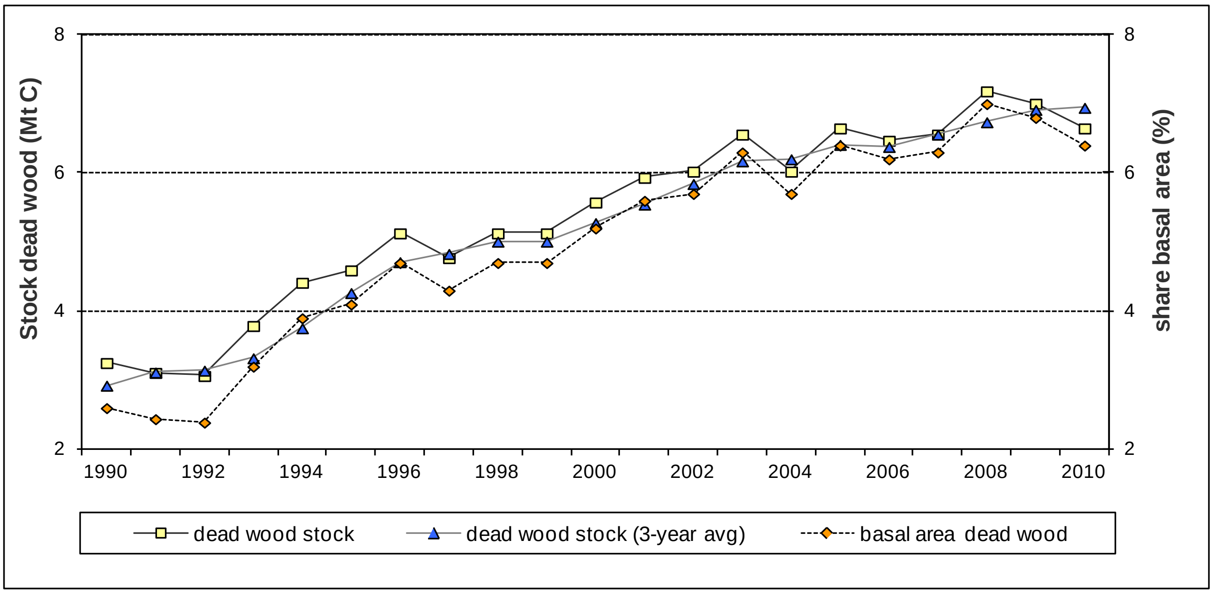

Figure 7-9 Annual stock of dead wood and the share of basal area of dead wood (Dobbertin 2011) 1990-2010. Weighted annual values of dead wood stock in Swiss productive forests were averaged over three years ("3-year avg").

Carbon in organic soil horizons on mineral forest soils

The soil horizons L (litter), F (fermentation) and H (humus) were estimated in a study done by Moeri (2007) as follows.

Acquisition of data: 30 sites were sampled for which the Swiss Federal Institute for Forest, Snow and Landscape Research (WSL) already had a complete dataset of soil C concentrations and density in the mineral soils. On each of these 30 study sites, measurements were made within an area of 50 x 50 m: eight randomly distributed samples of the forest floor (20 x 20 cm) were taken, stratified for the individual organic layers. The thickness of the organic layers (L-, F-, H- horizons) was measured perpendicular to the surface. In addition, the thickness of the organic layers was recorded along two transects with 20 measurements.

Analysis: Samples were dried at a temperature of 60°C to constant weight (at least 24 hours), weighted and the densities (g/cm^3) were calculated. The average densities (± sd) were: L = 0.09 ± 0.05, F = 0.14 ± 0.06, H = 0.22 ± 0.08. Finally, samples were milled and analysed for their C and N concentrations (NC 2500, Carlo Erba Instruments).

Database: Data of approximately 1300 soil profiles, investigated during the past 10-15 years, are stored in a database at WSL. Approximately 870 sites with different information on the soil characteristics distributed among different forest types throughout Switzerland were chosen for this study. The information included thickness of the organic layers and sometimes measured carbon content analysis. Additional information had to be deduced from pictures and field protocols.

The soil organic carbon stock at each site as shown in Table 7-23 was calculated in two steps:

(1) The mass of the organic layers was assessed by their thickness and density (mass = density * thickness).

(2) The C concentration (%) was derived from laboratory data contained in the WSL database. Approximately 400 sites were selected and used for this study. The C concentrations were stratified for coniferous, mixed and for deciduous forests and average C

concentrations were calculated. These average C concentration values per stratum enabled the calculation of the amount of carbon in organic soil horizons for each site.

In this submission, no changes in carbon stocks in organic soil horizons on mineral forest soils are reported for all inventory years (see Chapter 7.3.4.9).

Total dead organic matter

According to the Good Practice Guidance LULUCF (IPCC 2003) annual values of carbon stock in dead organic matter are calculated as the sum of carbon in dead wood and of carbon in the organic soil horizons of mineral forest soils (CC12, CC13). While carbon in the dead wood pool consists of annually changing values, no changes in carbon stocks of organic soil horizons are assumed. Annual changes in dead organic matter are calculated for all 15 spatial strata as shown in Table 7-5.

In Switzerland, afforestations (CC11) occur mostly on grasslands and settlements (see Table 7-9 in Chapter 7.2.3) where there is no litter and no dead wood. Therefore, assuming no carbon stock in dead organic matter on afforestation sites, we could follow the Tier 1 approach in terms of IPCC good practice (IPCC 2003, Sect. 3.1.5) and consistently report no changes in the litter and dead wood pool.

Table 7-23 exemplarily presents the CC12 values for the year 2010 (see Table 7-5 for entire 1990-2010 dataset).

So far, there are no data available about dead wood in unproductive forests (CC13) and dead wood stock is reported as not estimated “NE” in Table 7-24. Assuming no carbon stock in dead wood on CC13 sites, we followed the Tier 1 approach in terms of IPCC good practice (IPCC 2003, Sect. 3.1.5) and report no changes in the dead wood pool. Thus, for unproductive forests the amount of dead organic matter is estimated as the carbon content in organic soil horizons of mineral forest soils. CC13 values listed in Table 7-24 are valid for the period 1990-2010.

Table 7-23 Carbon stock in dead organic matter of productive forests (CC12) for the year 2010.

NFI region	Altitude [m]	Carbon in dead wood [t C ha^{-1}]	Carbon in L, F and H horizon [t C ha^{-1}]	Carbon stock in dead organic matter (stockCd,i) [t C ha^{-1}]
1	<601	5.17	9.70	14.87
1	601-1200	5.86	9.70	15.56
1	>1200	4.00	9.70	13.70
2	<601	4.03	9.50	13.53
2	601-1200	5.26	9.50	14.76
2	>1200	12.22	9.50	21.72
3	<601	5.41	17.40	22.81
3	601-1200	6.76	17.40	24.16
3	>1200	10.72	17.40	28.12
4	<601	4.52	33.40	37.92
4	601-1200	7.10	33.40	40.50
4	>1200	7.31	33.40	40.71
5	<601	6.70	22.30	29.00
5	601-1200	4.00	22.30	26.30
5	>1200	5.45	22.30	27.75

Table 7-24 Carbon stock in dead organic matter of unproductive forests (CC13); values valid for all inventory years. Carbon stock in dead wood was not estimated (“NE”).

NFI region	Altitude [m]	Carbon in dead wood [t C ha^{-1}]	Carbon in L, F and H horizon [t C ha^{-1}]	Carbon stock in dead organic matter (stockCd,i) [t C ha^{-1}]
1	<601	NE	9.70	9.70
1	601-1200	NE	9.70	9.70
1	>1200	NE	9.70	9.70
2	<601	NE	9.50	9.50
2	601-1200	NE	9.50	9.50
2	>1200	NE	9.50	9.50
3	<601	NE	17.40	17.40
3	601-1200	NE	17.40	17.40
3	>1200	NE	17.40	17.40
4	<601	NE	33.40	33.40
4	601-1200	NE	33.40	33.40
4	>1200	NE	33.40	33.40
5	<601	NE	22.30	22.30
5	601-1200	NE	22.30	22.30
5	>1200	NE	22.30	22.30

7.3.4.9 Soil carbon in Productive Forests (CC12), Unproductive Forests (CC13) and Afforestations (CC11)

Carbon Stock in Mineral Soils

Perruchoud et al. (2000) interpolated 136 forest soil samples from the “Waldzustandsinventar 1993 – Bodenkundliche Erhebungen” (Lüscher et al. 1994). According to this study an average carbon stock of mineral forest soils of 76 t C ha^{-1} in 0-30 cm topsoil is assumed. These soil samples were stratified for the five NFI production regions (Table 7-25).

Table 7-25 Soil organic carbon (SOC) of mineral forest soils (CC11, CC12, CC13) in mineral soil horizons (0-30 cm) in t C ha^{-1} in the 5 NFI production regions (n = number of samples): The average values ± standard deviation are given.

NFI region (n)	SOC of mineral topsoil 0-30 cm [t C ha^{-1}]
1. Jura (32)	75.0 (± 37.2)
2. Central Plateau (24)	62.6 (± 32.6)
3. Pre-Alps (25)	75.3 (± 21.4)
4. Alps (39)	72.1 (± 40.6)
5. Southern Alps (16)	109.0 (± 43.7)
Total Switzerland (136)	76.0 (± 37.6)

Changes in Mineral Soil Carbon Stocks

Switzerland uses the conservative Tier 1 approach (IPCC 2003, Sect. 3.1.5) for reporting changes in the soil carbon pool and assumes the soil carbon pool to be in balance. For a detailed argumentation see Chapter 7.3.6.

Carbon Stock in Organic Soils

No specific information is available related to carbon stocks in organic soils under forest land. Therefore, the value calculated for cropland and permanent grassland based on Leifeld et al. (2003, 2005) is adopted for forest land. The approach uses measured carbon stocks in Swiss organic soils. The mean soil organic carbon stock (0-30 cm) for organic soils is 240 ± 48 t C ha^{-1}.

Changes in Carbon Stocks in Drained Organic Soil

Drainage of forests is not a permitted practice in Switzerland (Swiss Confederation 1991). There are no nation-wide survey data available. It is possible that small parts of the Swiss forest have been drained before 1990 or have been established on drained areas. We conservatively report all organic forest soils to be drained (which are definitely an overestimation).

In order to calculate CO_2 emissions due to drainage, we used equation 3.2.15 of the GPG for LULUCF (IPCC 2003) and applied the default emission factor of 0.68 Mg ha^{-1} yr^{-1}.

The impact of old drainages on organic soils could lead to some emissions from organic soils. However, the reporting of non-CO_2 emissions is not mandatory for Forest Land and as no data are available, Switzerland decided not to prepare estimates for these categories. Therefore, no N_2O emissions are estimated (“NE”) in CRF Table 5(I) (cf. also Chapter 7.6.4.4).

7.3.4.10 Carbon Stock of Afforestations (CC11)

Growing stock and growth

As the NFI 3 data have not yet been analysed with respect to afforestations, the average growing stock and growth of afforestations were empirically assessed from NFI 1 and NFI 2 data, specifically with those stands that were approximately 10 years old in the first NFI and 20 years old in the second NFI. The average growing stock of those 20 year old stands was derived from NFI 2. The NFI data were therefore stratified per altitudinal level. The growing stock of forest stands below 600 m was on average 90 m^3 ha^{-1}. The growing stock on sites between 600 and 1200 m was assumed to be one-third smaller (60 m^3 ha^{-1}) than on sites below 600 m, and two-thirds smaller on sites above 1200 m (30 m^3 ha^{-1}). As trees below 12 cm diameter at breast height (DBH) were not measured in the NFI, the growing stock of 10 year old stands below 600 m was assumed to be 2 m^3 ha^{-1}. Within the first few years of stand age, the growing stock was assumed to develop exponentially. The development of the growing stock between 10 and 20 years on sites below 600 m was simulated by calibrating a logistical growth function. To simulate the development of growing stock on intermediate and poor sites, growing stock was assumed to develop one-third slower on intermediate, and two-thirds slower on poor sites. The annual growth was calculated as the difference between growing stocks of two following years. These assumptions are not valid for single stands, but can be applied as a rough simplification. Table 7-26 shows the simulated growing stock and growth for the three altitudinal levels.

Table 7-26 Estimated average growing stock and annual growth of forest stands in stem-wood over bark including stock (defined below in Table 7-27) up to 20 years (CC11) specified per altitudinal zone. Bench marks derived from NFI 1 and NFI 2 (see text above) in bold letters.

Stand age	**< 601 m altitude**		**601 - 1200 m altitude**		**> 1200 m altitude**	
	Growing stock	**Growth**	**Growing stock**	**Growth**	**Growing stock**	**Growth**
[yr]	**[m^3 ha^{-1}]**	**[m^3 ha^{-1} $year^{-1}$]**	**[m^3 ha^{-1}]**	**[m^3 ha^{-1} $year^{-1}$]**	**[m^3 ha^{-1}]**	**[m^3 ha^{-1} $year^{-1}$]**
0-9	0	0	0	0	0	0
10	2	2	0	0	0	0
11	7	5	0	0	0	0
12	13	6	1	1	0	0
13	19	6	5	4	0	0
14	27	8	10	5	0	0
15	35	8	16	6	1	1
16	44	9	23	7	5	4
17	54	10	31	8	10	5
18	66	12	40	9	16	6
19	78	12	50	10	23	7
20	**90**	12	**60**	10	**30**	7

To convert the estimated growing stock (m^3 ha^{-1}) and growth (m^3 ha^{-1} $year^{-1}$), both expressed in volume units, into tonnes of carbon, the following equations were applied:

C stock in living biomass = Average growing stock * BCEF * C-content

Growth of living biomass = Average growth * BCEF * C-content

In Table 7-27, abbreviations and units are explained. Table 7-28 shows the values of the specific parameters.

Table 7-27 Conversion of growing stock and growth to total carbon in biomass.

Name	**Description**	**Value**	**Unit**
Average growing stock	Average growing stock of stem-wood over bark including stock without branches	See Table 7-28	m^3 ha^{-1}
Average growth	Average growth per ha and year	See Table 7-28	m^3 ha^{-1} yr^{-1}
BCEF	Biomass conversion and expansion factor converts the volume of growing stock and the volume of net annual increment to total tree biomass and total tree biomass growth, respectively; averaged value for coniferous and deciduous trees (see Chapter 7.3.4.4)	0.7	-
C-content	Carbon to total biomass ratio (IPCC default)	0.5	-
C stock in living biomass	Carbon content in total above- and belowground biomass	See Table 7-28	t C ha^{-1}
Growth of living biomass	Growth of carbon in t C per ha and year	See Table 7-28	t C ha^{-1} yr^{-1}

Table 7-28 Carbon stock in living biomass and growth of living biomass in afforestations (CC11) specified for altitude zone.

Altitude [m]	Average growing stock [m^3 ha^{-1}]	Average growth [m^3 ha^{-1} yr^{-1}]	BCEF	Carbon content	Carbon stock in living biomass [t C ha^{-1}]	Growth of living biomass [t C ha^{-1} yr^{-1}]
<601	21.7	4.5	0.7	0.5	7.84	1.63
601-1200	11.8	3	0.7	0.5	4.3	1.09
>1200	4.25	1.5	0.7	0.5	1.61	0.57

7.3.4.11 N_2O Emissions from N Fertilization and Drainage of Soils

Fertilization of forests is prohibited by the Swiss forest law and adherent ordinances (Swiss Confederation 1991, 1992). Additionally, the “Ordinance on Chemical Risk Reduction“ (Swiss Confederation 2005) prohibits the application of fertilizers, including liming, in forests. Therefore, no emissions are reported in CRF Table 5(I).

The calculation of C losses due to drainage is described in Chapter 7.3.4.9. N_2O-emissions due to drainage are not estimated (“NE”).

7.3.4.12 Emissions from Wildfires

Data on wildfires affecting Swiss forest land are obtained from cantonal authorities and are compiled by FOEN (FOEN 2011e). Table 7-29 shows the annual number of fires and the burnt area from 1990 to 2010.

As controlled burning is not allowed in Switzerland all fires are assigned to “wildfires”. It was assumed that all fires affected productive forests.

The emission factor for CH_4 is 0.354 Mg CH_4 ha^{-1} as proposed by EEA (2006).

For N_2O, the default emission factor of 0.11 g (kg combusted biomass)$^{-1}$ is applied (IPCC 2003, Table 3A.1.16).

The mass of available fuel considered for calculating the emissions, depends on the greenhouse gas reported:

(1) For reporting CH_4 and N_2O emissions from wildfires, the mass of available fuel encompasses carbon stock of living biomass, litter and dead wood.

(2) For reporting CO_2 emissions from wildfires, the mass of available fuel only encompasses carbon stock of litter. Losses in living biomass and dead wood due to wildfires are already reflected in the NFI dataset and included in CRF Table 5A. Yearly values of these losses are shown in Table 7-5 under “cut and mortality” and under “net change in dead organic matter”.

On average, the amount of living biomass amounts to 128.65 t C ha^{-1}or 257.29 t biomass ha^{-1}. This value has been derived from the mean growing stock in NFI 2 and NFI 3 (360.05 m^3 ha^{-1}; Brassel and Brändli 1999, Brändli 2010) and the mean BCEF (0.7146).

On average in Swiss forests, the amount of litter amounts to19.80 t C ha^{-1}or 39.60 t biomass ha^{-1}. The amount of dead wood amounts on average to 7.90 t C ha^{-1} or 15.79 t biomass ha^{-1}. These values are derived from Table 7-23 as weighted averages over all spatial strata.

The fraction of the biomass combusted is 0.45 (IPCC 2003, Table 3A.1.12). Inserting these values in equation 3.2.20 of IPCC (2003), the emissions shown in Table 7-29 are calculated.

CH_4 and and N_2O emissions caused by wildfires are reported in CRF Table 5(V). CO_2 emissions caused by wildfires are included in CRF Table 5A (as described above) and 5(V).

In Table 5(V), the emissions from all forest fires are reported under 5(V)A1, because it is not known which fires occur on forest land remaining forest land and which on land converted to forest land. Consequently, 5(V)A2 has the notation key "IE".

Table 7-29 Productive forest land affected by wildfires (FOEN 2011e) and resulting GHG emissions 1990-2010.

Year	Number	Area burnt [ha]	CH_4 [Mg]	N_2O [Mg]	CO_2 [Mg]
1990	216	1102	390.11	17.06	30’068.03
1991	157	148	52.39	2.29	4’038.18
1992	111	52	18.41	0.8	1’418.82
1993	99	42	14.87	0.65	1’145.97
1994	52	293	103.72	4.54	7’994.50
1995	56	438	155.05	6.78	11’950.82
1996	61	233	82.48	3.61	6’357.40
1997	77	1511	534.89	23.39	41’227.58
1998	88	249	88.15	3.85	6’793.96
1999	31	9	3.19	0.14	245.56
2000	41	36	12.74	0.56	982.26
2001	39	37	13.1	0.57	1’009.54
2002	75	410	145.14	6.35	11’186.84
2003	189	564	199.66	8.73	15’388.72
2004	46	20	7.08	0.31	545.7
2005	97	47	16.64	0.73	1’282.39
2006	70	101	35.75	1.56	2’755.78
2007	64	234	82.84	3.62	6’384.68
2008	42	36	12.74	0.56	982.26
2009	52	42	14.87	0.65	1’145.97
2010	59	25	8.85	0.39	682.12

7.3.4.13 NMVOC Emissions

Estimates for annual biogenic emissions of NMVOC in Switzerland for forests (and natural grassland) are available in SAEFL (1996a): The values are 92.0 Gg for coniferous forests, 2.4 Gg for deciduous forests and 0.61 Gg for forest fires. These numbers are based on a study from Andreani-Aksoyoglu and Keller (1995). Approximately 97% of the total emissions are monoterpene and the rest consists of isoprene (Keller et al. 1995).

7.3.5 Uncertainties and Time-Series Consistency

Uncertainties

For living biomass, the following information was used:

- Growth and Cut & Mortality: NFI data without application of climate factor: 2% (background: Brassel and Brändli 1999)
- Carbon content in solid wood: 5-10% (background: Lamlom and Savidge 2003, assessment of carbon content in wood; Monni et al. 2007, 2%)
- Wood density: guess 10-20% (background: Lamlom and Savidge 2003)
- Biomass expansion: The uncertainty is estimated to be 30% (background: Monni et al. 2007, Appendix 1, 2.7-21.3%; Vanninen and Mäkelä 1999; Cronan 2003; Helmisaari and Hallbäcken 1998).

Thus, the total uncertainty of carbon losses and gains in living biomass in terms of carbon per unit area can be calculated as:

$$U_{liv.biom} = (2^2 + 2^2 + 10^2 + 15^2 + 30^2)^{0.5} = 35\%$$

The total uncertainty of the annual changes in dead wood depends on several factors:

- Accuracy of the Sanasilva observations: The estimate of the share of the basal area of dead wood shows relatively large confidence intervals, resulting in an error of 36.7% (Dobbertin 2011).
- Spatial representativity of the Sanasilva plots: Sanasilva plots have to be representative for Swiss forests. The 48 Sanasilva plots cover ca. 10’000 ha, corresponding to an error of 12% (Brassel and Brändli 1999).
- Biomass expansion: The uncertainty of applying biomass functions is comparable with the uncertainty typical for BCEF and is estimated to be 30% (e.g. Monni et al. 2007).
- Accuracy of the estimations of dead wood, provided by the NFI data: The error is estimated to be 2-3% and thus plays a minor role.

Thus, the total uncertainty for dead wood amounts to approximately 50%. For comparison, the uncertainty on mortality data from Finnish NFI is assessed to be 30% (Monni et al. 2007).

$$U_{dead\ biom} = (36.7^2 + 12^2 + 30^2 + 3^2)^{0.5} = 49\%$$

The uncertainty for litter amounts to approximately 60% (Moeri 2007).

By weightening these emission factor uncertainties with the relative importance of the carbon pools (in terms of share of C t/ha of total C t/ha), an overall uncertainty of 36% was calculated for the forest sector considering emission factor uncertainties of living and dead biomass (see also Table 7-6).

Uncertainties of activity data of Forest land are described in Chapter 7.2.5.

Time-Series Consistency

Consistent time series of annual growing stocks were calculated backward or forward starting from the growing stock 2005, as derived from NFI 3 (see Chapter 7.3.4.6).

A consistent time series of dead wood was calculated for the inter-survey period 1995-2005 by weighting the difference in the dead wood pool between the two national forest inventories with the relative share of the basal area. For the time period 1990-1995 and for the years after 2005, annual values of dead wood were calculated by extrapolating the dependency found between the relative basal area and the amount of dead wood for the period 1995-2005. Finally, values of dead wood were stratified over the 15 spatial strata by using a distribution pattern derived from NFI 2 and NFI 3 data (see Chapter 7.3.4.8).

7.3.6 Category-Specific QA/QC and Verification

Expert Peer Review

The LULUCF sector was reviewed thoroughly at the end of 2010 by sectoral experts from the Johann Heinrich von Thünen-Institut, Germany (vTI 2011). The recommendations of the review report have contributed to the preparation of the LULUCF estimates for this submission (cf. also FOEN 2012a: Annex E).

Brush Forests

In a recent study, Düggelin and Abegg (2011) calculated values of total growing stock (also < 7 cm) for brush forest. They measured an average growing stock of 166 m^3 ha^{-1} for *Pinus mugo* stands and 74 m^3 ha^{-1} for stands with *Alnus viridis.*

Carbon Balance of two Mountain Forest Ecosystems in Switzerland: Net Ecosystem Exchange and Soil Respiration

Measurements of the net ecosystem exchange (NEE) and of soil respiration were conducted at a montane mixed forest over 5 years (Lägeren; 2005–2009; NFI production region 2), and at a subalpine coniferous forest over 12 years (Davos; 1997–2009; Swiss Plateau, NFI production region 4).

(1) Etzold et al. (2011) determined the net ecosystem exchange (NEE) by eddy covariance (EC) measurements. EC measurements, as well as biometric estimates indicate that both sites with two different mountain forest types were significant C sinks in the respective periods. During 2005 to 2009 NEE of the Lägeren forest ranged from -366 to -662 g C m^{-2} yr^{-1} (mean: -415 g C m^{-2} yr^{-1}), and of the Davos forest from -47 to -274 g C m^{-2} yr^{-1} (mean: -154 g C m^{-2} yr^{-1}).

(2) Rühr and Eugster (2009) measured soil respiration rates at these two Swiss forest sites. Modeled changes in soil C storage with the dynamic soil carbon model Yasso07 (see also Thürig et al. 2005) gave comparable results with measured soil respiration. The authors found that soils at the alpine site Davos acted as a significant C sink. Soils at the Lägeren site were neither a significant C sink nor a significant C source. This domestic study confirms the broadly spread knowledge that it is very difficult to detect short term changes in soil C stocks, since the uncertainty of the measurement is often higher than the actual change of the annual estimates (e.g. Falloon and Smith 2003).

Changes in Soil Carbon Stocks

Below, arguments are provided (A) why it is assumed that forest soils in Switzerland are not a net source of carbon (see Chapter 7.3.4.9, UNFCCC 2009: §78; UNFCCC 2011: §93, §99). Further, a soil organic carbon (SOC) dataset (B) provided by the Swiss Soil Monitoring Network strongly supports this assumption.

(A) Due to following reasons it is assumed that in the years 1990 to 2010 forest soils in Switzerland were no net source of carbon:

- Using the decomposition model ForCLim-D, Perruchoud et al. (1999) found that forest soils contribute substantially to the biospheric C sequestration in Switzerland. They calculated an increase of 0.35 Mt C y^{-1} in 1985 in forest soils with an uncertainty of 0.11 - 0.58 Mt C y^{-1}. They also showed that the increase in soil organic carbon is strongly related to the increase in growing stock, which has increased since then.
- As growing stock of living biomass (
- Table 7-18) and also dead wood stock (Figure 7-9 and description in NIR Chapter 7.3.4.8) has increased since many years, soil carbon is assumed to increase by trend due to increasing litter production.
- Within the last decades, no relevant changes in management practices in forests have been taken place. This is also warranted by the Swiss Forest Law (Swiss Confederation 1991).
- The following activities favouring the decomposition of soil carbon are not common practice in Switzerland:
    - Fertilization of forests is prohibited by the Swiss forest law and adherent ordinances (Swiss Confederation 1991, 1992).
    - Drainage of forests is not a permitted practice in Switzerland since 1991 (Swiss Confederation 1991). There are no nation-wide survey data available. It is possible that a small part of the Swiss forest has been drained before 1990 or has been established on drained areas.

(B) SOC Dataset of the Swiss Soil Monitoring Network

The objective of the Swiss Soil Monitoring Network (http://www.nabo.admin.ch/?lang=en; NABO) is to assess soil quality in the long term and to validate appropriate soil protection measures. The network was established in 1985. Currently, it comprises 105 observation sites throughout Switzerland. For the statements below, the NABO sites had been classified according to the 18 LULUCF combination categories (CC).

Changes in SOC content of forest soils are being measured since 1985 at soil monitoring benchmark sites in the Swiss Soil Monitoring Network (SAEFL 1993). Repeated soil inventories at the soil monitoring sites are carried out every 5 years. Four replicate bulked soil samples from the upper soil layer 0-20 cm are taken at the monitoring sites (10m x 10m). For each bulked sample 25 single cores are taken at the site according to a stratified random sampling scheme. Further details can be found in SAEFL (2000a).

SOC of the archived soil samples was measured with a modified Walkley and Black method (ACW/ART 1998) in the same laboratory since 2006. Thus, the SOC dataset (n = 1'790 measurements) presented here and in Chapters 7.4.6 and 7.5.6 is not subject to systematic methodological errors caused by different laboratories or methods. To assure the reliability and accuracy of the measurements, sampling quality, sampling preparation, chemical extraction, analysis and sample storage in the soil archive is evaluated. SOC measurements of a soil sample were repeated if a SOC value deviated more than a certain degree from the values of the other three bulked soil samples of the same sampling campaign.

The spatial variation of bulk density is included in calculating the carbon pools. Bulk density measurements and soil skeleton (> 2mm) were measured at the monitoring sites in the 4th (2000-04) and 5th (2005-09) re-sampling campaign (n=4 in each campaign per site), but not in the previous campaigns. As the mass of the fine earth (FE) is the relevant fraction for the element pools in the soil, the bulk density refers to the mass FE. The measured skeleton fraction of the volume sample is substracted before. The temporal changes of the top soil bulk density between the 4th and 5th campaign were quite small and they differ between -0.2 and 0.1 g/cm^3. We presumed that the bulk density of the first three sampling campaigns ranged within the values measured in the 4th and 5th re-sampling campaign, i.e. propagated the variability of the measurements through Latin Hypercube sampling (n = 1000 simulation runs) assuming a normal distribution of the bulk density and SOC measurements for each site.

The SOC pools for the forest top soils (0-20 cm) ranged between 30.9 t C/ha (min) and 148.9 t C ha^{-1} (max) and were in average 63.0 t C ha^{-1}. Figure 7-10 shows that in average, SOC pools did not change monotonously during the measurement period between 1989 and 2009 in the sampled forest soils. At some of the forest monitoring sites higher values were found in the 3rd re-sampling campaign.

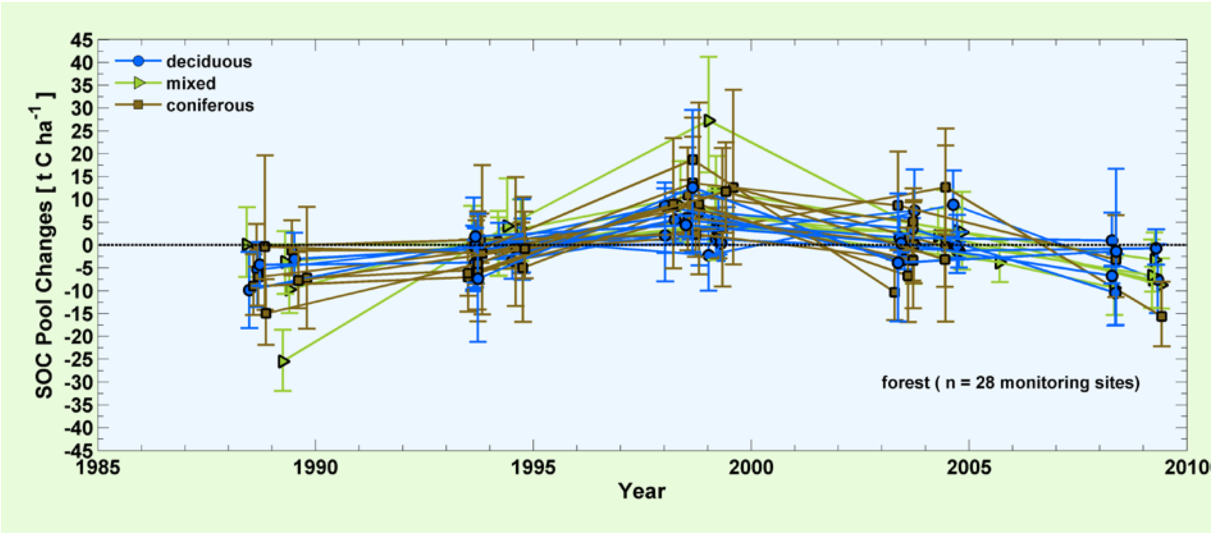

Figure 7-10 Time series of measured SOC pool changes in the top soil (0-20 cm) at the 28 NABO forest sites from the 1st to the 5th re-sampling campaigns. SOC pools were centred by the median SOC pool of all re-samplings of the monitoring site. Each pool value presents the median of four bulked soil samples per campaign with measured SOC and bulk density. The error bars indicate the 25% and 75% percentiles resulting from the spatial variation of the sites and the errors along the measurement chain. The altitude of the forest sites ranges between 380 and 1690 m a.s.l.

Detailed studies at monitoring sites showed that short-term temporal variation of soil properties can result from different site conditions at the sampling date, e.g. regarding soil moisture, soil temperature and bulk density (Keller et al. 2006). For instance, at two forest sites six re-samplings within three years revealed short-term variation of the SOC content between ± 1.8 % and ± 0.6 %. Therefore, the majority of the measured temporal variation for all forest sites is interpreted as natural variation (noise) and not as real SOC changes (signal). This hypotheses is also supported by the fact that the soil samples in the 3rd resampling campaign were taken earlier in spring time as in the other sampling campaigns and hence, soil moisture content of the samples was higher in average. This might explain the large temporal variation, in particular at coniferous forest sites with a pronounced organic layer. In order to capture as good as possible the natural variation of these site-specific characteristics, standard operation procedures and quality assurance were implemented since the 4th soil campaign.

In summary, we state that these results give indeed verifiable and reliable information that carbon pools did not change at the investigated NABO forest sites. The results of the soil monitoring data over the last 20 years also indicate that Swiss forest soils did not act as a net source of carbon.

Implied Emission Factors

The implied emission factors of categories 5A and 5(V) in the Swiss Inventory have been compared to the corresponding emission factors of other countries (UNFCCC http://unfccc.int/di/FlexibleQueries.do) for the year 2009 (INFRAS 2012). In general, Switzerland's net carbon stock changes (sinks) lie in the lower end of the countries' range. However, it is worth mentioning that the Swiss inventory shows quite large variations from year to year due to annual changes in cut, mortality (see Chapter 7.3.4.6) and forest fires. Therefore, the significance of the comparison for only one year is limited.

7.3.7 Category-Specific Recalculations

The increase of available AREA activity data (see Chapter 7.2.7) has led to a recalculation in category 5A.

The following methodological change and corrections have been made for the submission 2012:

- Following the recommendations of the review of the LULUCF-sector (vTI 2011), the application of weighting factors has been simplified. For all areas, the weighting factors for living biomass W_l, dead organic matter W_d and soil carbon W_s are removed except for Ws=0.5 in the case of a conversion where "buildings and constructions" are involved (see 7.1.3.2).
- The values for gross growth of productive forests for the years 1995 and 1996 have been recalculated (Table 7-5). In the previous submission (FOEN 2011), these values were not averaged over a 3-year period. This change has also an implication on the values of growing stock for the period 1990-1996. Updated values of growing stock are listed in Table 7-5.
- Also the values of carbon stock in living biomass for the years 2006-2009 were corrected, since there was an error in the calculation program. Recalculated values are approximately 0.2% higher.
- Emissions from organic soils under forest land are reported. A default emission factor of 0.68 t C ha^{-1} yr^{-1} is used (see Chapter 7.3.4.9).

7.3.8 Category-Specific Planned Improvements

In November 2011, ART started a three-year running research project that aims to identify (drained) fens and raised bogs under different land uses beyond the national inventories of bogs and fens in order to improve the AD estimates of organic soils First tests in this direction have been carried out by Meteotest (2009a, 2011a).

Further research is underway to estimate yearly values for gross growth. First results of a study investigating the relationship between climate and gross growth (Thürig et al. 2009) are expected in the course of 2013.

In future, it is planned to calculate the conversion and expansion of stem-wood over bark including stock and branches (m^3 ha^{-1}) into total biomass (t ha^{-1}) by means of single-tree-biomass-equations. New data will be available for the next submission.

To improve the estimation of soil carbon pools in mineral soils and its changes, some case studies are underway.

- The YASSO07 model will be applied to test the sink effect of Swiss forest soils. First results are expected to be available for the 2013 GHG inventory submission. This project is funded by FOEN and conducted by the WSL. The results of this project will be validated by another project named "Testing the Yasso07 model with long term litterbag data from five LTFER sites and two elevation gradients in the Swiss Prealps". This project is also funded by FOEN and conducted by the WSL.
- More precise estimates of soil carbon will be calculated in the project "Stocks of soil organic carbon in Swiss forest soils". Based on a WSL database containing data of 1050 soil profiles and using geostatistical methods a map of soil organic carbon in Swiss

forests will be produced. The project is funded by FOEN and conducted by the ETHZ and WSL. Results are expected for summer 2012.

- Better estimates of changes in soil carbon under afforestations in alpine regions will be provided by the COST E639-project “Turnover and stabilization of soil organic matter: effect of land-use change in alpine regions”. The project is co-funded by FOEN and conducted by the WSL. Results are expected for summer 2012.
- FOEN also cofinances the COST E639-project „Testing the warming and nitrogen theory of carbon sequestration“. Here, it is investigated whether higher temperature and higher nitrogen inputs, as expected under a changing climate, have an impact on soil respiration. This project is carried out by the Institute of Botany at Basel University. Results will be available in spring 2012.
- Furthermore, Switzerland intends to make better use of the SOC data provided by the Swiss Soil Monitoring Network in forthcoming submissions. A contract has been signed in 2011 that arranges a close collaboration for the period 2012-2014.

7.4 Category 5B – Cropland

7.4.1 Description

Tier 2 Key category 5B1
CO_2 from 5B1 Cropland remaining Cropland
(2010: level).

The category 5B2 Land converted to Cropland is not a key category.

Swiss croplands belong to the cold temperate wet climatic zone. Carbon stocks in aboveground living biomass and carbon stocks in mineral and organic soils are considered. Croplands (CC21) include annual crops and leys in arable rotations. Because arable cropping mainly occurs in the temperate Swiss Central Plateau and no elevation-dependent soil carbon stocks are available for Swiss croplands (Leifeld et al. 2005), no stratification of carbon stocks has been applied.

In 2010 5B1 Cropland remaining Cropland was a net source of 392.7 Gg CO_2. Since carbon stocks on mineral soils are assumed to be in balance (i.e. no carbon stock changes occur on mineral soils) basically all emissions are due to carbon mineralization in organic soils, mainly in the lowest altitudinal zone (z1: 97.7%). Overall, organic soils account only for 2.8% of cropland area in Switzerland. Changes in living biomass on croplands are of minor importance in the overall context.

5B2 Land converted to Cropland was a small net source of 27.1 Gg CO_2 in 2010. The highest contribution came from 5B2.2 Grassland converted to Cropland being responsible for a net source of 38.0 Gg CO_2.

7.4.2 Information on Approaches Used for Representing Land Areas and on Land-use Databases Used for the Inventory Preparation

See Chapter 7.2.

7.4.3 Land-use Definitions and the Classification Systems Used and their Correspondence to the LULUCF Categories

See Chapter 7.2.

7.4.4 Methodological Issues

7.4.4.1 Carbon in Living Biomass

Annual biomass carbon stocks are shown in Table 7-30. They are calculated as area-weighted means of standing stocks at harvest for the seven most important annual crops (wheat, barley, maize, silage maize, sugar beet, fodder beet, potatoes) and as cumulated annual harvested biomass for leys.

The annual mean standing biomass carbon stock per hectare is calculated as:

$$\text{Biomass cropland} = \Sigma_f \, (A_f / A_t) * C_f$$

where A_f = Area of crop type f, A_t = total cropping area and C_f = yield (annual crops, leys) for the particular crop (t C ha^{-1}). All annual values for A_f, A_t and C_f were published by the Swiss Farmers Union (SBV 2011).

The resulting mean biomass stock for Swiss cropland over the whole inventory time period is 4.65 ± 0.15 (1 SD) t C ha^{-1}.

Table 7-30 Annual values for arable crop yields and area weighted mean (t C ha^{-1} yr^{-1}); SBV 2011, assuming a carbon fraction of 0.5 (IPCC default).

crop	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
	CC21: yield [t C ha^{-1} yr^{-1}]									
Barley	2.36	2.47	2.48	2.54	2.19	2.29	2.69	2.69	2.86	2.18
Wheat	2.36	2.54	2.35	2.53	2.34	2.56	2.84	2.55	2.63	2.24
Maize	3.51	3.42	3.53	3.78	3.72	3.55	3.64	3.94	3.87	3.78
Silage maize	7.37	6.59	7.15	6.72	6.11	6.03	4.98	7.08	6.88	6.49
Sugar beet	7.41	6.91	7.04	7.63	6.72	6.78	7.83	7.76	7.42	7.48
Fodder beet	6.70	6.51	6.64	6.77	5.66	5.49	6.41	6.53	6.06	5.79
Potatoes	4.47	4.39	4.65	4.83	3.65	3.88	5.36	5.05	4.44	3.87
Leys	6.11	5.83	6.11	6.94	6.94	6.11	6.11	6.11	6.11	6.11
Mean	4.34	4.23	4.39	4.67	4.33	4.28	4.51	4.72	4.67	4.43

crop	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
	CC21: yield [t C ha^{-1} yr^{-1}]									
Barley	2.55	2.38	2.68	2.35	2.92	2.61	2.64	2.57	2.58	2.73
Wheat	2.53	2.35	2.42	2.16	2.62	2.46	2.49	2.57	2.58	2.60
Maize	4.10	3.80	3.92	1.83	4.09	4.10	3.30	4.32	4.12	4.42
Silage maize	6.68	6.45	4.93	5.96	6.52	8.23	7.01	8.02	8.09	7.60
Sugar beet	8.74	6.51	8.52	7.89	8.60	8.50	7.29	8.37	8.73	9.37
Fodder beet	6.71	5.75	5.95	5.67	6.13	6.15	6.25	6.21	6.30	6.72
Potatoes	4.67	4.13	4.30	3.71	4.34	4.26	3.60	4.59	4.71	5.12
Leys	6.11	6.11	6.11	6.11	6.11	6.11	6.11	6.11	6.11	6.11
Mean	4.71	4.51	4.54	4.41	4.89	4.97	4.70	5.07	5.13	5.19

crop	2010	mean 1990-2010
	CC21: yield [t C ha^{-1} yr^{-1}]	
Barley	2.56	2.54
Wheat	2.48	2.49
Maize	3.61	3.73
Silage maize	7.47	6.78
Sugar beet	8.03	7.79
Fodder beet	6.49	6.23
Potatoes	4.26	4.39
Leys	6.11	6.18
Mean	4.99	4.65

7.4.4.2 Carbon in Soils

Soil carbon stocks in mineral soils under cropland are calculated based on Leifeld et al. (2003, 2005). The approach correlates measured soil organic carbon stocks (t ha^{-1}) for arable land and leys with soil texture after correction for soil depth and stone content. Area upscaling uses the Swiss digital soil map (SFSO 2000a), and average stocks are calculated as weighted means using the area of arable land and leys. The mean soil organic carbon stock (0-30 cm) for cropland is 53.40 ± 5 t C ha^{-1}. It should be noted that the current C stocks are not only the result of the conditions for productivity and C turnover under different land-use types, but are also determined by farmers' decisions to use a site in a specific way due to the demands of a crop or the suitability of a site, e.g. regarding machine use (see Leifeld et al. 2003: 65).

Soil carbon stocks in organic soils under cropland are calculated based on Leifeld et al. (2003, 2005). The approach uses measured carbon stocks in Swiss organic soils. The mean soil organic carbon stock (0-30 cm) for cultivated organic soils is 240 ± 48 t C ha^{-1}.

7.4.4.3 Changes in Carbon Stocks

Carbon stocks in living biomass intermittently increased from 4.34 t C ha^{-1} in 1990 to 4.99 t C ha^{-1} in 2010 (Table 7-30).

Changes of carbon stocks in mineral soils are assumed to be zero for cropland remaining cropland.

The annual net carbon stock change in organic soils was estimated to -9.52 t C ha^{-1} according to measurements in Europe including Switzerland as compiled by Leifeld et al. (2003, 2005) and rechecked by ART (2009b).

In the case of land-use change, the net changes in biomass and soil are calculated as described in Chapter 7.1.3.

7.4.4.4 N_2O Emissions from Land-Use Conversion to Cropland

N_2O emissions as a result of the disturbance associated with land-use conversion to cropland are reported in CRF Table 5(III). The emissions are calculated with default values proposed by IPCC (2003, following Equations 3.3.14 and 3.3.15, and Chapter 3.3.2.3.1.2):

$$\text{Emission } (N_2O) = \text{delta}C_s * 1 / (C : N) * EF1 * 44 / 28 \qquad [\text{Gg } N_2O]$$

where:

deltaC$_s$: soil carbon loss in soils induced by land-use conversion to cropland [Gg C]

C:N: C:N ratio = 9.8 in grassland soils (Leifeld et al. 2007)

EF1: IPCC default emission factor = 0.0125 kg N_2O-N $(kg\ N)^{-1}$

DeltaC$_s$ is calculated according to the methodology described in Chapter 7.1.3. If DeltaC$_s$ is zero or positive (carbon gain) there is no N_2O emission. On mineral soils this is specifically the case for settlements converted to cropland, stony grassland converted to cropland and other land converted to cropland. On organic soils the carbon stock differences for land-use conversions to cropland are zero or positive (CC51, CC61) (cf. Table 7-4).

The country specific C/N ratio of 9.8 for grassland proposed by Leifeld et al. (2007) has been used because the largest part of the area converted to cropland consisted of grassland (cf. CRF Table 5B2).

7.4.4.5 Carbon Emissions from Agricultural Lime Application

The total annual amount of limestone input to agricultural soils (CRF Table 5(IV)) is between 51’300 Mg and 74'050 Mg. It was estimated by ART (2009) for the period 1990-2008 (see Table 7-31). For 2009–2010 the same value as for 2008 is used as no newer survey is available.

Dolomite is probably applied only in small quantities. The available data do not allow to differentiate $Ca(CO_3)$ and $CaMg(CO_3)_2$.

The availability of a country specific emission factor for agricultural lime application has been investigated, but no domestic measurement data could be found. Consequently, the IPCC default carbon conversion factor for carbonate containing lime of 0.12 Mg C per Mg $Ca(CO_3)$ or $CaMg(CO_3)_2$ (IPCC 2003) has been used. The resulting carbon emissions associated with liming range from 22.57 to 32.58 Gg CO_2 yr^{-1}.

Table 7-31 Amount of limestone applied on agricultural soils and resulting CO_2 emissions 1990-2010.

Year	Limestone	Emission
	Mg	Gg CO2
1990	51'300	22.57
1991	51'342	22.59
1992	52'383	23.05
1993	53'425	23.51
1994	54'467	23.97
1995	55'508	24.42
1996	56'550	24.88
1997	57'592	25.34
1998	58'633	25.80
1999	59'675	26.26
2000	60'717	26.72
2001	61'758	27.17
2002	62'800	27.63
2003	63'842	28.09
2004	69'883	30.75
2005	70'925	31.21
2006	71'967	31.67
2007	73'008	32.12
2008	74'050	32.58
2009	74'050	32.58
2010	74'050	32.58

7.4.5 Uncertainties and Time-Series Consistency

Uncertainties for soil carbon stocks are given together with the mean value in the text above: 9% for mineral soils and 20% for cultivated organic soils. They take into account uncertainties in measured C contents and predicted soil bulk densities, i.e., they consider only uncertainties in emission factors.

The relative uncertainty in yield determination has been estimated at 13% for biomass carbon from agricultural land (Leifeld and Fuhrer 2005). Data on biomass yields for different elevations and management intensities as published by FAL/RAC (2001) are based on many agricultural field experiments and have a high reliability.

In the uncertainty analysis, a higher, conservative value of 50% was chosen for the overall emission factor uncertainty in sector 5B2 (Land converted to Cropland) (Table 7-6).

The uncertainty of the carbon stock change in organic soils is 23% as reported by Leifeld et al. (2003: 56). A rounded value of 25% is used for further processing.

For the uncertainty of the emission factor for N_2O on land converted to cropland a default value of 90% is used (Table 7-6).

The amount of total lime application in agriculture is mainly based on expert judgement; the resulting number is uncertain. A relative uncertainty of ± 40% can be used as an approximation (ART 2009). For the emission factor of lime a lower uncertainty of ± 25% was chosen, because it is a plain chemical process.

Uncertainties of activity data of Cropland are described in Chapter 7.2.5.

7.4.6 Category-Specific QA/QC and Verification

Changes in SOC pools

A SOC pool dataset provided by the Swiss Soil Monitoring Network (NABO; see Chapter 7.3.6) supports the Tier 1 assumption that changes of carbon stocks in mineral soils are zero for cropland remaining cropland (cf. UNFCCC 2009: §79; UNFCCC 2010: §72; UNFCCC 2011: §94). The SOC pool changes measured at 38 cropland monitoring sites in the Swiss Soil Monitoring Network did not show any significant change since 1985 (Figure 7-11). The range of the calculated SOC pools is quite large (23.7 - 522 t C ha^{-1}), as two cropland soil monitoring sites are on peat soils. Average SOC pool in the topsoils (0-20 cm) of the 38 cropland monitoring sites for all soil sampling campaigns was 56.5 t C ha^{-1} (44.3 t C ha^{-1} without the peat soils). At the two cropland sites on peat soils the temporal variation of SOC content during the last 20 years ranged between ± 0.4%, corresponding to SOC pool changes larger than ± 10 t C ha^{-1}. However, for the majority of cropland sites the temporal variation found was smaller (± 0.2%), i.e. SOC pool changes were smaller than ± 1.5 t C ha^{-1} over the last 20 years. This finding is in agreement with the detailed study mentioned in Chapter 7.3.6 (Keller et al. 2006), where six re-samplings of two cropland sites within three years revealed natural SOC content variation of ± 0.23% in the topsoil. Therefore, the temporal variation of the SOC content and SOC pools at the cropland sites indicate natural variation (noise) and the results suggest that Swiss cropland mineral soils did not act as a net carbon source or sink during the last 20 years.

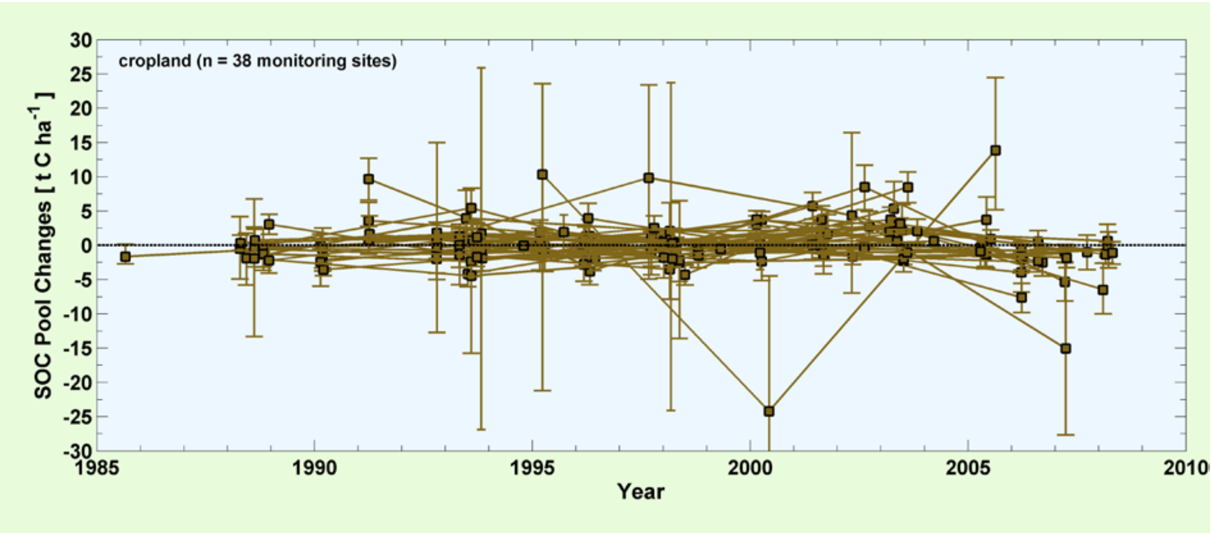

Figure 7-11 Time series of measured SOC pool changes in the top soil (0-20 cm) at the 38 NABO cropland sites from the 1st to the 5th re-sampling campaigns. SOC pools were centred by the median SOC pool of all re-samplings of the monitoring site. Each pool value presents the median of four bulked soil samples per campaign with measured SOC and bulk density. The error bars indicate the 25% and 75% percentiles resulting from the spatial variation of the sites and the errors along the measurement chain. The altitude of the cropland sites ranges between 209 and 945 m a.s.l.

Implied Emission Factors

The implied emission factor of category 5B1 (organic soil) in the Swiss Inventory has been compared to the corresponding emission factors of other countries (UNFCCC http://unfccc.int/di/FlexibleQueries.do) for the year 2009 (INFRAS 2012). Switzerland's net carbon stock change (emission) in organic soils lies in the midfield of the countries' range.

7.4.7 Category-Specific Recalculations

The increase of available AREA activity data (see Chapter 7.2) has led to a recalculation in category 5B.

Annual values for carbon stocks in living biomass have been calculated for the period 1990–2010. In former submissions, a constant mean value was used for all years.

7.4.8 Category-Specific Planned Improvements

In November 2011, ART started a three-year running research project that aims to identify (drained) fens and raised bogs under different land uses beyond the national inventories of bogs and fens in order to improve the AD estimates of organic soils.

Switzerland intends to make better use of the SOC data provided by the Swiss Soil Monitoring Network in forthcoming submissions. A contract has been signed in 2011 that arranges a close collaboration for the period 2012-2014.

Furthermore, information about carbon stock changes in soils for cropland remaining cropland will become available from research activities of Agroscope ART in the future: In 2011 a pilot study has started to evaluate possible Tier 3 methodological approaches for quantification of carbon stocks and carbon stock changes in agricultural soils (cf. UNFCCC 2009: §79; UNFCCC 2010: §72; UNFCCC 2011: §94).

On-going efforts to combine SOC measurements on the level of soil fractions with modelled pools (Zimmermann et al. 2007; Leifeld et al. 2009) will be combined with the planned Tier 3 approach for an independent check of emission and removal rates for cropland and grassland conversions.

The Research Institute of Organic Agriculture FiBL in CH-Frick runs a project with focus on the determination of sources and sinks of greenhouse gases in Swiss arable soils (project duration 2012-2014; co-funded by FOEN).

N_2O emissions as a result of the disturbance associated with land-use conversion of wetlands to croplands are currently not accounted for. The option to estimate the respective emissions will be considered for the next submission.

7.5 Category 5C – Grassland

7.5.1 Description

Tier 2 Key category 5C1
CO_2 from Grassland remaining Grassland
(2010: level).

Tier 2 Key category 5C2
CO_2 from Land converted to Grassland
(2010: level and trend)

Swiss grasslands belong to the cold temperate wet climatic zone.

Grasslands are subdivided into permanent grassland (CC31), shrub vegetation (CC32), vineyards, low-stem orchards (‘Niederstammobst’) and tree nurseries (CC33), copse (CC34), orchards (‘Hochstammobst’; CC35), stony grassland (CC36), and unproductive grassland (CC37). Carbon stocks in living biomass and carbon stocks in soils have been estimated for every subclass and have been considered accordingly in the calculation scheme.

In the CRF Table 5C2, the land-use types CC32, CC33, CC34 and CC35 are merged under the notation ‘woody’ and CC36 and CC37 are merged under ‘unproductive’ (see Table 7-2).

In 2010 5C1 Grassland remaining Grassland was a net source of 163.6 Gg CO_2. Carbon stocks in mineral soils and carbon stocks in living biomass under constant land use are considered to be in balance (i.e. no carbon stock changes do occur). The highest contribution came thus from carbon mineralization on organic soils under permanent grasslands in the lowest altitudinal zone (z1: 175.3 Gg CO_2), although only 0.45% of all grassland soils in Switzerland are organic soils. Contributions of other grassland subcategories remaining grassland were of minor importance.

5C2 Land converted to Grassland was a net source of 172.5 Gg CO_2 in 2010. The highest individual contribution came from 5C2.1 Forest Land converted to Grassland being responsible for a net source of 328.4 GgCO_2. Most of this source (67.5%) is due to net changes in living biomass from deforestation. All other land use change subcategories (i.e. 5C2.2-5C2.5) were small net sinks due to sequestration of CO_2 in soils and biomass during the conversion to grassland.

7.5.2 Information on Approaches Used for Representing Land Areas and on Land-use Databases Used for the Inventory Preparation

See Chapter 7.2.

7.5.3 Land-use Definitions and the Classification Systems Used and their Correspondence to the LULUCF Categories

See Chapter 7.2.

7.5.4 Methodological Issues

7.5.4.1 Carbon in Living Biomass

Permanent Grassland (CC31)

Permanent grasslands range in altitude from < 300 m to 3000 m above sea level. Because both biomass productivity and soil carbon rely on the prevailing climatic and pedogenic conditions, grassland stocks were calculated separately for three altitude zones (corresponding to those used in category 5A - Forest Land).

Standing stocks for permanent grasslands (t C ha^{-1}) are calculated as the annual cumulative yield of differentially managed grasslands (meadows, pastures, alpine meadows and pastures) based on FAL/RAC (2001; Table 7-32), assuming a carbon fraction of 0.5 (IPCC default). Mean standing above-ground biomass stocks were taken for each of the altitudinal zones because the spatial distribution of grassland management types is not known.

Table 7-32 Annual yields of differentially managed permanent grassland (CC31). Each value represents the mean of two fertilization levels.

Management	Altitude [m]	Annual yield [t C ha^{-1}]
Meadow	<601	5.88
	601-1200	4.38
	>1200	3.25
Pasture	<601	4.63
	601-1200	3.75
	>1200	2.75
Alpine pasture and meadow	601-1200	3.75
	>1200	0.75

Data for root biomass C was compiled by ART (2011a) based on published data of Swiss grassland. Carbon stocks in roots are in the range of 1.82–5.70 t C ha^{-1} depending on altitude. Root biomass is added to above-ground biomass to derive the total living biomass for CC31. Table 7-33 shows the living biomass of permanent grassland for the three altitudinal zones presented as the cumulated annual yield including roots.

Table 7-33 Root biomass C_{root} and total living biomass C_l of permanent grassland (CC31).

Altitude [m]	C_{root} [t C ha^{-1}]	C_l [t C ha^{-1}]
<601	1.82	7.08
601-1200	2.04	6.00
>1200	5.70	7.95

Shrub Vegetation (CC32) and Copse (CC34)

Due to the lack of more precise data, the living biomass of shrub vegetation and copse was assumed to be equal to the living biomass of brush forest as described in Chapter 7.3.4.7, where brush forest is assumed to contain 12.9 t C ha^{-1}.

Vineyards, Low-stem Orchards and Tree Nurseries (CC33)

Low-stem orchards are small fruit trees distinguished from CC35 (‘orchards’) by a maximum stem-height of 1 m and a much higher stand density. Only low-stem orchards and vineyards are considered in the following because no stand densities for tree nurseries are available. Data from SFSO (2002) indicate a very small contribution of tree nurseries (1’378 ha) as compared to the sum of vineyards (15'436 ha, ASCH2) and low-stem orchards (240 ha, based on Widmer 2006).

The standing carbon stock of living biomass per ha (Cl) for CC33 is therefore calculated as:

Cl = [(Cl vineyards * area vineyards) + (Cl low-stem orchards * area low-stem orchards)] / (area vineyards + area low-stem orchards)

Cl of vineyards is 3.61 t C ha^{-1}, calculated based on the mean stand density (5'556 vines ha^{-1}) and woody biomass of a plant including roots (0.65 kg C; Ruffner 2005).

For small fruit trees on low-stem orchards, no literature value was found for biomass expansion factors. Therefore, following assumptions were met. Diameter at breast height (DBH) of such trees was assumed to be around 10 cm and the tree height was assumed to be around 1 m. The bole shape of low-stem apple trees can be approximated by a cylinder shape.

Stem wood volume = $r^2 * \pi *$ height = $(5\ cm)^2 * 3.1 * 100\ cm = 7.75\ dm^3$

Based on expert knowledge (Kaufmann 2005), the percentage of branches was estimated as 100%, and the percentage of roots was estimated as 30% of the stem wood volume. This results in a BEF of 2.3. A wood density of 0.55 kg dm^{-3} (Vorreiter 1949) and the default carbon content of 50% were assumed. With these assumptions the carbon content of a tree of the type low-stem ('Niederstamm') is calculated as follows:

C low-stem = stem wood volume * BEF * wood density * carbon content
= 7.75 dm^3 * 2.3 * 0.55 kg/dm^3 * 50% C-content = 4.9 kg C

The mean stand density of low-stem orchards is estimated at 2500 ha^{-1} (Widmer 2006), resulting in a Cl of 12.25 t C ha^{-1}.

The resulting Cl for CC33 is 3.74 t C ha^{-1}.

Orchards (CC35)

Orchards are loosely planted larger fruit trees ('Hochstammobst') with grass understory. Cl of orchards trees is calculated as:

Cl biomass = (carbon per fruit tree [t] * number of fruit trees / area orchards [ha]) + carbon in grass [t ha^{-1}]

The carbon content of a large fruit tree with a DBH of 25 - 35 cm was calculated as follows:

C (Hochstamm) = Stem wood volume * KE-Factor = 225 kg C

where:

Stem wood volume of an apple tree assuming a cylindrical stem with mean DBH of 30 cm and a stem height of 7 m amounts to 0.5 m^3;

KE-Factor [t C m^{-3}]= BEF * Density * C-content = 0.45, (Wirth et al. 2004: 68, Table 16).

From the total fruit-growing area of 41'480 ha (ASCH2 data), the area of small fruit trees (240 ha, see CC33) was subtracted, and the remaining area was divided by the number of large fruit trees. Large fruit trees were counted in 1991 (3'616'301) and 2001 (2'900'000; SFSO 2002), and the mean value was divided by 41'240 ha to obtain a mean stand density of 79 trees ha^{-1}. The resulting woody biomass of CC35 is thus 17.78 t C ha^{-1}. Because orchards typically have a grass understory, the biomass of CC31 was added to the woody biomass. ASCH2 data showed that orchards are located below 1000 m a.s.l., so the mean of grass biomass of the classes <601 and 601-1200 m a.s.l. (i.e., 6.86 t C ha^{-1}; taken from FOEN 2011) was taken to obtain a total biomass stock of 24.63 t C ha^{-1} for CC35.

Stony Grassland (CC36)

Approximately 35% of the surface of CC36 (herbs and shrubs on stony surfaces) is covered by vegetation. No accurate data were available for this category. Therefore, the carbon content of brush forest (12.90 t C ha^{-1}) was multiplied by 0.35 to account for the 35% vegetation coverage. This results in a carbon content of 4.52 t C ha^{-1}.

Unproductive Grassland (CC37)

The category CC37 includes grass and herbaceous plants at watersides of lakes and rivers including dams and other flood protection structures, constructions to protect against avalanches and rock slides, and alpine infrastructure (e.g. for skiing). For none of these land-use types, biomass data are currently available. Therefore, the mean value of all grasslands, 6.05 t C ha^{-1} (taken from FOEN 2011), is arbitrarily chosen as the preliminary biomass value for CC37.

7.5.4.2 Carbon in Soils

Permanent Grassland (CC31)

Carbon stocks in grassland soil refer to a depth of 0-30 cm.

Soil carbon stocks in mineral soils under permanent grassland CC31 are calculated based on Leifeld et al. (2003, 2005). The approach correlates measured soil organic carbon stocks (t ha^{-1}) for permanent grasslands with soil texture and elevation after correction for soil depth and stone content. Area upscaling makes use of the Swiss digital soil map (SFSO 2000a) and topography. Mean Cs values calculated for grasslands CC31 are given in Table 7-34. It should be noted that the current C stocks are not only the result of the conditions for productivity and C turnover under different land-use types, but are also determined by farmers' decisions to use a site in a specific way due to the demands of a crop or the suitability of a site, e.g. regarding machine use (see Leifeld et al. 2003: 65).

Table 7-34 Mean carbon stocks under permanent grassland on mineral soils (0-30 cm).

Altitude [m]	Cs [t C ha^{-1}]
<601	62.02 ± 13
601-1200	67.50 ± 12
>1200	75.18 ± 9

Soil carbon stocks in organic soils under permanent grassland are calculated based on Leifeld et al. (2003, 2005). The approach uses measured carbon stocks in Swiss organic soils without differentiation among cropland and grassland. The mean soil organic carbon stock (0-30 cm) for organic soils is 240 ± 48 t C ha^{-1}.

Shrub Vegetation (CC32)

Due to the lack of data, the mean value of Table 7-34, 68.23 t ha^{-1} was used as the mineral soil carbon default for this category (0-30 cm).

The mean soil organic carbon stock (0-30 cm) for organic soils is 240 t C ha^{-1}.

Vineyards, Low-stem Orchards and Tree Nurseries (CC33)

The category includes carbon stocks in soils of vineyards, small fruit trees and tree nurseries. In accordance to carbon stocks in biomass, only vineyards and small fruit trees are considered. Both land-use types are assumed to have no grass undercover. Therefore, the soil carbon values of cropland, i.e. 53.40 t C ha^{-1} (mineral soils, 0-30 cm) and 240 t ha^{-1} (organic soils, 0-30 cm) are taken for CC33 (see Chapter 7.4.4.2).

Copse (CC34)

Due to the lack of data, the mean value of Table 7-34, 68.23 t ha^{-1} was used as the soil carbon default for this category (0-30 cm).

The mean soil organic carbon stock (0-30 cm) for organic soils is 240 t C ha^{-1}.

Orchards (CC35)

Cs of orchards was calculated in accordance to the biomass calculation. No specific Cs orchards values are available, and the mean value of grassland mineral soil carbon stocks from the two lower altitudinal zones (i.e., 64.76 t C ha^{-1}; cf. Table 7-34) was taken for mineral soils (0-30 cm), and the value of 240 t ha^{-1} for organic soils (0-30 cm).

Stony Grassland (CC36)

Soil organic carbon stocks under herbs and shrubs on stony surfaces were calculated according to the procedure described in Chapter 7.5.4.1, i.e. it is assumed that not more than 35% of the area of CC36 are covered with vegetation and thus only 35% of the area bears a mineral soil while the remainder is bare rock. Land-use of this category mostly belongs to ‘grassland’ and ‘unproductive land’ and likely includes many of the former (ASCH2) alpine grasslands. These grasslands are mainly located at altitudes > 1200m a.s.l. Thus, using the respective value from Table 7-34, the carbon stock Cs of CC36 is calculated as:

Cs of CC36 = 0.35 * Cs permanent grassland > 1200 m = 26.31 t C ha^{-1} (0-30 cm)

The mean soil organic carbon stock (0-30 cm) for organic soils is 240 t C ha^{-1}.

Unproductive Grassland (CC37)

The category CC37 ‚unproductive grasslands’ includes grass and herbaceous plants at watersides of lakes and rivers including dams and other flood protection structures, constructions to protect against avalanches and rock slides, and alpine infrastructure (e.g. for skiing). For none of these land-use types, Cs data are currently available. Soil carbon stocks of CC37 ‘unproductive grassland’ were arbitrarily set as the mean value of carbon stocks under permanent grassland on mineral soils (Table 7-34) in accordance to the procedure followed for biomass. Cs of CC37 is thus 68.23 t C ha^{-1}.

The mean soil organic carbon stock (0-30 cm) for organic soils is 240 t C ha^{-1}.

7.5.4.3 Changes in Carbon Stocks

Changes of carbon stock in biomass and in mineral soils are assumed to be zero for constant land use.

The annual net carbon stock change in organic soils on managed grassland (CC31, CC33 and CC35) was estimated to -9.52 t C ha^{-1} according to measurements in Europe including Switzerland as compiled by Leifeld et al. (2003, 2005) and rechecked by ART (2009b). For weakly managed grassland (CC32, CC34, CC36 and CC37) the emission from organic soils was estimated to -5.30 t C ha^{-1} according to available domestic data (ART 2011b).

In the case of land-use change, the net changes in biomass and soil of CC31, CC32, CC33, CC34, CC35, CC36, and CC37 are calculated as described in Chapter 7.1.3.

7.5.4.4 Carbon Emissions from Agricultural Lime Application

All CO_2 emissions caused by agricultural lime application are included under the category 5B Cropland (Chapter 7.4.4.5).

7.5.4.5 NMVOC Emissions

Estimates for annual biogenic emissions of NMVOC in Switzerland for forests and natural grassland are available in SAEFL (1996a): the value for natural grassland (unproductive vegetation) is 0.51 Gg.

7.5.5 Uncertainties and Time-Series Consistency

Uncertainties for soil carbon stocks are given together with the mean value in the text above: 12-21% for mineral soils and 20% for organic soils. They take into account uncertainties in measured C contents and predicted soil bulk densities, i.e., they consider only uncertainties in emission factors.

The relative uncertainty in yield determination has been estimated at 13% for biomass carbon from both, cropland and grassland (Leifeld and Fuhrer 2005). Data on biomass yields for different elevations and management intensities as published by FAL/RAC (2001) are based on many agricultural field experiments and have a high reliability.

In the uncertainty analysis, a higher, conservative value of 50% was chosen for the overall emission factor uncertainty in sector 5C (see Table 7-6).

Uncertainties of activity data of Grassland are described in Chapter 7.2.5.

7.5.6 Category-Specific QA/QC and Verification

Changes in living biomass

The assumption of a constant carbon stock in living biomass has been reconsidered (UNFCCC 2007: §97). According to Schneider (2010) yields on meadows and pastures did not increase since 1990. Neither management nor the share of clover did significantly change over the past 20 years. Consequently, the current approach has been reconfirmed.

Changes in SOC pools

A SOC pool dataset provided by the Swiss Soil Monitoring Network (NABO; see Chapter 7.3.6) supports the Tier 1 assumption that changes of carbon stocks in mineral soils are zero for grassland remaining grassland (cf. UNFCCC 2007: §97). The SOC pool measured at 32 grassland monitoring sites in the Swiss Soil Monitoring Network showed in average a slight increase during the period 1985 to 2000 and a slight decrease thereafter (Figure 7-12). SOC pools ranged between 18.5 and 159.5 t C ha^{-1}, the average SOC pool for the 32 grassland monitoring sites was 63.8 t C ha^{-1} (0-20 cm). In total, the results of the soil monitoring data indicate that Swiss grassland mineral soils did not act as a net source or sink of carbon during the last 20 years.

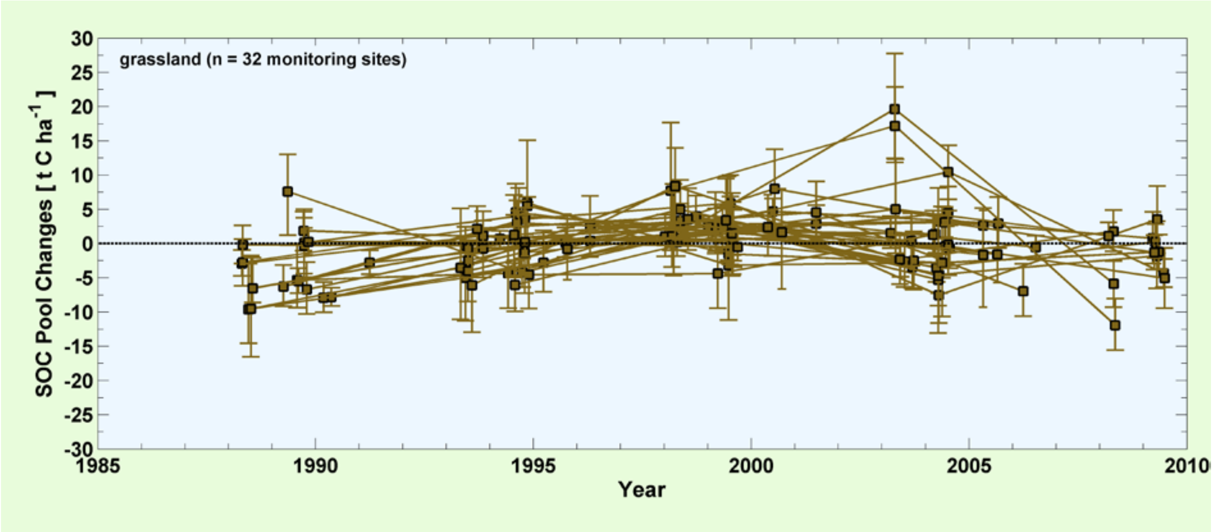

Figure 7-12 Time series of measured SOC pool changes in the top soil (0-20 cm) at the 32 NABO grassland sites from the 1st to the 5th re-sampling campaigns. SOC pools were centred by the median SOC pool of all re-samplings of the monitoring site. Each pool value presents the median of four bulked soil samples per campaign with measured SOC and bulk density. The error bars indicate the 25% and 75% percentiles resulting from the spatial variation of the sites and the errors along the measurement chain. The altitude of the grassland sites ranges between 265 and 2340 m a.s.l.

The slight increase and decrease will be subject for further detailed analysis. Partly, it may be attributed to natural variation of soil sampling (see Chapter 7.3.6). Furthermore, we presume that at grassland sites with intensive management and large manure application the temporal change of the SOC content is partly related to the nitrogen input fluxes and nitrogen content in soil. Therefore, the total nitrogen content of the archived soil samples will be measured and the correlation to the SOC content analysed. Moreover, management data of the monitoring sites gathered directly from the farmers since 1985 permit the calculation of annual nutrient fluxes of the sites (Keller et al. 2005). In this way temporal changes in nutrient management of the grassland sites can be separated from other effects that may cause temporal changes of SOC contents in grassland soils.

Implied Emission Factors

The implied emission factors of category 5C in the Swiss Inventory have been compared to the corresponding emission factors of other countries (UNFCCC http://unfccc.int/di/FlexibleQueries.do) for the year 2009 (INFRAS 2012).Switzerland's net carbon stock changes in living biomass, in dead organic matter and in mineral soils lie in the midfield of the countries' range. The net carbon stock loss (emission) in organic soils is the highest of all countries, but it is based on domestic measurements (see Chapter 7.5.4.3).

7.5.7 Category-Specific Recalculations

The increase of available AREA activity data (see Chapter 7.2) has led to a recalculation in the category 5C.

The root biomass for permanent grassland (CC31) has been differentiated by altitude on the basis of published data for Switzerland (ART 2011a). In former submissions, one average value was used.

For weakly managed grassland (CC32, CC34, CC36 and CC37) the emission from organic soils was estimated to -5.30 t C ha^{-1} (instead of 0 t C ha^{-1}) (ART 2011b).

7.5.8 Category-Specific Planned Improvements

In November 2011, ART started a three-year running research project that aims to identify (drained) fens and raised bogs under different land uses beyond the national inventories of bogs and fens in order to improve the AD estimates of organic soils.

Switzerland intends to make better use of the SOC data provided by the Swiss Soil Monitoring Network in forthcoming submissions. A contract has been signed in 2011 that arranges a close collaboration for the period 2012-2014.

Furthermore, information about carbon stock changes in soils for grassland remaining grassland will become available from research activities of Agroscope ART in the future: In 2011 a pilot study has started to evaluate possible Tier 3 methodological approaches for quantification of carbon stocks and carbon stock changes in agricultural soils (cf. UNFCCC 2007: §97).

On-going efforts to combine SOC measurements on the level of soil fractions with modelled pools (Zimmermann et al. 2007; Leifeld et al. 2009) will be combined with the planned Tier 3 approach for an independent check of emission and removal rates for cropland and grassland conversions.

The research project “Baumbiomasse in der Landschaft”, which aimed to improve estimates of tree biomass in non-forest areas, has been completed (Mathys and Thürig 2010). The applicability of the obtained data for reporting in the category 5C will be further evaluated.

7.6 Category 5D – Wetlands

7.6.1 Description

The categories 5D1 Wetlands remaining Wetlands and 5D2 Land converted to Wetlands are not key categories.

Wetlands consist of surface waters (CC41) and unproductive wet areas such as shore vegetation, fens or (raised) bogs. (CC42) (see Table 7-2)

7.6.2 Information on Approaches Used for Representing Land Areas and on Land-use Databases Used for the Inventory Preparation

See Chapter 7.2.

7.6.3 Land-use Definitions and the Classification Systems Used and their Correspondence to the LULUCF Categories

See Chapter 7.2.

7.6.4 Methodological Issues

7.6.4.1 Carbon in Living Biomass

Surface Waters (CC41)

Surface waters have no carbon stocks by definition.

Unproductive Wetland (CC42)

CC42 consists of unmanaged or weakly managed grassland, bushes or tree groups. The research project “Baumbiomasse in der Landschaft” (Mathys and Thürig 2010) aimed to improve estimates of tree biomass in non-forest areas. For the mixed category CC42, the pool of living biomass was estimated to 6.50 t C ha^{-1}.

7.6.4.2 Carbon in Soils

In general, the soil carbon stock for surface waters (CC41) is zero. However, for CC41 situated in areas with organic soil (see Chapter 7.2.3.1 and Table 7-7), the soil carbon stock is set to 240 t C ha^{-1} (0-30 cm). These surface waters are assumed to be shallow ponds as integrated parts of fens or bogs.

Land cover in CC42 explicitly includes peatlands protected by Federal Legislation (Swiss Confederation 1991a, 1994) as well as reed. More than 10% of these peatlands are located on organic soils (cf. Table 7-7) as defined in Chapter 7.2.3.1. In this case the carbon stock in soils is 240 t C ha^{-1} (0-30 cm). Currently, no specific soil data are available for CC42 on mineral soils. As a first guess, it is suggested that the soil carbon stock of unproductive wetlands is similar to permanent grassland on mineral soils (mean value: 68.23 t C ha^{-1}; 0-30 cm).

7.6.4.3 Changes in Carbon Stocks

Changes of carbon stock in biomass and in mineral soils are assumed to be zero for wetlands remaining wetlands.

The emission from organic soils under CC41 is assumed to be zero because the respective areas are not drained.

The emission from organic soils under CC42 was estimated to -5.30 t C ha^{-1} according to domestic data (ART 2011b). This value is used for weakly managed ecosystems such as fens and unmanaged ecosystems such as raised bogs. Bogs and fens are protected to a large part by Federal Ordinances (Swiss Confederation 1991a, 1994) and drainage is therefore not allowed. However, the impact of old drainages constructed before 1990 probably leads to a certain emission.

In the case of land-use change, the net changes in biomass and soil of both CC41 and CC42 are calculated as described in Chapter 7.1.3.

For land converted to unproductive wetland (CC42) a conversion time of one year was chosen for the carbon stock change in living biomass and in dead organic matter (see Table 7-3). This was done because at the moment when the land-use change is detected in the sense of changes in the vegetation cover on the AREA aerial photographs the land-use change has already occurred (cf. UNFCCC 2009: §82). For carbon stock changes in soil the conversion time is 20 years.

7.6.4.4 N_2O emissions from drainage of soils

The impact of old drainages in bogs and fens could lead to some emissions from organic soils. However, the reporting of non-CO_2 emissions is not mandatory for wetlands and as no data are available, Switzerland decided not to prepare estimates for these categories. Therefore, no N_2O emissions are reported in CRF Table 5(II).

7.6.5 Uncertainties and Time-Series Consistency

As a first guess, a value of 50% was chosen for the overall emission factor uncertainty in sector 5D (Table 7-6).

The uncertainty of the emission factor for carbon stock losses in organic soils is 100% based on monitoring values compiled by ART (2011b).

Uncertainties of activity data of Wetlands are described in Chapter 7.2.5.

7.6.6 Category-Specific QA/QC and Verification

No category-specific QA/QC activities have been carried out.

7.6.7 Category-Specific Recalculations

The increase of available AREA activity data (see Chapter 7.2) has led to a recalculation in the category 5D.

The carbon stock of living biomass for unproductive wetlands (CC42) was estimated to 6.50 t C ha^{-1} based on Mathys and Thürig (2010). In former submissions a value of 8.5 t C ha^{-1} had been used, which was based on a less reliable method (evaluation of "tags" of the AREA survey).

In former submissions, the soil carbon stock for CC42 was 154 t C ha^{-1}. It was calculated as arithmetic mean of the stocks for mineral soils (grassland) and organic soils. Now, with the improved method to geographically delineate the areas of organic soils (cf. Chapter 7.2.3.1) this procedure is not adequate any more. Instead two values are used: 68.23 t C ha^{-1} on mineral soils and 240 t C ha^{-1} on organic soils.

For unproductive wetlands (CC42), an emission rate of -5.30 t C ha^{-1} yr^{-1} is applied for organic soils (ART 2011b). In former submissions this value was 0 t C ha^{-1} yr^{-1}.

7.6.8 Category-Specific Planned Improvements

In November 2011, ART started a three-year running research project that aims to identify (drained) fens and raised bogs under different land uses beyond the national inventories of bogs and fens in order to improve the AD estimates of organic soils.

7.7 *Category 5E – Settlements*

7.7.1 Category Description

Tier 2 Key category 5E2 CO_2 from Land converted to Settlements (2010: level and trend)

The category 5E1 Settlements remaining Settlements is not a key category.

Settlements consist of buildings/constructions (CC51), herbaceous biomass in settlements (CC52), shrubs in settlements (CC53), and trees in settlements (CC54) as shown in Table 7-2.

7.7.2 Information on Approaches Used for Representing Land Areas and on Land-use Databases Used for the Inventory Preparation

See Chapter 7.2.

7.7.3 Land-use Definitions and the Classification Systems Used and their Correspondence to the LULUCF Categories

See Chapter 7.2.

7.7.4 Methodological Issues

7.7.4.1 Carbon in Living Biomass

Buildings and Constructions (CC51)

Buildings/constructions contain no carbon by default.

Herbaceous Biomass, Shrubs and Trees in Settlements (CC52, CC53, CC54)

Results of the research project “Baumbiomasse in der Landschaft” are used for carbon stocks in living biomass as follows: 9.54 t C ha^{-1} for CC52, 15.43 t C ha^{-1} for CC53 and 20.72 t C ha^{-1} for CC54 (Mathys and Thürig 2010: Table 7).

Mathys and Thürig (2010) used new digital terrain and surface models to assess specific crown cover areas for the land-use categories. For calculating the carbon stocks, a crown cover area based annual growth rate (CRW) is used.

In a Tier 1a approach, the IPCC provides a default value for CRW in settlements remaining settlements (IPCC 2003; p. 3.297).This value ranges from 1.8 to 3.4 t C ha^{-1} yr^{-1}, the arithmetic mean is 2.9 t C ha^{-1} yr^{-1}. It is an estimate for the average annual growth rate per tree crown cover area in settlements remaining settlements.

Expert assessment in Switzerland estimated the average age of trees in settlements remaining settlements to be older than 20 years (Kuhn 2011; expert judgment). In the GPG LULUCF (IPCC 2003), growth of trees in settlements is limited to the first 20 years. Therefore, the average carbon stock per tree crown cover area in settlements remaining settlements was assumed to be 20 times the crown cover area based annual growth rate (t C ha^{-1} yr^{-1}).

7.7.4.2 Carbon in Soils

The carbon stock in soil for CC51 (buildings and construction) was set to zero. However, a weighting factor of 0.5 was applied to soil carbon changes due to land-use changes involving CC51 (see Chapter 7.1.3.2). The reason for this is that in general the soil organic matter on construction sites is stored temporarily and later used for replanting the surroundings or it is used to vegetate dumps for example. The oxidative carbon loss due to the disturbance of the soil structure may reach 50% (see discussion in Leifeld et al. 2003: 67).

The carbon stock in mineral soil for CC52, CC53 and CC54 is 53.40 t C ha^{-1} (0-30 cm, same value as for cropland). For organic soils the carbon stock is 240 t C ha^{-1} (0-30 cm, same value as for the other land use categories on organic soils).

7.7.4.3 Changes in Carbon Stocks

Changes of carbon stock in biomass and in soil are assumed to be zero for settlements remaining settlements.

In the case of land-use change, the net changes in biomass and soil of CC51, CC52, CC53, and CC54 are calculated as described in Chapter 7.1.3.

7.7.5 Uncertainties and Time-Series Consistency

As a first guess, a value of 50% was chosen for the overall emission factor uncertainty in sector 5E (Table 7-6).

Uncertainties of activity data of Settlements are described in Chapter 7.2.5.

7.7.6 Category-Specific QA/QC and Verification

The implied emission factors of category 5E2 in the Swiss Inventory has been compared to the corresponding emission factors of other countries (UNFCCC http://unfccc.int/di/FlexibleQueries.do) for the year 2009 (INFRAS 2012). Switzerland's net carbon stock changes (emissions) in living biomass and soils lie in the midfield of the countries' range.

7.7.7 Category-Specific Recalculations

The increase of available AREA activity data (see Chapter 7.2) has led to a recalculation in the category 5E.

In former submissions, no changes in soil carbon stock due to land-use changes on organic soils were reported, i.e. it was assumed that the carbon stock of organic soils is always 240 t C ha^{-1}. In this submission, the carbon stock changes are calculated also for organic soils according to Chapter 7.1.3.2 and based on the stocks listed in Table 7-4. Thus, carbon stock changes on organic soils occur, if CC51 (Buildings and Constructions) is involved in the land-use transition, because for this combination category the soil carbon stock is set to 0 t C ha^{-1}.

7.7.8 Category-Specific Planned Improvements

Following improvements for CC52, CC53, and CC54 will be considered in subsequent submissions:

(1) So far, the understory vegetation was not considered in the estimation of the C stocks for CC52, CC53, and CC54. Accounting for understory vegetation will increase the estimated C stock of those categories.

(2) To convert tree crown coverage to carbon pool, the factor given by IPCC for settlements was applied. The accuracy of this factor is assumed to be low as it is only a Tier 1 default. More reliable estimates of this factor could significantly increase the accuracy of the estimation method.

The first point leads to an underestimation of C stocks in CC52, CC53, and CC54. In case of land-use changes, this underestimation influences the general carbon budget. In the land-use change tables, those categories show an increasing tendency (CC52 and CC53) or are more or less stable (CC54). This indicates that the inaccuracies of the present submission lead to a slight underestimation of the general sink effect in those categories.

Furthermore, the option to introduce an emission factor for carbon stock changes in organic soils under CC52, CC53 and CC54 will be considered in subsequent submissions.

7.8 Category 5F – Other Land

7.8.1 Description

The categories 5F1 Other Land remaining Other Land and 5F2 Land converted to Other Land are not key categories.

As shown in Table 7-2 other land (CC61) covers non-vegetated areas such as glaciers, rocks and shores.

7.8.2 Information on Approaches Used for Representing Land Areas and on Land-use Databases Used for the Inventory Preparation

See Chapter 7.2.

7.8.3 Land-use Definitions and the Classification Systems Used and their Correspondence to the LULUCF Categories

See Chapter 7.2.

7.8.4 Methodological Issues

By definition, other land has no carbon stocks. Coherently, changes of carbon stock in biomass and in soil are assumed to be zero for other land remaining other land.

In the case of land-use change, the net C changes in biomass and soil are calculated as described in Chapter 7.1.3.

7.8.5 Uncertainties and Time-Series Consistency

As a first guess, a value of 50% was chosen for the overall emission factor uncertainty in sector 5F2 (Table 7-6).

Uncertainties of activity data of Other Land are described in Chapter 7.2.5.

7.8.6 Category-Specific QA/QC and Verification

The implied emission factors of category 5F2 in the Swiss Inventory has been compared to the corresponding emission factors of other countries (UNFCCC http://unfccc.int/di/FlexibleQueries.do) for the year 2009 (INFRAS 2012). Switzerland's net carbon stock changes (emissions) in living biomass, dead organic matter and soils lie in the midfield of the countries' range.

7.8.7 Category-Specific Recalculations

The increase of available AREA activity data (see Chapter 7.2) has led to a recalculation in the category 5F.

In former submissions, no changes in soil carbon stock due to land-use changes on organic soils were reported, i.e. it was assumed that the carbon stock of organic soils is always 240 t C ha^{-1}. In this submission, the carbon stock changes are calculated also for organic soils according to Chapter 7.1.3.2 and based on the stocks listed in Table 7-4. Thus, carbon stock changes on organic soils occur, if CC61 is involved in the land-use transition, because for this combination category the soil carbon stock is set to 0 t C ha^{-1}.

7.8.8 Category-Specific Planned Improvements

There are no planned improvements.

8 Waste

8.1 Overview

8.1.1 Greenhouse Gas Emissions

Within the waste sector, emissions from four source categories are considered:

- 6A Solid Waste Disposal on Land,
- 6B Wastewater Handling,
- 6C Waste Incineration,
- 6D Other Waste

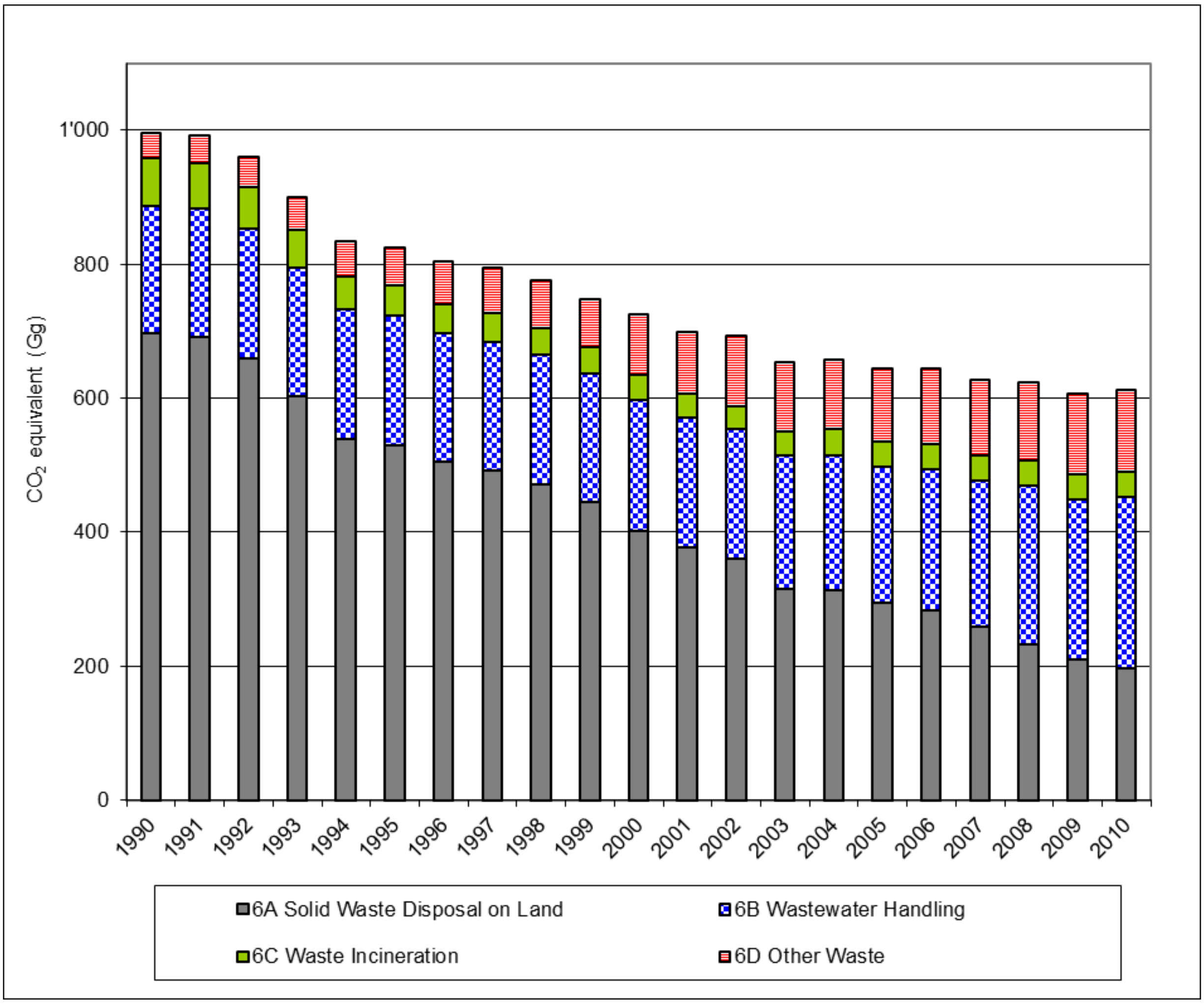

Figure 8-1 Switzerland's greenhouse gas emissions in the waste sector 1990–2010.

Table 8-1 Trend of total GHG emissions from waste management in Switzerland 1990-2010.

Gas	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
	CO_2 equivalent (Gg)									
CO_2	63	60	56	50	40	35	31	28	26	23
CH_4	724	721	696	644	591	590	568	559	541	517
N_2O	207	210	211	208	209	210	212	214	217	216
Sum	995	991	963	902	840	835	811	802	783	755

Gas	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
	CO_2 equivalent (Gg)									
CO_2	19	16	13	12	11	11	12	11	11	11
CH_4	488	467	460	413	413	397	388	368	360	339
N_2O	224	222	226	233	238	238	243	249	254	258
Sum	731	706	698	658	663	646	643	629	624	608

Gas	2010
	CO_2 eq (Gg)
CO_2	11
CH_4	342
N_2O	259
Sum	612

As illustrated in Table 8-1, in the waste sector a total of 612 Gg CO_2 equivalents were emitted in the year 2010. 32.3% stem from category 6A Solid Waste Disposal on Land, 41.6% of the emissions stem from category 6B Wastewater Handling, 6.3% from 6C Waste Incineration and 19.9% from 6D Others.

The total greenhouse gas emissions in the waste sector show a decrease of -38.51% from 1990 until 2010. From 1990 – 2007, the greenhouse gas emissions were clearly dominated by the ones from the source category 6A Solid Waste Disposal on Land. In 2008, emissions of 6A Solid Waste Disposal on Land and 6B Wastewater Handling have become equivalent. Since 2009, 6B Wastewater Handling is the most important source category.

CH_4 is still the most important greenhouse gas in the waste sector. Emissions have however decreased from 1990 until 2010 by 52.80%. The second most important greenhouse gas in the waste sector is N_2O. N_2O emissions have increased by 25.25% from 1990 until 2010. CO_2 is of minor importance in the waste sector. CO_2 emissions remained rather constant since 2004 at a low level of 11Gg. Since 1990 they were reduced by 83.14%.

The relative trends of the gases can be seen in Figure 8-2.

Please note that according to IPCC Good Practice Guide all emissions from waste-to-energy, where waste material is used directly as fuel or converted into a fuel, are reported under the Energy sector. Therefore the largest share of waste-related emissions in Switzerland is not reported under category 6 Waste, as the box below shows.

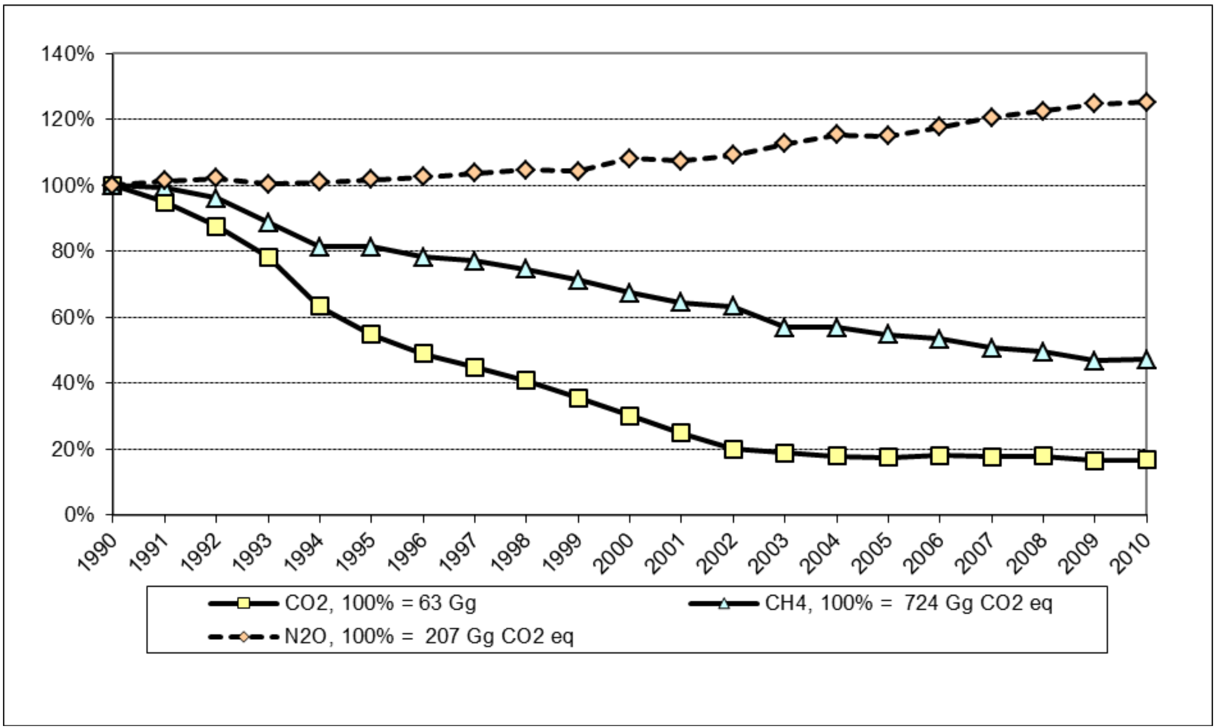

Figure 8-2 Trend of total GHG emissions from waste management in Switzerland 1990-2010.

Box: Waste related GHG emissions in Switzerland

The respective GHG emissions are reported in different chapters within the National Inventory. The following figure provides an overview on all waste related GHG emissions in Switzerland, not only the ones reported in the present Chapter 8.

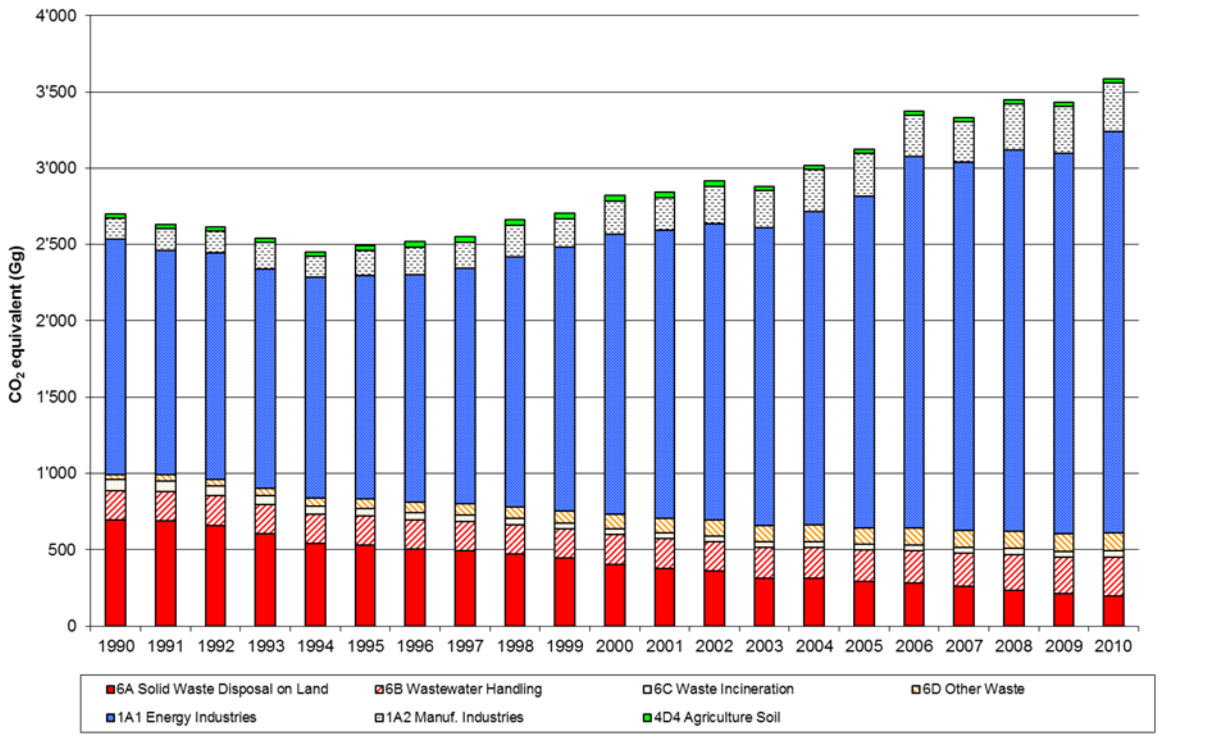

Figure 8-3 Waste related GHG emissions from 1990-2010.

8.1.2 Overview on Waste Management in Switzerland

The goals and principles regarding waste management in Switzerland are stated in the Guidelines on Swiss Waste Management (BUS 1986) and in the Waste Concept for Switzerland (SAEFL 1992). The four principles are:

1. The generation of waste shall be avoided as far as possible.
2. Pollutants from manufacturing processes and in products shall be reduced as far as possible.
3. Waste shall be recycled wherever this is environmentally beneficial and economically feasible.
4. Waste shall be treated in an environmentally sound way. In the long term only materials of final storage quality shall be disposed of in landfills.

Figure 8-4 gives a general overview on waste management and waste flow in Switzerland in 2010.

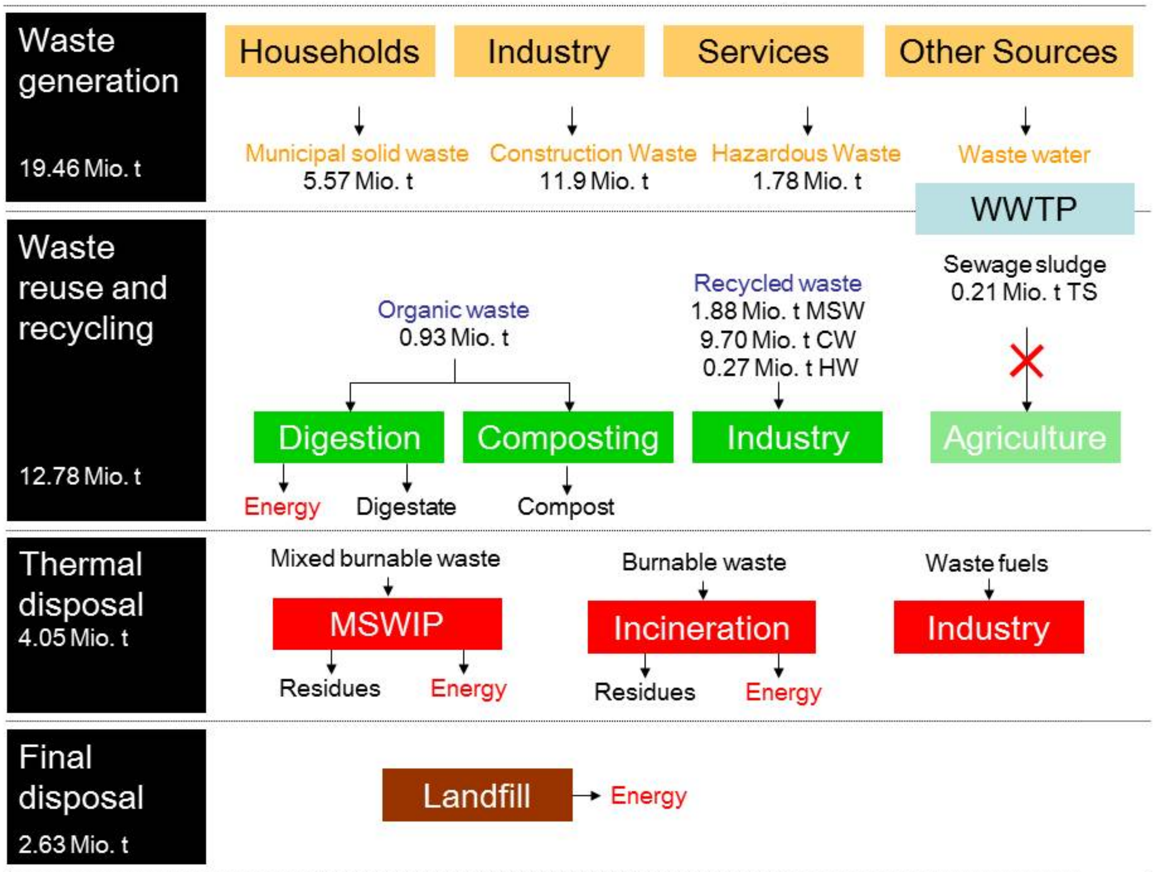

Figure 8-4 General overview on waste flow and waste management in Switzerland in 2010[16].
WWTP: Waste water treatment plant
MSWIP: Municipal solid waste incineration plant
MSW: Municipal solid waste
CW: Construction waste
HW: Hazardous waste

[16] The data refer to the year 2010 Source: FOEN 2011c.

Please note, that the quantities in Figure 8-4 are indicative. For the calculation of greenhouse gas emissions for the present Inventory, other activity data are used that consider imports and exports. A more detailed description of the treatment facilities is provided in the respective chapters [17].

Figure 8-4 shows that of the 5’568 Gg of municipal solid waste (MSW) generated in 2010, 2'808 Gg or 50% were recycled. The main recycled waste types were paper/cardboard (1’298 Gg), organic waste (930 Gg treated in centralized composting and digestion plants, without backyard composting), and used glass (345 Gg) (FOEN 2011c). The part of MSW that was not recycled was mainly incinerated (2'760 Gg or 50%). The amount of MSW landfilled dropped down to zero (EMIS 2012/1A1a & 6 A1 Kehrichtdeponien).

It is assumed that the same quantities as in 2009, e.g. about 11'900 Gg construction waste (FOEN 2010j), was generated in Switzerland in 2010. From this quantity about 9’700 Gg (82%) was recycled[18]. About half of the recycling took place at the construction site, e.g. by reusing material left after breaking up the road cover. The other half was separated at the construction site and recycled individually, e.g. used glass, used metals, used concrete etc. A minor amount, 477 Gg, of the construction waste was incinerated and the remaining, inert waste materials, 1’723 Gg were disposed of in landfills for inert waste (SAEFL 2001).

About 1’784 Gg hazardous waste was generated in Switzerland in 2010. About 246 Gg hazardous waste was recycled, 588 Gg were incinerated, 164 Gg were biologically treated, 572 Gg landfilled and approximately 214 Gg were exported (FOEN 2011c).

About 210 Gg (dry matter) sewage sludge was generated in 2010 (FOEN 2011c). Since 2006 it is forbidden to use sewage sludge as a fertilizer in agriculture due to the content of organic contaminants. In 2010 100% of sewage sludge was incinerated (in municipal solid waste incineration plants and mono incineration plants).

Imports are not considered in Figure 8-4. Imports of burnable waste stem in the first place from neighbouring countries (Germany, France, Austria and Italy).The imported municipal solid waste is burned in municipal solid waste incineration plants. The import of waste into Switzerland requires a license from the Federal Office for the Environment. A company that wishes to import waste must demonstrate that a waste incinerator plant in Switzerland receives and burns the waste. The import of waste for final disposal in a landfill is in principle not permitted, except in the case of waste imported in terms of a contract on regional transboundary cooperation or of slag from the incineration of previously exported municipal solid waste.

[17] Detailed data about the Swiss waste management sector can be found on the FOEN web-site (http://www.bafu.admin.ch/abfall/01517/01519/11645/index.html?lang=de).

[18] The latest available data for the shares of different types of treatments for construction waste on this general level refer to the year 2000 and are derived from a model, not from actual survey data (SAEFL 2001). Shares in the year 2010 are assumed to be the same as in the year 2000.

Table 8-2 Reporting of greenhouse gas emissions from waste management activities in present inventory.

Source	Waste Management Activity
1A1a Public Electricity/Heat	Co-generation of landfill gas Co-generation of biogas from fermentation Municipal solid waste incineration Special waste incineration
1A2d Pulp, Paper and Print	Waste derived fuel in paper industry and cellulose production
1A2f Other	Waste derived fuel in cement industry
4D4 Other	Sewage sludge and compost used as fertilizer
6A Solid Waste Disposal on Land	Waste disposal
6B Waste Water Handling	Waste water treatment
6C Waste Incineration	Waste incineration
6D Other Waste	Composting and digesting of organic waste, car shredding

8.2 Source Category 6A – Solid Waste Disposal on Land

8.2.1 Source Category Description

Key category 6A
CH_4 emissions from managed waste disposal on land (level and trend)

The source category 6A1 “Managed Waste Disposal on Land” comprises all emissions from managed solid waste landfill sites.

Emissions from the source category 6A2 “Unmanaged Waste Disposal Sites” are included in source category 6A1 “Managed Waste Disposal on Land”. This is motivated by the fact that in Switzerland officially no unmanaged waste disposal sites exist. The effective quantity of waste not properly treated in landfills is estimated to be very small. However, no reliable data are available.

In Switzerland, in 2010 seven managed biogenic active landfills are equipped to recover landfill gas (SFOE 2011a). The landfill gas is generally used in co-generation plants in order to produce electricity and heat. Some landfill gas is used to generate heat only. A very small portion of the landfill gas is flared.

Table 8-3 Specification of source category 6A “Solid Waste Disposal on Land”.

6A	Source	Specification	Data Source
6A1	Managed Waste Disposal on Land	Emissions from managed solid waste landfill sites.	EMIS 2012/1A1a & 6A1 Kehrichtdeponien
6A2	Unmanaged Waste Disposal Sites	Emissions from all other waste disposal sites not included in source category 6A1. (included in 6A1)	
6A3	Others	Not occurring in Switzerland	

8.2.2 Methodological Issues, Managed Waste Disposal on Land (6A1)

8.2.2.1 Methodology

The emissions are calculated in four steps:

i) The rate of CH_4 generation over time is based on the First Order Decay model (FOD) according to IPCC (IPCC 1997a-c). The following equation is applied to calculate the

CH_4 generation in the year t:

CH_4 generated in the year t [Gg/year] = $\sum_x$ [A • k • M(x) • L_0(x) • $e^{-k(t-x)}$] • (1-OX)

where

t = current year
x = the year of waste input, $x \leq t$
A = (1-k)/k, norm factor (fraction)
k = methane generation rate [1/yr]
M(x) = the amount of waste disposed in year x
L_0(x) = methane generation potential (MCF(x) • DOC(x) • DOC_F • F • 16/12) [Gg CH_4 / Gg waste]
MCF(x) = methane correction factor (fraction)
DOC(x) = degradable organic carbon [Gg C/ Gg waste]
DOC_F = portion of DOC, that is converted to landfill gas (fraction)
F = portion of CH_4 in landfill gas (fraction)
16/12 = factor to convert C to CH_4.
OX = oxidation factor (fraction)

The following general assumptions are made:

MCF(x) = constant = 1 (default value according to IPCC for managed solid waste disposal sites)

OX = 0.1 (default value according to IPCC 1997a-c)

DOC_F = 0.6 (default value according to IPCC 1997a-c)

F = 0.5 (default value according to IPCC 1997a-c)

The degradable organic carbon DOC(x) is calculated based on country specific waste composition for municipal solid waste, construction waste and sewage sludge and default values for DOC (x) adopted from IPCC Guidelines, table 6-3. (see EMIS 2012/1A1a & 6A1 Kehrichtdeponien).

The methane generation rate k is based on expert judgement taking into account the country specific conditions as well as the type of waste disposed of in landfills (see EMIS 2012/1A1a & 6A1 Kehrichtdeponien).

For the calculation of CH_4 generation three different categories of waste are distinguished. The three categories are i) municipal solid waste, ii) construction waste, and iii) sewage sludge.

The following parameters are applied for the calculation of CH_4 generated.

Table 8-4 Parameters used for FOD model

	k [1/yr]	**L_0** [Gg CH_4 / Gg waste]	**DOC** [-]
municipal solid waste	0.139	0.050	1990-1992: 0.15 1993-2002: linear interpolation 2003-2010: 0.12
construction waste	0.046	0.08	0.20
sewage sludge	0.069	0.068	0.17

ii) In a second step, the amount of CH_4 that is recovered and used as fuel for co-generation units as well as for flaring is subtracted from the CH_4 generated in landfills (resulting from step 1).

CH_4 emissions $_{step\ ii)}$ = CH_4 emissions $_{step\ i)}$ – (CH_4 emissions $_{step\ i)}$ * Fl(t)) – Qco-gen(t)

where
Fl(t) = portion of generated methane that is flared in the present year (fraction)
Qco-gen(t) = CH_4 which is recovered in co-generation units in the present (Gg)

iii) In the third step CH_4 emissions from on-site open burning are added. This results in the overall CH_4 emissions from landfill sites.

CH_4 emissions $_{step\ iii)}$ = CH_4 emissions $_{step\ ii)}$ + Qopen(t)

where
Qopen(t) = CH_4 which is emitted from open burning in the present year (Gg)

iv) In the fourth and last step the emissions of the other gases are calculated. The respective emissions are considered as proportional to the CH_4 burnt (co-generation and flaring), or to the waste quantity burnt (open burning), respectively.

8.2.2.2 Emission Factors

Emission factors for CO_2, CH_4, CO, NMVOC and SO_2 are country specific based on measurements and expert estimates, documented in EMIS 2012/1A1a & 6A1 Kehrichtdeponien. CO_2 emissions from non-biogenic waste are included, while the CO_2 emissions from biogenic waste are excluded from total emissions.

The following table presents the emission factors used in 6A1:

Table 8-5 Emission Factors for 6A1 "Managed Waste Disposal Sites on Land" in 2010.

Source	CO_2 biogen	CO_2 fossil	CH_4	NO_x	CO	NMVOC	SO_2
6A1 Managed Waste Disposal on Land	t / t CH_4 produced						
Direct emisions from landfill	3.00	0	1				
	kg / t CH_4 burned						
Flaring	2750	0		1	17		
	kg / t waste burned						
Open burning	674	597	6	2.5	50	16	0.8

8.2.2.3 Activity data

One set of activity data for Managed Waste Disposal on Land (6A1) are the waste quantities disposed on landfills and the municipal solid waste burnt on-site.

Activity data for Managed Waste Disposal on Land (6A1) are taken from EMIS 2012/1A1a & 6A1 Kehrichtdeponien.

Table 8-6 Activity data in 6A1: Waste disposed of on Managed Landfill Sites from 1990 to 2010 (source EMIS 2012/1A1a & 6A1 Kehrichtdeponien).

Source / Parameter	Unit	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
6A1 Managed Waste Disposal on Land											
Municipal solid waste (MSW)	Gg	637.0	637.0	637.0	637.0	581.2	531.9	482.7	472.8	463.0	465.3
Construction waste	Gg	147.0	170.5	170.5	123.5	59.1	47.3	35.5	35.5	41.4	41.6
Sewage sludge	Gg (dry)	58.8	58.8	58.8	48.8	39.0	27.7	16.3	12.2	8.1	6.1
Open burned waste	Gg	17.2	20.0	20.0	18.2	10.9	9.7	8.5	8.3	8.2	5.5
Total waste quantity	Gg	860.0	886.3	886.3	827.5	690.2	616.6	542.9	528.7	520.6	518.5

Source / Parameter	Unit	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
6A1 Managed Waste Disposal on Land											
Municipal solid waste (MSW)	Gg	288.8	184.8	80.8	52.2	23.7	13.6	3.5	1.5	1.2	0.0
Construction waste	Gg	30.7	17.7	4.8	3.4	2.0	1.4	0.8	0.0	0.0	0.0
Sewage sludge	Gg (dry)	4.1	3.9	3.6	2.6	1.6	1.0	0.3	0.0	0.0	0.0
Open burned waste	Gg	3.5	2.2	0.9	0.6	0.1	0.1	0.0	0.0	0.0	0.0
Total waste quantity	Gg	327.0	208.6	90.1	58.8	27.5	16.1	4.7	1.5	1.2	0.0

Source / Parameter	Unit	2010
6A1 Managed Waste Disposal on Land		
Municipal solid waste (MSW)	Gg	0.0
Construction waste	Gg	0.0
Sewage sludge	Gg (dry)	0.0
Open burned waste	Gg	0.0
Total waste quantity	Gg	0.0

Table 8-6 documents the amounts of municipal solid waste, construction waste, sewage sludge and open burnt waste disposed of on managed waste disposal sites over the time period 1990 – 2010.

The continuous reduction happened due to changes in the legislative framework, making incineration the mandatory disposal option for burnable waste and banning its disposal on landfills from 1 January 2000. The amounts of burnable waste disposed of on managed waste diposal sites dropped down to zero in 2009.

The other activity data for Managed Waste Disposal on Land (6A1) is CH_4 flared. The landfill gas recovered and used as fuel for co-generation units is reported under 1A1 Energy in accordance to the IPCC Good Practice Guide.

Table 8-7 Activity data in 6A1: CH_4 direct emissions and CH_4 flared from 1990 to 2010 (source EMIS 2012/1A1a & 6A1 Kehrichtdeponien).

Source / Parameter	Unit	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
6A1 Managed Waste Disposal on Land											
CH_4 direct emissions	Gg	32.7	32.3	30.8	28.2	25.4	25.0	23.8	23.2	22.2	21.0
CH_4 flared	Gg	4.2	4.2	4.3	4.3	4.2	4.1	4.0	3.9	3.7	3.6

Source / Parameter	Unit	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
6A1 Managed Waste Disposal on Land											
CH_4 direct emissions	Gg	19.0	18.0	17.2	15.0	15.0	14.1	13.5	12.4	11.1	10.1
CH_4 flared	Gg	3.4	3.1	2.8	2.5	2.3	2.0	1.8	1.6	1.4	1.3

Source / Parameter	Unit	2010
6A1 Managed Waste Disposal on Land		
CH_4 direct emissions	Gg	9.4
CH_4 flared	Gg	1.2

The CH_4 generated in landfills decreased since 1990 due to the fact that waste quantities disposed of in landfills have been decreasing. Together with the relative increase of CH_4 recovery from 1990 until 2010 this is the reason for CH_4 emissions from the source category 6A being a key source regarding trend.

8.2.3 Uncertainties and Time-Series Consistency

8.2.3.1 Uncertainty in CH_4 emissions from Solid Waste disposal on land in 6A

Uncertainty of direct CH_4 emissions from sanitary landfills is estimated to be 58.3%.

For the amount of waste disposed of on a landfill an uncertainty of 30% is assumed. This is because most of the emissions in the nineties stem from waste disposed of in the eighties, when waste statistics were reported less accurately. An uncertainty of 50% is assumed for the emission factor (EMIS 2012/1A1a & 6A1 Kehrichtdeponien).

For CO_2 a medium confidence of 10% in emissions estimates is assumed according to an uncertainty assessment based on expert judgments.

8.2.3.2 Qualitative estimate of uncertainties of non-key source emissions in 6A

A preliminary uncertainty assessment based on expert judgment results in medium confidence in emission estimates.

Consistency: The time series is consistent.

8.2.4 Source-Specific QA/QC and Verification

In addition to the general QA/QC measures described in Chapter 1.6 subsequent source-specific activities have been carried out:

- Cross check of activity data (waste quantities disposed of on landfills) used in the FOD model, stated in the EMIS database and the primary source (FOEN 2011c).
- Verification of country specific degradable organic carbon DOC(x) calculations for municipal solid waste, construction waste and sewage sludge.
- The time series have been compared between the current and the previous submission. All activity data, implied emission factors and emissions undergo the triple check.
- The results for 2010 are compared with the results 2009 within the current CRF
- The CRF tables for the year 2009 are compared between the current CRF tables and the CRF tables of submission 2011.
- The CRF tables for the base year 1990 are compared between the current CRF tables and the CRF tables of submission 2011.

8.2.5 Source-Specific Recalculations

For open burning a constant share of 40% of fossil carbon has been assumed in previous submissions. The share of fossil and organic matter in the municipal solid waste has been revised based on the continuation of the FOCAWIN study (fossil carbon dioxide emission from waste incineration facilities) by EMPA (Mohn 2011). The actual share of fossil carbon in municipal waste is around 47.8%. This value will be implemented for the emissions 2011. Until 2002, the value is estimated to be 40%. In between 2002 and 2011, the values have been linearly interpolated and resulted in a value of 46.93% for 2010. This results in a corresponding change of emission factors of fossil and biogenic carbon and recalculations for the emissions of the years 2003 - 2009.

8.2.6 Source-Specific Planned Improvements

There are no source-specific planned improvements in this category.

8.3 Source Category 6B – Wastewater Handling

8.3.1 Source Category Description

Key category 6B
N_2O emissions from waste water handling (Tier 1 and 2 levels).

The source category 6B1 "Industrial Waste Water" comprises all emissions from liquid waste handling and sludge from industrial processes such as food processing, textiles, or pulp and paper production. Food processing may result in effluents with a high load of organics. In order to reduce the load of polluted wastewater (and to meet the regulatory standards as well as to reduce discharge fee) the effluent is pre-treated on site. The treatment is generally anaerobic, in order to use the biogas as source for heat and power generation. Currently, there are about 22 Industrial wastewater pre-treatment plants (see EMIS 2012/ 6B1 industrielle Abwässer).

The source category 6B2 "Domestic and Commercial Waste Water" comprises all emissions from liquid waste handling and sludge from housing and commercial sources (including gray water and night soil). The pre-treated effluents from industries are also handled for final treatment in these waste water treatment plants. Switzerland's wastewater management infrastructure - comprising some 900 sewage plants and 40'000-50'000 km of public sewers - is now practically complete (FOEN 2011g). Municipal Wastewater treatment plants are treating wastewater from single cities or from several cities or municipalities together. Waste water in general is treated in three steps: 1. Mechanical treatment, 2. Biological treatment, and 3. Chemical treatment. Most of the MWWTP are using biogas as power and heat supply for their process.The treated waste water flows into a receiving system (lake, river or stream).

Table 8-8 Specification of source category 6B "Wastewater Handling".

6B	Source	Specification	Data Source
6B1	Industrial Waste Water	Emissions from handling of liquid wastes and sludge from industrial processes.	AD: EMIS 2012/6B1 Kläranlagen Industriell and SFOE 2011 EF: EMIS 2012/6B1 Kläranlagen Industriell
6B2	Domestic and Commercial Waste Water	Emissions from liquid waste handling and sludge from housing and commercial sources	AD: EMIS 2012/6B2 Kläranlagen Kommunal and SFOE 2011 EF: EMIS 2012/6B2 Kläranlagen Kommunal
6B3	Others	Not occurring in Switzerland	

The emissions related to wastewater treatment are included in various categories as illustrated in Figure 8-5 below. The system boundaries of category 6B contain all emissions from direct wastewater handling, some emissions from sewage sludge drying and no emissions from sewage sludge use or disposal.

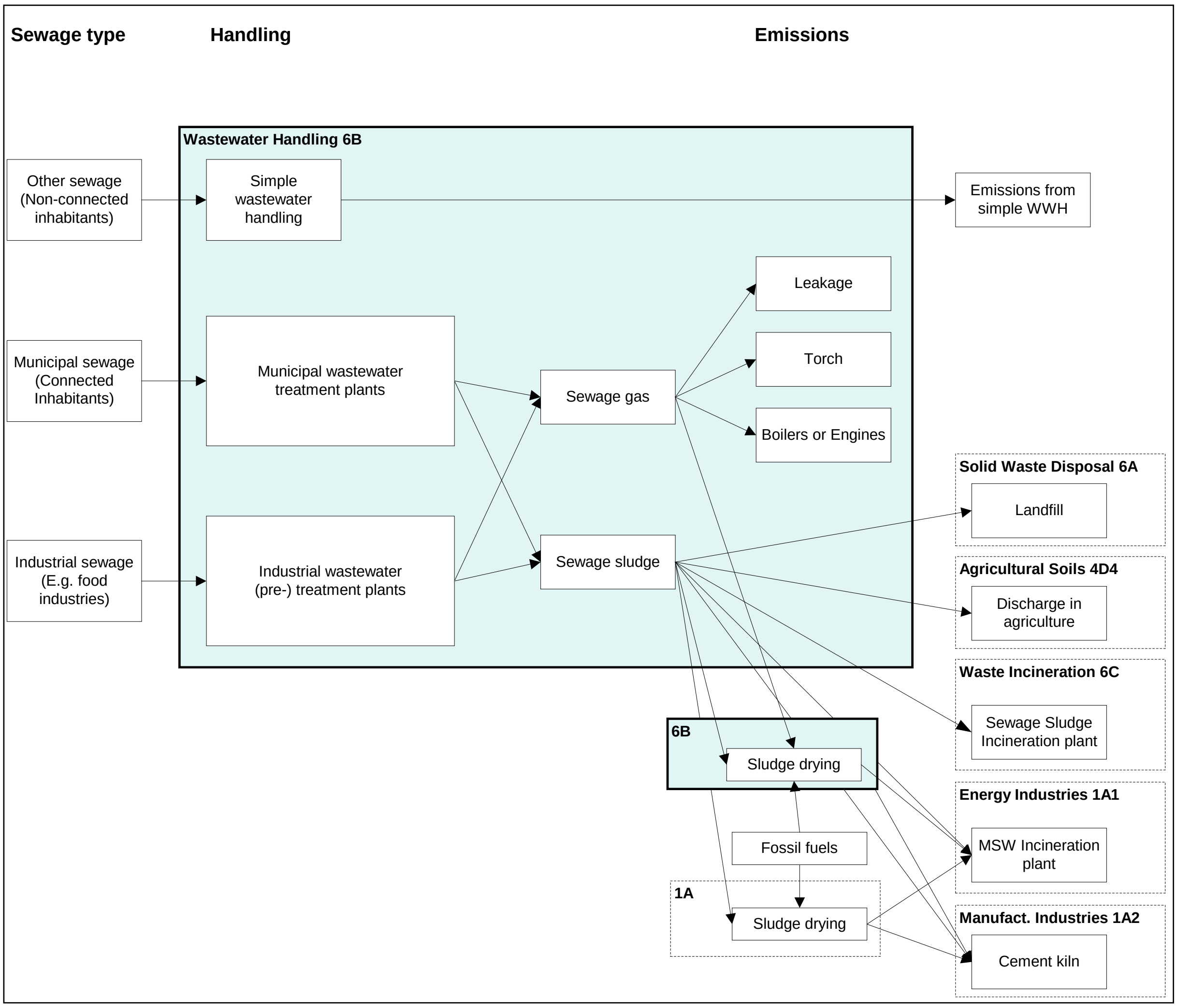

Figure 8-5 System boundaries of emissions related to wastewater treatment.

8.3.2 Methodological Issues, Wastewater Handling (6B)

8.3.2.1 Methodology

For industrial waste water treatment (6B1) a country specific method is used. For domestic and commercial waste water treatment (6B2), a country specific method is used, with the exception of N_2O. The N_2O emissions are calculated according to the IPCC default method. The GHG emissions are calculated by multiplying the number of inhabitants connected to waste water treatment plants by emission factors. N_2O emissions are taking into account the yearly protein consumption in Switzerland.

8.3.2.2 Emission Factors

Emission factors for CO_2, CH_4, N_2O, CO, NMVOC and SO_2 are country specific based on measurements and expert estimates, documented in the EMIS 2012/6B1 Industrielle Abwässer and EMIS2011/6B2 Kommunale Kläranlagen. Emission factors are adapted on a yearly basis due to respective changes in the fraction of inhabitants connected to waste water treatment plants. All emission factors have been converted and standardized for all emissions into g/inhabitants.

EF for N_2O is derived based on the IPCC-default method (see EMIS 2012 6B2 Kläranlage kommunal. According to the Swiss Farmer's Union, total protein consumption in Switzerland raised from 236 t in 1990 to 268 t in 2010 (SBV 2011b). Protein consumption factors thus range around 33 kg/ inhabitant and year. Using an N fraction of 0.16 kg N per kg protein (FracNPR; IPCCdefault) an emission factor of around 86 g N_2O per inhabitant results for the year 2010.

CH_4 emissions reported are due to flaring, leakage from sewage gas upgrading as well as leakage from piping systems. Although the emission factor for CH_4 in kg/ TJ has not changed since 2007, rather brusque changes in EF [g/ inhabitant] can be observed since 2007. This is related to the changes in mass flows, e.g. sewage gas produced. Additionally, the amount of sewage gas fed into the natural gas pipes has increased significantly (from 14.92 to 25.80 GWh, SFOE 2011a) thus the increase in emissions are mostly related to sewage gas upgrading.

The emission factors used in 6B1 and 6B2 are summarized in the following table.

Table 8-9 Emission Factors for 6B1 Industrial Waste Water and 6B2 Domestic and Commercial Waste Water in 2010.

Source	**CO_2 biog.**	**N_2O**	**CH_4**	**NO_x**	**CO**	**NMVOC**	**SO_2**
	kg/inhabitant	g/inhabitant	g/inhabitant				
6B1 Industrial Waste Water	1.6	NO	4.0	1.4	1.7	0.05	0.11
6B2 Municipal Waste Water	15.1	86	274	24	42	0.5	3

Please note that the activity data for N_2O emissions of municipal waste water is the total number of inhabitants (not connected inhabitants), in line with IPCC. For industrial waste water it is assumed that N_2O emissions are not occurring (EMIS 2012/6B1 Industrielle Abwässer).

In 2010 96.8 % of the domestic waste water is being treated in waste water treatment plants. Emissions from wastewater of the inhabitants not connected to public waste water treatment are not considered, as their contribution is of minor importance.

Several waste water treatment plants also accept co-substrates (organic wastes) and add them to the digestion process. As they are rich in energy content a considerable part of the sewage gas stems therefrom. A part of the emissions are thus related to the addition of co-substrates.

8.3.2.3 Activity data

Activity data in 6B correspond to the number of connected inhabitants. Activity data for Domestic and Commercial Waste Water (6B2) are extracted from EMIS 2012/6B2 Kläranlage kommunal from SFOE 2011. For 6B1 the same activity data were adopted.

Table 8-10 Activity data 6B2 Domestic and Commercial Waste Water; Population and fraction connected to waste water treatment plants.

Source/Parameter	Unit	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
6B2 Domestic and Commercial Waste Water											
Population	inhabitants in 1000	6'796	6'880	6'943	6'989	7'037	7'081	7'105	7'113	7'132	7'167
Fraction connected to waste water treatment plants	%	90.0	91.0	91.5	92.0	93.0	93.5	94.0	94.5	95.0	95.3
connected inhabitants	inhabitants in 1000	6'116	6'261	6'353	6'430	6'544	6'621	6'679	6'722	6'775	6'830

Source/Parameter	Unit	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
6B2 Domestic and Commercial Waste Water											
Population	inhabitants in 1000	7'209	7'285	7'343	7'405	7'454	7'501	7'558	7'617	7'710	7'799
Fraction connected to waste water treatment plants	%	95.4	95.7	96.0	96.3	96.6	96.7	96.7	96.7	96.7	96.8
connected inhabitants	inhabitants in 1000	6'877	6'972	7'049	7'131	7'201	7'253	7'309	7'366	7'456	7'549

Source/Parameter	Unit	2010
6B2 Domestic and Commercial Waste Water		
Population	inhabitants in 1000	7'870
Fraction connected to waste water treatment plants	%	96.8
connected inhabitants	inhabitants in 1000	7'618

8.3.3 Uncertainties and Time-Series Consistency

8.3.3.1 Uncertainty in N_2O emissions from 6B2

Activity data is highly reliable (estimated uncertainty 1.3%). The uncertainty for the emission factor is estimated to be 50%, according to EMIS 2012/6B1 Kläranlage Industriell.

8.3.3.2 Qualitative estimate of uncertainties of non-key category emissions in 6B

A preliminary uncertainty assessment based on expert judgment results in medium uncertainty of emissions estimates for CH_4 and low uncertainty for N_2O.

The time series is consistent.

8.3.4 Source-Specific QA/QC and Verification

In addition to the general QA/QC measures described in Section 1.6 subsequent source-specific activities have been carried out:

- Verification of CH_4 emission factor
- Check of greenhouse gas emission calculations for 2010.
- The time series have been compared between the current and the previous submission. All activity data, implied emission factors and emissions undergo the triple check.
    - the results for 2010 are compared with the results 2009 within the current CRF
    - the CRF tables for the year 2009 are compared between the current CRF tables and the CRF tables of submission 2011.
    - the CRF tables for the base year 1990 are compared between the current CRF tables and the CRF tables of submission 2011.

8.3.5 Source-Specific Recalculations

N_2O emission were recalculated for the whole time series using year-specific values for protein consumption according to the numbers provided by the Swiss Farmer's Union (SBV 2011b).

AD of sewage gas treatment has changed for the years 2008 and 2009, according to SFOE 2011a. This results in changed EF for CH_4 and recalculations of CH_4 emissions for both years.

8.3.6 Source-Specific Planned Improvements

There are no source-specific planned improvements in this category.

8.4 Source Category 6C – Waste Incineration

8.4.1 Source Category Description

Source category 6C "Waste Incineration" is **not a key category**.

There is a long tradition in Switzerland to incinerate waste. The waste heat generated during the incineration has to be recovered if technically and economically feasible. In accordance with the IPCC provisions (IPCC 1997c) emissions from the combustion of waste-to-energy activities are dealt with in 1A "Fuel Combustion Activities".

The following sources are included in source category 6C:

Table 8-11 Overview on waste incineration sources reported under 6C.

Waste incineration	**Specification**	**Data Source**
Hospital waste incineration	Emissions from incinerating hospital waste in hospital incinerators	AD, EF: EMIS 2012/6C2 Spitalabfall-Verbrennung
Illegal waste incineration	Emissions from illegal incineration of municipal solid wastes at home Emissions from waste incineration at construction sites (open burning)	AD, EF: EMIS 2012/6C2 Abfallverbrennung illegal
Insulation material from cables	Emissions from incinerating cable insulation materials	AD, EF: EMIS 2012/6C2 Kabelabbrand
Sewage sludge	Emissions from sewage sludge incineration plants	AD, EF: EMIS 2012/6C2 Klärschlamm-Verbrennung
Crematoria	Emissions from the burning of bodies in crematoria	AD, EF: EMIS 2012/6C Krematorien

The following table gives an overview on other waste incineration activities in Switzerland and the respective source category, where the GHG emissions are reported in the national inventory.

Table 8-12 Overview of other waste incineration activities in Switzerland, and indication of source categories where the waste incineration activity is reported in the national inventory.

Waste incineration	Specification	Source category
Paper and pulp industries	Emissions from incineration of residues and sludge from industrial waste water treatment plants as fuel for paper/pulp production	1A2d Biomass
Municipal solid waste incineration plants	Emissions from waste incineration in municipal solid waste incineration plants	1A1a Other
Waste in cement plants	Emissions from waste use as alternative fuels in cement kilns	1A2f Other
Special waste	Emissions from incinerating industrial and hazardous waste	1A1a Other

8.4.2 Methodological Issues

8.4.2.1 Methodology

For the calculation of the greenhouse gas emissions a country specific Tier 2 method is used. In general, the GHG emissions are calculated by multiplying the waste quantity incinerated by emission factors. For crematoria, the GHG emissions are calculated by multiplying the number of cremations by emission factors.

For sewage sludge incineration plants the respective waste quantities are based on reliable statistical data and the emission factors are taking into account different flue gas cleaning standards.

For hospital waste incineration, illegal waste incineration and incineration of insulation material, the waste quantities used are based on rough expert estimates.

8.4.2.2 Emission Factors

Emission factors for CO_2, CH_4, N_2O, CO, NMVOC and SO_2 are country specific based on measurements and expert estimates, documented in the EMIS 2012/6C database. In the years with no specific data for the emission factors the respective data are interpolated.

The following table presents the emission factors used in 6C:

Table 8-13 Emission Factors for 6C “Waste Incineration” in 2010 (source EMIS 2012/6C, several EMIS comments see Table 8-11).

6C Waste Incineration							
Source	**CO_2** t/t	**CH_4** kg/t	**N_2O** g/t	**NO_x** kg/t	**CO** kg/t	**NMVOC** kg/t	**SO_2** kg/t
Hospital waste incineration	0.9	0	60	1.5	1.4	0.3	1.3
Illegal waste incineration	0.51	6	150	2.5	50.0	16	0.75
Insulation material cables	1.3	0	0	1.3	2.5	0.5	6
Sewage sludge plants	0	0.08	800	0.7	0.15	0.0039	0.31
	CO_2 t/crem.	**CH_4** kg/crem.	**N_2O** g/crem.	**NO_x** kg/crem.	**CO** kg/crem.	**NMVOC** kg/crem.	**SO_2** kg/crem.
Crematoria	0	0	0	0.21	0.19	0.015	0

Additional information on the emission factor CO_2:

For all waste incineration options the CO_2 emissions only from non-biodegradable waste are taken into account.

- Hospital waste incineration plants: Mainly waste of fossil origin. Default value for the CO_2 emission factor taken from CORINAIR (1992).

- Illegal waste incineration: The main source of non-biodegradable CO_2 emissions is plastic. It is assumed that the waste mix is the same as it was for municipal solid waste incineration in previous submissions, i.e. 40% of the waste mix is of fossil origin.
- Insulation materials: The CO_2 emission factor is based on measurements of the flue gas quantity and the assumption, that the ratio CO_2/O_2 is the same as in municipal solid waste incineration plants.
- Sewage sludge plants: Sewage sludge is biodegradable waste. Emission factor for CO_2 is 0. It is assumed that the share of fossil fuel used during the start-ups is negligible.

Additional information on other emission factors:

- Sewage sludge plants: Gradual technical improvements lead to reductions in NMVOC, CO, SO_2 and CH_4 emissions. The emission factors of 2010 were calculated by linearly interpolating estimations for 2008 and 2020 respectively (see EMIS 2012 6C 2 Klärschlammverbrennung).
- A new EF for N_2O of 150g/t for illegal waste incineration is used in this year's submission (IPCC 2006).
- Crematoria: NMVOC and CO emissions were reduced by technical improvements. Emission factors therefore depend on the number of technically improved crematoria. The emission factors of 2010 were calculated by linearly extrapolating estimations for 2008 by taking into account an increase in the number of technically improved crematoria (see EMIS 2012 6C Krematorien).

8.4.2.3 Activity Data

The activity data for Waste Incineration (6C) are the quantities of waste incinerated.

Table 8-14 Activity data for the different emission sources within source category 6C "Waste Incineration".

Source/Parameter	Unit	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Hospital Waste Incineration	Gg	30.0	27.5	25.0	22.5	20.0	17.5	15.0	12.5	10.0	7.5
Illegal waste	Gg	32.3	31.7	31.0	29.7	27.3	26.2	25.0	24.6	24.2	25.1
Insulation material cables	Gg	7.5	6.0	4.5	3.0	1.5	0.0	0.0	0.0	0.0	0.0
Sewage sludge	Gg dry	57.0	53.9	50.7	47.6	44.4	50.2	56.0	59.6	63.2	63.8
Total	Gg	126.8	119.1	111.2	102.8	93.2	93.9	96.0	96.7	97.4	96.4
Cremations	Numb.	37'513	37'407	37'939	38'884	39'620	40'968	41'932	43'468	43'456	44'180

Source/Parameter	Unit	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Hospital Waste Incineration	Gg	5.0	2.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Illegal waste	Gg	24.9	24.1	23.8	22.9	22.3	21.7	22.6	22.1	22.4	20.7
Insulation material cables	Gg	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Sewage sludge	Gg dry	64.3	70.2	76.0	86.5	97.0	94.9	92.7	94.7	96.6	98.6
Total	Gg	94.2	96.8	99.8	109.4	119.3	116.6	115.3	116.8	119.0	119.3
Cremations	Numb.	44'821	45'681	45'979	47'488	46'128	48'169	48'083	49'413	50'885	51'273

Source/Parameter	Unit	2010
Hospital Waste Incineration	Gg	0.0
Illegal waste	Gg	21.0
Insulation material cables	Gg	0.0
Sewage sludge	Gg dry	100.5
Total	Gg	121.5
Cremations	Numb.	51'662

Note: Since 2002, all special hospital waste incinerator plants have been closed and hospital waste is incinerated in municipal solid waste incineration plants (accounted for in 1A1).

8.4.3 Uncertainties and Time-Series Consistency

8.4.3.1 Qualitative estimate of uncertainties of (non-key source) emissions in 6C

A preliminary uncertainty assessment based on expert judgment results in high uncertainty for CO_2 und CH_4 and low uncertainty for N_2O of emissions estimates.

The time series is consistent.

8.4.4 Source-Specific QA/QC and Verification

In addition to the general QA/QC measures described in Section 1.6 the activity data and emission factors were verified.

The time series have been compared between the current and the previous submission. All activity data, implied emission factors and emissions undergo the triple check.

- the results for 2010 are compared with the results 2009 within the current CRF
- the CRF tables for the year 2009 are compared between the current CRF tables and the CRF tables of submission 2011.
- the CRF tables for the base year 1990 are compared between the current CRF tables and the CRF tables of submission 2011.

8.4.5 Source-Specific Recalculations

For illegal waste incineration, the new EF for N_2O of 150 g/t (IPCC 2006) has led to recalculations for the whole time series 1990 - 2009.

Estimations of AD for illegal waste quantities have been improved. It is calculated to be a decreasing fraction (1% in 1990 - 0.25% in 2035) of total waste quantities (burnable and construction waste). This has led to recalculations for the whole time series 1990 – 2009.

8.4.6 Source-Specific Planned Improvements

The share of fossil and organic carbon in the illegally burnt waste will be revised based on the results of the continuation of the FOCAWIN study (fossil carbon dioxide emission from waste incineration facilities) by EMPA (Mohn 2011). Therefore in the next submission a recalculation will take place for illegal waste incineration.

8.5 Source Category 6D – Other Waste

8.5.1 Source Category Description

Key category 6D
CH_4 from composting and digesting organic waste (trend)

The source category 6D “Other Waste” comprises the GHG emissions from car shredding plants, and the process related GHG emissions from composting and from digesting organic waste.

Within the composting activity four types of composting means are distinguished, i.e. i) hall composting, ii) field edge composting, iii) box composting and iv) windrow composting. Composting covers the GHG emissions from centralized composting plants with a capacity of more than 100 tons of organic matter/year. Backyard composting is also common practice in Switzerland. It is assumed that the quantities treated in small composting facilities such as gardens, backyards etc., add up to 10% of those treated in industrial composting plants (EMIS 2012 6D Kompostierung Industrie).

The digestion of organic waste takes places under anaerobic conditions. The digested matter (solid left-overs after completion of a process of anaerobic microbial degradation of organic matter) is being composted. The biogas generated during the fermentation is used as fuel in co-generation plants or upgraded and used as fuel for cars. In 6D “Other Waste” the emissions from the composting of the digested matter as well as the methane losses due to biogas up-grading are included. The emissions from the biogas use in co-generation plants and as fuel for transportation are reported under the energy sector.

Table 8-15 Specification of source category 6D “Other Waste”.

6	Source	Specification	Data Source
6D	Car shredding plants	Emissions from car shredding plants	AD, EF: EMIS 2012/6D Shredder Anlagen
6D	Composting and digesting	Process related emissions from composting and digesting organic waste	AD, EF: EMIS 2012/6D Kompostierung Industrie, EMIS 2012/1A1a und 6D Vergärung IG und EMIS 2012/1A1a und 6D Vergärung LW

8.5.2 Methodological Issues

8.5.2.1 Methodology

For the emissions from car shredding a country specific method is used. The GHG emissions are calculated by multiplying the quantity of scrap by the emission factors. For all years the same constant emission factors have been applied.

For the emissions from composting a country specific method is used. The GHG emissions are calculated by multiplying the quantity of waste by the emission factors. For all years the same constant emission factors have been applied.

For the emissions from digesting a country specific method is used. Digestion plants lead to GHG emissions from the storage of fermentable waste, losses due to leakages and diffusion, power water (storage of liquid fermented waste), rotting (storage of solid fermented waste) and flaring. The GHG emissions are calculated by multiplying the quantity of fermented waste by the emission factors. For all years the same constant emission factors have been applied. In addition, the methane emissions from biogas up-grading are calculated by multiplying the biogas quantity up-graded by the percentage of methane losses.

Because of the increase in composting and digesting organic waste the source category 6D “Other Waste” is a key source regarding trend.

8.5.2.2 Emission Factors

Emission factors for car shredding, composting and digestion are country specific based on measurements and expert estimates, documented in the EMIS 2012/6D database.

The following table presents the emission factors used in 6D:

Table 8-16 Emission Factors for 6D Others in 2010.

Source	Unit	CH_4	N_2O	NO_x	CO	NMVOC	SO_2
Shredding	g/t scrap				5	200	
Composting	g/t composted waste	5'000	70			1'700	
Fermentation (industrial, storage)	g/t fermentable waste	100	12			70	
Fermentation (industrial, losses)	g/t biogas	426'903					
Fermentation (industrial, power water)	g/t fermented waste (liquid)	2'000	2			400	
Fermentation (industrial, rotting)	g/t fermented waste (solid)	1'100	98			230	
Fermentation (industrial, flaring)	g/t CH4	45		4'066	2'054	82	616
Fermentation (agricultural, losses)	g/t biogas	482					
Fermentation (agricultural, rotting)	g/t fermented waste (solid)	1'100	98			230	
Fermentation (agricultural, flaring)	g/t CH4	246		4'066	2'054	82	616
Biogas up-grade	g/GJ	1.0063					

The revision of the EMIS database has led to several new and revised EF for the fermentation process deduced for both agricultural and industrial biogas plants, whereas in previous submissions, only one EF for CH_4, N_2O and NMVOC has been accounted for. The fermentation process has been split into different activities for industrial and agricultural biogas plants, respectively. These are following activities: storage of fermentable waste, losses due to leakages and diffusion, power water (storage of liquid fermented waste), rotting (storage of solid fermented waste) and flaring. For agricultural plants, no EF factors could be found for the storage of fermentable waste and storage of the liquid fermented waste. For each activity, new AD and EF have been reported, based on the newest data available. However, uncertainties are relatively high.

The NMVOC emissions from car shredding stem from residues of fuels in the tanks of shredded cars (EMIS 2012/6D Shredder). For emission factors of NMVOC constant values are used since 2005 (see EMIS 2012/6D Shredder Anlagen).

It is assumed that CH_4 emissions of biogas–upgrading, which occur due to leakage, can be reduced from 5 % of the total biogas production (value for 1990 – 2007) to 2.5% in the year 2020/2035 due to technical improvements. In between, the EF factor has been linearly extrapolated, resulting in a current EF of 1.0063 g/GJ.

Emissions from composting encompass CO_2, CH_4 NH_3, N_2O and NMVOC and are based on measured or estimated values reported in literature.

8.5.2.3 Activity data

Activity data for shredding and composting are extracted from EMIS 2012/6D Shredder Anlagen and Kompostierung Industrie. Activity data of fermentation are extracted from EMIS 2012/1A1a und 6D Vergärung IG und EMIS 2012/1A1a und 6D Vergärung LW.

Activity data for composting are generally based on reliable statistical data. The quantities for backyard composting are estimated values, i.e. 10% of the amount of waste from composting plants.

Activity data of fermentation are based on information provided by biogas plants (see EMIS 2012/1A1a und 6D Vergärung IG und EMIS 2012/1A1a und 6D Vergärung LW) and encompass activity data of all relevant processes, e.g. storage of fermentable waste, losses due to leakages and diffusion, power water (storage of liquid fermented waste), rotting (storage of solid fermented waste) and flaring.

The biogas used as fuel for co-generation units is reported under 1 A 1 “Energy” in accordance to the IPCC Good Practice Guide.

Table 8-17 Activity data in 6D Other Waste.

Source/Parameter	Unit	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Shredding	Gg	280	284	288	292	296	300	300	300	300	300
Composting	Gg	260	300	320	350	370	400	450	480	500	510
Fermentation (ind., fermentable waste)	Gg	0	0	9	9	17	27	26	33	40	51
Fermentation (ind., biogas)	Gg	0.00	0.00	0.00	0.01	0.01	0.02	0.03	0.04	0.05	0.06
Fermentation (ind., fermented waste liquid)	Gg	0	0	3	3	6	9	9	11	14	17
Fermentation (ind., fermented waste solid)	Gg	0	0	5	5	10	15	15	18	22	28
Fermentation (ind., CH4)	Gg	0.00	0.00	0.01	0.01	0.02	0.03	0.05	0.06	0.08	0.09
Fermentation (agr., biogas)	Gg	0.28	0.28	0.27	0.26	0.25	0.23	0.22	0.21	0.22	0.25
Fermentation (agr., fermented waste solid)	Gg	6	6	6	5	5	5	5	5	5	5
Fermentation (agr., CH4)	Gg	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Biogas up-grade	GJ	0	0	0	0	0	0	0	3'084	5'722	8'526

Source/Parameter	Unit	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Shredding	Gg	300	300	300	300	300	300	300	300	300	300
Composting	Gg	640	650	730	732	733	735	737	739	759	779
Fermentation (ind., fermentable waste)	Gg	66	79	94	91	111	133	160	189	216	266
Fermentation (ind., biogas)	Gg	0.08	0.09	0.11	0.11	0.13	0.16	0.18	0.21	0.23	0.27
Fermentation (ind., fermented waste liquid)	Gg	22	27	32	31	38	45	55	65	74	91
Fermentation (ind., fermented waste solid)	Gg	37	44	52	51	62	74	89	105	120	148
Fermentation (ind., CH4)	Gg	0.11	0.13	0.17	0.16	0.19	0.23	0.28	0.33	0.38	0.47
Fermentation (agr., biogas)	Gg	0.28	0.31	0.34	0.38	0.45	0.60	0.78	1.02	1.03	0.82
Fermentation (agr., fermented waste solid)	Gg	6	6	7	8	9	12	18	27	34	34
Fermentation (agr., CH4)	Gg	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Biogas up-grade	GJ	20'160	25'617	20'956	23'267	33'385	41'381	42'632	52'181	73'137	86'855

Source/Parameter	Unit	2010
Shredding	Gg	300
Composting	Gg	799
Fermentation (ind., fermentable waste)	Gg	278
Fermentation (ind., biogas)	Gg	0.27
Fermentation (ind., fermented waste liquid)	Gg	95
Fermentation (ind., fermented waste solid)	Gg	155
Fermentation (ind., CH4)	Gg	0.49
Fermentation (agr., biogas)	Gg	0.42
Fermentation (agr., fermented waste solid)	Gg	33
Fermentation (agr., CH4)	Gg	0.09
Biogas up-grade	GJ	124'300

8.5.3 Uncertainties and Time-Series Consistency

8.5.3.1 Uncertainty in CH_4 emissions from composting and digestion 6D

The uncertainty of the CH_4 emissions in Category 6D from composting and digesting of organic waste is estimated to be 100% (expert estimate). The uncertainty of the related activity data is estimated to be 10% (expert estimate), because waste statistics are rather reliable.

8.5.3.2 Qualitative estimate of uncertainties of non-key source emissions in 6D

A preliminary uncertainty assessment based on expert judgment results in medium confidence in emissions estimates.

The time series is consistent.

8.5.4 Source-Specific QA/QC and Verification

In addition to the general QA/QC measures described in Section 1.6 subsequent source-specific activities have been carried out:

- Cross check of activity data in EMIS Commentaries.
- Verification of NMVOC emission factor for car shredding. The time series have been compared between the current and the previous submission. All activity data, implied emission factors and emissions undergo the triple check.
  - the results for 2010 are compared with the results 2009 within the current CRF

- the CRF tables for the year 2009 are compared between the current CRF tables and the CRF tables of submission 2011.
- the CRF tables for the base year 1990 are compared between the current CRF tables and the CRF tables of submission 2011.

8.5.5 Source-Specific Recalculations

The fermentation process has been revised and was separated into various sub-processes. Recalculations were made for all relevant processes occurring in agricultural and industrial biogas plants.

For car shredding constant NMVOC emission factors since 2005 were assumed as defined in EMIS 2012/6D Shredder Anlagen.

8.5.6 Source-Specific Planned Improvements

The activity data for backyard composting are based on rough estimates. For further submissions more reliable data will be sought.

The EF for CH_4 and CO_2 biogenic will be corrected. For agricultural plants wrong values have been imported into the database. They should be the same as for industrial biogas plants. This will result in recalculations for the whole time series 1990-2010.

9 Other

9.1 Overview

9.1.1 Greenhouse Gas Emissions

Within the sector 7 “Other” emissions from various sources are considered:

- Fire damage estates,
- Fire damage motor vehicles

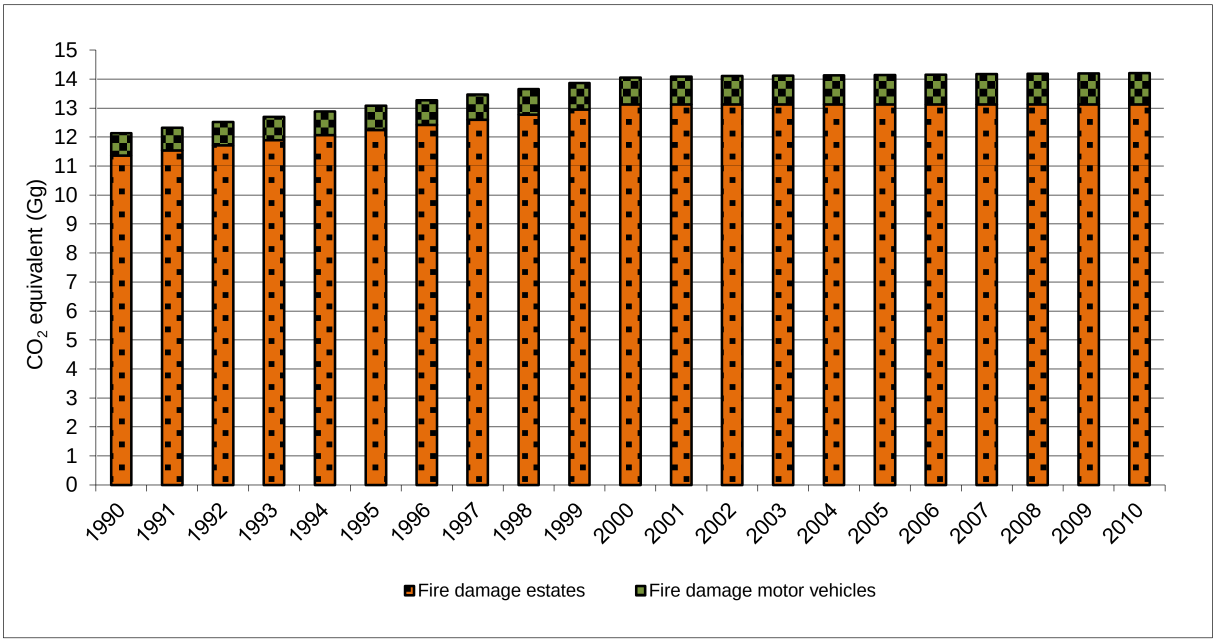

Figure 9-1 Switzerland’s greenhouse gas emissions in the sector 7 “Other” 1990–2010.

Table 9-1 Trend of total GHG emissions from 7 “Other” in Switzerland 1990-2010.

Gas	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
	CO_2 equivalent (Gg)									
CO_2	11.0	11.2	11.3	11.5	11.7	11.9	12.1	12.3	12.5	12.7
CH_4	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6
N_2O	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6
Sum	12.1	12.3	12.5	12.7	12.9	13.1	13.3	13.5	13.7	13.9

Gas	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
	CO2 equivalent (Gg)									
CO_2	12.9	12.9	12.9	12.9	12.9	13.0	13.0	13.0	13.0	13.0
CH_4	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6
N_2O	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6
Sum	14.1	14.1	14.1	14.1	14.1	14.1	14.2	14.2	14.2	14.2

Gas	2010
	CO_2 eq. (Gg)
CO_2	13.0
CH_4	0.6
N_2O	0.6
Sum	14.2

In the sector “Other” a total of 14.2 Gg CO_2 equivalents was emitted in the year 2010. 91.9% of the emissions stem from “fire damage estates”, the rest from “fire damage motor vehicles”. The total greenhouse gas emissions of this sector show an increase of 17.1% from 1990 until 2010.

9.2 Source Category – Other non-specified

9.2.1 Source Category Description

Tier 2 key category 7
Source category 7 “Other”is **not a key category**.

The sources reported in 7 “Other” are depicted in Table 9-2.

Table 9-2 Specification of source category 7 “Other non-specified”

7	Source	Specification	Data Source
7 D	Fire damage estates	Emissions from fires in buildings.	EMIS 2012/7D “Brand- und Feuerschäden Immobilien”
7 D	Fire damage motor vehicles	Emissions from fires and fire damage in motor vehicles.	EMIS 2012/7D “Brand- und Feuerschäden Motorfahrzeuge”

9.2.2 Methodological Issues: Fire damage estates and motor vehicles

9.2.2.1 Methodology

Fire damage estate

Based on average damage sums from insurances between 1992 and 2001, the average damage sum per fire case is estimated to be 15’600 CHF representing 780 kg of flammable material per fire case. Further assuming that not the whole amount burns down due to the intervention of the fire brigade, an amount of 400kg of burnt material per fire case is estimated. On average between 1992 and 2001, 20’650 cases of fire incidents happened each year. For emission calculation, a constant number of yearly 20’000 fire cases is assumed (EMIS 2012/7D “Brand- und Feuerschäden Immobilien”).

Fire damage motor vehicles

Based on data from a Swiss insurance company with 25% market share in 2002, the number of reported vehicle fires was extrapolated to 100%. Based on this estimate and the total vehicle number of Switzerland it was estimated that one fire case per 790 vehicles occurs per year and this was assumed to remain constant from 1990-2010. Multiplied with the actual vehicle number, the number of burnt vehicles in Switzerland per year is obtained (EMIS 2012/7D “Brand- und Feuerschäden Motorfahrzeuge”).

9.2.2.2 Emission Factors

Fire damages

Fire damages in estates*:* Emission factors for CO_2, CO, NO_x and SO_2 are country specific based on measurements and expert estimates originally completed for illegal waste incineration. It is assumed that emissions are similar to emissions of fire damage in estates (EMIS 2012/7D “Brand- und Feuerschäden Immobilien”).

In this submission, emissions for CH_4 and N_2O are reported for the first time.

The fraction between fossil and biogenic CO_2 emissions is assumed to remain constant since 2000 with 80% being fossil and 20% biogenic CO_2 emissions. Before 2000, it is assumed that the fraction of fossil CO_2 emissions from burnt goods has been increasing linearly from 20% in 1950 to 80% in 2000.

Fire damages in motor vehicles: Emission factors for CO_2, CO, NO_x and SO_2 are country specific values based on measurements and expert estimates originally gained from the combustion of cables, documented in EMIS 2012/7D “Brand- und Feuerschäden Motorfahrzeuge”.

In this submission, emissions for CH_4 from fire damage in motor vehicles are reported for the first time. N_2O emissions however have not been estimated for this source.

Table 9-3 Emission Factors for fire damages in 2009 (EMIS 2012/7D).

Source 7 Other	CO_2 biogenic	CO_2 fossil	CH_4	N_2O	NO_x	CO	NMVOC	SO_2
	t / t burned good							
Fire damage estates	0.40	1.5	0.003	0.00025	0.0020	0.100	0.016	0.001
Fire damage motor vehicles	NO	1.5	0.005	NE	0.0013	0.002	0.002	0.005

9.2.2.3 Activity data

Fire damages

Activity data is the weight of burnt goods, calculated according to the following rule of proportion: 400 kg of burnt goods per incidence of fire cases in estates (EMIS 2012/7D “Brand- und Feuerschäden Immobilien”) and 100 kg of burnt goods per incidence of burnt vehicles (EMIS 2012/7D “Brand- und Feuerschäden Motorfahrzeuge”).

Table 9-4 Activity data: Burnt goods from 1990 to 2010 (source EMIS 2012/7D).

Source / Parameter	Unit	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Fire damage estates	Gg	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0
Fire damage motor vehicles	Gg	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.6	0.6

Source / Parameter	Unit	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Fire damage estates	Gg	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0
Fire damage motor vehicles	Gg	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.7	0.7	0.7

Source / Parameter	Unit	2010
Fire damage estates	Gg	8.0
Fire damage motor vehicles	Gg	0.7

9.2.3 Uncertainties and Time Series consistency

Uncertainty of CO_2, CH_4 and N_2O emissions is estimated to be high (according to Table 1-13 it is set to 40%).

Source-Specific QA/QC and Verification In addition to the general QA/QC measures described in Section 1.6 subsequent source-specific activities have been carried out:

- Cross check of activity data in EMIS Commentaries.

- Verification of NMVOC emission factor for car shredding. The time series have been compared between the current and the previous submission. All activity data, implied emission factors and emissions undergo the triple check.
  - the results for 2010 are compared with the results 2009 within the current CRF
  - the CRF tables for the year 2009 are compared between the current CRF tables and the CRF tables of submission 2011.
  - the CRF tables for the base year 1990 are compared between the current CRF tables and the CRF tables of submission 2011.

9.2.4 Source-Specific Recalculations

According to UNFCCC 2011 (ARR 2010, para 114), CH_4 and N_2O emissions from fire damages are newly reported.

The reallocation of indirect CO_2 emissions from decomposition of NMVOC in the atmosphere that was reported in Submission 2011 (from NFR Sector 3 to 7 “Other”) has been undone in the review process. The recalculation took place in the Saturday Paper (see Chapter 16) and is therefore not a recalculation of Submission 2012.

9.2.5 Source-Specific Planned Improvements

Due to a data error, N_2O emissions from private use of fertilizers are double counted , i.e. they are reported correctly in the CRF in sector 4D as well as wrongly in sector 7. Thus, in this chapter, N_2O emissions are not reported. In the emission totals of the overview tables in this NIR they are reported contrariwise in order to be consistent with CRF totals.

For the next submission the error will be corrected and the emissions depicted in Table 9-5 will not be reported under sector 7 „Other“. Consequently, the Swiss national emission total of the whole time-series will decrease by the corresponding amount.

Table 9-5 N_2O emissions from private use of fertilizers 1990-2010.

Source	**1990**	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**
	N_2O (Gg)									
Urea and other synthetic fertilizers (private use)	0.052	0.053	0.052	0.049	0.046	0.046	0.044	0.038	0.039	0.040

Source	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**
	N_2O (Gg)									
Urea and other synthetic fertilizers (private use)	0.040	0.043	0.042	0.040	0.040	0.040	0.039	0.041	0.038	0.036

Source	**2010**
	N_2O (Gg)
Urea and other synthetic fertilizers (private use)	0.042

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10 Recalculations

10.1 Explanations and Justifications for Recalculation

10.1.1 GHG Inventory

The Inventory Development Plan (IDP, see in FOEN 2012a) is regularly updated, mainly based on the various "Reports of the individual review of the greenhouse gas inventory of Switzerland" (e.g. UNFCCC 2010, 2011, 2012) and the outcome of domestic reviews. The IDP represents the main instrument for continuous improvement of the Swiss GHG inventory in subsequent inventory cycles. It includes suggestions and recommendations for recalculations that have an impact on emission levels in the corresponding sectors.

The processing of the expert review team's recommendations in the course of inventory preparation and compilation led to several recalculations (see also Table 1-12). Further recalculations had to be carried out due to improvements in some sectors. The details are explained below. An extensive list with all detailed recalculations and specifics of the recalculations is compiled by the EMIS experts and available to the reviewers (in German/French only).

1 Energy

- 1A: The activity data of all fuels of the overall time series has been recalculated based on the new data from SFOE 2011. See Chapter 3.2.6.5.
- 1A: The activity data of wood consumption has been recalculated for the overall time series based on the new data from SFOE 2011b. See Chapter 3.2.6.5.
- 1A: Marine Bunkers from navigation on international Swiss lakes are reported for the first time with this submission. This is documented in chapter 3.2.2.
- 1A1: The double-counting of the energy from waste incineration has been eliminated. In previous submissions, the activity data (TJ) of waste incineration was counted in category 1A1a Biomass and 1A1a Other Fuels. Now, the activity data is split between 1A1a Biomass and 1A1a Other fuels according to the fossil/biogenic fraction of the waste. This also implicates a change in the implied emission factors of these categories. See Chapter 3.2.6.5.
- 1A1:The share of fossil and organic matter in the municipal solid waste has been revised based on results of the continuation of the FOCAWIN study (fossil carbon dioxide emission from waste incineration facilities) by EMPA (Mohn 2011). The share of fossil matter in municipal waste in 2011 has been measured to be 47.8% on average. The value derived in 2002 was 40%. In between 2002 and 2011, the values have been linearly interpolated. This results in a corresponding change of emission factors of fossil and biogenic carbon and recalculations for the emission for the years 2003 – 2009 (see also 6A). See Chapter 3.2.6.5.
- 1A1: New process description for biogas installations led to a recalculation in the activity data and emission factors for the whole time series of biomass emissions. See Chapter 3.2.6.5.
- 1A1: Activity data of incineration plants have been recalculated based on the correction of the calorific value of waste. See Chapter 3.2.6.5.
- 1A1: Biomass consumption is now consistently reported in Table 3-14 and CRF. See Chapter 3.2.6.5.
- 1A2: Country-specific CO_2-emission factors for bituminous coal and lignite have been determined by measurements commissioned by cemsuisse. In previous submissions, a

mixed emission factor based on other countries default values has been applied. The emission factors for brown coal and bituminous coal have been separated accordingly. The emission factor for bituminous coal from changed from 94 to 92.7 t/TJ and for brown coal from 104 to 96.1 t/TJ. See Chapter 3.2.7.5.

- 1A2fi: A country-specific emission factor for petroleum coke (1A2fi) has been adopted, changing the value from 94 to 91.4 t/TJ based on the measurements commissioned by cemsuisse. See Chapter Chapter 3.2.7.5.
- 1A2fi: Country-specific CO_2 emission factors for alternative fuels used in cement production (1A2fi) have been derived based on measurements commissioned by cemsuisse. The N_2O emission factor has not been measured, so the default factor is used. See Chapter 3.2.7.5.
- 1A2fi: The activity data and emission factors for CO_2, CH_4 and N_2O of glass production was recalculated based on a correction of the previously counted liquid petroleum gas as natural gas instead of fuel oil.
- 1A3b: following the update of the road traffic model in the last submission, a modification in the activity data calculation steps leads to a recalculation of the activity data for all GHG gases for the whole time series and all fuels. See Chapter 3.2.8.5
- 1A3b: due to a correction of an error in data aggregation, activity data for all GHG gases related to the combustion of Biogas was recalculated for the year 2009. See Chapter 3.2.8.5
- 1A3b: activity data for all GHG gases related to the combustion of gaseous fuels was recalculated for the years 2007-2009 due to changes in the Swiss Overall Energy Statistic (SFOE 2011). This affected primarily use of gaseous fuels in tank tourism. See Chapter 3.2.8.5.

2 Industrial Processes

- 2A1: Activity data for clinker and cement production of 2009 which were preliminary interpolated values in last year’s submission have been replaced by official production data. See Chapter 4.2.5.
- 2A5: Until the last submission also CH4 emissions had been reported from the production of asphalt roofing materials. According to the Revised 1996 IPCC guidelines (IPCC 1996) no CH4 emissions are released during the production process and therefore they are deleted in the current submission. See Chapter 4.2.5.
- 2A7: There has been an adjustment of the AD for glass wool production for the year 2006 due to an output correction of one plant. The cullet ratio for glass wool production has been adjusted for the whole time series according to new information from the plants. See Chapter 4.2.5.
- 2B4: Recalculations have been made due to more precise production data for the years 1997 to 2009. See Chapter 4.3.5.
- 2B5: Recalculations were made due to more precise activity data for the years 1991 to 2009. See Chapter 4.3.5.
- 2C5: Recalculations were made for source category 2C5 Battery Recycling for the years 2000-2005 and 2007-2009 as additional annual activity data was available from industry for the years 2000, 2003, 2004 and 2007-2009. See Chapter 4.4.5.
- 2F: For the various recalculations in source category 2F see Chapter 4.7.5 Table 4-31.
- 2G: Due to changes in data for crude oil handling in Switzerland activity data for Claus units has been adapted for the years 1990-2009. See Chapter 4.8.5.

3 Solvent and Other Product Use

- 3: The indirect CO_2 emissions due to the decomposition of NMVOC in the atmosphere were shifted back from sector 7 into sector 3.
- 3D: A new emission factors for domestic solvent use was available for 2010 (small change only). Due to interpolation of data also the values for 2008 and 2009 underwent a slight change. See Chapter 5.5.5.
- 3D: Activity data was corrected for the year 2006 for glass wool impregnation. See Chapter 5.5.5.

4 Agriculture

- 4A/4B/4D: Livestock population data time-series consistency was improved (ART/SHL 2012) (see Chapter 6.2.5, 6.3.5, 6.5.5)
- 4A/4B/4D: Activity data for non-agricultural horses & mules and asses are newly reported (see Chapter 6.2.5, 6.3.5, 6.5.5)
- A general recalculation for the years 2008 - 2009 due to some data updates by the Swiss Farmers Union (SBV2011) took place (see Chapter 6.2.5, 6.3.5, 6.5.5)

5 Land Use, Land-Use change and Forestry

- 5: The increment of available AREA activity data (see Chapter 7.2.2.1, SFSO 2011) has led to a recalculation in category 5 LULUCF.
- 5: The geographic delineation of organic soils has been improved by including the Inventory of Raised Bogs (see Chapter 7.2.3.1). This leads to larger areas of drained organic soils.
- 5A: The use of weighting factors (W factors) has been abandoned except for soil organic carbon if a land-use change involves ”buildings and constructions” (CC51; see Chapter 7.1.3.2).
- 5A: The values for gross growth of productive forests for the years 1995 and 1996 have been recalculated (correction of calculation errors; Table 7-5).
- 5A: Recalculated values for carbon stock and yearly changes in the dead wood pool are reported (Table 7-23).
- 5A: Minor revisions (correction of calculation errors) were made with respect to carbon stocks in living biomass (2006–2009).
- 5A: Emissions from organic soils under forest land are reported. A default emission factor of 0.68 t C ha^{-1} yr^{-1} is used. So far, it was assumed that forest land on organic soils is not drained, which was not correct in all cases (see Chapter 7.3.4.9).
- 5B: Annual values of carbon stock in living biomass are used instead of a constant mean value.
- 5C: The root biomass of grassland was recalculated following new field observation results. It was now possible to calculate different root biomass values for each altitude belt. So far, a constant value was used for all altitudes.
- 5C: Emissions from organic soils are reported for all grassland types, i.e. also for the weakly managed combination categories CC32, CC34, CC36 and CC37 (-5.30 t C ha^{-1} yr^{-1}). So far, only emissions from CC31, CC33 and CC35 were reported.

- 5D: The carbon stock of living biomass for unproductive wetland was recalculated (6.50 t C ha^{-1} yr^{-1}) based on Mathys and Thürig (2010). So far, a rough estimate based on “tags” of the AREA survey had been used (8.5 t C ha^{-1}).
- 5D: For unproductive wetland, new values for the soil carbon stocks are used: 68.23 t C ha^{-1} for mineral soils and 240 t C ha^{-1} for organic soils. So far, only one mean value was used for both soil types (154 t C ha^{-1}), which was not entirely consistent with the concept of spatial stratification described in Chapter 7.2.3.1.
- 5D: Emissions from organic soils under unproductive wetland are reported with a country-specific emission factor of 5.30 t C ha^{-1} yr^{-1}.
- 5E/F: For Buildings and Constructions (CC51) and Other Land (CC61) situated on organic soils, a soil carbon content of 0 t C ha^{-1} is used. In former submissions this value was 240 t C ha^{-1}.

6 Waste

- 6A: The share of fossil and organic matter in the municipal solid waste has been revised based on results of the continuation of the FOCAWIN study (fossil carbon dioxide emission from waste incineration facilities) by EMPA (Mohn 2011). The share of fossil matter in municipal waste in 2011 has been measured to be 47.8% on average. The value derived in 2002 was 40%. In between 2002 and 2011, the values have been linearly interpolated. This results in a corresponding change of emission factors of fossil and biogenic carbon and recalculations for the emission for the years 2003 – 2009 (see also 1A1). See Chapter 8.2.5.
- 6B: N_2O emission were recalculated for the whole time series using year-specific values for protein consumption according to the numbers provided by the Swiss Farmer’s Union (SBV 2011b). See Chapter 8.3.5.
- 6B: AD of sewage gas treatment has changed for the years 2008 and 2009, according to SFOE 2011a. This results in changed EF for CH_4 and recalculations of CH_4 emissions for both years. See Chapter 8.3.5.
- 6C: For illegal waste incineration, the new EF for N_2O of 150g/t (IPCC 2006) has led to recalculations for the whole time series 1990- 2009. See Chapter 8.4.5.
- 6D: The fermentation process has been revised and has been separated into various sub-processes. Recalculations were made for all relevant processes occurring in agricultural and industrial biogas plants for the whole time series 1990-2009. See Chapter 8.5.5.
- 6D: For car shredding constant NMVOC emission factors since 2005 were assumed as defined in EMIS 2012/6D Shredder Anlagen. This led to recalculations for the years 2005-2009. See Chapter 8.5.5.

7 Other

- Emissions for CH_4 and N_2O are newly reported for fire damages estates and for CH_4 for fire damages motor vehicles (see Chapter 9.2.5.)
- The indirect CO_2 emissions due to the decomposition of NMVOC in the atmosphere were shifted from Chapter 9 to Chapter 5 (see Chapter 9.2.5., 5.2.5., 5.3.5, 5.4.5).

10.1.2 KP- LULUCF Inventory

A recalculation of the years 2008 and 2009 was carried out. The methodological improvements are described in detail in Chapter 11.3.1.4 (Kyoto specific recalculations) and Chapter 7.3.7 (Recalculations LULUCF Forest Land).

- The increment of available AREA activity data (see Chapter 7.2.2.1, SFSO 2011) has led to a recalculation of all areas reported under Art. 3.3 and Art 3.4 Forest Management.
- Following the recommendations of the in-country Review of the LULUCF-sector (vTI 2011), the application of weighting factors has been simplified. For all areas, the weighting factors for living biomass W_l, dead organic matter W_d and soil carbon W_s are 1 except for Ws=0.5 in the case of a conversion where “buildings and constructions” are involved (see 7.1.3.2). Consequently, the conversion time for all land-use changes is now 20 years.
- The values for gross growth of productive forests for the years 1995 and 1996 have been recalculated (Table 7-5). In the previous submission (FOEN 2011), these values were not averaged over a 3-year period. This change has also an implication on the values of growing stock for the period 1990-1996. Updated values of growing stock are listed in Table 7-5.
- Productive forests CC12: dead wood stock and temporal changes in dead wood stock, values for gross growth 1995 and 1996 and values for growing stock 1990-1996 and 2006-2009 were recalculated (see Table 7-5). Recalculated values are approximately 0.2% higher than in the previous submission.
- Following the recommendations of the in-country Review of the LULUCF-sector (vTI 2011), CO_2 emissions due to drainage of areas under Forest Management are reported (see Chapter 11.3.1.2). A default emission factor of 0.68 t C ha^{-1} yr^{-1} was used. So far, it was assumed that forest land on organic soils is not drained, which was not correct in all cases (see Chapter 7.3.4.9).

10.2 Implications for Emission Levels 1990 and 2009

10.2.1 GHG Inventory

Table 10-1 shows the recalculation results for the base year 1990. It results in a decrease of the total emissions in CO_2 equivalents (without emissions/removals from CO_2 from LULUCF) of 65.84 Gg CO_2 eq. This corresponds to a decrease of the latest submission compared to the previous submission (2011,v2.2) by 0.12% of the national total. If the LULUCF sector is included, there is a decrease of 1188.21 Gg CO_2 eq (2.36%) due to recalculations of the LULUCF sector.

Table 10-1 Overview of implications of recalculations on 1990 data. Emissions are shown before the recalculation according to the previous submission in 2011 "Prev." (FOEN 2011b) and after the recalculation according to the present submission "Latest". The differences "Differ." are defined as latest minus previous submission.

Recalculation		**CO_2**			**CH_4**			**N_2O**			**Sum (CO_2, CH_4 and N_2O)**	
Emissions for 1990	Prev.	Latest	Differ.	Prev.	Latest	Differ.	Prev.	Latest	Differ.	Prev.	Latest	Differ.
Source and Sink Categories	CO_2 equivalent (Gg)									CO_2 equivalent (Gg)		
1 Energy	41'206	41'136	-70.51	620.1	624.5	4.37	314.7	283.3	-31.38	42'141	42'043	-97.51
2 Ind. Processes (without syn. gases)	3'064	3'059	-4.63	10.0	9.6	-0.37	68.1	68.1	0.00	3'142	3'137	-5.00
3 Solvent and Other Product Use	358	362	4.28			0.00	110.1	110.1	0.00	468	472	4.28
4 Agriculture				3'341.2	3'339.3	-1.88	2'787.0	2'799.0	11.90	6'128	6'138	10.02
5 LULUCF	-2'745	-3'867	-1'122.4	8.2	8.2	0.00	11.4	11.4	-0.01	-2'725	-3'847	-1'122.37
6 Waste	62	63	1.24	727.1	724.5	-2.61	200.3	206.7	6.46	989	995	5.09
7 Other	11	11	0.00	NO	0.6		NO	16.7		11	28	17.27
Sum (without synthetic gases)	41'956	40'764	-1'192.0	4'707	4'707	-0.48	3'492	3'495	-13.02	50'154	48'966	-1'188.21

Recalculation		**HFC**			**PFC**			**SF6**			**Sum (synthetic gases)**	
Emissions for 1990	Prev.	Latest	Differ.	Prev.	Latest	Differ.	Prev.	Latest	Differ.	Prev.	Latest	Differ.
Source and Sink Categories	CO_2 equivalent (Gg)									CO_2 equivalent (Gg)		
2 Ind. Processes (only syn. gases)	0.02	0.02	0.00	100.2	100.2	0.00	143.6	143.6	0.00	243.85	243.85	0.00

Recalculation			**Sum (all gases)**	
Emissions for 1990		Prev.	Latest	Differ.
Source and Sink Categories		CO_2 equivalent (Gg)		
Total CO_2 eq Em. with LULUCF		**50'398**	**49'210**	**-1'188.21**
		100%	97.64%	-2.36%
Total CO_2 eq Em. without LULUCF		**53'123**	**53'057**	**-65.84**
		100%	99.88%	-0.12%

For 2009, the recalculation results in an increase of the total emissions in CO_2 equivalents (without emissions/removals from LULUCF) of 509.86 Gg CO_2 eq. This corresponds to an increase of the latest submission compared to the previous submission of 0.98% of the national total. If the LULUCF sector is included, a decrease of 677.50 Gg CO_2 eq. (1.30%) is found due to major recalculations in the LULUCF sector.

Table 10-2 Overview of implications of recalculations on 2009 data. Emissions are shown before the recalculation according to the previous submission in 2011 “Prev.” (FOEN 2011b) and after the recalculation according to the present submission “Latest”. The differences “Differ.” are defined as latest minus previous submission.

Recalculation	**CO_2**			**CH_4**			**N_2O**			**Sum (CO_2, CH_4 and N_2O)**		
Emissions for 2009	Prev.	Latest	Differ.	Prev.	Latest	Differ.	Prev.	Latest	Differ.	Prev.	Latest	Differ.
Source and Sink Categories	CO_2 equivalent (Gg)									CO_2 equivalent (Gg)		
1 Energy	41'688	41'900	211.78	268.5	269.5	1.02	298.7	320.8	22.17	42'256	42'491	234.97
2 Ind. Processes (without syn. gases)	2'084	2'171	86.83	8.4	7.9	-0.49	58.0	58.0	0.00	2'151	2'237	86.34
3 Solvent and Other Product Use	161	162	1.06			0.00	56.2	56.2	0.00	217	218	1.06
4 Agriculture			0.00	3'199	3'199	-0.25	2'431	2'438	7.31	5'630	5'637	7.06
5 LULUCF	84	-1'104	-1'187.41	0.3	0.3	0.00	4.4	4.4	0.05	89	-1'099	-1'187.37
6 Waste	15	11	-4.73	349.0	339.4	-9.64	249.9	257.8	7.88	614	608	-6.49
7 Other	13	13	0.00	NO	0.6		NO	11.9		13	25	12.45
Sum (without synthetic gases)	44'046	43'153	-892.47	3'825	3'816	-9.37	3'098	3'148	37.41	50'969	50'117	-851.98

Recalculation	**HFC**			**PFC**			**SF6**			**Sum (synthetic gases)**		
Emissions for 2009	Prev.	Latest	Differ.	Prev.	Latest	Differ.	Prev.	Latest	Differ.	Prev.	Latest	Differ.
Source and Sink Categories	CO_2 equivalent (Gg)									CO_2 equivalent (Gg)		
2 Ind. Processes (only syn. gases)	854.32	1'022.68	168.36	34.7	35.0	0.34	181.3	187.1	5.78	1'070.34	1'244.82	174.48

Recalculation		**Sum (all gases)**		
Emissions for 2009		Prev.	Latest	Differ.
Source and Sink Categories		CO_2 equivalent (Gg)		
Total CO_2 eq Em. with LULUCF		**52'040**	**51'362**	**-677.50**
		100%	98.70%	-1.30%
Total CO_2 eq Em. without LULUCF		**51'951**	**52'461**	**509.86**
		100%	100.98%	0.98%

10.2.2 KP- LULUCF Inventory

Data for 2008, 2009 and 2010 are reported. A recalculation of the years 2008 and 2009 was carried out. The methodological improvements are described in detail in Chapter 11.3.1.4. (Kyoto specific recalculations) and Chapter 7.3.7 (Recalculations LULUCF Forest Land).

10.3 Implications for Emissions Trends, including Time Series Consistency

10.3.1 GHG Inventory

Due to recalculations, the emission trend 1990–2009 reported in the 2011 submission (FOEN 2011b) has slightly changed. Compared to 1990, 2009 emissions (national total without emissions/removals from LULUCF) showed a decrease of 2.21% before recalculation (previous submission). After recalculation, the decrease turns out to be lower with 1.12% (latest submission).

Table 10-3 Change of the emission trend 1990–2009 due to recalculation. “Previous” refers to data reported in FOEN (2011b), whereas “latest” refers to the present submission.

Recalculation	**1990**		**2009**		**change 2009/1990**	
Submission	previous	latest	previous	latest	previous	latest
Unit	CO_2 eq (Gg)				%	
Total excl. LULUCF	53'123	53'057	51'951	52'461	-2.21%	-1.12%

All-time series in the present submission are consistent.

10.3.2 KP- LULUCF Inventory

As for KP-LULUCF 2008, 2009 and 2010 data was submitted, recalculation was done for 2008 and 2009 data and there are no implications for emission trends.

10.4 Recalculations, Including in Response to the Review Process, and Planned Improvements to the Inventory

10.4.1 Recalculations GHG Inventory

Many recalculations have been carried out in response to recommendations proposed in review reports. All relevant recalculations are listed in Chpt. 10.1.1. Further information on improvements due to the ERT recommendations are found in Table 1-12.

10.4.2 Recalculations KP-LULUCF Inventory

For recalculations see Chapter 10.1.2. Further information on improvements due to the ERT recommendations are found in Table 1-12. The methodological improvements are described in detail in Chapter 11.3.1.4. (Kyoto specific improvements) and Chapter 7.3.7 (Improvements LULUCF Forest Land).

10.4.3 Planned Improvements

1A3a Civil Aviation: For the years to come, efficiency improvements in the fuel consumption of large aircrafts will be considered in the modelling approach in order to avoid overestimation of consumption.

2A3: New measurement data on the release of geogenic CO_2 emissions from brick and tile production is available from industry. A recalculation will be done for next year’s submission.

2F: The emission factors of SF_6 in source category 2F8 Electrical Equipment shows a discontinuity from 2005 to 2006. It is intended to verify the emission factors for the next submission.

2F: For the next submission it is also planned to eliminate the existing double counting between the inventory reports of Switzerland and Liechtenstein.

4A/4B: A revision of energy intake estimates of non-cattle animals, particularly mules and asses, is aspired.

4B/4D: Implementation of new projections of the AGRAMMON model.

4D: Minor inconsistency, N used in biogas production (6D) is not subtracted in the N applied to soils (4D), leads to an overestimation of emissions. This issue is planned to be improved in the subsequent submissions (see Table 1-12).

4D: Consideration of implementation of new data for crop nitrogen- and dry matter content from Flisch et al. (2009).

5 LULUCF Sector: Switzerland will further reduce the uncertainty of its activity data for land areas by gradually increasing the AREA sample size. Full coverage is expected in 2013 (see Chapter 7.2.8).

5 LULUCF Sector: Various other planned improvements are listed in the corresponding chapters (see Chapters 7.3.8, 7.4.8, 7.5.8, 7.6.8 and 7.7.8).

6C Waste sector: Estimations of AD for illegal waste quantities will be improved. It is planned to calculate them as decreasing fraction (1% - 0.25%) of total waste quantities (burnable and construction waste).

6D Waste sector: The activity data for backyard composting are based on rough estimates. For further submissions more reliable data will be sought.

7: The double counted emissions from private use of synthetic fertilizers will be removed from sector 7 in the next submission for the whole time-series.

PART 2

11 KP-LULUCF

Switzerland has chosen to account annually for emissions and removals from the LULUCF sector (FOEN 2006h, Sect. G). In addition to the mandatory submission of the inventory years 2008, 2009 and 2010, data for the years 1999-2007 are available and shown in Switzerland's NIR on a voluntary basis. Switzerland has elected to account for Forest Management under the voluntary activities of Article 3, paragraph 4 of the Kyoto Protocol (FOEN 2006h, Sect. F). Switzerland applies the condition of "direct human-induced" in relation to Afforestation and Deforestation very strictly (see Chapter 11.1.3, FOEN 2010d, FOEN 2010h).

Table 11-1 shows the activity coverage and the carbon pools reported for the activities under Article 3, paragraph 3 and Forest Management under paragraph 4 of the Kyoto Protocol. The areas and change in areas between the previous and the current inventory year are shown in Table 11-2. Table 11-3 summarizes the results of the KCA for LULUCF activities under the Kyoto Protocol.

Table 11-1 NIR 1 – Summary Table.

TABLE NIR 1. SUMMARY TABLE
Activity coverage and other information relating to activities under Article 3.3 and elected activities under Article 3.4

Activity		Change in carbon pool reported[1]					Greenhouse gas sources reported[2]						
		Above-ground biomass	Below-ground biomass	Litter	Dead wood	Soil	Fertilization[3]	Drainage of soils under forest management	Disturbance associated with land-use conversion to croplands	Liming	Biomass burning[4]		
							N_2O	N_2O	N_2O	CO_2	CO_2	CH_4	N_2O
Article 3.3 activities	Afforestation and Reforestation	R	IE	NR	NR	R	NO			NO	NO	NO	NO
	Deforestation	R	IE	R	R	R			R	NO	NO	NO	NO
Article 3.4 activities	Forest Management	R	IE	NR	R	NR	NO	NE		NO	R,IE	R	R
	Cropland Management	NA	NA	NA	NA	NA			NA	NA	NA	NA	NA
	Grazing Land Management	NA	NA	NA	NA	NA				NA	NA	NA	NA
	Revegetation	NA	NA	NA	NA	NA				NA	NA	NA	NA

(1) Indicate R (reported), NR (not reported), IE (included elsewhere) or NO (not occurring), for each relevant activity under Article 3.3 or elected activity under Article 3.4. If changes in a carbon pool are not reported, it must be demonstrated in the NIR that this pool is not a net source of greenhouse gases. Indicate NA (not applicable) for each activity that is not elected under Article 3.4. Explanation about the use of notation keys should be provided in the text.

(2) Indicate R (reported), NE (not estimated), IE (included elsewhere) or NO (not occurring) for greenhouse gas sources reported, for each relevant activity under Article 3.3 or elected activity under Article 3.4. Indicate NA (not applicable) for each activity that is not elected under Article 3.4. Explanation about the use of notation keys should be provided in the text.

(3) N_2O emissions from fertilization for Cropland Management, Grazing Land Management and Revegetation should be reported in the Agriculture sector. If a Party is not able to separate fertilizer applied to Forest Land from Agriculture, it may report all N_2O emissions from fertilization in the Agriculture sector.

(4) If CO_2 emissions from biomass burning are not already included under changes in carbon stocks, they should be reported under biomass burning; this also includes the carbon component of CH_4. Parties that include CO_2 emissions from biomass burning in their carbon stock change estimates should report IE (included elsewhere).

Table NIR 1.1 Additional information
Selection of parameters for defining "Forest"under the Kyoto Protocol

Parameter	Range	Selected value
Minimum land area	0.05 - 1 ha	0.06
Minimum crown cover	10 - 30 %	20.00
Minimum height	2 - 5 m	3.00

Table 11-2 NIR 2 – Land Transition Matrix Inventory Year 2010

Table NIR 2. LAND TRANSITION MATRIX

Areas and changes in areas between the previous and the current inventory year (1), (2), (3)

From previous inventory year / To current inventory year		Article 3.3 activities: Afforestation and Reforestation	Article 3.3 activities: Deforestation	Article 3.4 activities: Forest Management (if elected)	Article 3.4 activities: Cropland Management (if elected)	Article 3.4 activities: Grazing Land Management (if elected)	Article 3.4 activities: Revegetation (if elected)	Other (5)	Total area at the beginning of the current inventory year(6)
		(kha)							
Article 3.3 activities	Afforestation and Reforestation	2.14	NO						2.14
	Deforestation		6.99						6.99
Article 3.4 activities	Forest Management (if elected)		0.34	1'195.47					1'195.80
	Cropland Management(4) (if elected)	NA	NA		NA	NA	NA		NA
	Grazing Land Management(4) (if elected)	NA	NA		NA	NA	NA		NA
	Revegetation(4) (if elected)	NA			NA	NA	NA		NA
Other (5)		0.05	NA	1.46	NA	NA	NA	2'921.98	2'923.48
Total area at the end of the current inventory year		2.19	7.33	1'196.93	NA	NA	NA	2'921.98	4'128.42

(1) This table should be used to report land area and changes in land area subject to the various activities in the inventory year. For each activity it should be used to report area change between the previous year and the current inventory year. For example, the total area of land subject to Forest Management in the year preceding the inventory year, and which was deforested in the inventory year, should be reported in the cell in column of Deforestation and in the row of Forest Management.

(2) Some of the transitions in the matrix are not possible and the cells concerned have been shaded.

(3) In accordance with section 4.2.3.2 of the IPCC good practice guidance for LULUCF, the value of the reported area subject to the various activities under Article 3.3 and 3.4 for the inventory year should be that on 31 December of that year.

(4) Lands subject to Cropland Management, Grazing Land Management or Revegetation which, after 2008, are subject to activities other than those under Article 3.3 and 3.4, should still be tracked and reported under Cropland Management, Grazing Land Management or Revegetation, respectively.

(5) "Other" includes the total area of the country that has not been reported under an Article 3.3 or an elected Article 3.4 activity.

(6) The value in the cell of row "Total area at the end of the current inventory year" corresponds to the total land area of a country and is constant for all years.

Table 11-3 NIR 3 – Summary Overview for Key Categories for LULUCF Activities under the KP (cf. Chapter 11.6.1). A detailed description of the KCA for Article 3.3 and 3.4 activities is given in Chapter 11.6.1.

TABLE NIR 3. SUMMARY OVERVIEW FOR KEY CATEGORIES FOR LAND USE, LAND-USE CHANGE AND FORESTRY ACTIVITIES UNDER THE KYOTO PROTOCOL

KEY CATEGORIES OF EMISSIONS AND REMOVALS	GAS	CRITERIA USED FOR KEY CATEGORY IDENTIFICATION			COMMENTS [3]
		Associated category in UNFCCC inventory[1] is key (indicate which category)	Category contribution is greater than the smallest category considered key in the UNFCCC inventory [1], [4] (including LULUCF)	Other [2]	
Specify key categories according to the national level of disaggregation used[1]					
Forest Management	CO2	Forest land remaining forest land	Yes	Since the total Swiss forest	Associated category in UNFCCC inventory is KC level and KC trend (Tier 2; 2010).
Afforestation and Reforestation	CO2	Conversion to forest land	No	Natural forest regeneration	Associated category in UNFCCC inventory is KC level and KC trend (Tier 2; 2010).
Deforestation	CO2	Conversion to settlements	Yes	see NIR Chapter 11.6.1	Associated category in UNFCCC inventory is KC level and KC trend (Tier 2; 2010).

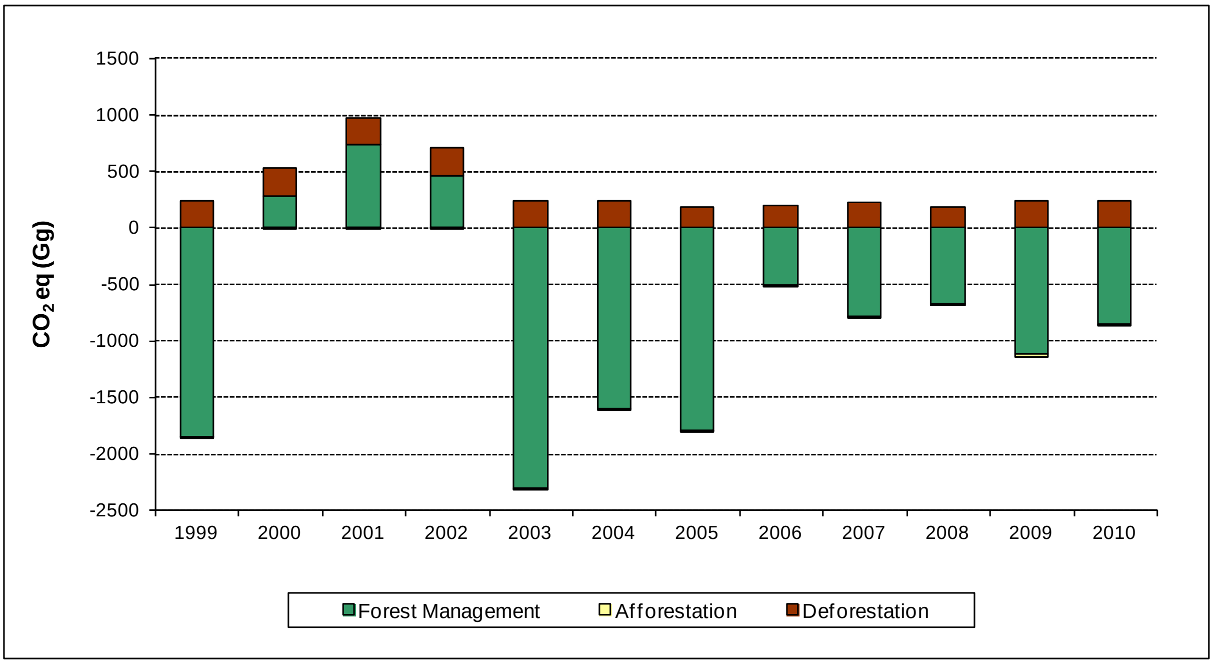
(1) See section 5.4 of the IPCC good practice guidance for LULUCF.

(2) This should include qualitative consideration as per section 5.4.3 of the IPCC good practice guidance for LULUCF or any other criteria.

(3) Describe the criteria identifying the category as key.

(4) If the emissions or removals of the category exceed the emissions of the smallest category identified as key in the UNFCCC inventory (including LULUCF), Parties should indicate YES. If not, Parties should indicate NO.

An overview of net CO_2 equivalent emissions and removals of activities under Article 3, paragraph 3 and Forest Management under Article 3, paragraph 4 of the Kyoto Protocol is shown in Figure 11-1 and Table 11-4. Differences in the annual emissions from Deforestation can mainly be attributed to the changes in the area of Deforestations (see Table 11-5). Year-to-year differences in removals from Afforestations are mainly due to changes in the yearly afforested area (see Table 11-5). Other relevant factors are the application of a logistical growth curve for Afforestations and the fact that for Afforestations after the conversion period of 20 years the emission factors of Forest Management are applied (see Chapter 11.3.1.1). Fluctuations in the contribution of Forest Management can mainly be explained by changes in the losses of living (cut and mortality) and dead biomass, whereas changes in the area of managed forest are relatively small (see Table 11-5). From 2000 until 2002, Forest Management was a net source of CO_2 eq due to the damage caused by the storm Lothar.



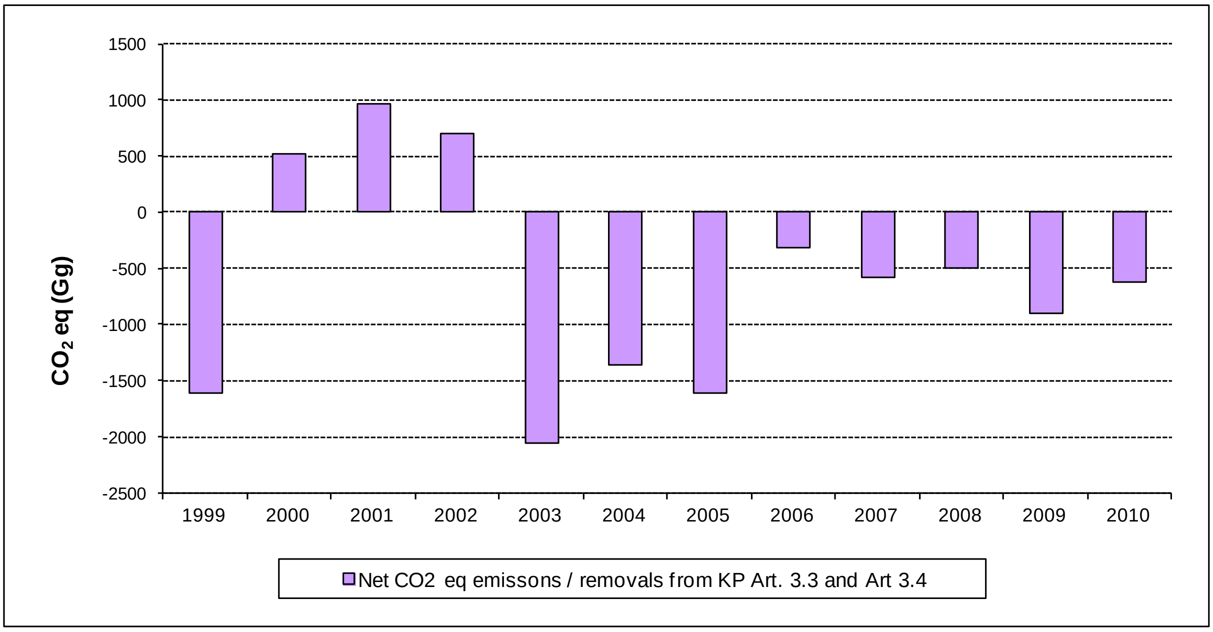


Figure 11-1 CO_2 eq emissions (positive sign) and removals (negative sign) from Afforestation and Deforestation under Article 3, paragraph 3 and Forest Management under Article 3, paragraph 4 (upper panel) and net CO_2 eq emissions and removals of these activities (lower panel), 1999-2010.

Table 11-4 Overview on net CO_2 equivalent emissions (positive sign) and removals (negative sign) for activities under Article 3, paragraph 3 and Forest Management under Article 3, paragraph 4 of the Kyoto Protocol, 1999-2010.

Greenhouse gas source and sink activities	1999	2000	2001	2002	2003	2004	2005
	Net CO_2 equivalent emissions/removals (Gg CO_2 eq)						
A. Article 3.3 activities	**239.04**	**238.64**	**237.33**	**235.55**	**233.50**	**231.33**	**174.61**
A.1. Afforestation and Reforestation	-1.57	-2.15	-2.97	-4.18	-5.69	-7.29	-9.29
A.1.1. Units of land not harvested since the beginning of the commitment period	-1.57	-2.15	-2.97	-4.18	-5.69	-7.29	-9.29
A.1.2. Units of land harvested since the beginning of the commitment period	0.00	0.00	0.00	0.00	0.00	0.00	0.00
A.2. Deforestation	240.61	240.79	240.30	239.74	239.18	238.62	183.91
B. Article 3.4 activities	**-1855.92**	**280.50**	**730.05**	**477.17**	**-2282.30**	**-1602.81**	**-1797.00**
B.1. Forest Management incl. biomass burning	-1855.92	280.50	730.05	477.17	-2282.30	-1602.81	-1797.00
gains living biomass	-12279.01	-12288.92	-12297.53	-12306.01	-12314.58	-12324.28	-12345.86
losses living biomass	10411.75	13530.40	13988.59	13837.99	11189.06	10815.73	11293.34
changes dead wood	2.14	-971.28	-971.35	-1080.35	-1188.60	-103.92	-755.25
changes soil C org. soils	8.83	8.83	8.84	8.84	8.84	8.85	8.85
sum forest management excl. Biomass burning	-1856.28	279.03	728.54	460.47	-2305.28	-1603.63	-1798.91
B.2. Cropland Management (if elected)	NA	NA	NA	NA	NA	NA	NA
B.3. Grazing Land Management (if elected)	NA	NA	NA	NA	NA	NA	NA
B.4. Revegetation (if elected)	NA	NA	NA	NA	NA	NA	NA
Total Art. 3.3 and 3.4	**-1616.88**	**519.14**	**967.38**	**712.73**	**-2048.80**	**-1371.49**	**-1622.38**

Greenhouse gas source and sink activities	2006	2007	2008	2009	2010	2011	2012
	Net CO_2 equivalent emissions/removals (Gg CO_2 eq)						
A. Article 3.3 activities	**178.86**	**210.09**	**166.33**	**220.61**	**215.41**		
A.1. Afforestation and Reforestation	-11.39	-14.12	-15.88	-17.74	-23.08		
A.1.1. Units of land not harvested since the beginning of the commitment period	-11.39	-14.12	-15.88	-17.74	-16.35		
A.1.2. Units of land harvested since the beginning of the commitment period	0.00	0.00	0.00	0.00	-6.73		
A.2. Deforestation	190.26	224.21	182.20	238.35	238.50		
B. Article 3.4 activities	**-503.00**	**-784.05**	**-671.33**	**-1122.66**	**-850.38**		
B.1. Forest Management incl. biomass burning	-503.00	-784.05	-671.33	-1122.66	-850.38		
gains living biomass	-12362.71	-12377.48	-12388.78	-12397.41	-12401.07		
losses living biomass	11736.13	12232.90	12371.03	11929.04	11659.37		
changes dead wood	110.60	-657.96	-663.95	-664.91	-118.64		
changes soil C org. soils	8.87	8.95	8.96	8.96	8.96		
sum forest management excl. Biomass burning	-507.12	-793.59	-672.75	-1124.32	-851.37		
B.2. Cropland Management (if elected)	NA	NA	NA	NA	NA		
B.3. Grazing Land Management (if elected)	NA	NA	NA	NA	NA		
B.4. Revegetation (if elected)	NA	NA	NA	NA	NA		
Total Art. 3.3 and 3.4	**-324.14**	**-573.96**	**-505.00**	**-902.05**	**-634.97**		

The KPCRF Tables “Information table on accounting for activities under Article 3, paragraph 3 and 4 of the Kyoto Protocol” give an overview of the CO_2 eq emissions and removals from Afforestation and Deforestation under Article 3, paragraph 3 and Forest Management under Article 3, paragraph 4 and also provides information on the extent to which GHG removals by sinks offsets the debit incurred under Article 3.3.

- In 2008 Forest Management in Switzerland caused removals of -671.33 Gg CO_2 eq. The debit incurred from activities under Article 3.3 is 166.33 Gg CO_2 eq. In total, -505.00 Gg CO_2 eq. were removed from the atmosphere in Switzerland by activities under Article 3.3 and Article 3.4.

- In 2009 Forest Management in Switzerland caused removals of -1122.66 Gg CO_2 eq. The debit incurred from activities under Article 3.3 is 220.61 Gg CO_2 eq. In total, -902.05 Gg CO_2 eq. were removed from the atmosphere in Switzerland by activities under Article 3.3 and Article 3.4.
- In 2010 Forest Management in Switzerland caused removals of -850.38 Gg CO_2 eq. The debit incurred from activities under Article 3.3 is 215.41 Gg CO_2 eq. In total, -634.97 Gg CO_2 eq. were removed from the atmosphere in Switzerland by activities under Article 3.3 and Article 3.4.

11.1 General Information

The inventory datasets on which the calculations are based (Swiss Land Use Statistics AREA and National Forest Inventory NFI) are described in Chapters 7.2.2 and 7.3.4.1, respectively.

Methodological issues and assumptions concerning the calculation of activity data and emission factors used for the reporting under Article 3, paragraphs 3 and 4 of the Kyoto Protocol, follow the IPCC good practice guidance and are described in Chapter 7.3.4 and in FOEN (2012d).

11.1.1 Definition of Forest and any other Criteria

The forest definition used under the Kyoto Protocol is defined in Switzerland's Initial Report (FOEN 2006h, Sect. E and Chapter 7.3.1 in this submission). Forest is defined as a minimum area of land of 0.0625 ha with crown cover of at least 20% and a minimum width of 25 m. The minimum height of the dominant trees must be 3 m or have the potential to reach 3 m at maturity in situ. The selected values are also listed in KP LULUCF Table NIR1 (see Table 11-1).

Some subcategories were excluded from the category “Forest Land”, although they may partly fulfil the requirements of the Swiss forest definition used under the Kyoto Protocol (see Chapter 7.2.4, Table 7-10). Those are:

- Vineyards, Low-Stem Orchards, Tree nurseries, Copses and Orchards in the category “Grassland”;
- Cemeteries and public parks in the category “Settlements”.

11.1.2 Elected Activities under Article 3, Paragraph 4, of the Kyoto Protocol

Switzerland has decided to account for Forest Management under the elective voluntary activities of Article 3, paragraph 4 of the Kyoto Protocol (FOEN 2006h, Sect. F). In accordance with the Annex to Decision 16/CMP.1, credits from Forest Management are capped in the first commitment period. For Switzerland the cap amounts to 1.83 Mt CO_2 y^{-1} (0.5 Mt C y^{-1}), or 9.15 Mt CO_2 for the whole commitment period 2008-2012.

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 Swiss definitions of Afforestation, Deforestation and Forest Management are published in Switzerland's Initial Report (see FOEN 2006h, Sect. E and F).

Afforestation

Afforestation is the conversion to forest of an area not fulfilling the definition of forest for a period of at least 50 years if the definition of forest in terms of minimum area (625 m^2) is fulfilled, and the conversion is a direct human-induced activity.

Natural forest regeneration due to abandonment of land, mainly occurring in the Alpine area, is not considered to be a direct human-induced activity. Only afforestations which can clearly be attributed as direct human-induced from aerial photographs (SFSO 2011; see also Chapter 7.2) are considered as Afforestation. Some examples of direct human-induced afforestations are shown in FOEN (2010h).

Deforestation

Deforestation is the permanent conversion of areas fulfilling the definition of forest in terms of minimum forest area (625 m^2) to areas not fulfilling the definition of forest as a consequence of direct human influence.

Temporary removals of tree stand (e.g. for the construction of high-tension lines and pipelines) are not reported as Deforestation under the Kyoto Protocol because in those cases the forest stand has to be re-established. In the NFI methodology (Brändli 2010: 91) “forest aisles” under high-tension are explicitly classified as forests. These forest aisles underlie however a specific management, i.e. maximum tree height is limited to a certain height. The NFI dataset thus covers such areas with a specific forest management practice.

Reforestation

Reforestation does not occur in Switzerland (FOEN 2006h, Sect. E; see also Chapter 11.4.1).

Forest management

Forest management includes all activities serving the purpose of fulfilling the Federal Law on Forests (Swiss Confederation 1991, Art. 1c), i.e. the obligation to conserve forests and to ensure forest functions – such as wood production, protection against natural hazards, preservation of biodiversity, purification of drinking water and maintenance of recreational value – in a sustainable manner.

11.1.4 Description of Precedence Conditions and/or Hierarchy among 3.4. Activities and how they have been consistently applied in determining how Land was classified.

Since Switzerland only elected Forest Management from the elective activities of Article 3, paragraph 4 of the Kyoto Protocol, the hierarchy among 3.4 activities does not affect Swiss reporting.

11.2 Land-related Information

11.2.1 Spatial Assessment Unit used for determining the Area of the units of Land

The spatial assessment unit for the submission of the KP LULUCF tables covers the entire territory of Switzerland, i.e. 4128.42 kha (see Table 11-2).

All activity data for reporting the activities under the Kyoto Protocol are retrieved from the Swiss Land Use Statistics (SFSO 2011; see also Chapter 7.2.2.1).

The Swiss Land Use Statistics AREA (SFSO 2006a) uses a regular sample grid with a grid size of 100 m to frame her fixed sample points with known coordinates. To each grid point a specific combination category (see Table 7-2) is assigned.

11.2.2 Methodology used to develop the Land Transition Matrix

The methodology used to develop the land transition matrix is described in detail in Chapter 7.2.3.2.

11.2.3 Maps / Database to identify the geographical Locations and the system of Identification Codes for the geographical Locations

All Afforestations and Deforestations are accounted for under Article 3, paragraph 3 and are not reported under Forest Management under Article 3, paragraph 4. Also in the case of Afforestations older than the general conversion period of 20 years, these areas are still reported under Afforestations: CRF Table 5(KP-I)A.1.2. For these sites, the same emission factors as for areas under Forest Management are applied (see Chapter 11.3.1.1). The changes in areas between the activities under Article 3, paragraph 3 and Article 3, paragraph 4 are listed in KP-Table NIR2 (see Table 11-2).

Forest areas under Forest Management are subdivided into productive forests (CC12) and unproductive forests (CC13; Table 7-10). Productive forests in Switzerland reveal a high heterogeneity in terms of elevation; growth conditions and tree species composition (see Chapter 7.2.3.1 and Figure 7-5). We therefore stratified Switzerland into five National Forestry Inventory production regions (L1: Jura, L2: Central Plateau, L3: Pre-Alps, L4: Alps, L5: Southern Alps), three altitudinal zones (Z1: <601 m, Z2: 601-1200 m, Z3: >1200 m) and two soil types (mineral soils and organic soils). In the KP CRFtables, the stratification of the activity data into production region (L) and altitudinal level (Z) is indicated in the column “Subdivision”.

Afforestation

Activity data for Afforestations are derived from the Swiss Land Use Statistics (AREA) (SFSO 2006a, 2011; see also Chapter 7.2.2.1). A detailed description of the identification of Afforestations fulfilling the Kyoto definition is provided in FOEN (2010h).

Deforestation

Data for Deforestations are derived from the Swiss Land Use Statistics (AREA). A detailed description of the identification of Deforestations under the Kyoto Protocol from the AREA dataset is given in FOEN (2010d) and Sigmaplan (2010a).

Briefly, not all changes from a forest combination category (afforestation CC11, productive forest CC12 and unproductive forest CC13) to a non-forest combination category do correspond to the definition of Deforestation according to the Kyoto Protocol Art. 3.3. The following criteria identify conversions from a forest combination category to a non-forest combination category, which are not classified as Deforestations under the Kyoto Protocol Art. 3.3 (FOEN 2010d):

1. Non-permanent conversions are due to forest management practices, natural dynamics or hazards:

- Tree loss is temporally limited: areas with loss of tree biomass, but where a change in land use cannot be identified. Natural regeneration, which is a common practice in Swiss forest management, is expected, but could not yet be recognized on the aerial photograph at the time the AREA survey (see Chapter 7.2.2.1) was conducted.
- Tree loss is spatially limited: conversion is caused by an alteration of the surrounding stand, but the change does not affect the tree cover at the sample point.

2. Conversions of combination categories not meeting the definition of Deforestation as defined under the Kyoto Protocol and in Switzerland's Initial Report (FOEN 2006h).
   - Areas smaller than the minimum area of 625 m^2.
   - Areas with a reduction in forest cover on the grid point but still fulfilling the Kyoto definition of Forest, i.e. having the potential to reach 3 m at maturity in situ.
3. No change in land use took place: reduction of tree cover without land-use change; former land use was mainly pasture
4. Tree loss is not human-induced: Conversion due to natural hazards and dynamics.

Forest Management

Since all forests in Switzerland are subject to Forest Management, the area of managed forest corresponds to the forest area (see FOEN 2006h, Sect. E) as derived from the Swiss Land Use Statistics (AREA; SFSO 2006a, 2011; see also Chapter 7.2.2.1). We report changes in pools for the following geographical locations:

- productive forest remaining productive forests (CC12 remaining)
- productive forest converted to unproductive forests (CC12 to CC13)
- unproductive forest remaining unproductive forests (CC13 remaining)
- unproductive forest converted to productive forests (CC13 to CC12).

Difference in area reported under KP Art. 3.4 Forest Management and area "Forest Land remaining Forest Land" reported under the UNFCCC

The area reported under Forest Management and the area reported as "Forest Land remaining Forest Land" under the UNFCCC are not identical because of the following reasons:

- Conversions to Forest Land which are not human-induced are not accounted for as "Afforestations under the Kyoto Protocol". These areas are reported under KP Art. 3.4 Forest Management in table 5(KP-I)B.1 as soon as the definition of Forest is fulfilled. Under the Convention, these afforestations are reported under land-use category 5A2 with a conversion time of 20 years.
- Afforestations under the Kyoto Protocol which are older than 20 years are always reported under Art. 3.3 (KP-CRF-Table 5(KP-I)A.1.2), whereas under the Convention, these afforestations older than 20 years move to the land-use category 5A1 "Forest Land remaining forest land".
- Not all changes from a forest combination category to a non-forest combination category correspond to the definition of Deforestation according to the Kyoto Protocol Art. 3.3. (see above). These areas remain under the KP Art. 3.4 activity Forest Management and are included in the areas as reported in table 5(KP-I)B.1.
- Reporting of land-use changes LUC: Since only the KP activity "Forest Management" is chosen under KP Art. 3.4, changes from other KP-Activities to FL are not reported as LUC but are reported as CC12 or CC13 as soon as the KP definition of forest is fulfilled. Only conversions within the activity "Forest Management" are reported under the Kyoto

Protocol, i.e. CC12 to CC13 and CC13 to 12. Under the Convention, LUC to forest land are reported in land-use category 5A2.

Area reported under Afforestation, Deforestation and Forest Management

AREA data allow to clearly separate between the land areas subject to a specific activity. Absolute and cumulated activity data of Afforestations, Deforestations and forests under Forest Management are listed in Table 11-5. The total Swiss area remains constant and amounts to 4128.42 kha.

Table 11-5 Activity data for activities under Article 3, paragraphs 3 and 4, 1990-2010. Afforestation, Deforestation data and values depicting the area of Forest Management are derived from the Swiss Land Use Statistics (AREA) (SFSO 2006a, 2011).

Year	Deforested area [kha]	Cumulated deforested area since 1990 [kha]	Afforested area [kha]	Cumulated afforested area since 1990 [kha]	Area Forest Management [kha]
1990	0.35	0.35	0.27	0.27	1157.03
1991	0.35	0.70	0.26	0.53	1159.58
1992	0.35	1.05	0.26	0.79	1162.13
1993	0.35	1.40	0.22	1.01	1164.52
1994	0.37	1.77	0.16	1.16	1166.77
1995	0.38	2.15	0.10	1.26	1168.88
1996	0.38	2.53	0.10	1.36	1170.84
1997	0.38	2.92	0.07	1.43	1172.78
1998	0.40	3.31	0.05	1.48	1174.56
1999	0.39	3.71	0.05	1.54	1176.29
2000	0.38	4.09	0.05	1.59	1178.03
2001	0.38	4.47	0.05	1.65	1179.76
2002	0.37	4.84	0.05	1.70	1181.50
2003	0.37	5.21	0.05	1.76	1183.23
2004	0.36	5.57	0.05	1.81	1184.97
2005	0.26	5.82	0.08	1.89	1187.86
2006	0.26	6.09	0.07	1.97	1190.38
2007	0.32	6.41	0.07	2.03	1192.63
2008	0.25	6.66	0.06	2.09	1194.22
2009	0.34	6.99	0.05	2.14	1195.80
2010	0.34	7.33	0.05	2.19	1196.93

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

Yearly values for carbon stocks and changes in the pools of living biomass (above and below ground; see chapter 7.3.4.4), dead wood, litter and soil carbon of the land-use combination categories afforestations (CC11), productive (CC 12) and unproductive forests (CC13) are displayed in Table 7-4 and Table 7-5. For calculating stock changes following changes between CC12 and CC13, equations 7.1, 7.2 and 7.3 are used and conversion times of 20 years are applied. The methodology is summarized in

Table 11-6. Additional methodological information can be found in FOEN (2012d). Differences in carbon stock changes for living biomass, dead organic matter and soil are shown in Meteotest 2012a.

Table 11-6 Application of equations 7.1-7.3 for calculating changes in carbon pools for the Kyoto activities Afforestations (CC11) ≤ 20 years, Afforestations (CC11) > 20 years, Deforestations (DEF) and Forest Management (FM) with the 4 geographical locations: CC12 remaining, CC13 remaining, conversions from CC12 to CC13 (FM CC1213) and conversions from CC13 to CC12 (FM CC1312). Losses in soil carbon due to soil disturbance caused by Deforestation are accounted for by reducing the soil carbon pool by 50%. A conversion time CT of 20 years is applied for all pools.GG = gross growth; C&M= cut and mortality; SLB = stock living biomass; dDW = yearly change in dead wood pool; SDW = stock dead wood pool; dSOC = yearly change in soil carbon pool; SSOC = stock in soil carbon pool; dLitter = yearly change in litter pool. Suffices of pool-abbreviations refer to the specific combination category or to the KP activity (see Table 7-2).

	Living biomass	Dead Wood	Soil-C	Litter
Afforestation CC11 ≤ 20 y	$GG_{11} - C\&M_{11} + (SLB_{11}-SLB_{31})/CT$ $= GG_{11} - 0 + (SLB_{11}-SLB_{31})/CT$	$dDW_{11} + (SDW_{11} - SDW_{31})/ CT$ = 0 + (0 - 0)/CT	$dSOC_{11} + (SOC_{11} - SOC_{31})/CT$ $= 0 + (SOC_{11} - SOC_{31})/CT$	$dLitter_{11} + (Litter_{11}-Litter_{31})/CT$ = 0 + (0 - 0)/ CT
Afforestation CC11 > 20 y	$GG_{12} - C\&M_{12}$ or $GG_{13} - C\&M_{13} = 0 - 0$	dDW_{12} or $dDW_{13} = 0$	$dSOC_{12}$ or $dSOC_{13}$	$dLitter_{12} = 0$ or $dLitter_{13} = 0$
Deforestation DEF	$GG_{DEF} - C\&M_{DEF} + (0-SLB_{12})/ CT$ $= 0 - (0 - SLB_{12})/ CT$ $= - SLB_{12}/ CT$	$dDW_{DEF} + (0- SDW_{12})/ CT$ $= (0 - SDW\ CC_{12})/ CT$ $= - SDW_{12}/ CT$	- 0.5*(SOC12)/ CT	$dLitter + (0 - Litter_{12}) / CT$ $= (0 - Litter_{12})/ CT$ $= - Litter_{12}/ CT$
FM CC12 remaining	$GG_{12} - C\&M_{12}$	dDW_{12}	$dSOC_{12}$	$dLitter_{12} = 0$
FM CC13 remaining	$GG_{13} - C\&M_{13}$ = 0 - 0	$dDW_{13} = 0$	$dSOC_{13}$	$dLitter_{13} = 0$
FM CC1213	$GG_{13} - C\&M_{13} + (SLB_{13}-SLB_{12})/ CT$ $= 0 - 0 + (SLB_{13}-SLB_{12})/ CT$ $= (SLB_{13}-SLB_{12})/ CT$	$dDW_{13} + (SDW_{13}- SDW_{12})/ CT$ $= 0 + (SDW_{13}- SDW_{12})/ CT$ $= (SDW_{13} - SDW_{12})/ CT$ $= 0 - SDW_{12}/ CT$	$dSOC_{13} + (SOC_{13}- SOC_{12})/ CT$ $= dSOC_{13} + 0$	$dLitter_{13} + (Litter_{13}-Litter_{12})/ CT$ $= dLitter_{13} + 0$
FM CC1312	$GG_{12} - C\&M_{12} + (SLB_{12}-SLB_{13})/ CT$ $= GG_{12} - C\&M_{12} + (SLB_{12}-SLB_{13})/ CT$	$dDW_{12} + (SDW_{12}- SDW_{13})/ CT$ $= dDW_{12} + (SDW_{12}- 0)/ CT$ $= SDW_{12} + SDW_{12}/ CT$	$dSOC_{12} + (SOC_{12}- SOC_{13})/ CT$ $= dSOC_{12} + 0$	$dLitter_{12} + (Litter_{12}-Litter_{13})/ CT$ $= dLitter_{12} + 0$

Reforestation

Reforestation does not occur in Switzerland (FOEN 2006h, Sect. E).

Afforestation ≤ 20 years

Living Biomass:

- Annual increase/decrease: Gross growth of living biomass of Afforestations follows a logistical growth function. Values are available for three altitudinal levels (Table 7-26). The total gross growth of the cumulative afforested area was determined by multiplying the afforested area of a specific year with the corresponding age-specific growth values.
- Change in carbon stock due to conversion: In Switzerland, Afforestations mostly occur on grasslands and on areas with settlements CC51. The difference in stocks of living biomass between on the one hand permanent grasslands CC31 and areas with settlements CC51 and on the other hand afforestations CC11 is considered.

Soil Carbon:

- Annual increase/decrease: A conservative estimate was made and no changes in soil carbon pool on mineral soil under Afforestations are reported (see also Chapters 7.3.4.9, 7.3.6 and 11.3.1.2). In the case of organic soils, emissions due to drainage are calculated as described in Chapter 11.3.1.2.
- Change in carbon stock due to conversion: In the case of land-use conversions to Afforestations, the difference in soil carbon stocks between permanent grasslands CC31 and afforestations CC11 is considered. The soil carbon stock of areas with settlements CC51 was not taken into account (i.e. conservative approach: SOC_{CC51} is zero (see Table 7-4). Thus the difference in stock change would be bigger resulting in higher sinks in the case of afforstations).

Dead Wood and Litter:

- Annual increase/decrease: In the initial phase of forest establishment and growth, the pools of dead wood and litter start to increase. Conservatively (in terms of IPCC good practice: IPCC 2003, Sect. 3.1.5), no net changes in the carbon pools of dead wood and litter are reported.
- Change in carbon stock due to conversion: On grasslands and areas with settlements there are no dead wood and no litter available. Assuming no dead wood nor litter on afforestations, the difference in the carbon stocks of these pools are zero. This is a conservative estimate, since there actually is a small pool of dead wood and litter under afforestations.

Afforestation > 20 years

Emissions and removals for the carbon pools of afforestations older than 20 years are calculated using the methodology and emission factors applied for Forest Management (FM CC12 remaining or FM CC13 remaining).

Deforestation

- Annual increase/decrease: during the inventory year, we do not account for yearly gains (e.g. gross growth of living biomass) or losses of any pool (e.g. cut and mortality of living biomass).
- Change in carbon stock due to conversion: Total carbon stock of living biomass, dead wood and litter are immediately removed after deforestation. Losses in soil carbon due to soil disturbance caused by Deforestation are accounted for by reducing the soil carbon pool by 50% (Covington 1981, Rusch et al 2009; see also Chapter 7.1.3.2) over a conversion period of 20 years (see Table 7-3).

Forest management

The methodology used for calculating carbon stock changes in case of land-use changes within forest land is described in detail in Chapter 7.1.3.2 and summarized in

Table 11-6:.

Living Biomass:

- Annual increase, gains of living biomass: Gross growth of productive forests is used for the categories “CC12 remaining” and “CC13 to CC12”. Gross growth of unproductive forests is used for “CC13 remaining” and “CC12 to CC13” and is set to zero (see chapter 7.3.4.7 and Table 7-5). By using the biomass conversion and expansion factors (Chapter 7.3.4.4) gains in below ground biomass are included in the gains of above ground biomass.
- Annual decrease, losses of living biomass: Cut and mortality reflect yearly losses of living biomass in productive forests (“CC12 remaining” and “CC13 to CC12”). Unproductive forests are not systematically harvested and since yearly harvesting amounts from forest statistics (FOEN 2011e) are divided over the productive forests, cut and mortality for unproductive forests (“CC13 remaining” and “CC12 to CC13”) is set to zero.
- Change in carbon stock due to conversion: For areas which changed from “CC13 to CC12” and from “CC12 to CC13” the difference in carbon stocks of living biomass was considered. In the case of a conversion from “CC12 to CC13”, we report a net loss in carbon stock of living biomass; in the case of a conversion from “CC13 to CC12” a net gain. By using biomass conversion and expansion factors (Chapter 7.3.4.4) stocks in below ground biomass are included in the stocks of above ground biomass.

Dead wood:

- Annual increase/decrease: Estimates of yearly changes in dead wood were derived from NFI data and additional data from 48 plots from the Sanasilva Network (see Chapter 7.3.4.8). For productive forests (i.e. “CC12 remaining” and “CC13 to CC12”), values for yearly changes in carbon stock of dead wood from Table 7-5 are used. For unproductive forests (i.e. “CC 13 remaining” and “CC12 to CC13”), changes in dead wood stock are assumed to be zero (see

Table 7-24).

- Change in carbon stock due to conversion: The difference in carbon stock of dead wood is taken into account.

Litter and soil carbon pool:

- Annual increase/decrease: For the litter and soil carbon pool in mineral soils, we make a conservative estimate and do not report yearly changes (see also Chapters 7.3.4.9, 7.3.6 and 11.3.1.2).). In the case of organic soils, emissions due to drainage are calculated as described in Chapter 11.3.1.2.
- Change in carbon stock due to conversion: For the conversion “CC12 to CC13”, were report a net loss in carbon stock, in the case of a conversion “CC13 to CC12”, we report a net gain (Table 7-4 and Table 7-23 and Table 7-24).

Differences in accounting for “Forest Sector 5A1 and 5A2” under UNFCCC and „Forest Management“ under KP Art. 3.4

Under KP Art. 3.4, conversions from other KP-Activities to “Forest Management” are not reported as land-use change but are reported as CC12 or CC13 as soon as the KP definition of Forest is fulfilled. Only conversions within the activity “Forest Management” are reported under the Kyoto Protocol, i.e. CC12 to CC13 and CC13 to 12.

Under UNFCCC, all changes in land-use from non-forest land to forest land are reported in the land-use category 5A2. Thus, for these areas, the stock difference is taken into account. This results in a considerable C-sink reported under UNFCCC, but missing in KP-crf-tables.

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.

KP LULUCF Table NIR1 (Table 11-1) summarizes the activity coverage and the carbon pools reported. When using the conservative Tier 1 approach (IPCC 2003, Sect. 3.1.5) assuming a specific carbon pool to be in balance, the carbon pool is indicated as not reported (NR).

Change in Carbon Pool Reported

- The pool “above ground biomass” always reflects the total living biomass, which was calculated by applying the BCEF factor (see Chapter 7.3.4.4). Since we cannot separate the above and below ground biomass carbon pool, below ground biomass is included in the above ground biomass pool and therefore always marked as “include elsewhere” (IE).
- Switzerland reports no changes in soil carbon pool and litter on areas under forest management. As argued in Chapter 7.3.6, former studies showed that soil organic matter in and litter on forest soils in Switzerland are not a carbon source. Work to quantify temporal changes in soil carbon and in litter by using the soil model Yasso07 is going on (see Chapter 7.3.8).

Greenhouse Gas Sources Reported

- Fertilization of forests is prohibited by the Swiss forest law and adherent ordinances (Swiss Confederation 1991, 1992). Additionally, the “Ordinance on Chemical Risk Reduction“ (Swiss Confederation 2005) prohibits the application of fertilizers, including liming, in forests. Thus, emissions from fertilization are reported as “not occurring”.
- Drainage of forests is not a permitted practice in Switzerland and since 1991 not a permitted practice in Switzerland (Swiss Confederation 1991). There are no nation-wide survey data available. It is possible that a small part of the Swiss forest has been drained before 1990 or has been established on drained areas. We conservatively report all

organic forest soils to be drained which is definitely an overestimation. In order to calculate CO_2 emissions due to drainage, we used equation 3.2.15 of the GPG for LULUCF (IPCC 2003) and applied the default emission factor of 0.68 Mg ha^{-1} yr^{-1}. N_2O-emissions due to drainage are not estimated as no data are available. Moreover, reporting is not mandatory according to the Annex of chapter 3 of the IPCC GPG for LULUCF (reported as “NE” in KP-Table NIR1 (Table 11-1).

- Biomass burning: emissions of CO_2, CH_4 and N_2O are reported. The calculation of these emissions is described in Chapter 7.3.4.12 according to the methodology of the Good Practice Guidance (IPCC 2003).

11.3.1.3 Information on whether or not indirect and natural GHG Emissions and Removals have been factored out

No anthropogenic greenhouse gas emissions and removals resulting from LULUCF activities under Article 3, paragraphs 3 and 4 have been factored out.

11.3.1.4 Changes in Data and Methods since the previous Submission (Recalculations)

The increase of available AREA activity data (see Chapter 7.2.7, SFSO 2011) has led to recalculations in category 5A and in the areas of Art. 3.3 and Art 3.4 Forest Management of the Kyoto Protocol.

Some methodological changes have been made for the present submission. In detail, the changes in the calculation of the emission factors calculated for LULUCF Forest Land (category 5A) are described in Chapter 7.3.7. The following Kyoto-specific methodological modification was made for this submission:

- Afforestations older than 20 years are subject to normal forest management treatment. Starting in 2010, these areas and corresponding emissions and removals are reported in CRF Tables 5(KP-I)A.1.2 and 5(KP-I)A.1.3.

11.3.1.5 Uncertainty Estimates

An overview of the uncertainty estimates of activity data is discussed in detail in Chapter 7.2.5 and is shown in Table 7-11. Uncertainty estimates of emission factors for the reported activities under the Kyoto Protocol are shown in Table 7-6, overall uncertainties in Table 11-7.

A detailed description of the determination of the emission factor uncertainty of Forest Management can be found in Chapter 7.3.5. An overall uncertainty of 36% was calculated for Afforestations, 50% for Deforestations and 36% for Forest Management.

Table 11-7 Uncertainty estimates of activity data and emission factors and the overall uncertainty of activities reported under the Kyoto Protocol Article 3.3 and Article 3.4

Activity under KP	**Associated category in UNFCCC inventory (chapter 7.3)**	**Activity data uncertainty [%]**	**Emission factor uncertainty [%]**	**Overall uncertainty [%]**
Afforestation	5A2 Land converted to Forest Land	4	36	36
Deforestation	mainly 5E2 Land converted to Settlements	5	50	50
Forest Management	5A1 Forest Land remaining Forest Land	4	36	36

11.3.1.6 Other methodological Issues

Methodology used for reporting under the Kyoto Protocol is described in detail in previous sections.

N_2O emissions as a result of the disturbance associated with land-use conversion (Deforestation) to Cropland are reported in KP-CRF Table 5(KP-II)3. The emissions are calculated according to the methodology described in Chapter 7.4.4.4

11.3.1.7 The Year of the onset of an Activity, if after 2008

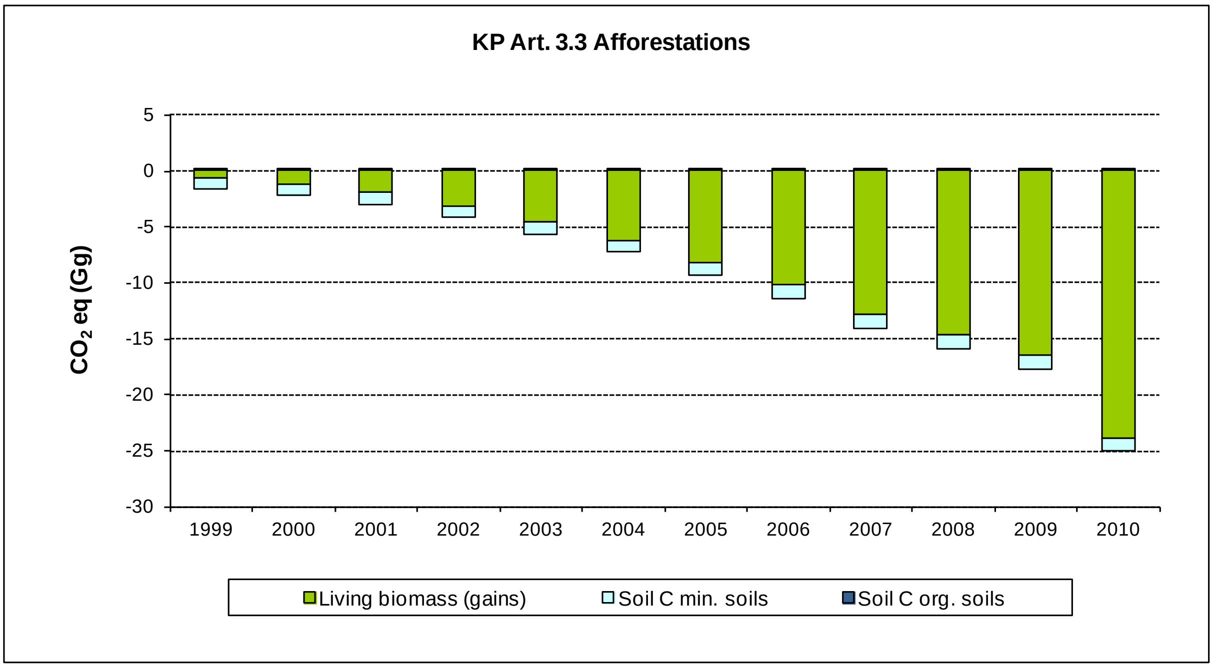
All activities reported started in 1990, i.e. before the beginning of the first commitment period.

11.3.2 Category-Specific QA/QC and Verification

In Chapter 7.3.6 category-specific QA/QC and verification items for forest land are described in detail. Differences between the forest areas reported in “Forest Sector 5A1 and 5A2” under UNFCCC and „Forest Management“ under KP Art. 3.4 are explained in Chapter 11.3.1.1. For transparency reasons, we will add a table in the next submission showing the specific areas of all Land-Use-Categories under 5A1, 5A2 (UNFCCC-reporting) and activities under the Kyoto Protocol.

11.4 Article 3.3.

Figure 11-2 shows removals of CO_2 eq from Afforestations and emissions of CO_2 eq from Deforestations for the years 1999-2010. The corresponding values are listed in Table 11-4. Most emission factors are retrieved from the Swiss National Forest Inventory (NFI, see also Chapter 7.3.4.1).



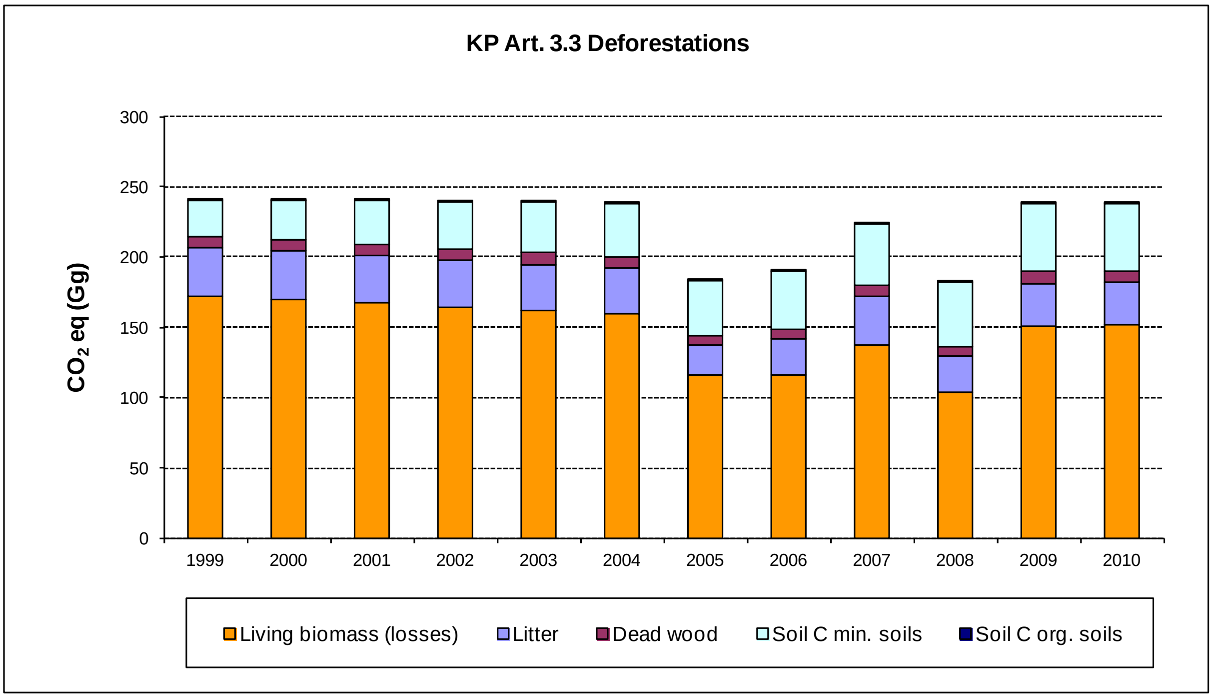


Figure 11-2 Removals (negative sign) and emissions (positive sign) of CO_2 eq from Afforestations (upper panel) and from Deforestations (lower panel) shown per carbon pool, 1999-2010.

The order of magnitude of total removals or emissions of CO_2 eq from Afforestations and Deforestations is considerably different (Figure 11-2). Since carbon from living biomass is immediately removed after clear-cutting, Deforestation can be seen as a “quick carbon-losing process”. In contrast, due to the slow increase of living biomass, Afforestation is a “slow process with increasing importance” in terms of carbon accumulation. CO_2 emissions on organic soils under afforestations are due to drainage (see Chapter 11.3.1.2). Under deforestations, CO_2 emissions are reported because of a change in land-use (see Chapter 11.3.1.1 for a detailed description of methodology).

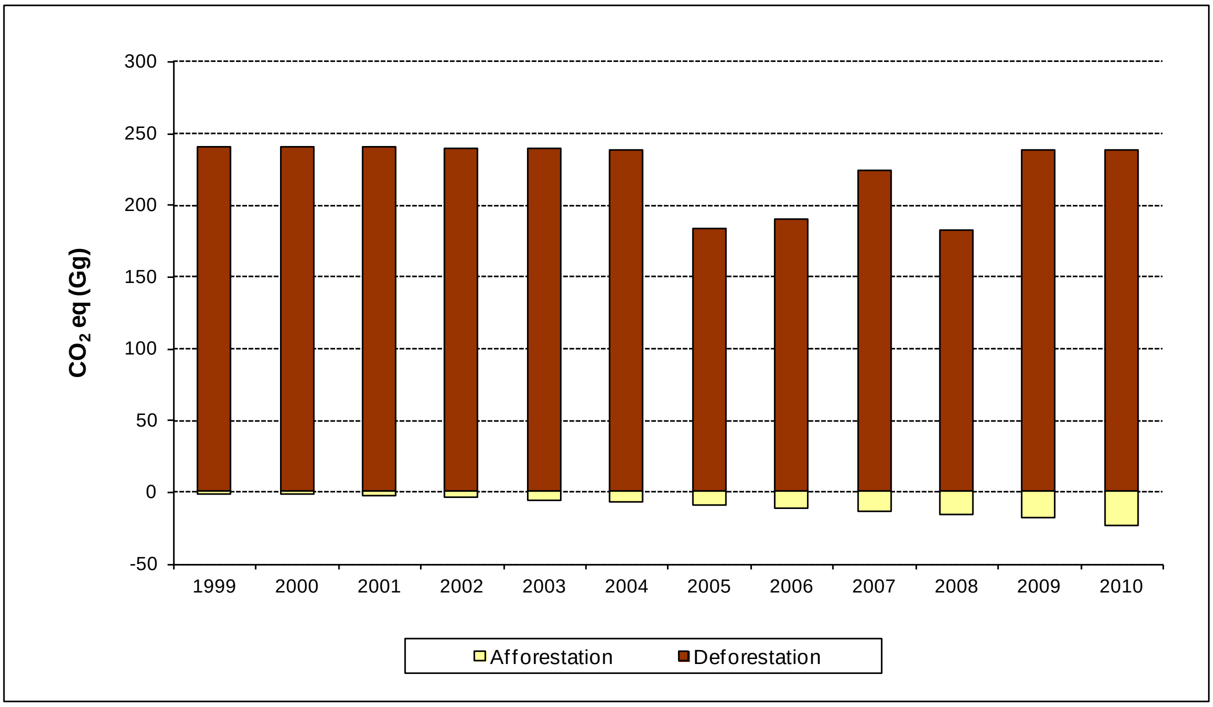


Figure 11-3 Removals (negative sign) and emissions (positive sign) of CO_2 eq of Afforestations and Deforestations, 1999-2010.

11.4.1 Information that demonstrates that Activities under Article 3.3. began on or after 1 January 1990 and before December 2012 and are direct Human-induced.

The Swiss definitions of Afforestation and Deforestation only consider directly human-induced activities (see FOEN 2006h, Sect. E and FOEN 2010d).

Reforestation

For more than 100 years, the area of forest in Switzerland has been increasing (see Chapter 11.5.3), and a decrease in forest area as a result of deforestation is prohibited by the Federal Law on Forests (Swiss Confederation 1991). Therefore, reforestation of areas not forested for a period of at least 50 years does not occur in Switzerland (FOEN 2006h, Sect. E). Switzerland only considers Afforestation and Deforestation under Article 3, paragraph 3.

Afforestation

Switzerland is very restrictive in reporting Afforestations under the Kyoto Protocol and only reports planted Afforestations (see Chapter 11.1.3; FOEN 2010h).

The annual rate of Afforestation since 1990 is assessed by AREA (Chapter 7.2.2). For reporting under the Kyoto Protocol, afforested areas since 1990 always remain in the "Afforestation" category. Therefore, the area of Afforestations is increasing since 1990 (see Table 11-5).

Afforestations older than 20 years are subject to normal forest management practices including harvesting. These areas are reported in CRF Tables 5(KP-I)A.1.2 and 5(KP-I)A.1.3.

Deforestation

In Switzerland, direct human-induced Deforestation is subject to authorization (Swiss Confederation 1991, Art. 5). Only deforestations carried out after 01 January 1990 are considered. For reporting under the Kyoto Protocol, deforested areas since 1990 remain in the "Deforestation" category. Therefore, the area of Deforestations is increasing since 1990 (see Table 11-5). Since Switzerland decided to only account for KP Art. 3.4 activity "Forest Management", these deforested areas are not subject to another KP Art. 3.4 activity.

11.4.2 Information on how Harvesting or Forest Disturbance that is followed by the Re-Establishment of Forest is distinguished from Deforestation

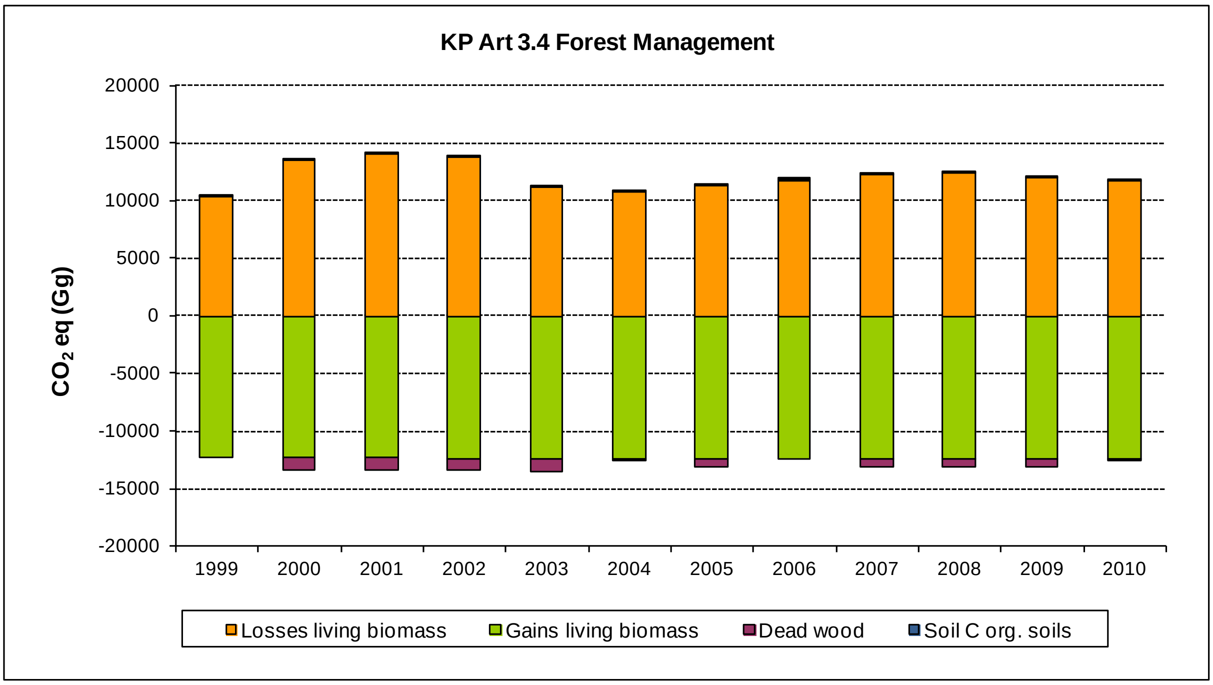
The Swiss definition of Deforestation only covers permanent conversions from forest land into non-forest land and is assessed by AREA applying the criteria discussed in chapter 11.2.3. They implicitly distinguish between permanent conversions and transient situations like harvesting or forest disturbance. Construction of e.g. pipelines and power supply lines within a forest area are transient situations (see Chapter 11.1.3 and 11.2.3). As described in FOEN (2010d), these non-permanent conversions are not classified as Deforestation under the Kyoto Protocol.

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

AREA provides a detailed overview of land-use changes with regard to land cover and land use (see Chapter 7.2). Temporal changes of land cover can lead to a reclassification in AREA from a forest category to a non-forest category. In FOEN (2010d) and in Chapter 11.2.3 the criteria are listed which conversions from a forest combination category to a non-forest combination category are not identified as Kyoto Deforestation under the Kyoto Protocol.

11.5 Article 3.4

CO_2 eq emissions and removals from the reported pools and total CO_2 eq emissions and removals of the Kyoto Protocol activity Forest Management for the years 1999 until 2010 are shown in Figure 11-4. The corresponding values are listed in Table 11-4. Most emission factors are retrieved from the Swiss National Forest Inventory (NFI, see also Chapter 7.3.4.1).



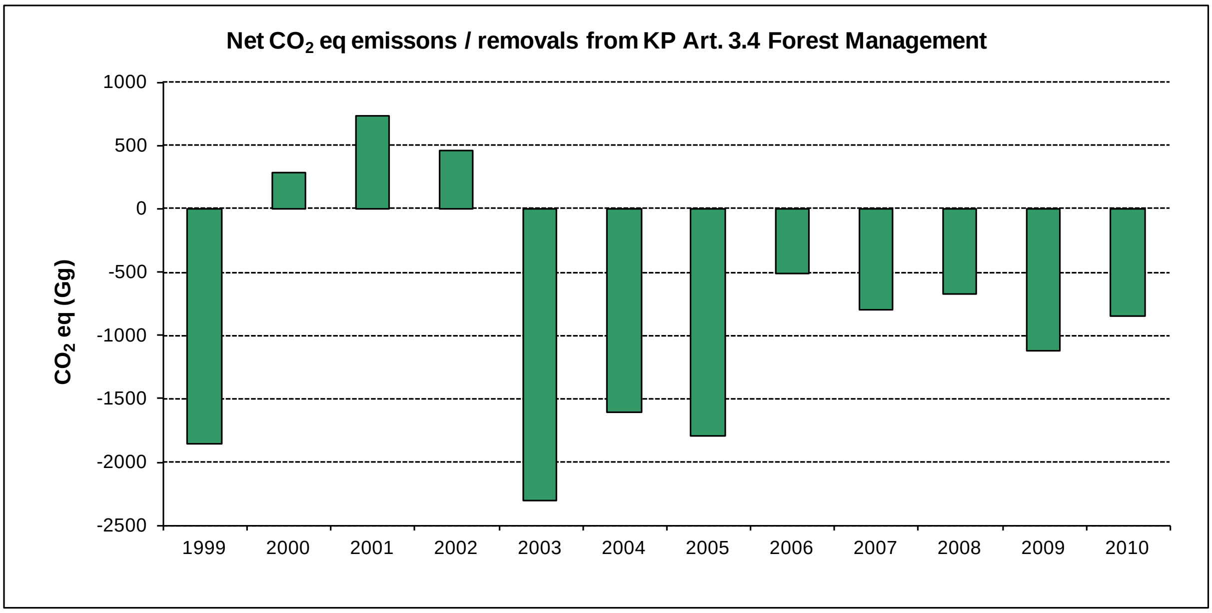


Figure 11-4 CO_2 eq emissions (positive sign) and removals (negative sign) from the reported carbon pools under Forest Management (upper panel) and the total CO_2 eq emissions and removals from Forest Management (lower panel), 1999-2010.

The yearly fluctuations in the greenhouse gas emissions and removals from Forest Management can mainly be explained by changes in the losses of living biomass and differences in stock of dead biomass (cf. Table 11-4). Changes in the area of managed forest are relatively small (Table 11-5). In 2000, 2001 and 2002, Forest Management in Swiss forests caused CO_2 eq emissions. This was due to an elevated amount of losses in living biomass after storm Lothar, which ravaged Swiss forests in December 1999.

11.5.1 Information that demonstrates that Activities under Article 3.4. have occurred since 1 January 1990 and are Human-induced

According to the Swiss Federal Law on Forests, the extent and the spatial distribution of the total forest area in Switzerland has to be preserved (Swiss Confederation 1991, Art. 1) and thus, any change of the forested area has to be authorized. All Swiss forests are under continuous observation of the Swiss Forest Service and monitored by the NFI. Therefore, all forests in Switzerland are subject to Forest Management (FOEN 2006h, Sect. F).

11.5.2 Information relating to Cropland Management, Grazing Land Management and Revegetation, if elected, for the Base Year

Not applicable.

11.5.3 Information Relating to Forest Management

There is a long tradition of forest protection in Switzerland. The first federal Forest Act came into force in 1876, but it only covered the Alpine region. Its aim was to put a halt to the depletion of forests, to manage the remaining forest areas in a sustainable way, and to promote afforestation. The Forest Act of 1902 covered the whole country. The Forest Act as well as an enabling overall economic development resulted in an increase of the forested area in Switzerland by nearly 50% compared to the mid-19th century (Figure 11-5). Also growing stock increased significantly due to changes in forest management practices. The Forest Act (Swiss Confederation 1991) that came into force in 1993 reaffirms the long-standing Swiss tradition of preserving both forest area and forest as a natural ecosystem. It prescribes sustainable forest management, prohibits clearing, and bans deforestation unless it is replaced by an equal area of afforested land or an equivalent measure to improve biodiversity.

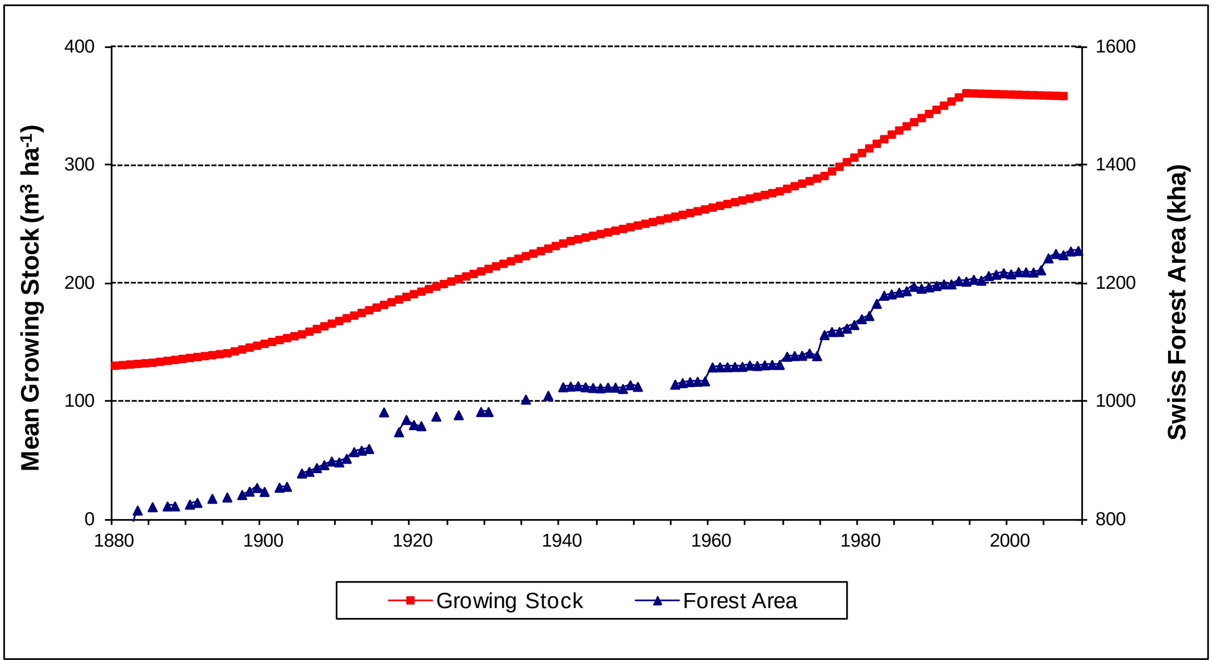


Figure 11-5: Historical mean growing stock and forest area in Switzerland since 1880.

In 2004, the Swiss national forest programme was published, outlining an action plan for the period 2004-2015 (SAEFL 2004b). It specifies five priority objectives: (1) the forest's protective function is guaranteed, (2) the economic viability of the forestry sector is improved, (3) the value-added chain for wood is strengthened, (4) biodiversity is conserved and (5) forest soils, trees and drinking water are not threatened. These objectives encompass that CO_2 removals by sinks and emissions by sources in the forests shall be recognized in terms of compliance with the Kyoto Protocol while making better use of the potential of forests for timber production and fuel wood through economic incentives and implementing new technologies.

In November 2006, the Swiss government communicated in its initial report to the UNFCCC that Switzerland will be accounting for Forest Management under Article 3.4 of the Kyoto Protocol (FOEN 2006h).

To implement the objectives of the national forest programme (SAEFL 2004b), FOEN has formulated its wood resource policy (FOEN 2008h) which is coordinated with the other relevant sectoral policies (e.g. energy policy, regional development policy). This wood resource policy defines, among other things, the direction to be taken by federal policy in relation to wood promotion on completion of the "Wood 21" wood promotion programme which was terminated at the end of 2008. Under this programme, a wood action plan was started in 2009. The main focus in the implementation of the action plan lies on the ecologically and economically effective use of wood. With a view to the efficient use of wood, cascade use is prioritized, i.e. wood is used as material prior to its use for energy. In the case of energy use, greater overall efficiency of the conversion technology should be targeted.

11.6 Other Information

11.6.1 Key Category Analysis for Article 3.3. and 3.4. Activities

The results of the Tier 2 key category analysis including LULUCF are shown and explained in Chapter 1.5 and are displayed in Table 1-9 for the year 2010. The smallest UNFCCC category considered key based on a Tier 2 level assessment is “6D Waste, Other, CH_4” with a contribution of 95.23 Gg CO_2 eq.

The following LULUCF activities under the Kyoto Protocol are listed in Kyoto Table NIR 3 (Table 11-3) because their associated LULUCF categories in the UNFCCC inventory are key categories under the level or trend assessment:

- **Forest Management** (-850.38 Gg CO_2 eq) is a key category under the Kyoto Protocol because its absolute contribution is higher than the smallest category considered key (95.23 Gg CO_2 eq for Tier 2) in the UNFCCC inventory. This activity is associated with the UNFCCC category „Forest Land remaining Forest Land“ (-945.76 Gg CO_2 eq). Since the total Swiss forest is considered as managed, there is a good agreement between the category under the Kyoto Protocol and the UNFCCC inventory category. According to Table 1-9, the UNFCCC category ”Forest Land remaining Forest Land“ is both level and trend key category under a Tier 2 assessment in 2010.

- **Afforestation and Reforestation** (-23.08 Gg CO_2 eq) is not a key category under the Kyoto Protocol because its absolute contribution is substantially lower than the smallest category considered key (95.23 Gg CO_2 eq for Tier 2) in the UNFCCC inventory. Natural forest regeneration due to abandonment of land is not reported as Afforestation under the Kyoto Protocol. The contribution of the associated UNFCCC category “Land converted to Forest Land” is 1205.09 Gg CO_2 eq. The UNFCCC category “Land converted to Forest Land” is both level and trend key category under a Tier 2 assessment in 2010 (Table 1-9).

- **Deforestation** (238.49 Gg CO_2 eq) is a key category under the Kyoto Protocol because its contribution is higher than the smallest UNFCCC category considered key (95.23 Gg CO_2 eq for Tier 2). The associated UNFCCC category is „Land converted to Settlements” (297.07 Gg CO_2 eq), but only a part of this UNFCCC category represents the activity Deforestation under the Kyoto Protocol. The UNFCCC category ”Land converted to Settlements” is both level and trend key category under a Tier 2 assessment in 2010 (Table 1-9).

11.7 Information Relating to Article 6

Switzerland does not host Joint Implementation projects.

12 Information on Accounting of Kyoto Units

12.1 Background Information

The Swiss Registry completed the go-live process and got fully operational with the International Transaction Log (ITL) on December 4, 2007. As part of the go-live process the entire Assigned Amount of 242’838’402 has been issued as AAUs.

The user interface is located on the Swiss national registry website (www.national-registry.ch). Switzerland uses the Seringas™ registry software, which has been developed by the French Caisse des Dépôts et Consignations, CDC and cooperates with Liechtenstein and Monaco by hosting the Registry of these Parties on Swiss servers. However, all three National Registries are maintained as independent systems with independent registry administrators.

The following registry systems’ reporting includes the standard electronic format (SEF) tables and the standard independent assessment report (SIAR) tables in accordance with sections E and G of the annex to decision 15/CMP.1.

12.2 Summary of Information Reported in the SEF Tables

The Standard Electronic Format report for 2011 has been submitted to the UNFCCC Secretariat electronically.
By the end of the reporting year 2011 a total balance of 290,881,886 Assigned Amount Units (AAUs) were held in the national registry (Fig. 1), which represents a decrease of approximately 22 million units compared to 2010. From the initial assigned amount of 242,838,402 AAUs, 13,541,247 units have been allocated to companies participating in the Swiss Emissions Trading Scheme for the years 2008, 2009, 2010, and 2011. 172,587 AAUs have been cancelled under Article 3.3/3.4 into Switzerland’s Net Source Cancellation account. The remaining 229,124,568 units are held on the party account. An additional 8 AAUs have been voluntary cancelled in 2011, with 12 AAUs having been cancelled in 2010.

21,939,124 Certified Emission Reductions (CERs) were held in the national registry. This is a notable increase of over 9.65 million units compared to the previous reporting year. 578,809 CERs have been voluntarily cancelled. 7,637,735 Emission Reduction Units (ERUs) were held in the national registry, an increase of approximately 2.36 million ERUs.

Table 12-1 Total quantities of Kyoto Protocol units by account type at the end of 2011 (SEF table 4)

Party	Switzerland
Submission year	2012
Reported year	2011
Commitment period	1

Table 4. Total quantities of Kyoto Protocol units by account type at end of reported year

Account type	Unit type					
	AAUs	ERUs	RMUs	CERs	tCERs	lCERs
Party holding accounts	229124568	NO	889349	28740	NO	NO
Entity holding accounts	61584711	7637735	NO	21331575	NO	NO
Article 3.3/3.4 net source cancellation accounts	172587	NO	NO	NO		
Non-compliance cancellation accounts	NO	NO	NO	NO		
Other cancellation accounts	20	NO	NO	578809	NO	NO
Retirement account	NO	NO	NO	NO	NO	NO
tCER replacement account for expiry	NO	NO	NO	NO	NO	
lCER replacement account for expiry	NO	NO	NO	NO		
lCER replacement account for reversal of storage	NO	NO	NO	NO		NO
lCER replacement account for non-submission of certification report	NO	NO	NO	NO		NO
Total	290881886	7637735	889349	21939124	NO	NO

12.3 Discrepancies and Notifications

Switzerland's reports on discrepancies (R-2), CDM notifications (R-3), non-replacements (R-4) including reversal of storage and failure of certification and invalid units (R-5) have been uploaded on the UNFCCC Submission Portal.

During the reported year 2011, the Swiss registry had no discrepancies, no CDM notifications, no non-replacements including reversal of storage and failure of certification and no invalid units. Therefore the SIAR tables R-2, R-3, R-4 and R-5 are empty and no actions and changes have been taken to address discrepancies.

12.4 Publicly Accessible Information

In accordance to section E of the annex to decision 13/CMP.1 the Swiss registry makes non-confidential information available to the public via webpage or user-interface.

Non-confidential information is publicly available on the Swiss national registry website www.national-registry.ch. The national allocation plan is accessible under "National Allocation Plan". All other information can be downloaded by selecting the menu item "Public reports". The Reports "List of legal entities holding an account in the national registry", "List of installations created in the national registry", "List of accounts opened in the national registry", "Summary statement on the quantity of surrendered Allowances", "Surrendered allowances table", "Compliance statement status table" and "Annual summary of quantity per type of operation made in the national registry" are publicly accessible on www.national-registry.ch.

Data of transfers and holdings of individual accounts are considered as business secrets and the disclosure may prejudice their competitiveness. Information on acquiring and transferring units of companies (as legal persons) is therefore regarded as personal data. Article 19 of the Federal Act on Data Protection (FADP, SR 235.1 Bundesgesetz vom 19. Juni 1992 über den Datenschutz (DSG) 2) enacts that Federal bodies may disclose personal data if there is a legal basis for doing so or if there is an overriding public interest. In the present case these conditions are not fulfilled. Therefore the registry of Switzerland cannot make the information on acquiring and transferring accounts publicly available and considers them as confidential. A statement on which information is considered as confidential can be found on the public website www.national-registry.ch.

All other information referred to in paragraphs 44 to 48 to the annex to decision 13/CMP.1 are made publicly available by the Swiss registry, if they are not covered by the above mentioned articles.

Information related to Article 6 projects is publicly accessible on the website (http://www.bafu.admin.ch/emissionshandel/05556/05560/index.html?lang=en&lang=en). Switzerland does not host JI-projects and therefore no issuance of ERUs has taken place.

12.5 Calculation of the Commitment Period Reserve (CPR)

The commitment period reserve remains unchanged and is the same as defined in the update of the Initial Report (submitted on 20 December 2007; FOEN 2006h). The calculation of the commitment period reserve is based on the assigned amount (Method 1 in Table 12-2).

Table 12-2 Calculation of the commitment period reserve

Method 1 (based on assigned amount)	**Method 2 (based on latest reviewed submission)**
90 % of the assigned amount [t CO_2 equivalent]	Total of 2009 emissions of sectors 1,2,3,4,6 times 5 [t CO_2 equivalent]
242 838 402 x 0.9 = **218 554 562**	51 937 940 x 5 = **259 689 700**

Method 1 results in the lower value.

The commitment period reserve of Switzerland is calculated as 218 554 562 tonnes CO_2 equivalent.

12.6 KP-LULUCF Accounting

According to the "Report of the individual review of the annual submission of Switzerland submitted in 2010" (http://unfccc.int/resource/docs/2011/arr/che.pdf), Switzerland was allowed to issue 716,763 removal units (RMU) in its national registry. Based on the Net Source Cancellation notification of the ITL (ID: 1000200466) from 31 May 2011, Switzerland initially cancelled 172,587 AAUs for its Deforestation activity into its Net Source Cancellation account, and subsequently issued 35,243 removal units (RMUs) for Afforestation and Reforestation as well as 854,106 RMUs for Forest Management (a total of 885,349 RMUs). The resulting balance equals 716,762 RMUs.

13 Information on Changes in National System

The initial Swiss national inventory system is described in detail in FOEN (2006h). The detailed description of the national inventory system is updated annually in the description of the quality management system (FOEN 2012a). Changes to the national system in accordance with 15/CMP.1, annex II, 30a-g are listed below.

Change of name or contact information (15/CMP.1 annex II.D 30a):
National inventory compiler:
Mr. Beat Mueller (replacing Sophie Hoehn as of 1. March 2012)
beat.mueller@bafu.admin.ch
Phone: +41 31 322 07 88

All other contact information remains unchanged.

Change of roles and responsibilities as well as change of the institutional, legal and procedural arrangements (15/CMP.1 annex II.D 30b):
The current arrangements for cooperation within the national inventory system are shown in Table 13-1. Changes are marked in bold.

Changes in the process of inventory compilation (15/CMP.1 annex II.D 30c):
No changes.

Change of key source identification and archiving (15/CMP.1 annex II.D 30d):
No changes.

Change of process for recalculations (15/CMP.1 annex II.D 30e):
No changes.

Changes to QA/QC plan, activities and procedures (15/CMP.1 annex II.D 30f):
No Changes.

Change to official consideration and approval procedures (15/CMP.1 annex II.D 30g):
No changes.

Table 13-1: Formal arrangements for cooperation within the national inventory system. Items marked in bold have changed in the past year.

Partner	Subject/Sector	Type of arrangement	Duration
Institutions of the federal administration			
Swiss Federal Office of Energy (SFOE)	Energy statistics	Agreement	**open-ended**
Federal Office of Civil Aviation (FOCA)	Aviation emissions	Agreement	**open-ended**
Swiss Federal Statistical Office (SFSO)	**LULUCF (area surveys)**	**Agreement**	**open-ended**
Agroscope Reckenholz-Tänikon research station ART	Agriculture emissions and removals	Contract	2009-2012
FOEN air pollution control and non-ionizing radiation division	- EMIS inventory data base & archive - Energy emissions - Industrial process emissions (without F-gases) -Solvent and Other Product Use emissions - Waste emissions **-** Key category analysis	Documentation of roles and responsibilities	**open-ended**
FOEN forest division	Forestry emissions and removals	Documentation of roles and responsibilities	2014

Private companies			
Carbotech	F-gas emissions	Contract	renewed annually
Sigmaplan / Meteotest	LULUCF data compilation	Contract	renewed annually
EBP / INFRAS	- NIR - Uncertainty analysis	Contract	2009-2014
Prognos / TEP (in collaboration with CEPE / Basics, the former contractor)	Allocation of energy data to specific industrial and commercial sectors	Contract	renewed annually

14 Information on Changes in National Registry

Table 14-1: Changes in the national registry in accordance with §32 decision 15/CMP.1

Annual Submission Item	Reporting
15/CMP.1 annex II.E paragraph 32.(a): Change of name or contact	Main contact: Ms. Christine Kieffer Phone: +41 31 322 95 23 christine.kieffer@bafu.admin.ch Alternative contact: Mr. Stefan Meier Phone: +41 31 325 34 85 stefan.meier@bafu.admin.ch
15/CMP.1 annex II.E paragraph 32.(b): Change of cooperation arrangement	No change in this submission
15/CMP.1 annex II.E paragraph 32.(c): Change of the database or the capacity of National Registry	No change in this submission
15/CMP.1 annex II.E paragraph 32.(d): Change of conformance to technical standards	Switzerland's National Registry software (Seringas™) has been updated from version 4.2 to 5.3 (including all relevant patches of version 4.2). The new version significantly increased the operational as well as user security (e.g. two-factor authentication). Please refer to the Seringas release notes (Seringas 2010, Seringas 2010a) for a detailed list of changes. To reflect several changes of the new software version, the General Terms and Conditions had to be amended. All registry users have been subsequently informed about these changes by email. On the same occasion, the upgrade of the new software version was also communicated. We have been in contact with the ITL Service Desk on a continuing basis during our testing phase as well as for the go-live of the PROD environment after the upgrade of the new software version. Prior to the installation of the new software version, extensive tests have been performed on the REG (test) environment. Please find the detailed test report (FOEN 2011h) (in German).
15/CMP.1 annex II.E paragraph 32.(e): Change of procedures	No change in this submission

15/CMP.1 annex II.E paragraph 32.(f):
Change of Security
	The Swiss Registry has implemented the two-person rule on a voluntary basis in 2011. By 1 April 2012, it will become mandatory for all accounts in the Swiss Registry. Next to several other security improvements, the two-factor authentication (by smsTAN) was also implemented with the new release of the registry software. It will become mandatory for all registry users by 1 October 2012.
	• Registry software changes:
	    o Improved password standards
	    o Hardening against OWASP (Open Web Application Security Project) top ten vulnerabilities
	    o Many minor bug fixes
	• Setup of an additional Web Application Firewall (WAF) in addition to the existing stateful inspection (SPI) firewall
	• Process and Organisation Changes
	    o Dedicated workstations for registry administration
	    o Account application process underwent security improvement
	    o Introduction of two-person rule (mandatory as of 1 April 2012)
	    o Introduction of two-factor-authentication (mandatory as of 1 October 2012)
	Additional confidential material regarding security issues can be made available to reviewers on request.

15/CMP.1 annex II.E paragraph 32.(g): Change of list of publicly available information	No change in this submission
15/CMP.1 annex II.E paragraph 32.(h): Change of Internet address	No change in this submission
15/CMP.1 annex II.E paragraph 32.(i): Change of data integrity measures	No change in this submission
15/CMP.1 annex II.E paragraph 32.(j): Change of test results	No change in this submission

Following the recommendation of the 2011 SIAR Part 2, the two-person rule (additional authorised representative) has been implemented on a voluntary basis already in 2011. It will become mandatory for all accounts in the Swiss Registry on 1 April 2012. With the installation of the new release of the registry software, the two-factor authentication by smsTAN was also implemented. The registry users will have the possibility for registering a mobile phone number by 1 April 2012. The two-factor authentication will become mandatory for all registry users by 1 October 2012.

15 Information on Minimization of Adverse Impacts in Accordance with Article 3, Paragraph 14

The Convention (Art. 4 §8 and §10) and its Kyoto Protocol (Art. 2 §3 and Art. 3 §14) commit Parties to strive to implement climate policies and measures in such a way as to minimize adverse economic, social and environmental impacts on developing countries when responding to climate change.

Context

Switzerland strives to design climate change policies and measures in a way as to ensure a balanced distribution of mitigation efforts by implementing climate change response measures in all sectors and for different gases. Indirectly, this approach is deemed to minimize also the scope of potential adverse impacts on concerned actors (including developing countries). Due to Switzerland's size and share related to international trade – mainly concentrated on the EU – and greenhouse gas emissions, it is not assumed that Swiss climate change policies have any significant adverse economic, social and environmental impacts in developing countries. Additionally, the policies and measures are very much compatible and consistent with those of the European Union in order to avoid trade distortion, non-tariff barriers to trade and to set similar incentives. All major projects of law in Switzerland are accompanied by impact assessments, inter alia including evaluation of trade-related issues. In accordance with international law, this approach strives at ensuring that Switzerland is implementing those climate change response measures, which are least trade distortive and do not create unnecessary barriers to trade. Consistently, Switzerland notifies all proposed non-tariff measures having a potential impact on trade to the WTO, where specific concerns can be raised by other parties. Moreover, Switzerland belongs to the most important donors in the area of Aid for Trade. SECO's technical assistance for trade promotion amounts to CHF 42 million for the year 2010 (non-reimbursable grant contributions).

The impact assessment is accompanied by a broad internal and external consultation process, inter alia inviting competent actors to provide advice on international economic, social and environmental aspects of proposed policies and measures. The open public consultation process, together with regular policy dialogues with other countries guarantee that all domestic and foreign stakeholders can raise concerns and issues about new policy initiatives, i.e. including those concerns about possible adverse impacts on other countries.

Progressive reduction or phasing out of market imperfections, fiscal incentives, tax and duty exemptions and subsidies in all greenhouse-gas-emitting sectors, taking into account the need for energy price reforms to reflect market prices and externalities

Environmental policy in Switzerland, including climate change policies, are guided by the "polluter pays" principles, as enshrined in the Federal Law on the Protection of the Environment. Accordingly, the internalization of external costs and adequate price signals are key aspects of Switzerland's climate change policy. Regarding greenhouse gas emissions, market-based instruments, such as the Swiss Emissions Trading Scheme, the supplemental use of Certified Emission Reductions from the Clean Development Mechanism or levies for heating and process fuels are important measures to put a price on emissions of greenhouse gases (see Fifth National Communication for more details), thus reflecting market prices and internalizing externalities.

Fiscal incentives, tax and duty exemptions and subsidies

Fiscal incentives are recognized as an essential instrument for promoting the efficient use of resources and to reduce market imperfections. In 2001 Switzerland introduced a heavy vehicle fee (HVF). It is applied to passenger and freight transport vehicles of more than 3.5 tonnes gross weight. The impact of the HVF introduction was most clearly reflected by changes in traffic volume (truck-kilometres) but also in reduced air pollution, a renewal of the heavy vehicle fleet and an increase of load per vehicle, fewer trucks have transported more goods. Two thirds of the revenues are used to finance major railway infrastructure projects (such as the two base tunnels through the Alps), and one third is transferred to the cantons.

In 2008 Switzerland introduced a CO_2 levy on heating and process fuel to set an incentive for a more efficient use of fossil fuels, promote investment in energy-efficient technologies and the use of low-carbon or carbon-free energy sources. Companies, especially those industries with substantial CO_2 emissions from use of heating fuels, may apply for exemption from the CO_2 levy, provided the company commits to emission reductions. The company has to elaborate an emission reduction target, based on the technological potential and economic viability of various measures within the company. While the proceeds from the CO_2 levy were initially to be fully and equally refunded to the Swiss population and to the business community in proportion of wages paid, a parliamentary decision of June 2009 earmarked a third (up to CHF 200 million per year) of the revenues from the CO_2 levy to CO_2 relevant measures in the building sector (Building refurbishment programme).

The economic impact of the Swiss climate policy was analysed in two studies[19]. The impact is considered to be very small.

Switzerland generally does not subsidize fossil fuels. Meanwhile, there are some minor schemes in place that may be regarded as fossil fuel subsidies. In international comparison, however, these schemes are very limited: At the federal level, a few tax exemptions and reductions provide some form of support to users of fossil fuels. Farmers, foresters and fishermen are exempt from the mineral oil tax that is normally levied on sales of mineral oils, while transport companies benefit from a reduced rate. Some vehicles are also exempt from the performance-related Heavy Vehicle Fee (HFV), e.g. agricultural vehicles, vehicles used for the concessionary transport of persons or vehicles for police, fire brigade, oil and chemical emergency unit, civil protection and ambulances.

The need for energy prices reforms

World-wide subsidies for fossil fuels are estimated at 300-500 billion USD per annum, depending on the level of energy prices. This huge market distortion does not only produce severe fiscal problems for the countries concerned, it is also a major obstacle for enhanced investments in energy efficiency measures and renewable energies.

Switzerland as a member of the Friends of Fossil Fuels Subsidies Reform group supports the gradual and sustained reduction of unnecessary market-distortions. Switzerland under its Economic Development Cooperation supports partner countries in the design and implementation of energy tariff reforms, as an element of infrastructure financing programs. Switzerland has been an initiator of specialized international programs, including the World Bank's Energy Sector Management Program ESMAP. The Energy Efficiency Governance Handbook has been produced with Swiss financing (IEA/EBRD 2010).

[19] Ecoplan (2009): Volkswirtschaftliche Auswirkungen der Schweizer Post-Kyoto-Politik, im Auftrag des BAFU. BAFU (2010): Synthesebericht zur Volkswirtschaftlichen Beurteilung der Schweizer Klimapolitik nach 2012.

Removing subsidies associated with the use of environmentally unsound and unsafe technologies

Switzerland doesn't subsidize the use of environmentally unsound and unsafe technologies.

Strengthening the capacity of developing country Parties for improving efficiency in upstream and downstream activities relating to fossil fuels, taking into consideration the need to improve the environmental efficiency of these activities

Switzerland supports through different projects the enhancement of efficiency in industrial production, i.e. "cleaner production". These cleaner production projects promote eco-efficient means of production and better working conditions attained through technical improvements and behavioural changes in both management and staff in industrial companies and services. The resulting rise of economic and environmental efficiency and improved competiveness is gained through the systematic optimisation of energy use, processing of raw material, more efficient use of resources and thus better protection of the environment.

Furthermore, there is a rising awareness and demand by consumers for environmentally sound products. In order to alleviate potential adverse economic impacts of corresponding national measures Switzerland promotes and supports the development of international standards, especially with regard to the sustainable use of natural resources (including agricultural commodities), e.g. through the creation of sustainability standards, financial incentives and favourable framework conditions in developing countries by consultancy services and technology transfer. Further information is contained in Chapter 7 of Switzerland's Fifth National Communication (FOEN 2009d).

Assisting developing country Parties which are highly dependent on the export and consumption of fossil fuels in diversifying their economies

Most developing and transition countries have, in recent years, taken important steps towards trade liberalisation, in order to frame their trade policies in line with multilateral trade agreements. The Swiss State Secretariat for Economic Affairs (SECO) promotes these efforts, because a multilaterally acknowledged and respected set of regulations for international transactions not only strengthens trade as such, but also creates more potent and legally secure markets to the advantage of all the players.

The measures taken by SECO are aimed at creating the necessary conditions for earning additional income in the beneficiary countries and thereby contribute directly to the alleviation of poverty. SECO is focusing on three areas of intervention along the value chain: (i) International competitiveness (ii) Enabling framework conditions for trade (iii) Improving market access.

For example market access: Trade between developing and industrial countries is still insufficiently developed respectively not diversified enough. On one hand, the developing countries lack the necessary production capacities, transport infrastructure and know-how; on the other hand, tariff and non-tariff barriers to trade make direct access to markets more difficult.

Switzerland promotes access to Swiss markets by granting preferential tariffs on products from developing and emerging countries. In addition, SECO runs programmes for promoting imports to Switzerland and the rest of Europe. The easing of market entry for products from disadvantaged countries is an important contribution to the promotion and diversification of trade, the increase of export revenues and thus to the economic development of the partner countries. Switzerland supports developing and transition countries in the following areas:

- Generalized system of preferences (GSP)

- Swiss Import Promotion Program (www.sippo.ch)

- Development of new private voluntary social and environmental standards based on international multi-stakeholder approaches: private sustainability standards Better Cotton, 4C (Common Code for the Coffee Community), Roundtable for Sustainable Biofuels, etc.

Finally, Switzerland is a strong supporter of the EITI (Extractive Industries Transparency Initiative). We share a belief that the prudent use of natural resource wealth should be an important engine for sustainable economic growth that contributes to sustainable development and poverty reduction, but if not managed properly, can create negative economic and social impacts. The sustainable management of natural resource wealth – as supported by EITI principle and criteria incl. regular publication and audit of revenues – is key to mobilize the funds for diversification strategies.

Changes compared to the latest submission

While there have been no changes in Switzerland’s measures to minimize adverse impacts, a paragraph has been added to the section above on fiscal incentives, tax and duty exemptions to describe the national circumstances in more detail.

16 Other Information

This Chapter contains Switzerland's public version of the response to the Saturday Paper. Together with this response, Switzerland has also submitted a resubmission of the CRFs to the UNFCCC in November 2011 (FOEN 2011b):

Bonn 24 September 2011

Potential Problems and Further Questions from the ERT formulated in the course of the 2011 review of the greenhouse gas inventories of the Switzerland submitted in 2011

For the ERT,

Mr. Kiyoto Tanabe,

Lead Reviewer

Mr. Hongwei Yang,

Lead Reviewer

Inventory related potential problems

With reference to the Guidelines for review under Article 8 of the Kyoto Protocol, the ERT requests that additional information and/or revised estimates for the 2009 greenhouse gas (GHG) inventory corresponding to the potential problems identified in this paper (see attached tables) be forwarded to the ERT, through the UNFCCC secretariat, not later than by 7 Nov 2011.

Should Switzerland decide to submit by 7 Nov 2011, in response to some or all potential problems, revised estimates of its GHG emissions, the ERT requests that the revised estimates contain the following:

- Relevant background information and a descriptive summary of the revisions made by Switzerland in its 2011 inventory submission, in particular in the year 2009 with respect to CH_4 from liquid fuels, road transportation (energy), CH_4 from carbide production (IP), CO_2 from solvents and other product use, CO_2 from deforestation (KP-LULUCF);
- A complete resubmission of the 2011 CRF tables, reflecting the revised estimates for the entire time series 1990–2009;
- A complete resubmission of the 2011 KP-LULUCF CRF tables (for 2008 and 2009), reflecting the revised estimates and updated tables.
- Should Switzerland provide the revised estimates for KP-LULUCF activities for 2008 and 2009, the ERT requests to submit the information about the removal units (RMUs) that intent to issue or cancel for these years.

ATTACHMENT A

Overview of inventory potential problems identified for 2009

Annex A sources

2011 GHG inventory review

Switzerland

Abbreviations:

GPG: IPCC good practice guidance

AD: activity data, EF: emission factor, IEF: implied emission factor

KC: key category, ERT: Expert Review Team

Sector, category, sub-category (with code)	Gas	KC / non-KC	Identified inventory problem in terms of:		
			Missing estimate	Estimate provided but not in line with GPG	Estimate provided but lack of transparency
1. Energy, 1.A.3 Transport, 1.A.3.b. road transportation, liquid fuels	CH_4	Non-KC	X		

Description of problem identified:

In its 2011 submission, Switzerland reports CH_4 emissions from natural gas use in road transportation as not occurring (NO) even though there are activity data reported in the CRF and EFs provided in the NIR. The ERT also noted that the CH_4 EFs provided in the NIR (0.0059 g/MJ for 2009) are significantly lower than the Revised 1996 IPCC Guidelines default values (0.29 g/MJ) (p. 1.86 in the Reference Manual).

Switzerland responded to a question raised by the ERT that it is correct that for 2007–2009 EFs are reported in the NIR and therefore CH_4 emissions should have been reported in the CRF tables. Due to a technical error in the export to the CRF Reporter, CH_4 emissions from natural gas from road transportation have not been copied to the CRF Reporter. Switzerland explained that it intends to report the CH_4 emissions in the 2012 submission.

The ERT considers that the omission of CH_4 emissions from natural gas use in road transportation results in an underestimation of emissions.

Recommendation by ERT:

1. The ERT recommends that Switzerland estimate emissions of CH_4 from natural gas use in road transportation for the time series 1990 to 2009 and provide a description of the AD and EF used.
2. Switzerland should use country-specific CH_4 emission factors if they are justified to be the best available factors for Switzerland and are properly documented. If country-specific EFs are not available or considered justifiable, Switzerland should use IPCC default values provided in the Revised 1996 IPCC Guidelines.

Response / Information by Party:

Emissions from CH_4 for 2007-2009 have been estimated according to the methodology already described in the NIR Chapter 3.2.6.9 b) where AD and EF are reported. Data for emissions is country specific and stems from FOEN 2010i: Pollutant Emissions from Road Transport, 1990 to 2035. Updated in 2010. Environmental studies no. 1021. Federal Office for the Environment, Bern. http://www.bafu.admin.ch/publikationen/publikation/01565/index.html?lang=en.

Details of the relevant data are given in the table below: There are two vehicle types in Switzerland that currently use CNG: passenger cars and urban buses (Linienbusse). Emission factors for CH_4 (in t/TJ) from CNG in the transportation sector are based on activity data and actual emissions.

Emission factors in g/Veh-km (vehicle kilometres) for passenger cars are based on “emission functions” derived from a compilation of measurements in various European countries (including Switzerland) with programs using similar driving cycles (legislative as well as standardized real-world cycles, like “Common Artemis Driving Cycle” (CADC)). The method has been developed in 1990-1995 and has been extended and updated in 2000, 2004 and 2010. The underlying database contains a dynamic fleet composition model simulating the release of new exhaust technologies and the fading out of old technologies. Corrective factors are provided to account for future technologies.

Emission factors in g/Veh-km for busses are based on the study by FVT, 2007: Emissions and Fuel Consumption of Clean City Bus Concepts. Report No. FVT-85/06/ Haus Em 29/04-6770. BMLFUW, BAFU, GVB, STGW. Graz. For Switzerland, EF associated with VOLVO 7000 CNG busses (Euro IV) are chosen because this bus type is predominantly used by respective companies. It is assumed that 90% of the total hydrocarbon release (0.75 g/Veh-km) is CH_4, resulting in 0.67 g CH_4/Veh-km (written communication from M. Keller, 2011).

Based on activity data (in Veh-km), emissions are calculated for both vehicle types and summed up. Activity data in vehicle kilometres (Veh-km) is determined according to vehicle stock, transport performance and numbers of starts and stops, as described in the NIR chapter 3.2.6.9b. Ultimately the implied emission factor CH_4 of CNG combustion in road transportation results from dividing the total CH_4 emissions by the total activity data (in TJ). For both factors, data from passenger cars and urban busses is summed up respectively.

Compared to the revised 1996 IPCC guidelines, the country specific implied CH_4-EF for CNG is considerably lower, when referenced to table 1-43 on page 1.86 (0.29 t/TJ). However, in table 1-7 on page 1.35, the revised 1996 IPCC guidelines give a default EF of 0.05 t/TJ. In view of the difference in the IPCC guidelines themselves and given that considerable technological progress has been made over the past decade, we consider the country-specific EF as the better estimate.

As described in the NIR in 3.2.6.9.b), in addition to the fuel consumed in Switzerland, a certain amount is used abroad (tank tourism). While the traffic model only deals with domestic traffic, the energy statistics provides total sales at fuel stations. The difference between the CNG used for transport as reported in the energy statistics and the CNG consumption according to the traffic model is assigned to tank tourism. The same emission factors apply. Please note that in the traffic model CNG use only emerges from 2007. Therefore, all CNG used for traffic falls under tank tourism. However, this has no impact on total emissions.

Emission Factor				
Veh. Cat.	**Fuel**	**2007**	**2008**	**2009**
		g/Veh-km		
Passenger car	CNG	0.016	0.015	0.014
Urban bus	CNG	0.670	0.670	0.670

Activity Data (Traffic Model)				
Veh. Cat.	**Fuel**	**2007**	**2008**	**2009**
		Veh-km		
Passenger car	CNG	27'084'452	56'586'694	67'727'479
Urban bus	CNG	5'647'264	7'474'297	8'009'857

Activity Data				
Veh. Cat.	**Fuel**	**2007**	**2008**	**2009**
		TJ		
Road transportation	CNG	188.70	301.92	339.29
Tank tourism	CNG	51.30	128.08	200.71

Emissions from Road Transportation				
CH_4	**Fuel**	**2007**	**2008**	**2009**
		t		
Passenger car	CNG	0.428	0.830	0.961
Urban bus	CNG	3.784	5.008	5.367
Tank tourism	CNG	1.145	2.477	3.743
Total emissions	**CNG**	**5.357**	**8.315**	**10.071**

Implied Emission Factors				
CH_4	**Fuel**	**2007**	**2008**	**2009**
		t/TJ		
Road transportation	CNG	0.022	0.019	0.019

ATTACHMENT A

Overview of inventory potential problems identified for 2009

Annex A sources

2011 GHG inventory review

Switzerland

Abbreviations:

GPG: IPCC good practice guidance

AD: activity data, EF: emission factor, IEF: implied emission factor

KC: key category, ERT: Expert Review Team

Sector, category, sub-category (with code)	Gas	KC / non-KC	Identified inventory problem in terms of:		
			Missing estimate	Estimate provided but not in line with GPG	Estimate provided but lack of transparency
2. Industrial Processes, 2.B Chemical Industry, 2.B.4 Carbide Production	CH_4	**Non-KC**	X		

Description of problem identified:

The ERT noted that Switzerland reported "NO" (not occurring) for CH_4 emissions from carbide production while reporting CO_2 emissions (e.g. 15.15 Gg for 2009). According to the Revised 1996 IPCC Guidelines, petrol coke use in the silicon carbide process may result in CH_4 emissions, and suggest emission factors (10.2kg/t-petrol coke, or 11.6kg/t-carbide production).

In response to the ERT's question, Switzerland calculated CH_4 emissions from the silicon carbide production from anthracite and coking coal, and agreed with the ERT that these emissions should have been included in the inventory. Therefore, the ERT concludes that there is a problem with regard to CH_4 emissions from this category in terms of a missing estimate.

Switzerland informed the ERT that these CH_4 emissions will be included in the next submission. However the ERT considers that the current reporting results in underestimation of the emissions and should be revised.

Recommendation by ERT:

The ERT recommends that Switzerland revise the inventory by including CH_4 emissions it calculated during the review week in response to the ERT's question. Namely, CH_4 emissions from silicon carbide production can be calculated using an emission factor of 3.9 kg/t SiC which was derived from the assumption that the emission factor for anthracite and coking coal is one third of the one of petrol coke.

The estimates should be provided for the entire time series and the appropriate documentation of the AD and EF used.

Response / Information by Party:

Following the request made during the review, the single Swiss production plant for silicon carbide (SiC) was contacted to clarify the use of petrol coke, coking coal and anthracite in the production of silicon carbide. Based on latest information, the production plant uses *petrol coke* and anthracite in the production of silicon carbide (not *coking coal* and anthracite as stated during the centralised review).

As no measurements on CH_4 emissions are carried out by the production plant, the emission factor from the revised 1996 IPCC Guidelines is taken to calculate the CH_4 emissions. The emission factor amounts to 11.6 kg CH_4 / t SiC and is considered to remain constant over the reporting period.

The AD, EF and resulting CH_4 emissions are confidential, but were reported to the ERT. The production plant provided estimates of the production data for the years 1990, 1995, 2000 and 2005. From the year 2008 onwards, the plant delivered actual production data. Data in between the years is interpolated. We have requested detailed production data for the years before 2008 and plan to include this in the next submission.

Potential problem unsolved? Rationale:

ATTACHMENT A

Overview of inventory potential problems identified for 2009

Annex A sources

2011 GHG inventory review

Switzerland

Abbreviations:

GPG: IPCC good practice guidance

AD: activity data, EF: emission factor, IEF: implied emission factor

KC: key category, ERT: Expert Review Team

<table>
<tr><th rowspan="2">Sector, category, sub-category (with code)</th><th rowspan="2">Gas</th><th rowspan="2">KC / non-KC</th><th colspan="3">Identified inventory problem in terms of:</th></tr>
<tr><th>Missing estimate</th><th>Estimate provided but not in line with GPG</th><th>Estimate provided but lack of transparency</th></tr>
<tr><td>3. Solvent and Other Product Use</td><td>CO_2</td><td>Non-KC</td><td>X</td><td></td><td></td></tr>
<tr><td colspan="6">Description of problem identified:

Switzerland reported indirect emissions of CO_2 due to decomposition of NMVOC in the atmosphere in Sector 7 “Other”, although such emissions were included in Sector 3 “Solvent and Other Product Use” in previous submissions.

Sector 7 “Other” is not included in Annex A to the Kyoto Protocol while Sector 3 is included. This means that emissions reported in Sector 7 will not be counted for the purpose of the Kyoto Protocol accounting for the first commitment period, while those reported in Sector 3 will be. The ERT noted that Switzerland had included indirect CO_2 emissions from NMVOCs in Sector 3 in the “Initial Report” for determining the assigned amount for the 1st commitment period. The ERT considers that the reallocation of emissions from Sector 3 to Sector 7 should not have been done as it underestimates total national GHG emissions.

Switzerland informed the ERT that the indirect CO_2 emissions will be included in Sector 3 in the next submission. However the ERT concluded that the current inventory needs to be revised since current allocation of emissions results in underestimation of the emissions.</td></tr>
<tr><td colspan="6">Recommendation by ERT:

The ERT recommends that Switzerland revise the inventory by reallocating the indirect CO_2 emissions currently reported in Sector 7 to Sector 3 for the entire time series.</td></tr>
<tr><td colspan="6">Response / Information by Party:
Indirect CO_2 emissions are reallocated to Sector 3. No changes to AD or EF have been made. Total emissions in Sector 3 are as follows:</td></tr>
</table>

April 2011			1990	1995	2000	2005	2007	2008	2009
3 A	**Paint Application**	**Gg**	**0.82**	**3.08**	**3.29**	**2.97**	**4.46**	**4.76**	**4.76**
3 B	**Degreasing**	**Gg**	**0.00**	**0.08**	**0.08**	**0.08**	**0.08**	**0.08**	**0.08**
3 C	**Chemical Products**	**Gg**	**12.10**	**17.74**	**20.55**	**25.96**	**24.59**	**23.88**	**23.72**
3 D	**Other**	**Gg**	**6.59**	**23.54**	**28.79**	**32.52**	**33.85**	**32.15**	**31.92**
Total		Gg	19.51	44.44	52.71	61.52	62.99	60.87	60.48

Nov. 2011			1990	1995	2000	2005	2007	2008	2009
3 A	**Paint Application**	**Gg**	**0.82**	**3.08**	**3.29**	**2.97**	**4.46**	**4.76**	**4.76**
3 A	***Indirect emissions***	***Gg***	***98.48***	***81.00***	***57.58***	***27.78***	***27.03***	***26.65***	***26.27***
3 B	**Degreasing**	**Gg**	**0.00**	**0.08**	**0.08**	**0.08**	**0.08**	**0.08**	**0.08**
3 B	***Indirect emissions***	***Gg***	***27.15***	***16.51***	***9.89***	***7.72***	***5.26***	***5.17***	***5.08***
3 C	**Chemical Products**	**Gg**	**12.10**	**17.74**	**20.55**	**25.96**	**24.59**	**23.88**	**23.72**
3 C	***Indirect emissions***	***Gg***	***65.33***	***24.11***	***13.02***	***9.75***	***9.66***	***9.57***	***9.49***
3 D	**Other**	**Gg**	**6.59**	**23.54**	**28.79**	**32.52**	**33.85**	**32.15**	**31.92**
3 D	***Indirect emissions***	***Gg***	***147.16***	***114.38***	***79.74***	***61.26***	***59.67***	***59.68***	***59.49***
Total		Gg	357.64	280.44	212.94	168.04	164.61	161.95	160.82

ATTACHMENT B

Overview of inventory potential problems identified for 2009

KP-LULUCF

2011 GHG inventory review

Switzerland

Abbreviations:

GPG: IPCC good practice guidance for LULUCF

AD: activity data, EF: emission factor, IEF: implied emission factor

KC: key category, ERT: Expert Review Team

Activity, sub-activity (with code)	Gas	KC / non-KC	Identified inventory problem in terms of:		
			Missing estimate	Estimate provided but not in line with GPG	Estimate provided but lack of transparency
KP-LULUCF 5(KP-1)B.1. Forest management	CO_2	**KC**	x		

Description of problem identified:

Switzerland reports that emissions from drained organic soils are not occurring in activities associated with afforestation, reforestation and forest management activities under Article 3.3 and 3.4 of the Kyoto Protocol. During the review the Party notified the ERT that reporting of emissions from organic soils are only mandatory if they are drained or have been previously drained. The Party also mentions that drainage of forest land is prohibited by law according to the Swiss Forest Act (1991) and the Article on the Protection of Bogs and Fens (1987). However, it is acknowledged by the Party that drainage of these lands has occurred prior to introduction of these acts, but there is currently no activity data to determine the extent of drainage of organic soils.

The ERT would agree that emissions for drained organic soils afforested since 1990 under article 3.3 are likely not to occur due to introduction of the Forest Act and Article on peatland protection. However, the ERT considers that organic soil drainage on pre 1990 forest land under forest management is likely to occur and the omission of this pool from the inventory would present an underestimation of CO_2 emissions. The ERT acknowledges that this represents a small area (1.09 kha) and that no activity data are available. However, by omitting to report on this pool and failing to provide transparent and verifiable information that it is not a source Switzerland has failed to comply with the IPCC good practice guidance for LULUCF (see chapter 4.2.3.1) and para. 6(e) of the annex to decision 15/CMP.1 and para 21 of the annex to decision 16/CMP.1.

Recommendation by ERT:he ERT recommends that the Party use the following alternatives to respond to the identified problem:

1. Estimate CO_2 emission for the 1.09 kha of managed forest lands, assuming all organic soils were drained prior to 1990 and to use the tier 1 default emission factor of 0.68 Mg C ha^{-1} yr^{-1} and equation 3.2.15 in the GPG for LULUCF, and to report these emissions in CRF table 5(KP-1)B.1 for 2008 and 2009. The ERT also recommends that the Party provide further information supporting the estimates.

2. Provide transparent and verifiable information that this pool does not represent a net source.

Response / Information by Party:

As the review team recommended, Switzerland provides estimates of CO_2 emissions from organic soils under forest management.

- Since there is no nation-wide information about which part of organic soils is drained, we conservatively assumed all organic soils (1.09 kha in 2008 and 1.09 kha in 2009) under forest management are drained.

- We applied the default emission factor of 0.68 Mg ha-1 yr-1 and equation 3.2.15 of the GPG for LULUCF.

Emissions from drained organic soils under FM amounts to 0.74 Gg C or 2.71 Gg CO_2 in 2008 and 2009 respectively. Values for 2008 and 2009 are updated in Table 5(KP-I)B.1 as well in the overview tables 5(KP) and the accounting table.

A complete set of revised KP-LULUCF CRF tables are submitted alongside this document. The Accounting table provides updated information on the activities related to Art. 3.3 and 3.4.

On June 28, 2011 Switzerland has

- cancelled 172’587 AAUs related with deforestation activities A.2

- issued 35’243 RMUs related with afforestation and reforestation activities A.1

- issued another 854’106 RMUs related to forest management B.1.

The cancellation and issuance of accounting quantities was in line with the final assessment of the review (FCCC/ARR/2010/CHE, Table 4).

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References to EMIS database comments

Table A - 1 Assignments of NFR Codes to titles of EMIS database comments. These internal documents will be made available, on request, to reviewers by the NIC.

NFR Code CRF [UNECE]	EMIS Title	NFR Code CRF [UNECE]	EMIS Title
1 A 1 a	Kehrichtverbrennungsanlagen	2 G	Sprengen und Schiessen
1 A 1 a	Sondermüllverbrennungsanlagen	3 A 1	Farben-Anwendung Bau
1 A 1 a & 6 A 1	Kehrichtdeponien	3 A 2	Farben-Anwendung andere industrielle
1 A 1 a & 6 D	Vergärung IG (industriell-gewerblich)	3 A 1	Farben-Anwendung Haushalte
1 A 1 a & 6 D	Vergärung LW (landwirtschaftlich)	3 A 1	Farben-Anwendung Holz
1 A 2 a	Eisengiessereien Kupolöfen	3 A 2	Farben-Anwendung andere nicht industrielle
1 A 2 a	Stahl-Produktion Wärmeöfen	3 A 2	Farben-Anwendung Autoreparatur
1 A 2 b	Buntmetallgiessereien übriger Betrieb	3 B 1	Elektronik-Reinigung
1 A 2 b & 2 C 3	Aluminium Produktion	3 B 1	Metallreinigung
1 A 2 d	Zellulose-Produktion Feuerung*	3 B 1	Reinigung Industrie übrige
1 A 2 f i & 2 A 3	Feinkeramik Produktion*	3 B 2	Chemische Reinigung
1 A 2 f i & 2 A 7	Glas übrige Produktion*	3 C	Druckfarben Produktion
1 A 2 f i & 2 A 7	Glaswolle Produktion Rohprodukt*	3 C	Farben-Produktion
1 A 2 f i & 2 A 7	Hohlglas Produktion*	3 C	Feinchemikalien-Produktion
1 A 2 f i	Kalkproduktion, Feuerung*	3 C	Gummi-Verarbeitung
1 A 2 f i	Mischgut Produktion	3 C	Klebband-Produktion
1 A 2 f i & 2 A 3	Steinwolle Produktion	3 C	Klebstoff-Produktion
1 A 2 f i & 2 A 3	Ziegeleien	3 C	Lösungsmittel-Umschlag und -Lager
1 A 2 f i	Zementwerke Feuerung	3 C	Pharmazeutische Produktion
1 A 2 f i & 2 D 1	Faserplatten Produktion*	3 C	Polyester-Verarbeitung
1 A 3 a & 1 A 5	Flugverkehr	3 C	Polystyrol-Verarbeitung
1 A 3 b i-viii	Strassenverkehr	3 C	Polyurethan-Verarbeitung
1 A 3 c	Schienenverkehr	3 C	PVC-Verarbeitung
1 A 3 e	Gasverteilung Netzverluste	3 C	Gerben von Ledermaterialien
1 A 4 c i	Grastrocknung	3 D [3 D 3]	Korrosionsschutz im Freien
1 A 4 div.	Off-Road	3 D 1 [3 D 3]	Lachgasanwendung Spitäler
1 Energy Model**	Energie New	3 D 5 [3 D 2]	Reinigungs- und Lösemittel; Haushalte
1A solid fuels/wood	Holzfeuerungen	3 D 5 [3 D 2]	Spraydosen Haushalte
1 B 2 a iv	Raffinerie, Leckverluste	3 D 5 [3 D 3]	Betonzusatzmittel-Anwendung
1 B 2 a v	Benzinumschlag Tanklager	3 D 5 [3 D 3]	Coiffeursalons
1 B 2 a v	Benzinumschlag Tankstellen	3 D 5 [3 D 1]	Druckereien
1 B 2 c	Raffinerie, Abfackelung	3 D 5 [3 D 3]	Entfernung von Farben und Lacken
2 A 1	Zementwerke Rohmaterial	3 D 5 [3 D 3]	Entwachsung von Fahrzeugen
2 A 1	Zementwerke übriger Betrieb	3 D 5 [3 D 3]	Fahrzeug-Unterbodenschutz
2 A 2	Kalkproduktion, Rohmaterial*	3 D 5 [3 D 3]	Feuerwerke
2 A 2	Kalkproduktion, übriger Betrieb*	3 D 5 [3 D 3]	Flugzeug-Enteisung
2 A 5	Dachpappen Produktion Emissionen aus Bitumen	3 D 5 [3 D 3]	Gas-Anwendung
2 A 5	Dachpappen Produktion Voranstrich	3 D 5 [3 D 3]	Gesundheitswesen, übrige
2 A 5	Dachpappen Verlegung Bitumen	3 D 5 [3 D 3]	Glaswolle Imprägnierung*
2 A 5	Dachpappen Verlegung Voranstrich	3 D 5 [3 D 3]	Holzschutzmittel-Anwendung
2 A 6	Strassenbelagsarbeiten Bitumen	3 D 5 [3 D 3]	Klebstoff-Anwendung
2 A 6	Strassenbelagsarbeiten Voranstrich	3 D 5 [3 D 3]	Kosmetika-Produktion
2 A 7	Gips-Produktion übriger Betrieb	3 D 5 [3 D 3]	Kosmetik-Institute
2 B 1	Ammoniak-Produktion*	3 D 5 [3 D 3]	Kühlschmiermittel-Verwendung
2 B 2	Salpetersäure Produktion*	3 D 5 [3 D 3]	Lachgasanwendung Haushalt
2 B 4	Graphit und Siliziumkarbid Produktion*	3 D 5 [3 D 3]	Lösungsmittel-Emissionen IG nicht zugeordnet
2 B 5	Ammoniumnitrat-Produktion*	3 D 5 [3 D 3]	Medizinische Praxen
2 B 5	Chlorgas-Produktion	3 D 5 [3 D 3]	Öl- und Fettgewinnung
2 B 5	Essigsäure-Produktion	3 D 5 [3 D 3]	Papier- und Karton-Produktion
2 B 5	Ethen-Produktion*	3 D 5 [3 D 3]	Parfum- und Aromen-Produktion
2 B 5	Formaldehyd-Produktion	3 D 5 [3 D 3]	Pflanzenschutzmittel-Verwendung
2 B 5	PVC-Produktion	3 D 5 [3 D 3]	Pharma-Produkte im Haushalt
2 B 5	Salzsäure-Produktion	3 D 5 [3 D 3]	Reinigung Gebäude IGD
2 B 5	Schwefelsäure-Produktion	3 D 5 [3 D 3]	Schmierstoff-Verwendung
2 C 1	Eisengiessereien Elektroschmelzöfen	3 D 5 [3 D 3]	Spraydosen IndustrieGewerbe
2 C 1	Eisengiessereien übriger Betrieb	3 D 5 [3 D 3]	Tabakwaren Konsum
2 C 1	Stahl-Produktion Elektroschmelzöfen	3 D 5 [3 D 3]	Tabakwaren Produktion
2 C 1	Stahl-Produktion übriger Betrieb	3 D 5 [3 D 3]	Textilien-Produktion
2 C 1	Stahl-Produktion Walzwerke	3 D 5 [3 D 3]	Wissenschaftliche Laboratorien
2 C 5 d	Verzinkereien	3 D 5 [3 D 3]	Steinwolle-Imprägnierung
2 C 5 e	Buntmetallgiessereien Elektroöfen	4 div.	Landwirtschaft
2 C 5 e	Batterie-recycling	4 F	Abfallverbrennung Land- und Forstwirtschaft
2 D 1	Zellulose Produktion übriger Betrieb*	6 B 1 [6 B]	Kläranlagen Industriell
2 D 1	Spanplatten Produktion*	6 B 2 [6 B]	Kläranlagen Kommunal
2 D 2	Bierbrauereien	6 C [6 C d]	Krematorien
2 D 2	Branntwein Produktion	6 C 2 [6 C a]	Spitalabfallverbrennung
2 D 2	Brot Produktion	6 C 2 [6 C b]	Kabelabbrand
2 D 2	Fleischräuchereien	6 C 2 [6 C b]	Klärschlammverbrennung
2 D 2	Kaffeeröstereien	6 C 2 [6 C c]	Abfallverbrennung illegal
2 D 2	Müllereien	6 D	Kompostierung Industrie
2 D 2	Wein Produktion	6 D	Shredder Anlagen
2 D 2	Zucker Produktion	6 D	Biogasaufbereitung (Methanverlust)
2 D 3	Holzkohle Produktion	7 C 1	Kompostierung, Verbreitung als Dünger im Haushalt
2 F div.	Synthetische Gase	7 D	Brand- und Feuerschäden Immobilien
2 G	Holzbearbeitung	7 D	Brand- und Feuerschäden Motorfahrzeuge

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** work in progress

Annexes

Annex 1: Key Category Analysis (KCA)

A1.1 Methodology

The key category analysis is performed according to the IPCC Good Practice Guidance (IPCC 2000, chapter 7): A Tier 1 level and trend assessment is applied with the proposed threshold of 95%. A Tier 2 key category analysis has also been carried out for this submission with the proposed threshold of 90% of the sum of all level assessments weighted with their uncertainty. All main source categories have been disaggregated into sub-sources (e.g. 2A, 2B, 2C etc.) and gases (CO_2, CH_4, N_2O, HFCs, PFCs, and SF_6).

For some important sources, an even more detailed level of disaggregation has been used in order to clearly identify and isolate the most important sources.

In the important source category 1A Energy Fuel Combustion sources have been disaggregated further to the level of sub-categories (e.g. 1A1 Fuel Combustion – Energy Industries, 1A2 Fuel Combustion – Manufacturing Industries, etc.) as well as fuels (e.g. gaseous fuels, liquid fuels, etc.). The source Transport (1A3) has been further split into Civil Aviation (1A3a), Road Transportation (1A3b), Railways (1A3c), and Navigation (1A3d).

A more detailed disaggregation has also been carried out for Other Sectors (1A4) which has been split into Commercial/Institutional (1A4a), Residential (1A4b) and Agriculture/Forestry (1A4c). Also the categories Mineral Products (2A) and Metal Production (2C) have been disaggregated into subcategories. Consumption of Halocarbons and SF_6 (2F) has been split into its subcategories 2F1 to 2F9. Agricultural Soils (4D) have been split into its subcategories 4D1 to 4D4.

Uncertainty data have been taken from the uncertainty analysis, where the disaggregation of source and sink categories is in accordance with the key category analysis.

A1.2 KCA Tier 1 2010 without LULUCF categories.

A1.2.1 Results of Key Category Analysis Tier 1 – Level

Table A - 2 Key category analysis Tier 1 2010 (without LULUCF) regarding level.

Tier 1 Key category analysis 2010 without LULUCF categories													
	A					B	C	D	E-L	E-T	F-T	M	N
No.	IPCC Source Categories and fuels if applicable (without LULUCF categories)					Direct GHG	Base Year 1990 Estimate [Gg CO2 eq]	Year 2010 Estimate [Gg CO2 eq]	Level Assessm.	Trend Assessm.	% Contrib. in Trend	Result level assessm.	Result trend assessm.
1	1A1	1. Energy	A. Fuel Combustion	1. Energy Industries	Other Fuels	CO2	1519.73	2582.10	4.76%	0.01854	5.4%	KC level	KC trend
2	1A1	1. Energy	A. Fuel Combustion	1. Energy Industries	Liquid Fuels	CO2	691.23	965.28	1.78%	0.00466	1.4%	KC level	KC trend
3	1A1	1. Energy	A. Fuel Combustion	1. Energy Industries	Gaseous Fuels	CO2	235.05	540.64	1.00%	0.00541	1.6%	KC level	KC trend
4	1A2	1. Energy	A. Fuel Combustion	2. Manufacturing Industries and Construction	Liquid Fuels	CO2	3876.46	2890.89	5.33%	0.01934	5.6%	KC level	KC trend
5	1A2	1. Energy	A. Fuel Combustion	2. Manufacturing Industries and Construction	Gaseous Fuels	CO2	1133.30	2216.12	4.09%	0.01906	5.6%	KC level	KC trend
6	1A2	1. Energy	A. Fuel Combustion	2. Manufacturing Industries and Construction	Solid Fuels	CO2	1227.96	520.65	0.96%	0.01325	3.9%	KC level	KC trend
7	1A2	1. Energy	A. Fuel Combustion	2. Manufacturing Industries and Construction	Other Fuels	CO2	134.24	315.35	0.58%	0.00321	0.9%	KC level	KC trend
8	1A3b	1. Energy	A. Fuel Combustion	3. Transport; Road Transportation	Gasoline	CO2	11335.25	9744.97	17.96%	0.03326	9.7%	KC level	KC trend
9	1A3b	1. Energy	A. Fuel Combustion	3. Transport; Road Transportation	Diesel	CO2	2587.68	6154.63	11.35%	0.06326	18.5%	KC level	KC trend
10	1A4a	1. Energy	A. Fuel Combustion	4. Other Sectors; Commercial/Institutional	Liquid Fuels	CO2	4429.39	3607.89	6.65%	0.01660	4.8%	KC level	KC trend
11	1A4a	1. Energy	A. Fuel Combustion	4. Other Sectors; Commercial/Institutional	Gaseous Fuels	CO2	905.76	1409.10	2.60%	0.00871	2.5%	KC level	KC trend
12	1A4b	1. Energy	A. Fuel Combustion	4. Other Sectors; Residential	Liquid Fuels	CO2	10226.25	8688.23	16.02%	0.03187	9.3%	KC level	KC trend
13	1A4b	1. Energy	A. Fuel Combustion	4. Other Sectors; Residential	Gaseous Fuels	CO2	1409.10	2661.45	4.91%	0.02201	6.4%	KC level	KC trend
14	1A4c	1. Energy	A. Fuel Combustion	4. Other Sectors; Agriculture/Forestry	Liquid Fuels	CO2	547.00	519.96	0.96%	0.00071	0.2%	KC level	-
15	2A1	2. Industrial Proc.	A. Mineral Products; Cement Production-CO2			CO2	2524.77	1928.12	3.55%	0.01178	3.4%	KC level	KC trend
16	2F1	2. Industrial Proc.	F. Consumption of Halocarbons and SF6; Refrig. & AC Eq.			HFC	0.02	1011.69	1.86%	0.01824	5.3%	KC level	KC trend
17	4A	4. Agriculture	A. Enteric Fermentation			CH4	2657.35	2537.97	4.68%	0.00323	0.9%	KC level	KC trend
18	4B	4. Agriculture	B. Manure Management			CH4	672.00	645.25	1.19%	0.00075	0.2%	KC level	-
19	4B	4. Agriculture	B. Manure Management			N2O	453.87	323.52	0.60%	0.00253	0.7%	KC level	KC trend
20	4D1	4. Agriculture	D. Agricultural Soils; Direct Soil Emissions			N2O	1364.15	1189.21	2.19%	0.00371	1.1%	KC level	KC trend
21	4D2	4. Agriculture	D. Agricultural Soils; Pasture, Range and Paddock Manure			N2O	128.10	245.40	0.45%	0.00206	0.6%	KC level	KC trend
22	4D3	4. Agriculture	D. Agricultural Soils; Indirect Emissions			N2O	820.73	710.51	1.31%	0.00232	0.7%	KC level	KC trend
23	6B	6. Waste	B. Wastewater Handling			N2O	184.72	208.89	0.39%	0.00036	0.1%	KC level	-
24	1A1	1. Energy	A. Fuel Combustion	1. Energy Industries	Gaseous Fuels	CH4	0.54	1.24	0.00%	0.00001	0.0%	-	-
25	1A1	1. Energy	A. Fuel Combustion	1. Energy Industries	Biomass	CH4	4.66	1.24	0.00%	0.00006	0.0%	-	-
26	1A1	1. Energy	A. Fuel Combustion	1. Energy Industries	Liquid Fuels	CH4	0.49	0.78	0.00%	0.00001	0.0%	-	-
27	1A1	1. Energy	A. Fuel Combustion	1. Energy Industries	Solid Fuels	CH4	0.10	0.00	0.00%	0.00000	0.0%	-	-
28	1A1	1. Energy	A. Fuel Combustion	1. Energy Industries	Solid Fuels	CO2	44.84	0.00	0.00%	0.00000	0.0%	-	-
29	1A1	1. Energy	A. Fuel Combustion	1. Energy Industries	Biomass	N2O	27.72	48.15	0.09%	0.00036	0.1%	-	-
30	1A1	1. Energy	A. Fuel Combustion	1. Energy Industries	Other Fuels	N2O	20.85	47.25	0.09%	0.00047	0.1%	-	-
31	1A1	1. Energy	A. Fuel Combustion	1. Energy Industries	Liquid Fuels	N2O	2.15	3.47	0.01%	0.00002	0.0%	-	-
32	1A1	1. Energy	A. Fuel Combustion	1. Energy Industries	Gaseous Fuels	N2O	0.13	0.30	0.00%	0.00000	0.0%	-	-
33	1A1	1. Energy	A. Fuel Combustion	1. Energy Industries	Solid Fuels	N2O	0.24	0.00	0.00%	0.00000	0.0%	-	-
34	1A2	1. Energy	A. Fuel Combustion	2. Manufacturing Industries and Construction	Gaseous Fuels	CH4	2.84	5.10	0.01%	0.00004	0.0%	-	-
35	1A2	1. Energy	A. Fuel Combustion	2. Manufacturing Industries and Construction	Biomass	CH4	2.46	2.01	0.00%	0.00001	0.0%	-	-
36	1A2	1. Energy	A. Fuel Combustion	2. Manufacturing Industries and Construction	Liquid Fuels	CH4	2.42	1.20	0.00%	0.00002	0.0%	-	-
37	1A2	1. Energy	A. Fuel Combustion	2. Manufacturing Industries and Construction	Solid Fuels	CH4	0.57	0.45	0.00%	0.00000	0.0%	-	-
38	1A2	1. Energy	A. Fuel Combustion	2. Manufacturing Industries and Construction	Other Fuels	CH4	0.00	0.00	0.00%	0.00000	0.0%	-	-
39	1A2	1. Energy	A. Fuel Combustion	2. Manufacturing Industries and Construction	Liquid Fuels	N2O	14.96	12.84	0.02%	0.00004	0.0%	-	-
40	1A2	1. Energy	A. Fuel Combustion	2. Manufacturing Industries and Construction	Biomass	N2O	2.44	10.79	0.02%	0.00015	0.0%	-	-
41	1A2	1. Energy	A. Fuel Combustion	2. Manufacturing Industries and Construction	Other Fuels	N2O	2.31	5.83	0.01%	0.00006	0.0%	-	-
42	1A2	1. Energy	A. Fuel Combustion	2. Manufacturing Industries and Construction	Solid Fuels	N2O	6.57	2.76	0.01%	0.00007	0.0%	-	-
43	1A2	1. Energy	A. Fuel Combustion	2. Manufacturing Industries and Construction	Gaseous Fuels	N2O	0.63	1.24	0.00%	0.00001	0.0%	-	-
44	1A3a	1. Energy	A. Fuel Combustion	3. Transport; Civil Aviation		CH4	0.24	0.27	0.00%	0.00000	0.0%	-	-
45	1A3a	1. Energy	A. Fuel Combustion	3. Transport; Civil Aviation		CO2	252.55	123.55	0.23%	0.00243	0.7%	-	KC trend
46	1A3a	1. Energy	A. Fuel Combustion	3. Transport; Civil Aviation		N2O	2.46	1.20	0.00%	0.00002	0.0%	-	-
47	1A3b	1. Energy	A. Fuel Combustion	3. Transport; Road Transportation	Gasoline	CH4	101.15	22.34	0.04%	0.00146	0.4%	-	KC trend
48	1A3b	1. Energy	A. Fuel Combustion	3. Transport; Road Transportation	Diesel	CH4	1.36	0.65	0.00%	0.00001	0.0%	-	-
49	1A3b	1. Energy	A. Fuel Combustion	3. Transport; Road Transportation	Natural Gas	CH4	0.00	0.27	0.00%	0.00000	0.0%	-	-
50	1A3b	1. Energy	A. Fuel Combustion	3. Transport; Road Transportation	Biomass	CH4	0.00	0.04	0.00%	0.00000	0.0%	-	-
51	1A3b	1. Energy	A. Fuel Combustion	3. Transport; Road Transportation	Natural Gas	CO2	0.00	39.05	0.07%	0.00070	0.2%	-	-
52	1A3b	1. Energy	A. Fuel Combustion	3. Transport; Road Transportation	Gasoline	N2O	137.27	111.15	0.20%	0.00053	0.2%	-	-
53	1A3b	1. Energy	A. Fuel Combustion	3. Transport; Road Transportation	Diesel	N2O	5.84	18.10	0.03%	0.00022	0.1%	-	-
54	1A3b	1. Energy	A. Fuel Combustion	3. Transport; Road Transportation	Biomass	N2O	0.00	0.44	0.00%	0.00001	0.0%	-	-
55	1A3b	1. Energy	A. Fuel Combustion	3. Transport; Road Transportation	Natural Gas	N2O	0.00	0.00	0.00%	0.00000	0.0%	-	-
56	1A3c	1. Energy	A. Fuel Combustion	3. Transport; Railways	Liquid Fuels	CH4	0.01	0.01	0.00%	0.00000	0.0%	-	-
57	1A3c	1. Energy	A. Fuel Combustion	3. Transport; Railways		CO2	28.69	37.77	0.07%	0.00015	0.0%	-	-
58	1A3c	1. Energy	A. Fuel Combustion	3. Transport; Railways	Liquid Fuels	N2O	0.38	0.49	0.00%	0.00000	0.0%	-	-
59	1A3d	1. Energy	A. Fuel Combustion	3. Transport; Navigation	Gasoline	CH4	0.58	0.51	0.00%	0.00000	0.0%	-	-
60	1A3d	1. Energy	A. Fuel Combustion	3. Transport; Navigation	Gas/Diesel Oil	CH4	0.01	0.02	0.00%	0.00000	0.0%	-	-
61	1A3d	1. Energy	A. Fuel Combustion	3. Transport; Navigation		CO2	111.86	116.98	0.22%	0.00005	0.0%	-	-
62	1A3d	1. Energy	A. Fuel Combustion	3. Transport; Navigation	Gas/Diesel Oil	N2O	0.64	0.76	0.00%	0.00000	0.0%	-	-
63	1A3d	1. Energy	A. Fuel Combustion	3. Transport; Navigation	Gasoline	N2O	0.60	0.53	0.00%	0.00000	0.0%	-	-
64	1A3ei	1. Energy	A. Fuel Combustion	3. Transport; Other non-specified		CH4	0.09	0.04	0.00%	0.00000	0.0%	-	-
65	1A3ei	1. Energy	A. Fuel Combustion	3. Transport; Other non-specified		CO2	49.01	48.71	0.09%	0.00003	0.0%	-	-
66	1A3ei	1. Energy	A. Fuel Combustion	3. Transport; Other non-specified		N2O	0.03	0.03	0.00%	0.00000	0.0%	-	-
67	1A4a	1. Energy	A. Fuel Combustion	4. Other Sectors; Commercial/Institutional	Biomass	CH4	9.74	5.12	0.01%	0.00009	0.0%	-	-
68	1A4a	1. Energy	A. Fuel Combustion	4. Other Sectors; Commercial/Institutional	Gaseous Fuels	CH4	2.27	3.75	0.01%	0.00003	0.0%	-	-
69	1A4a	1. Energy	A. Fuel Combustion	4. Other Sectors; Commercial/Institutional	Liquid Fuels	CH4	2.96	1.57	0.00%	0.00003	0.0%	-	-
70	1A4a	1. Energy	A. Fuel Combustion	4. Other Sectors; Commercial/Institutional	Liquid Fuels	N2O	11.28	9.25	0.02%	0.00004	0.0%	-	-
71	1A4a	1. Energy	A. Fuel Combustion	4. Other Sectors; Commercial/Institutional	Biomass	N2O	1.45	3.36	0.01%	0.00003	0.0%	-	-
72	1A4a	1. Energy	A. Fuel Combustion	4. Other Sectors; Commercial/Institutional	Gaseous Fuels	N2O	0.51	0.79	0.00%	0.00000	0.0%	-	-
73	1A4b	1. Energy	A. Fuel Combustion	4. Other Sectors; Residential	Biomass	CH4	95.89	38.15	0.07%	0.00108	0.3%	-	-
74	1A4b	1. Energy	A. Fuel Combustion	4. Other Sectors; Residential	Gaseous Fuels	CH4	3.26	6.26	0.01%	0.00005	0.0%	-	-
75	1A4b	1. Energy	A. Fuel Combustion	4. Other Sectors; Residential	Liquid Fuels	CH4	6.00	2.63	0.00%	0.00006	0.0%	-	-
76	1A4b	1. Energy	A. Fuel Combustion	4. Other Sectors; Residential	Solid Fuels	CH4	3.71	2.28	0.00%	0.00003	0.0%	-	-
77	1A4b	1. Energy	A. Fuel Combustion	4. Other Sectors; Residential	Solid Fuels	CO2	54.59	33.60	0.06%	0.00040	0.1%	-	-
78	1A4b	1. Energy	A. Fuel Combustion	4. Other Sectors; Residential	Liquid Fuels	N2O	25.94	22.06	0.04%	0.00008	0.0%	-	-
79	1A4b	1. Energy	A. Fuel Combustion	4. Other Sectors; Residential	Biomass	N2O	10.64	9.82	0.02%	0.00002	0.0%	-	-
80	1A4b	1. Energy	A. Fuel Combustion	4. Other Sectors; Residential	Gaseous Fuels	N2O	0.79	1.50	0.00%	0.00001	0.0%	-	-
81	1A4b	1. Energy	A. Fuel Combustion	4. Other Sectors; Residential	Solid Fuels	N2O	0.29	0.18	0.00%	0.00000	0.0%	-	-
82	1A4c	1. Energy	A. Fuel Combustion	4. Other Sectors; Agriculture/Forestry	Liquid Fuels	CH4	1.62	1.38	0.00%	0.00001	0.0%	-	-
83	1A4c	1. Energy	A. Fuel Combustion	4. Other Sectors; Agriculture/Forestry	Biomass	CH4	0.80	0.18	0.00%	0.00001	0.0%	-	-
84	1A4c	1. Energy	A. Fuel Combustion	4. Other Sectors; Agriculture/Forestry	Gaseous Fuels	CH4	0.09	0.04	0.00%	0.00000	0.0%	-	-
85	1A4c	1. Energy	A. Fuel Combustion	4. Other Sectors; Agriculture/Forestry	Gaseous Fuels	CO2	40.64	15.85	0.03%	0.00046	0.1%	-	-
86	1A4c	1. Energy	A. Fuel Combustion	4. Other Sectors; Agriculture/Forestry	Liquid Fuels	N2O	4.97	5.28	0.01%	0.00000	0.0%	-	-
87	1A4c	1. Energy	A. Fuel Combustion	4. Other Sectors; Agriculture/Forestry	Biomass	N2O	0.21	0.35	0.00%	0.00000	0.0%	-	-
88	1A4c	1. Energy	A. Fuel Combustion	4. Other Sectors; Agriculture/Forestry	Gaseous Fuels	N2O	0.02	0.01	0.00%	0.00000	0.0%	-	-
89	1A5	1. Energy	A. Fuel Combustion	5. Other	Liquid Fuels	CH4	0.16	0.12	0.00%	0.00000	0.0%	-	-
90	1A5	1. Energy	A. Fuel Combustion	5. Other	Liquid Fuels	CO2	203.58	119.55	0.22%	0.00160	0.5%	-	KC trend
91	1A5	1. Energy	A. Fuel Combustion	5. Other	Liquid Fuels	N2O	2.01	1.18	0.00%	0.00002	0.0%	-	-
92	1B2	1. Energy	B. Fugitive Emissions from Fue	2. Oil and Natural Gas		CH4	380.43	173.85	0.32%	0.00388	1.1%	-	KC trend
93	1B2	1. Energy	B. Fugitive Emissions from Fue	2. Oil and Natural Gas		CO2	91.36	74.04	0.14%	0.00035	0.1%	-	-
94	1B2	1. Energy	B. Fugitive Emissions from Fue	2. Oil and Natural Gas		N2O	0.00	0.00	0.00%	0.00000	0.0%	-	-
95	2A2	2. Industrial Proc.	A. Mineral Products; Lime Production-CO2			CO2	53.35	54.23	0.10%	0.00001	0.0%	-	-
96	2A3	2. Industrial Proc.	A. Mineral Products; Limestone and Dolomite Use, Emissions, CO2			CO2	103.25	72.39	0.13%	0.00060	0.2%	-	-
97	2A7	2. Industrial Proc.	A. Mineral Products; Other non-specified-CO2			CO2	15.12	5.93	0.01%	0.00017	0.1%	-	-
98	2B	2. Industrial Proc.	B. Chemical Industry			CH4	9.63	8.39	0.02%	0.00003	0.0%	-	-
99	2B	2. Industrial Proc.	B. Chemical Industry			CO2	109.80	121.41	0.22%	0.00016	0.0%	-	-

Table A - 2 continued. Key category analysis Tier 1 2010 (without LULUCF) regarding level.

Tier 1 Key category analysis 2010 without LULUCF categories										
	A			B	C	D	E-L	E-T	F-T	M
No.	**IPCC Source Categories and fuels if applicable (without LULUCF categories)**			**Direct GHG**	**Base Year 1990 Estimate** [Gg CO2 eq]	**Year 2010 Estimate** [Gg CO2 eq]	**Level Assessm.**	**Trend Assessm.**	**% Contrib. in Trend**	**Result level assessm.**
100	2B	2. Industrial Proc.	B. Chemical Industry	N2O	68.13	60.26	0.11%	0.00017	0.0%	-
101	2C	2. Industrial Proc.	C. Metal Production; Magnesium Foundries	SF6	0.00	29.66	0.05%	0.00053	0.2%	-
102	2C	2. Industrial Proc.	C. Metal Production; Aluminium Foundries	SF6	0.00	4.88	0.01%	0.00009	0.0%	-
103	2C1	2. Industrial Proc.	C. Metal Production; Steel Production	CO2	110.80	170.57	0.31%	0.00103	0.3%	-
104	2C3	2. Industrial Proc.	C. Metal Production; Aluminium Production-CO2	CO2	139.26	0.00	0.00%	0.00000	0.0%	-
105	2C3	2. Industrial Proc.	C. Metal Production; Aluminium Production-PFC	PFC	100.17	0.00	0.00%	0.00000	0.0%	-
106	2C5	2. Industrial Proc.	C. Metal Production; Non-ferrous metals-CO2	CO2	1.65	1.85	0.00%	0.00000	0.0%	-
107	2F1	2. Industrial Proc.	F. Consumption of Halocarbons and SF6; Refrigeration	PFC	0.04	7.43	0.01%	0.00013	0.0%	-
108	2F2	2. Industrial Proc.	F. Consumption of Halocarbons and SF6; Hard Foam	HFC	0.00	13.59	0.03%	0.00024	0.1%	-
109	2F4	2. Industrial Proc.	F. Consumption of Halocarbons and SF6; Metered Dose Inhalers and Other	HFC	0.00	14.71	0.03%	0.00027	0.1%	-
110	2F5	2. Industrial Proc.	F. Consumption of Halocarbons and SF6; Solvents	HFC	0.00	2.37	0.00%	0.00004	0.0%	-
111	2F5	2. Industrial Proc.	F. Consumption of Halocarbons and SF6; Solvents	PFC	0.00	7.88	0.01%	0.00014	0.0%	-
112	2F7	2. Industrial Proc.	F. Consumption of Halocarbons and SF6; Semiconductor Manufacture	PFC	0.00	14.56	0.03%	0.00026	0.1%	-
113	2F7	2. Industrial Proc.	F. Consumption of Halocarbons and SF6; Semiconductor Manufacture	PFC	0.00	6.63	0.01%	0.00012	0.0%	-
114	2F7	2. Industrial Proc.	F. Consumption of Halocarbons and SF6; Semiconductor Manufacture	SF6	0.00	6.99	0.01%	0.00013	0.0%	-
115	2F8	2. Industrial Proc.	F. Consumption of Halocarbons and SF6; Electrical Eq.	SF6	64.04	62.47	0.12%	0.00005	0.0%	-
116	2F9	2. Industrial Proc.	F. Consumption of Halocarbons and SF6; Other	HFC	0.00	30.62	0.06%	0.00055	0.2%	-
117	2F9	2. Industrial Proc.	F. Consumption of Halocarbons and SF6; Other	PFC	0.00	0.00	0.00%	0.00000	0.0%	-
118	2F9	2. Industrial Proc.	F. Consumption of Halocarbons and SF6; Other	SF6	79.58	51.12	0.09%	0.00055	0.2%	-
119	2G	2. Industrial Proc.	G. Other	CO2	1.04	0.96	0.00%	0.00000	0.0%	-
120	3	3. Solvent and Other Product Use		CO2	361.92	157.23	0.29%	0.00384	1.1%	-
121	3	3. Solvent and Other Product Use		N2O	110.14	57.33	0.11%	0.00100	0.3%	-
122	4D4	4. Agriculture	D. Agricultural Soils; Use of sewage sludge as fertilizers	N2O	28.19	22.56	0.04%	0.00011	0.0%	-
123	4F	4. Agriculture	F. Field Burning of Agricultural Residues	CH4	10.00	10.00	0.02%	0.00000	0.0%	-
124	4F	4. Agriculture	F. Field Burning of Agricultural Residues	N2O	3.91	3.91	0.01%	0.00000	0.0%	-
125	6A	6. Waste	A. Solid Waste Disposal on Land	CH4	688.16	198.00	0.36%	0.00912	2.7%	-
126	6A	6. Waste	A. Solid Waste Disposal on Land	CO2	9.24	0.00	0.00%	0.00000	0.0%	-
127	6B	6. Waste	B. Wastewater Handling	CH4	4.65	45.90	0.08%	0.00074	0.2%	-
128	6C	6. Waste	C. Waste Incineration	CH4	4.25	2.80	0.01%	0.00003	0.0%	-
129	6C	6. Waste	C. Waste Incineration	CO2	54.10	10.68	0.02%	0.00080	0.2%	-
130	6C	6. Waste	C. Waste Incineration	N2O	16.20	25.90	0.05%	0.00017	0.0%	-
131	6D	6. Waste	D. Other	CH4	27.44	95.23	0.18%	0.00121	0.4%	-
132	6D	6. Waste	D. Other	CO2	0.00	0.00	0.00%	0.00000	0.0%	-
133	6D	6. Waste	D. Other	N2O	5.82	24.15	0.04%	0.00033	0.1%	-
134	7	7. Other		CH4	0.55	0.58	0.00%	0.00000	0.0%	-
135	7	7. Other		CO2	10.96	13.02	0.02%	0.00003	0.0%	-
136	7	7. Other		N2O	16.72	13.63	0.03%	0.00006	0.0%	-

A1.2.2 Results of Key Category Analysis Tier 1 – Trend

Table A - 3 Key category analysis Tier 1 2010 (without LULUCF) regarding trend.

Tier 1 Key category analysis 2010 without LULUCF categories													
	A					B	C	D	E-L	E-T	F-T	M	N
No.	IPCC Source Categories and fuels if applicable (without LULUCF categories)					Direct GHG	Base Year 1990 Estimate [Gg CO2 eq]	Year 2010 Estimate [Gg CO2 eq]	Level Assessm.	Trend Assessm.	% Contrib. in Trend	Result level assessm.	Result trend assessm.
1	1A1	1. Energy	A. Fuel Combustion	1. Energy Industries	Other Fuels	CO2	1519.73	2582.10	4.76%	0.01854	5.4%	KC level	KC trend
2	1A1	1. Energy	A. Fuel Combustion	1. Energy Industries	Liquid Fuels	CO2	691.23	965.28	1.78%	0.00466	1.4%	KC level	KC trend
3	1A1	1. Energy	A. Fuel Combustion	1. Energy Industries	Gaseous Fuels	CO2	235.05	540.64	1.00%	0.00541	1.6%	KC level	KC trend
4	1A2	1. Energy	A. Fuel Combustion	2. Manufacturing Industries and Construction	Liquid Fuels	CO2	3876.46	2890.89	5.33%	0.01934	5.6%	KC level	KC trend
5	1A2	1. Energy	A. Fuel Combustion	2. Manufacturing Industries and Construction	Gaseous Fuels	CO2	1133.30	2216.12	4.09%	0.01906	5.6%	KC level	KC trend
6	1A2	1. Energy	A. Fuel Combustion	2. Manufacturing Industries and Construction	Solid Fuels	CO2	1227.96	520.65	0.96%	0.01325	3.9%	KC level	KC trend
7	1A2	1. Energy	A. Fuel Combustion	2. Manufacturing Industries and Construction	Other Fuels	CO2	134.24	315.35	0.58%	0.00321	0.9%	KC level	KC trend
8	1A3b	1. Energy	A. Fuel Combustion	3. Transport; Road Transportation	Gasoline	CO2	11335.25	9744.97	17.96%	0.03326	9.7%	KC level	KC trend
9	1A3b	1. Energy	A. Fuel Combustion	3. Transport; Road Transportation	Diesel	CO2	2587.68	6154.63	11.35%	0.06326	18.5%	KC level	KC trend
10	1A4a	1. Energy	A. Fuel Combustion	4. Other Sectors; Commercial/Institutional	Liquid Fuels	CO2	4429.39	3607.89	6.65%	0.01660	4.8%	KC level	KC trend
11	1A4a	1. Energy	A. Fuel Combustion	4. Other Sectors; Commercial/Institutional	Gaseous Fuels	CO2	905.76	1409.10	2.60%	0.00871	2.5%	KC level	KC trend
12	1A4b	1. Energy	A. Fuel Combustion	4. Other Sectors; Residential	Liquid Fuels	CO2	10226.25	8688.23	16.02%	0.03187	9.3%	KC level	KC trend
13	1A4b	1. Energy	A. Fuel Combustion	4. Other Sectors; Residential	Gaseous Fuels	CO2	1409.10	2661.45	4.91%	0.02201	6.4%	KC level	KC trend
14	1A4c	1. Energy	A. Fuel Combustion	4. Other Sectors; Agriculture/Forestry	Liquid Fuels	CO2	547.00	519.96	0.96%	0.00071	0.2%	KC level	-
15	2A1	2. Industrial Proc.	A. Mineral Products; Cement Production-CO2			CO2	2524.77	1928.12	3.55%	0.01178	3.4%	KC level	KC trend
16	2F1	2. Industrial Proc.	F. Consumption of Halocarbons and SF6; Refrig. & AC Eq.			HFC	0.02	1011.69	1.86%	0.01824	5.3%	KC level	KC trend
17	4A	4. Agriculture	A. Enteric Fermentation			CH4	2657.35	2537.97	4.68%	0.00323	0.9%	KC level	KC trend
18	4B	4. Agriculture	B. Manure Management			CH4	672.00	645.25	1.19%	0.00075	0.2%	KC level	-
19	4B	4. Agriculture	B. Manure Management			N2O	453.87	323.52	0.60%	0.00253	0.7%	KC level	KC trend
20	4D1	4. Agriculture	D. Agricultural Soils; Direct Soil Emissions			N2O	1364.15	1189.21	2.19%	0.00371	1.1%	KC level	KC trend
21	4D2	4. Agriculture	D. Agricultural Soils; Pasture, Range and Paddock Manure			N2O	128.10	245.40	0.45%	0.00206	0.6%	KC level	KC trend
22	4D3	4. Agriculture	D. Agricultural Soils; Indirect Emissions			N2O	820.73	710.51	1.31%	0.00232	0.7%	KC level	KC trend
23	6B	6. Waste	B. Wastewater Handling			N2O	184.72	208.89	0.39%	0.00036	0.1%	KC level	-
24	1A1	1. Energy	A. Fuel Combustion	1. Energy Industries	Gaseous Fuels	CH4	0.54	1.24	0.00%	0.00001	0.0%	-	-
25	1A1	1. Energy	A. Fuel Combustion	1. Energy Industries	Biomass	CH4	4.66	1.24	0.00%	0.00006	0.0%	-	-
26	1A1	1. Energy	A. Fuel Combustion	1. Energy Industries	Liquid Fuels	CH4	0.49	0.78	0.00%	0.00001	0.0%	-	-
27	1A1	1. Energy	A. Fuel Combustion	1. Energy Industries	Solid Fuels	CH4	0.10	0.00	0.00%	0.00000	0.0%	-	-
28	1A1	1. Energy	A. Fuel Combustion	1. Energy Industries	Solid Fuels	CO2	44.84	0.00	0.00%	0.00000	0.0%	-	-
29	1A1	1. Energy	A. Fuel Combustion	1. Energy Industries	Biomass	N2O	27.72	48.15	0.09%	0.00036	0.1%	-	-
30	1A1	1. Energy	A. Fuel Combustion	1. Energy Industries	Other Fuels	N2O	20.85	47.25	0.09%	0.00047	0.1%	-	-
31	1A1	1. Energy	A. Fuel Combustion	1. Energy Industries	Liquid Fuels	N2O	2.15	3.47	0.01%	0.00002	0.0%	-	-
32	1A1	1. Energy	A. Fuel Combustion	1. Energy Industries	Gaseous Fuels	N2O	0.13	0.30	0.00%	0.00000	0.0%	-	-
33	1A1	1. Energy	A. Fuel Combustion	1. Energy Industries	Solid Fuels	N2O	0.24	0.00	0.00%	0.00000	0.0%	-	-
34	1A2	1. Energy	A. Fuel Combustion	2. Manufacturing Industries and Construction	Gaseous Fuels	CH4	2.84	5.10	0.01%	0.00004	0.0%	-	-
35	1A2	1. Energy	A. Fuel Combustion	2. Manufacturing Industries and Construction	Biomass	CH4	2.46	2.01	0.00%	0.00001	0.0%	-	-
36	1A2	1. Energy	A. Fuel Combustion	2. Manufacturing Industries and Construction	Liquid Fuels	CH4	2.42	1.20	0.00%	0.00002	0.0%	-	-
37	1A2	1. Energy	A. Fuel Combustion	2. Manufacturing Industries and Construction	Solid Fuels	CH4	0.57	0.45	0.00%	0.00000	0.0%	-	-
38	1A2	1. Energy	A. Fuel Combustion	2. Manufacturing Industries and Construction	Other Fuels	CH4	0.00	0.00	0.00%	0.00000	0.0%	-	-
39	1A2	1. Energy	A. Fuel Combustion	2. Manufacturing Industries and Construction	Liquid Fuels	N2O	14.96	12.84	0.02%	0.00004	0.0%	-	-
40	1A2	1. Energy	A. Fuel Combustion	2. Manufacturing Industries and Construction	Biomass	N2O	2.44	10.79	0.02%	0.00015	0.0%	-	-
41	1A2	1. Energy	A. Fuel Combustion	2. Manufacturing Industries and Construction	Other Fuels	N2O	2.31	5.83	0.01%	0.00006	0.0%	-	-
42	1A2	1. Energy	A. Fuel Combustion	2. Manufacturing Industries and Construction	Solid Fuels	N2O	6.57	2.76	0.01%	0.00007	0.0%	-	-
43	1A2	1. Energy	A. Fuel Combustion	2. Manufacturing Industries and Construction	Gaseous Fuels	N2O	0.63	1.24	0.00%	0.00001	0.0%	-	-
44	1A3a	1. Energy	A. Fuel Combustion	3. Transport; Civil Aviation		CH4	0.24	0.27	0.00%	0.00000	0.0%	-	-
45	1A3a	1. Energy	A. Fuel Combustion	3. Transport; Civil Aviation		CO2	252.55	123.55	0.23%	0.00243	0.7%	-	KC trend
46	1A3a	1. Energy	A. Fuel Combustion	3. Transport; Civil Aviation		N2O	2.46	1.20	0.00%	0.00002	0.0%	-	-
47	1A3b	1. Energy	A. Fuel Combustion	3. Transport; Road Transportation	Gasoline	CH4	101.15	22.34	0.04%	0.00146	0.4%	-	KC trend
48	1A3b	1. Energy	A. Fuel Combustion	3. Transport; Road Transportation	Diesel	CH4	1.36	0.65	0.00%	0.00001	0.0%	-	-
49	1A3b	1. Energy	A. Fuel Combustion	3. Transport; Road Transportation	Natural Gas	CH4	0.00	0.27	0.00%	0.00000	0.0%	-	-
50	1A3b	1. Energy	A. Fuel Combustion	3. Transport; Road Transportation	Biomass	CH4	0.00	0.04	0.00%	0.00000	0.0%	-	-
51	1A3b	1. Energy	A. Fuel Combustion	3. Transport; Road Transportation	Natural Gas	CO2	0.00	39.05	0.07%	0.00070	0.2%	-	-
52	1A3b	1. Energy	A. Fuel Combustion	3. Transport; Road Transportation	Gasoline	N2O	137.27	111.15	0.20%	0.00053	0.2%	-	-
53	1A3b	1. Energy	A. Fuel Combustion	3. Transport; Road Transportation	Diesel	N2O	5.84	18.10	0.03%	0.00022	0.1%	-	-
54	1A3b	1. Energy	A. Fuel Combustion	3. Transport; Road Transportation	Biomass	N2O	0.00	0.44	0.00%	0.00001	0.0%	-	-
55	1A3b	1. Energy	A. Fuel Combustion	3. Transport; Road Transportation	Natural Gas	N2O	0.00	0.00	0.00%	0.00000	0.0%	-	-
56	1A3c	1. Energy	A. Fuel Combustion	3. Transport; Railways	Liquid Fuels	CH4	0.01	0.01	0.00%	0.00000	0.0%	-	-
57	1A3c	1. Energy	A. Fuel Combustion	3. Transport; Railways		CO2	28.69	37.77	0.07%	0.00015	0.0%	-	-
58	1A3c	1. Energy	A. Fuel Combustion	3. Transport; Railways	Liquid Fuels	N2O	0.38	0.49	0.00%	0.00000	0.0%	-	-
59	1A3d	1. Energy	A. Fuel Combustion	3. Transport; Navigation	Gasoline	CH4	0.58	0.51	0.00%	0.00000	0.0%	-	-
60	1A3d	1. Energy	A. Fuel Combustion	3. Transport; Navigation	Gas/Diesel Oil	CH4	0.01	0.02	0.00%	0.00000	0.0%	-	-
61	1A3d	1. Energy	A. Fuel Combustion	3. Transport; Navigation		CO2	111.86	116.98	0.22%	0.00005	0.0%	-	-
62	1A3d	1. Energy	A. Fuel Combustion	3. Transport; Navigation	Gas/Diesel Oil	N2O	0.64	0.76	0.00%	0.00000	0.0%	-	-
63	1A3d	1. Energy	A. Fuel Combustion	3. Transport; Navigation	Gasoline	N2O	0.60	0.53	0.00%	0.00000	0.0%	-	-
64	1A3ei	1. Energy	A. Fuel Combustion	3. Transport; Other non-specified		CH4	0.09	0.04	0.00%	0.00000	0.0%	-	-
65	1A3ei	1. Energy	A. Fuel Combustion	3. Transport; Other non-specified		CO2	49.01	48.71	0.09%	0.00003	0.0%	-	-
66	1A3ei	1. Energy	A. Fuel Combustion	3. Transport; Other non-specified		N2O	0.03	0.03	0.00%	0.00000	0.0%	-	-
67	1A4a	1. Energy	A. Fuel Combustion	4. Other Sectors; Commercial/Institutional	Biomass	CH4	9.74	5.12	0.01%	0.00009	0.0%	-	-
68	1A4a	1. Energy	A. Fuel Combustion	4. Other Sectors; Commercial/Institutional	Gaseous Fuels	CH4	2.27	3.75	0.01%	0.00003	0.0%	-	-
69	1A4a	1. Energy	A. Fuel Combustion	4. Other Sectors; Commercial/Institutional	Liquid Fuels	CH4	2.96	1.57	0.00%	0.00003	0.0%	-	-
70	1A4a	1. Energy	A. Fuel Combustion	4. Other Sectors; Commercial/Institutional	Liquid Fuels	N2O	11.28	9.25	0.02%	0.00004	0.0%	-	-
71	1A4a	1. Energy	A. Fuel Combustion	4. Other Sectors; Commercial/Institutional	Biomass	N2O	1.45	3.36	0.01%	0.00003	0.0%	-	-
72	1A4a	1. Energy	A. Fuel Combustion	4. Other Sectors; Commercial/Institutional	Gaseous Fuels	N2O	0.51	0.79	0.00%	0.00000	0.0%	-	-
73	1A4b	1. Energy	A. Fuel Combustion	4. Other Sectors; Residential	Biomass	CH4	95.89	38.15	0.07%	0.00108	0.3%	-	-
74	1A4b	1. Energy	A. Fuel Combustion	4. Other Sectors; Residential	Gaseous Fuels	CH4	3.26	6.26	0.01%	0.00005	0.0%	-	-
75	1A4b	1. Energy	A. Fuel Combustion	4. Other Sectors; Residential	Liquid Fuels	CH4	6.00	2.63	0.00%	0.00006	0.0%	-	-
76	1A4b	1. Energy	A. Fuel Combustion	4. Other Sectors; Residential	Solid Fuels	CH4	3.71	2.28	0.00%	0.00003	0.0%	-	-
77	1A4b	1. Energy	A. Fuel Combustion	4. Other Sectors; Residential	Solid Fuels	CO2	54.59	33.60	0.06%	0.00040	0.1%	-	-
78	1A4b	1. Energy	A. Fuel Combustion	4. Other Sectors; Residential	Liquid Fuels	N2O	25.94	22.06	0.04%	0.00008	0.0%	-	-
79	1A4b	1. Energy	A. Fuel Combustion	4. Other Sectors; Residential	Biomass	N2O	10.64	9.82	0.02%	0.00002	0.0%	-	-
80	1A4b	1. Energy	A. Fuel Combustion	4. Other Sectors; Residential	Gaseous Fuels	N2O	0.79	1.50	0.00%	0.00001	0.0%	-	-
81	1A4b	1. Energy	A. Fuel Combustion	4. Other Sectors; Residential	Solid Fuels	N2O	0.29	0.18	0.00%	0.00000	0.0%	-	-
82	1A4c	1. Energy	A. Fuel Combustion	4. Other Sectors; Agriculture/Forestry	Liquid Fuels	CH4	1.62	1.38	0.00%	0.00001	0.0%	-	-
83	1A4c	1. Energy	A. Fuel Combustion	4. Other Sectors; Agriculture/Forestry	Biomass	CH4	0.80	0.18	0.00%	0.00001	0.0%	-	-
84	1A4c	1. Energy	A. Fuel Combustion	4. Other Sectors; Agriculture/Forestry	Gaseous Fuels	CH4	0.09	0.04	0.00%	0.00000	0.0%	-	-
85	1A4c	1. Energy	A. Fuel Combustion	4. Other Sectors; Agriculture/Forestry	Gaseous Fuels	CO2	40.64	15.85	0.03%	0.00046	0.1%	-	-
86	1A4c	1. Energy	A. Fuel Combustion	4. Other Sectors; Agriculture/Forestry	Liquid Fuels	N2O	4.97	5.28	0.01%	0.00000	0.0%	-	-
87	1A4c	1. Energy	A. Fuel Combustion	4. Other Sectors; Agriculture/Forestry	Biomass	N2O	0.21	0.35	0.00%	0.00000	0.0%	-	-
88	1A4c	1. Energy	A. Fuel Combustion	4. Other Sectors; Agriculture/Forestry	Gaseous Fuels	N2O	0.02	0.01	0.00%	0.00000	0.0%	-	-
89	1A5	1. Energy	A. Fuel Combustion	5. Other	Liquid Fuels	CH4	0.16	0.12	0.00%	0.00000	0.0%	-	-
90	1A5	1. Energy	A. Fuel Combustion	5. Other	Liquid Fuels	CO2	203.58	119.55	0.22%	0.00160	0.5%	-	KC trend
91	1A5	1. Energy	A. Fuel Combustion	5. Other	Liquid Fuels	N2O	2.01	1.18	0.00%	0.00002	0.0%	-	-
92	1B2	1. Energy	B. Fugitive Emissions from Fue	2. Oil and Natural Gas		CH4	380.43	173.85	0.32%	0.00388	1.1%	-	KC trend
93	1B2	1. Energy	B. Fugitive Emissions from Fue	2. Oil and Natural Gas		CO2	91.36	74.04	0.14%	0.00035	0.1%	-	-
94	1B2	1. Energy	B. Fugitive Emissions from Fue	2. Oil and Natural Gas		N2O	0.00	0.00	0.00%	0.00000	0.0%	-	-
95	2A2	2. Industrial Proc.	A. Mineral Products; Lime Production-CO2			CO2	53.35	54.23	0.10%	0.00001	0.0%	-	-
96	2A3	2. Industrial Proc.	A. Mineral Products; Limestone and Dolomite Use, Emissions, CO2			CO2	103.25	72.39	0.13%	0.00060	0.2%	-	-
97	2A7	2. Industrial Proc.	A. Mineral Products; Other non-specified-CO2			CO2	15.12	5.93	0.01%	0.00017	0.1%	-	-
98	2B	1. Industrial Proc.	B. Chemical Industry			CH4	9.63	8.39	0.02%	0.00003	0.0%	-	-
99	2B	2. Industrial Proc.	B. Chemical Industry			CO2	109.80	121.41	0.22%	0.00016	0.0%	-	-

Table A – 3 continued. Key category analysis Tier 1 2010 (without LULUCF) regarding trend.

Tier 1 Key category analysis 2010 without LULUCF categories												
A				B	C	D	E-L	E-T	F-T	M	N
No.	IPCC Source Categories and fuels if applicable (without LULUCF categories)			Direct GHG	Base Year 1990 Estimate [Gg CO2 eq]	Year 2010 Estimate [Gg CO2 eq]	Level Assessm.	Trend Assessm.	% Contrib. in Trend	Result level assessm.	Result trend assessm.
100	2B	2. Industrial Proc.	B. Chemical Industry	N2O	68.13	60.26	0.11%	0.00017	0.0%	-	-
101	2C	2. Industrial Proc.	C. Metal Production; Magnesium Foundries	SF6	0.00	29.66	0.05%	0.00053	0.2%	-	-
102	2C	2. Industrial Proc.	C. Metal Production; Aluminium Foundries	SF6	0.00	4.88	0.01%	0.00009	0.0%	-	-
103	2C1	2. Industrial Proc.	C. Metal Production; Steel Production	CO2	110.80	170.57	0.31%	0.00103	0.3%	-	-
104	2C3	2. Industrial Proc.	C. Metal Production; Aluminium Production-CO2	CO2	139.26	0.00	0.00%	0.00000	0.0%	-	-
105	2C3	2. Industrial Proc.	C. Metal Production; Aluminium Production-PFC	PFC	100.17	0.00	0.00%	0.00000	0.0%	-	-
106	2C5	2. Industrial Proc.	C. Metal Production; Non-ferrous metals-CO2	CO2	1.65	1.85	0.00%	0.00000	0.0%	-	-
107	2F1	2. Industrial Proc.	F. Consumption of Halocarbons and SF6; Refrigeration	PFC	0.04	7.43	0.01%	0.00013	0.0%	-	-
108	2F2	2. Industrial Proc.	F. Consumption of Halocarbons and SF6; Hard Foam	HFC	0.00	13.59	0.03%	0.00024	0.1%	-	-
109	2F4	2. Industrial Proc.	F. Consumption of Halocarbons and SF6; Metered Dose Inhalers and Other	HFC	0.00	14.71	0.03%	0.00027	0.1%	-	-
110	2F5	2. Industrial Proc.	F. Consumption of Halocarbons and SF6; Solvents	HFC	0.00	2.37	0.00%	0.00004	0.0%	-	-
111	2F5	2. Industrial Proc.	F. Consumption of Halocarbons and SF6; Solvents	PFC	0.00	7.88	0.01%	0.00014	0.0%	-	-
112	2F7	2. Industrial Proc.	F. Consumption of Halocarbons and SF6; Semiconductor Manufacture	PFC	0.00	14.56	0.03%	0.00026	0.1%	-	-
113	2F7	2. Industrial Proc.	F. Consumption of Halocarbons and SF6; Semiconductor Manufacture	PFC	0.00	6.63	0.01%	0.00012	0.0%	-	-
114	2F7	2. Industrial Proc.	F. Consumption of Halocarbons and SF6; Semiconductor Manufacture	SF6	0.00	6.99	0.01%	0.00013	0.0%	-	-
115	2F8	2. Industrial Proc.	F. Consumption of Halocarbons and SF6; Electrical Eq.	SF6	64.04	62.47	0.12%	0.00005	0.0%	-	-
116	2F9	2. Industrial Proc.	F. Consumption of Halocarbons and SF6; Other	HFC	0.00	30.62	0.06%	0.00055	0.2%	-	-
117	2F9	2. Industrial Proc.	F. Consumption of Halocarbons and SF6; Other	PFC	0.00	0.00	0.00%	0.00000	0.0%	-	-
118	2F9	2. Industrial Proc.	F. Consumption of Halocarbons and SF6; Other	SF6	79.58	51.12	0.09%	0.00055	0.2%	-	-
119	2G	2. Industrial Proc.	G. Other	CO2	1.04	0.96	0.00%	0.00000	0.0%	-	-
120	3	3. Solvent and Other Product Use		CO2	361.92	157.23	0.29%	0.00384	1.1%	-	KC trend
121	3	3. Solvent and Other Product Use		N2O	110.14	57.33	0.11%	0.00100	0.3%	-	-
122	4D4	4. Agriculture	D. Agricultural Soils; Use of sewage sludge as fertilizers	N2O	28.19	22.56	0.04%	0.00011	0.0%	-	-
123	4F	4. Agriculture	F. Field Burning of Agricultural Residues	CH4	10.00	10.00	0.02%	0.00000	0.0%	-	-
124	4F	4. Agriculture	F. Field Burning of Agricultural Residues	N2O	3.91	3.91	0.01%	0.00000	0.0%	-	-
125	6A	6. Waste	A. Solid Waste Disposal on Land	CH4	688.16	198.00	0.36%	0.00912	2.7%	-	KC trend
126	6A	6. Waste	A. Solid Waste Disposal on Land	CO2	9.24	0.00	0.00%	0.00000	0.0%	-	-
127	6B	6. Waste	B. Wastewater Handling	CH4	4.65	45.90	0.08%	0.00074	0.2%	-	-
128	6C	6. Waste	C. Waste Incineration	CH4	4.25	2.80	0.01%	0.00003	0.0%	-	-
129	6C	6. Waste	C. Waste Incineration	CO2	54.10	10.68	0.02%	0.00080	0.2%	-	-
130	6C	6. Waste	C. Waste Incineration	N2O	16.20	25.90	0.05%	0.00017	0.0%	-	-
131	6D	6. Waste	D. Other	CH4	27.44	95.23	0.18%	0.00121	0.4%	-	KC trend
132	6D	6. Waste	D. Other	CO2	0.00	0.00	0.00%	0.00000	0.0%	-	-
133	6D	6. Waste	D. Other	N2O	5.82	24.15	0.04%	0.00033	0.1%	-	-
134	7	7. Other		CH4	0.55	0.58	0.00%	0.00000	0.0%	-	-
135	7	7. Other		CO2	10.96	13.02	0.02%	0.00003	0.0%	-	-
136	7	7. Other		N2O	16.72	13.63	0.03%	0.00006	0.0%	-	-

A1.3 KCA Tier 1 2010 including LULUCF categories

A1.3.1 Results of Key Category Analysis Tier 1 – Level

Table A - 4 Key category analysis Tier 1 2010 (with LULUCF) regarding level.

Tier 1 Key category analysis 2010 with LULUCF categories												
	A					B	C	D	E-L	E-T	F-T	M
No.	IPCC Source Categories and fuels if applicable (with LULUCF categories)					Direct GHG	Base Year 1990 Estimate [Gg CO2 eq]	Year 2010 Estimate [Gg CO2 eq]	Level Assessm.	Trend Assessm.	% Contrib. in Trend	Result level assessm.
1	1A3b	1. Energy	A. Fuel Combustion	3. Transport; Road Transportation	Gasoline	CO2	11335.25	9744.97	16.90%	0.02259	6.2%	KC level
2	1A4b	1. Energy	A. Fuel Combustion	4. Other Sectors; Residential	Liquid Fuels	CO2	10226.25	8688.23	15.07%	0.02222	6.1%	KC level
3	1A3b	1. Energy	A. Fuel Combustion	3. Transport; Road Transportation	Diesel	CO2	2587.68	6154.63	10.67%	0.06500	17.9%	KC level
4	1A4a	1. Energy	A. Fuel Combustion	4. Other Sectors; Commercial/Institutional	Liquid Fuels	CO2	4429.39	3607.89	6.26%	0.01240	3.4%	KC level
5	1A2	1. Energy	A. Fuel Combustion	2. Manufacturing Industries and Construction	Liquid Fuels	CO2	3876.46	2890.89	5.01%	0.01561	4.3%	KC level
6	1A4b	1. Energy	A. Fuel Combustion	4. Other Sectors; Residential	Gaseous Fuels	CO2	1409.10	2661.45	4.62%	0.02308	6.3%	KC level
7	1A1	1. Energy	A. Fuel Combustion	1. Energy Industries	Other Fuels	CO2	1519.73	2582.10	4.48%	0.01974	5.4%	KC level
8	4A	4. Agriculture	A. Enteric Fermentation			CH4	2657.35	2537.97	4.40%	0.00077	0.2%	KC level
9	1A2	1. Energy	A. Fuel Combustion	2. Manufacturing Industries and Construction	Gaseous Fuels	CO2	1133.30	2216.12	3.84%	0.01991	5.5%	KC level
10	2A1	2. Industrial Proc.	A. Mineral Products; Cement Production-CO2			CO2	2524.77	1928.12	3.34%	0.00936	2.6%	KC level
11	1A4a	1. Energy	A. Fuel Combustion	4. Other Sectors; Commercial/Institutional	Gaseous Fuels	CO2	905.76	1409.10	2.44%	0.00945	2.6%	KC level
12	5A2	5. LULUCF	A. Forest Land	2. Land converted to Forest Land		CO2	1306.70	1205.09	2.09%	0.00115	0.3%	KC level
13	4D1	4. Agriculture	D. Agricultural Soils; Direct Soil Emissions			N2O	1364.15	1189.21	2.06%	0.00242	0.7%	KC level
14	2F1	2. Industrial Proc.	F. Consumption of Halocarbons and SF6; Refrig. & AC Eq.			HFC	0.02	1011.69	1.75%	0.01806	5.0%	KC level
15	1A1	1. Energy	A. Fuel Combustion	1. Energy Industries	Liquid Fuels	CO2	691.23	965.28	1.67%	0.00525	1.4%	KC level
16	5A1	5. LULUCF	A. Forest Land	1. Forest Land remaining Forest Land		CO2	-3771.35	-945.76	1.64%	0.04851	13.3%	KC level
17	4D3	4. Agriculture	D. Agricultural Soils; Indirect Emissions			N2O	820.73	710.51	1.23%	0.00155	0.4%	KC level
18	4B	4. Agriculture	B. Manure Management			CH4	672.00	645.25	1.12%	0.00013	0.0%	KC level
19	1A1	1. Energy	A. Fuel Combustion	1. Energy Industries	Gaseous Fuels	CO2	235.05	540.64	0.94%	0.00558	1.5%	KC level
20	1A2	1. Energy	A. Fuel Combustion	2. Manufacturing Industries and Construction	Solid Fuels	CO2	1227.96	520.65	0.90%	0.01200	3.3%	KC level
21	1A4c	1. Energy	A. Fuel Combustion	4. Other Sectors; Agriculture/Forestry	Liquid Fuels	CO2	547.00	519.96	0.90%	0.00020	0.1%	KC level
22	5B1	5. LULUCF	B. Cropland	1. Cropland remaining Cropland		CO2	435.28	425.31	0.74%	0.00004	0.0%	KC level
23	4B	4. Agriculture	B. Manure Management			N2O	453.87	323.52	0.56%	0.00209	0.6%	KC level
24	1A2	1. Energy	A. Fuel Combustion	2. Manufacturing Industries and Construction	Other Fuels	CO2	134.24	315.35	0.55%	0.00330	0.9%	KC level
25	5E2	5. LULUCF	E. Settlements	2. Land converted to Settlements		CO2	361.84	297.07	0.52%	0.00097	0.3%	KC level
26	4D2	4. Agriculture	D. Agricultural Soils; Pasture, Range and Paddock Manure			N2O	128.10	245.40	0.43%	0.00216	0.6%	KC level
27	6B	6. Waste	B. Wastewater Handling			N2O	184.72	208.89	0.36%	0.00053	0.1%	KC level
28	6A	6. Waste	A. Solid Waste Disposal on Land			CH4	688.16	198.00	0.34%	0.00840	2.3%	KC level
29	1B2	1. Energy	B. Fugitive Emissions from Fuel	2. Oil and Natural Gas		CH4	380.43	173.85	0.30%	0.00349	1.0%	KC level
30	5C2	5. LULUCF	C. Grassland	2. Land converted to Grassland		CO2	74.60	172.45	0.30%	0.00179	0.5%	-
31	2C1	2. Industrial Proc.	C. Metal Production; Steel Production			CO2	110.80	170.57	0.30%	0.00112	0.3%	-
32	5C1	5. LULUCF	C. Grassland	1. Grassland remaining Grassland		CO2	146.77	163.58	0.28%	0.00038	0.1%	-
33	3	3. Solvent and Other Product Use				CO2	361.92	157.23	0.27%	0.00347	1.0%	-
34	1A3a	1. Energy	A. Fuel Combustion	3. Transport; Civil Aviation		CO2	252.55	123.55	0.21%	0.00217	0.6%	-
35	5F2	5. LULUCF	F. Other Land	2. Land converted to Other Land		CO2	97.88	121.89	0.21%	0.00048	0.1%	-
36	2B	2. Industrial Proc.	B. Chemical Industry			CO2	109.80	121.41	0.21%	0.00026	0.1%	-
37	1A5	1. Energy	A. Fuel Combustion	5. Other	Liquid Fuels	CO2	203.58	119.55	0.21%	0.00140	0.4%	-
38	1A3d	1. Energy	A. Fuel Combustion	3. Transport; Navigation		CO2	111.86	116.98	0.20%	0.00015	0.0%	-
39	1A3b	1. Energy	A. Fuel Combustion	3. Transport; Road Transportation	Gasoline	N2O	137.27	111.15	0.19%	0.00040	0.1%	-
40	6D	6. Waste	D. Other			CH4	27.44	95.23	0.17%	0.00122	0.3%	-
41	1B2	1. Energy	B. Fugitive Emissions from Fuel	2. Oil and Natural Gas		CO2	91.36	74.04	0.13%	0.00026	0.1%	-
42	2A3	2. Industrial Proc.	A. Mineral Products; Limestone and Dolomite Use, Emissions, CO2			CO2	103.25	72.39	0.13%	0.00050	0.1%	-
43	2F8	2. Industrial Proc.	F. Consumption of Halocarbons and SF6; Electrical Eq.			SF6	64.04	62.47	0.11%	0.00000	0.0%	-
44	2B	2. Industrial Proc.	B. Chemical Industry			N2O	68.13	60.26	0.10%	0.00011	0.0%	-
45	3	3. Solvent and Other Product Use				N2O	110.14	57.33	0.10%	0.00089	0.2%	-
46	2A2	2. Industrial Proc.	A. Mineral Products; Lime Production-CO2			CO2	53.35	54.23	0.09%	0.00004	0.0%	-
47	2F9	2. Industrial Proc.	F. Consumption of Halocarbons and SF6; Other			SF6	79.58	51.12	0.09%	0.00047	0.1%	-
48	1A3ei	1. Energy	A. Fuel Combustion	3. Transport; Other non-specified		CO2	49.01	48.71	0.08%	0.00002	0.0%	-
49	1A1	1. Energy	A. Fuel Combustion	1. Energy Industries	Biomass	N2O	27.72	48.15	0.08%	0.00038	0.1%	-
50	1A1	1. Energy	A. Fuel Combustion	1. Energy Industries	Other Fuels	N2O	20.85	47.25	0.08%	0.00048	0.1%	-
51	6B	6. Waste	B. Wastewater Handling			CH4	4.65	45.90	0.08%	0.00074	0.2%	-
52	1A3b	1. Energy	A. Fuel Combustion	3. Transport; Road Transportation	Natural Gas	CO2	0.00	39.05	0.07%	0.00070	0.2%	-
53	1A4b	1. Energy	A. Fuel Combustion	4. Other Sectors; Residential	Biomass	CH4	95.89	38.15	0.07%	0.00098	0.3%	-
54	1A3c	1. Energy	A. Fuel Combustion	3. Transport; Railways		CO2	28.69	37.77	0.07%	0.00018	0.0%	-
55	1A4b	1. Energy	A. Fuel Combustion	4. Other Sectors; Residential	Solid Fuels	CO2	54.59	33.60	0.06%	0.00035	0.1%	-
56	2F9	2. Industrial Proc.	F. Consumption of Halocarbons and SF6; Other			HFC	0.00	30.62	0.05%	0.00055	0.2%	-
57	5E1	5. LULUCF	E. Settlements	1. Settlements remaining Settlements		CO2	0.57	30.44	0.05%	0.00053	0.1%	-
58	2C	2. Industrial Proc.	C. Metal Production; Magnesium Foundries			SF6	0.00	29.66	0.05%	0.00053	0.1%	-
59	5D2	5. LULUCF	D. Wetlands	2. Land converted to Wetlands		CO2	19.81	27.69	0.05%	0.00015	0.0%	-
60	5B2	5. LULUCF	B. Cropland	2. Land converted to Cropland		CO2	47.04	27.07	0.05%	0.00033	0.1%	-
61	6C	6. Waste	C. Waste Incineration			N2O	16.20	25.90	0.04%	0.00018	0.0%	-
62	6D	6. Waste	D. Other			N2O	5.82	24.15	0.04%	0.00033	0.1%	-
63	4D4	4. Agriculture	D. Agricultural Soils; Use of sewage sludge as fertilizers			N2O	28.19	22.56	0.04%	0.00009	0.0%	-
64	1A3b	1. Energy	A. Fuel Combustion	3. Transport; Road Transportation	Gasoline	CH4	101.15	22.34	0.04%	0.00135	0.4%	-
65	1A4b	1. Energy	A. Fuel Combustion	4. Other Sectors; Residential	Liquid Fuels	N2O	25.94	22.06	0.04%	0.00006	0.0%	-
66	1A3b	1. Energy	A. Fuel Combustion	3. Transport; Road Transportation	Diesel	N2O	5.84	18.10	0.03%	0.00022	0.1%	-
67	1A4c	1. Energy	A. Fuel Combustion	4. Other Sectors; Agriculture/Forestry	Gaseous Fuels	CO2	40.64	15.85	0.03%	0.00042	0.1%	-
68	2F4	2. Industrial Proc.	F. Consumption of Halocarbons and SF6; Metered Dose Inhalers and Other			HFC	0.00	14.71	0.03%	0.00026	0.1%	-
69	2F7	2. Industrial Proc.	F. Consumption of Halocarbons and SF6; Semiconductor Manufacture			PFC	0.00	14.56	0.03%	0.00026	0.1%	-
70	7	7. Other				N2O	16.72	13.63	0.02%	0.00005	0.0%	-
71	2F2	2. Industrial Proc.	F. Consumption of Halocarbons and SF6; Hard Foam			HFC	0.00	13.59	0.02%	0.00024	0.1%	-
72	7	7. Other				CO2	10.96	13.02	0.02%	0.00004	0.0%	-
73	1A2	1. Energy	A. Fuel Combustion	2. Manufacturing Industries and Construction	Liquid Fuels	N2O	14.96	12.84	0.02%	0.00003	0.0%	-
74	1A2	1. Energy	A. Fuel Combustion	2. Manufacturing Industries and Construction	Biomass	N2O	2.44	10.79	0.02%	0.00015	0.0%	-
75	6C	6. Waste	C. Waste Incineration			CO2	54.10	10.68	0.02%	0.00075	0.2%	-
76	4F	4. Agriculture	F. Field Burning of Agricultural Residues			CH4	10.00	10.00	0.02%	0.00001	0.0%	-
77	1A4b	1. Energy	A. Fuel Combustion	4. Other Sectors; Residential	Biomass	N2O	10.64	9.82	0.02%	0.00001	0.0%	-
78	1A4a	1. Energy	A. Fuel Combustion	4. Other Sectors; Commercial/Institutional	Liquid Fuels	N2O	11.28	9.25	0.02%	0.00003	0.0%	-
79	2B	1. Industrial Proc.	B. Chemical Industry			CH4	9.63	8.39	0.01%	0.00002	0.0%	-
80	2F5	2. Industrial Proc.	F. Consumption of Halocarbons and SF6; Solvents			PFC	0.00	7.88	0.01%	0.00014	0.0%	-
81	2F1	2. Industrial Proc.	F. Consumption of Halocarbons and SF6; Refrigeration			PFC	0.04	7.43	0.01%	0.00013	0.0%	-
82	2F7	2. Industrial Proc.	F. Consumption of Halocarbons and SF6; Semiconductor Manufacture			SF6	0.00	6.99	0.01%	0.00012	0.0%	-
83	2F7	2. Industrial Proc.	F. Consumption of Halocarbons and SF6; Semiconductor Manufacture			PFC	0.00	6.63	0.01%	0.00012	0.0%	-
84	1A4b	1. Energy	A. Fuel Combustion	4. Other Sectors; Residential	Gaseous Fuels	CH4	3.26	6.26	0.01%	0.00006	0.0%	-
85	2A7	2. Industrial Proc.	A. Mineral Products; Other non-specified-CO2			CO2	15.12	5.93	0.01%	0.00016	0.0%	-
86	1A2	1. Energy	A. Fuel Combustion	2. Manufacturing Industries and Construction	Other Fuels	N2O	2.31	5.83	0.01%	0.00006	0.0%	-
87	1A4c	1. Energy	A. Fuel Combustion	4. Other Sectors; Agriculture/Forestry	Liquid Fuels	N2O	4.97	5.28	0.01%	0.00001	0.0%	-
88	1A4a	1. Energy	A. Fuel Combustion	4. Other Sectors; Commercial/Institutional	Biomass	CH4	9.74	5.12	0.01%	0.00008	0.0%	-
89	1A2	1. Energy	A. Fuel Combustion	2. Manufacturing Industries and Construction	Gaseous Fuels	CH4	2.84	5.10	0.01%	0.00004	0.0%	-
90	2C	2. Industrial Proc.	C. Metal Production; Aluminium Foundries			SF6	0.00	4.88	0.01%	0.00009	0.0%	-
91	5B2	5. LULUCF	B. Cropland	2. Land converted to Cropland		N2O	6.14	4.38	0.01%	0.00003	0.0%	-
92	4F	4. Agriculture	F. Field Burning of Agricultural Residues			N2O	3.91	3.91	0.01%	0.00000	0.0%	-
93	1A4a	1. Energy	A. Fuel Combustion	4. Other Sectors; Commercial/Institutional	Gaseous Fuels	CH4	2.27	3.75	0.01%	0.00003	0.0%	-
94	1A1	1. Energy	A. Fuel Combustion	1. Energy Industries	Liquid Fuels	N2O	2.15	3.47	0.01%	0.00002	0.0%	-
95	1A4a	1. Energy	A. Fuel Combustion	4. Other Sectors; Commercial/Institutional	Biomass	N2O	1.45	3.36	0.01%	0.00003	0.0%	-
96	6C	6. Waste	C. Waste Incineration			CH4	4.25	2.80	0.00%	0.00002	0.0%	-
97	1A2	1. Energy	A. Fuel Combustion	2. Manufacturing Industries and Construction	Solid Fuels	N2O	6.57	2.76	0.00%	0.00006	0.0%	-
98	1A4b	1. Energy	A. Fuel Combustion	4. Other Sectors; Residential	Liquid Fuels	CH4	6.00	2.63	0.00%	0.00006	0.0%	-
99	2F5	2. Industrial Proc.	F. Consumption of Halocarbons and SF6; Solvents			HFC	0.00	2.37	0.00%	0.00004	0.0%	-

Table A – 4 continued. Key category analysis Tier 1 2010 (with LULUCF) regarding level.

Tier 1 Key category analysis 2010 with LULUCF categories												
	A					B	C	D	E-L	E-T	F-T	M
No.	IPCC Source Categories and fuels if applicable (with LULUCF categories)					Direct GHG	Base Year 1990 Estimate [Gg CO2 eq]	Year 2010 Estimate [Gg CO2 eq]	Level Assessm.	Trend Assessm.	% Contrib. in Trend	Result level assessm.
100	1A4b	1. Energy	A. Fuel Combustion	4. Other Sectors; Residential	Solid Fuels	CH4	3.71	2.28	0.00%	0.00002	0.0%	-
101	1A2	1. Energy	A. Fuel Combustion	2. Manufacturing Industries and Construction	Biomass	CH4	2.46	2.01	0.00%	0.00001	0.0%	-
102	2C5	2. Industrial Proc.	C. Metal Production; Non-ferrous metals-CO2			CO2	1.65	1.85	0.00%	0.00000	0.0%	-
103	1A4a	1. Energy	A. Fuel Combustion	4. Other Sectors; Commercial/Institutional	Liquid Fuels	CH4	2.96	1.57	0.00%	0.00002	0.0%	-
104	1A4b	1. Energy	A. Fuel Combustion	4. Other Sectors; Residential	Gaseous Fuels	N2O	0.79	1.50	0.00%	0.00001	0.0%	-
105	1A4c	1. Energy	A. Fuel Combustion	4. Other Sectors; Agriculture/Forestry	Liquid Fuels	CH4	1.62	1.38	0.00%	0.00000	0.0%	-
106	1A2	1. Energy	A. Fuel Combustion	2. Manufacturing Industries and Construction	Gaseous Fuels	N2O	0.63	1.24	0.00%	0.00001	0.0%	-
107	1A1	1. Energy	A. Fuel Combustion	1. Energy Industries	Gaseous Fuels	CH4	0.54	1.24	0.00%	0.00001	0.0%	-
108	1A1	1. Energy	A. Fuel Combustion	1. Energy Industries	Biomass	CH4	4.66	1.24	0.00%	0.00006	0.0%	-
109	1A3a	1. Energy	A. Fuel Combustion	3. Transport; Civil Aviation		N2O	2.46	1.20	0.00%	0.00002	0.0%	-
110	1A2	1. Energy	A. Fuel Combustion	2. Manufacturing Industries and Construction	Liquid Fuels	CH4	2.42	1.20	0.00%	0.00002	0.0%	-
111	1A5	1. Energy	A. Fuel Combustion	5. Other	Liquid Fuels	N2O	2.01	1.18	0.00%	0.00001	0.0%	-
112	2G	2. Industrial Proc.	G. Other			CO2	1.04	0.96	0.00%	0.00000	0.0%	-
113	1A4a	1. Energy	A. Fuel Combustion	4. Other Sectors; Commercial/Institutional	Gaseous Fuels	N2O	0.51	0.79	0.00%	0.00001	0.0%	-
114	1A1	1. Energy	A. Fuel Combustion	1. Energy Industries	Liquid Fuels	CH4	0.49	0.78	0.00%	0.00001	0.0%	-
115	1A3d	1. Energy	A. Fuel Combustion	3. Transport; Navigation	Gas/Diesel Oil	N2O	0.64	0.76	0.00%	0.00000	0.0%	-
116	5A1	5. LULUCF	A. Forest Land	1. Forest Land remaining Forest Land	Biomass Burning,	CO2	-30.07	-0.68	0.00%	0.00051	0.1%	-
117	1A3b	1. Energy	A. Fuel Combustion	3. Transport; Road Transportation	Diesel	CH4	1.36	0.65	0.00%	0.00001	0.0%	-
118	7	7. Other				CH4	0.55	0.58	0.00%	0.00000	0.0%	-
119	1A3d	1. Energy	A. Fuel Combustion	3. Transport; Navigation	Gasoline	N2O	0.60	0.53	0.00%	0.00000	0.0%	-
120	1A3d	1. Energy	A. Fuel Combustion	3. Transport; Navigation	Gasoline	CH4	0.58	0.51	0.00%	0.00000	0.0%	-
121	1A3c	1. Energy	A. Fuel Combustion	3. Transport; Railways	Liquid Fuels	N2O	0.38	0.49	0.00%	0.00000	0.0%	-
122	1A2	1. Energy	A. Fuel Combustion	2. Manufacturing Industries and Construction	Solid Fuels	CH4	0.57	0.45	0.00%	0.00000	0.0%	-
123	1A3b	1. Energy	A. Fuel Combustion	3. Transport; Road Transportation	Biomass	N2O	0.00	0.44	0.00%	0.00001	0.0%	-
124	5D1	5. LULUCF	D. Wetlands	1. Wetlands remaining Wetlands		CO2	-2.79	-0.42	0.00%	0.00004	0.0%	-
125	1A4c	1. Energy	A. Fuel Combustion	4. Other Sectors; Agriculture/Forestry	Biomass	N2O	0.21	0.35	0.00%	0.00000	0.0%	-
126	1A1	1. Energy	A. Fuel Combustion	1. Energy Industries	Gaseous Fuels	N2O	0.13	0.30	0.00%	0.00000	0.0%	-
127	1A3b	1. Energy	A. Fuel Combustion	3. Transport; Road Transportation	Natural Gas	CH4	0.00	0.27	0.00%	0.00000	0.0%	-
128	1A3a	1. Energy	A. Fuel Combustion	3. Transport; Civil Aviation		CH4	0.24	0.27	0.00%	0.00000	0.0%	-
129	5A1	5. LULUCF	A. Forest Land	1. Forest Land remaining Forest Land		CH4	8.19	0.19	0.00%	0.00014	0.0%	-
130	1A4c	1. Energy	A. Fuel Combustion	4. Other Sectors; Agriculture/Forestry	Biomass	CH4	0.80	0.18	0.00%	0.00001	0.0%	-
131	1A4b	1. Energy	A. Fuel Combustion	4. Other Sectors; Residential	Solid Fuels	N2O	0.29	0.18	0.00%	0.00000	0.0%	-
132	5A1	5. LULUCF	A. Forest Land	1. Forest Land remaining Forest Land		N2O	5.30	0.12	0.00%	0.00009	0.0%	-
133	1A5	1. Energy	A. Fuel Combustion	5. Other	Liquid Fuels	CH4	0.16	0.12	0.00%	0.00000	0.0%	-
134	1A3ei	1. Energy	A. Fuel Combustion	3. Transport; Other non-specified		CH4	0.09	0.04	0.00%	0.00000	0.0%	-
135	1A4c	1. Energy	A. Fuel Combustion	4. Other Sectors; Agriculture/Forestry	Gaseous Fuels	CH4	0.09	0.04	0.00%	0.00000	0.0%	-
136	1A3b	1. Energy	A. Fuel Combustion	3. Transport; Road Transportation	Biomass	CH4	0.00	0.04	0.00%	0.00000	0.0%	-
137	1A3ei	1. Energy	A. Fuel Combustion	3. Transport; Other non-specified		N2O	0.03	0.03	0.00%	0.00000	0.0%	-
138	1A3d	1. Energy	A. Fuel Combustion	3. Transport; Navigation	Gas/Diesel Oil	CH4	0.01	0.02	0.00%	0.00000	0.0%	-
139	1A4c	1. Energy	A. Fuel Combustion	4. Other Sectors; Agriculture/Forestry	Gaseous Fuels	N2O	0.02	0.01	0.00%	0.00000	0.0%	-
140	1A3c	1. Energy	A. Fuel Combustion	3. Transport; Railways	Liquid Fuels	CH4	0.01	0.01	0.00%	0.00000	0.0%	-
141	1A1	1. Energy	A. Fuel Combustion	1. Energy Industries	Solid Fuels	CO2	44.84	0.00	0.00%	0.00000	0.0%	-
142	1A1	1. Energy	A. Fuel Combustion	1. Energy Industries	Solid Fuels	CH4	0.10	0.00	0.00%	0.00000	0.0%	-
143	1A1	1. Energy	A. Fuel Combustion	1. Energy Industries	Solid Fuels	N2O	0.24	0.00	0.00%	0.00000	0.0%	-
144	1A2	1. Energy	A. Fuel Combustion	2. Manufacturing Industries and Construction	Other Fuels	CH4	0.00	0.00	0.00%	0.00000	0.0%	-
145	1A3b	1. Energy	A. Fuel Combustion	3. Transport; Road Transportation	Natural Gas	N2O	0.00	0.00	0.00%	0.00000	0.0%	-
146	1B2	1. Energy	B. Fugitive Emissions from Fuel	2. Oil and Natural Gas		N2O	0.00	0.00	0.00%	0.00000	0.0%	-
147	2C3	2. Industrial Proc.	C. Metal Production; Aluminium Production-CO2			CO2	139.26	0.00	0.00%	0.00000	0.0%	-
148	2C3	2. Industrial Proc.	C. Metal Production; Aluminium Production-PFC			PFC	100.17	0.00	0.00%	0.00000	0.0%	-
149	2F9	2. Industrial Proc.	F. Consumption of Halocarbons and SF6; Other			PFC	0.00	0.00	0.00%	0.00000	0.0%	-
150	6A	6. Waste	A. Solid Waste Disposal on Land			CO2	9.24	0.00	0.00%	0.00000	0.0%	-
151	6D	6. Waste	D. Other			CO2	0.00	0.00	0.00%	0.00000	0.0%	-

A1.3.2 Results of Key Category Analysis Tier 1 – Trend

Table A - 5 Key category analysis Tier 1 2010 (with LULUCF) regarding trend.

Tier 1 Key category analysis 2010 with LULUCF categories

	A					B	C	D	E-L	E-T	F-T	M	N
No.	IPCC Source Categories and fuels if applicable (with LULUCF categories)					Direct GHG	Base Year 1990 Estimate [Gg CO2 eq]	Year 2010 Estimate [Gg CO2 eq]	Level Assessm.	Trend Assessm.	% Contrib. in Trend	Result level assessm.	Result trend assessm.
1	1A3b	1. Energy	A. Fuel Combustion	3. Transport; Road Transportation	Gasoline	CO2	11335.25	9744.97	16.90%	0.02259	6.2%	KC level	KC trend
2	1A4b	1. Energy	A. Fuel Combustion	4. Other Sectors; Residential	Liquid Fuels	CO2	10226.25	8688.23	15.07%	0.02222	6.1%	KC level	KC trend
3	1A3b	1. Energy	A. Fuel Combustion	3. Transport; Road Transportation	Diesel	CO2	2587.68	6154.63	10.67%	0.06500	17.9%	KC level	KC trend
4	1A4a	1. Energy	A. Fuel Combustion	4. Other Sectors; Commercial/Institutional	Liquid Fuels	CO2	4429.39	3607.89	6.26%	0.01240	3.4%	KC level	KC trend
5	1A2	1. Energy	A. Fuel Combustion	2. Manufacturing Industries and Construction	Liquid Fuels	CO2	3876.46	2890.89	5.01%	0.01561	4.3%	KC level	KC trend
6	1A4b	1. Energy	A. Fuel Combustion	4. Other Sectors; Residential	Gaseous Fuels	CO2	1409.10	2661.45	4.62%	0.02308	6.3%	KC level	KC trend
7	1A1	1. Energy	A. Fuel Combustion	1. Energy Industries	Other Fuels	CO2	1519.73	2582.10	4.48%	0.01974	5.4%	KC level	KC trend
8	4A	4. Agriculture	A. Enteric Fermentation			CH4	2657.35	2537.97	4.40%	0.00077	0.2%	KC level	-
9	1A2	1. Energy	A. Fuel Combustion	2. Manufacturing Industries and Construction	Gaseous Fuels	CO2	1133.30	2216.12	3.84%	0.01991	5.5%	KC level	KC trend
10	2A1	2. Industrial Proc.	A. Mineral Products; Cement Production-CO2			CO2	2524.77	1928.12	3.34%	0.00936	2.6%	KC level	KC trend
11	1A4a	1. Energy	A. Fuel Combustion	4. Other Sectors; Commercial/Institutional	Gaseous Fuels	CO2	905.76	1409.10	2.44%	0.00945	2.6%	KC level	KC trend
12	5A2	5. LULUCF	A. Forest Land	2. Land converted to Forest Land		CO2	1306.70	1205.09	2.09%	0.00115	0.3%	KC level	KC trend
13	4D1	4. Agriculture	D. Agricultural Soils; Direct Soil Emissions			N2O	1364.15	1189.21	2.06%	0.00242	0.7%	KC level	KC trend
14	2F1	2. Industrial Proc.	F. Consumption of Halocarbons and SF6; Refrig. & AC Eq.			HFC	0.02	1011.69	1.75%	0.01806	5.0%	KC level	KC trend
15	1A1	1. Energy	A. Fuel Combustion	1. Energy Industries	Liquid Fuels	CO2	691.23	965.28	1.67%	0.00525	1.4%	KC level	KC trend
16	5A1	5. LULUCF	A. Forest Land	1. Forest Land remaining Forest Land		CO2	-3771.35	-945.76	1.64%	0.04851	13.3%	KC level	KC trend
17	4D3	4. Agriculture	D. Agricultural Soils; Indirect Emissions			N2O	820.73	710.51	1.23%	0.00155	0.4%	KC level	KC trend
18	4B	4. Agriculture	B. Manure Management			CH4	672.00	645.25	1.12%	0.00013	0.0%	KC level	-
19	1A1	1. Energy	A. Fuel Combustion	1. Energy Industries	Gaseous Fuels	CO2	235.05	540.64	0.94%	0.00558	1.5%	KC level	KC trend
20	1A2	1. Energy	A. Fuel Combustion	2. Manufacturing Industries and Construction	Solid Fuels	CO2	1227.96	520.65	0.90%	0.01200	3.3%	KC level	KC trend
21	1A4c	1. Energy	A. Fuel Combustion	4. Other Sectors; Agriculture/Forestry	Liquid Fuels	CO2	547.00	519.96	0.90%	0.00020	0.1%	KC level	-
22	5B1	5. LULUCF	B. Cropland	1. Cropland remaining Cropland		CO2	435.28	425.31	0.74%	0.00004	0.0%	KC level	-
23	4B	4. Agriculture	B. Manure Management			N2O	453.87	323.52	0.56%	0.00209	0.6%	KC level	KC trend
24	1A2	1. Energy	A. Fuel Combustion	2. Manufacturing Industries and Construction	Other Fuels	CO2	134.24	315.35	0.55%	0.00330	0.9%	KC level	KC trend
25	5E2	5. LULUCF	E. Settlements	2. Land converted to Settlements		CO2	361.84	297.07	0.52%	0.00097	0.3%	KC level	-
26	4D2	4. Agriculture	D. Agricultural Soils; Pasture, Range and Paddock Manure			N2O	128.10	245.40	0.43%	0.00216	0.6%	KC level	KC trend
27	6B	6. Waste	B. Wastewater Handling			N2O	184.72	208.89	0.36%	0.00053	0.1%	KC level	-
28	6A	6. Waste	A. Solid Waste Disposal on Land			CH4	688.16	198.00	0.34%	0.00840	2.3%	KC level	KC trend
29	1B2	1. Energy	B. Fugitive Emissions from Fuel	2. Oil and Natural Gas		CH4	380.43	173.85	0.30%	0.00349	1.0%	KC level	KC trend
30	5C2	5. LULUCF	C. Grassland	2. Land converted to Grassland		CO2	74.60	172.45	0.30%	0.00179	0.5%	-	KC trend
31	2C1	2. Industrial Proc.	C. Metal Production; Steel Production			CO2	110.80	170.57	0.30%	0.00112	0.3%	-	KC trend
32	5C1	5. LULUCF	C. Grassland	1. Grassland remaining Grassland		CO2	146.77	163.58	0.28%	0.00038	0.1%	-	-
33	3	3. Solvent and Other Product Use				CO2	361.92	157.23	0.27%	0.00347	1.0%	-	KC trend
34	1A3a	1. Energy	A. Fuel Combustion	3. Transport; Civil Aviation		CO2	252.55	123.55	0.21%	0.00217	0.6%	-	KC trend
35	5F2	5. LULUCF	F. Other Land	2. Land converted to Other Land		CO2	97.88	121.89	0.21%	0.00048	0.1%	-	-
36	2B	2. Industrial Proc.	B. Chemical Industry			CO2	109.80	121.41	0.21%	0.00026	0.1%	-	-
37	1A5	1. Energy	A. Fuel Combustion	5. Other	Liquid Fuels	CO2	203.58	119.55	0.21%	0.00140	0.4%	-	KC trend
38	1A3d	1. Energy	A. Fuel Combustion	3. Transport; Navigation		CO2	111.86	116.98	0.20%	0.00015	0.0%	-	-
39	1A3b	1. Energy	A. Fuel Combustion	3. Transport; Road Transportation	Gasoline	N2O	137.27	111.15	0.19%	0.00040	0.1%	-	-
40	6D	6. Waste	D. Other			CH4	27.44	95.23	0.17%	0.00122	0.3%	-	KC trend
41	1B2	1. Energy	B. Fugitive Emissions from Fuel	2. Oil and Natural Gas		CO2	91.36	74.04	0.13%	0.00026	0.1%	-	-
42	2A3	2. Industrial Proc.	A. Mineral Products; Limestone and Dolomite Use, Emissions, CO2			CO2	103.25	72.39	0.13%	0.00050	0.1%	-	-
43	2F8	2. Industrial Proc.	F. Consumption of Halocarbons and SF6; Electrical Eq.			SF6	64.04	62.47	0.11%	0.00000	0.0%	-	-
44	2B	2. Industrial Proc.	B. Chemical Industry			N2O	68.13	60.26	0.10%	0.00011	0.0%	-	-
45	3	3. Solvent and Other Product Use				N2O	110.14	57.33	0.10%	0.00089	0.2%	-	-
46	2A2	2. Industrial Proc.	A. Mineral Products; Lime Production-CO2			CO2	53.35	54.23	0.09%	0.00004	0.0%	-	-
47	2F9	2. Industrial Proc.	F. Consumption of Halocarbons and SF6; Other			SF6	79.58	51.12	0.09%	0.00047	0.1%	-	-
48	1A3ei	1. Energy	A. Fuel Combustion	3. Transport; Other non-specified		CO2	49.01	48.71	0.08%	0.00002	0.0%	-	-
49	1A1	1. Energy	A. Fuel Combustion	1. Energy Industries	Biomass	N2O	27.72	48.15	0.08%	0.00038	0.1%	-	-
50	1A1	1. Energy	A. Fuel Combustion	1. Energy Industries	Other Fuels	N2O	20.85	47.25	0.08%	0.00048	0.1%	-	-
51	6B	6. Waste	B. Wastewater Handling			CH4	4.65	45.90	0.08%	0.00074	0.2%	-	-
52	1A3b	1. Energy	A. Fuel Combustion	3. Transport; Road Transportation	Natural Gas	CO2	0.00	39.05	0.07%	0.00070	0.2%	-	-
53	1A4b	1. Energy	A. Fuel Combustion	4. Other Sectors; Residential	Biomass	CH4	95.89	38.15	0.07%	0.00098	0.3%	-	-
54	1A3c	1. Energy	A. Fuel Combustion	3. Transport; Railways		CO2	28.69	37.77	0.07%	0.00018	0.0%	-	-
55	1A4b	1. Energy	A. Fuel Combustion	4. Other Sectors; Residential	Solid Fuels	CO2	54.59	33.60	0.06%	0.00035	0.1%	-	-
56	2F9	2. Industrial Proc.	F. Consumption of Halocarbons and SF6; Other			HFC	0.00	30.62	0.05%	0.00055	0.2%	-	-
57	5E1	5. LULUCF	E. Settlements	1. Settlements remaining Settlements		CO2	0.57	30.44	0.05%	0.00053	0.1%	-	-
58	2C	2. Industrial Proc.	C. Metal Production; Magnesium Foundries			SF6	0.00	29.66	0.05%	0.00053	0.1%	-	-
59	5D2	5. LULUCF	D. Wetlands	2. Land converted to Wetlands		CO2	19.81	27.69	0.05%	0.00015	0.0%	-	-
60	5B2	5. LULUCF	B. Cropland	2. Land converted to Cropland		CO2	47.04	27.07	0.05%	0.00033	0.1%	-	-
61	6C	6. Waste	C. Waste Incineration			N2O	16.20	25.90	0.04%	0.00018	0.0%	-	-
62	6D	6. Waste	D. Other			N2O	5.82	24.15	0.04%	0.00033	0.1%	-	-
63	4D4	4. Agriculture	D. Agricultural Soils; Use of sewage sludge as fertilizers			N2O	28.19	22.56	0.04%	0.00009	0.0%	-	-
64	1A3b	1. Energy	A. Fuel Combustion	3. Transport; Road Transportation	Gasoline	CH4	101.15	22.34	0.04%	0.00135	0.4%	-	KC trend
65	1A4b	1. Energy	A. Fuel Combustion	4. Other Sectors; Residential	Liquid Fuels	N2O	25.94	22.06	0.04%	0.00006	0.0%	-	-
66	1A3b	1. Energy	A. Fuel Combustion	3. Transport; Road Transportation	Diesel	N2O	5.84	18.10	0.03%	0.00022	0.1%	-	-
67	1A4c	1. Energy	A. Fuel Combustion	4. Other Sectors; Agriculture/Forestry	Gaseous Fuels	CO2	40.64	15.85	0.03%	0.00042	0.1%	-	-
68	2F4	2. Industrial Proc.	F. Consumption of Halocarbons and SF6; Metered Dose Inhalers and Other			HFC	0.00	14.71	0.03%	0.00026	0.1%	-	-
69	2F7	2. Industrial Proc.	F. Consumption of Halocarbons and SF6; Semiconductor Manufacture			PFC	0.00	14.56	0.03%	0.00026	0.1%	-	-
70	7	7. Other				N2O	16.72	13.63	0.02%	0.00005	0.0%	-	-
71	2F2	2. Industrial Proc.	F. Consumption of Halocarbons and SF6; Hard Foam			HFC	0.00	13.59	0.02%	0.00024	0.1%	-	-
72	7	7. Other				CO2	10.96	13.02	0.02%	0.00004	0.0%	-	-
73	1A2	1. Energy	A. Fuel Combustion	2. Manufacturing Industries and Construction	Liquid Fuels	N2O	14.96	12.84	0.02%	0.00003	0.0%	-	-
74	1A2	1. Energy	A. Fuel Combustion	2. Manufacturing Industries and Construction	Biomass	N2O	2.44	10.79	0.02%	0.00015	0.0%	-	-
75	6C	6. Waste	C. Waste Incineration			CO2	54.10	10.68	0.02%	0.00075	0.2%	-	-
76	4F	4. Agriculture	F. Field Burning of Agricultural Residues			CH4	10.00	10.00	0.02%	0.00001	0.0%	-	-
77	1A4b	1. Energy	A. Fuel Combustion	4. Other Sectors; Residential	Biomass	N2O	10.64	9.82	0.02%	0.00001	0.0%	-	-
78	1A4a	1. Energy	A. Fuel Combustion	4. Other Sectors; Commercial/Institutional	Liquid Fuels	N2O	11.28	9.25	0.02%	0.00003	0.0%	-	-
79	2B	1. Industrial Proc.	B. Chemical Industry			CH4	9.63	8.39	0.01%	0.00002	0.0%	-	-
80	2F5	2. Industrial Proc.	F. Consumption of Halocarbons and SF6; Solvents			PFC	0.00	7.88	0.01%	0.00014	0.0%	-	-
81	2F1	2. Industrial Proc.	F. Consumption of Halocarbons and SF6; Refrigeration			PFC	0.04	7.43	0.01%	0.00013	0.0%	-	-
82	2F7	2. Industrial Proc.	F. Consumption of Halocarbons and SF6; Semiconductor Manufacture			SF6	0.00	6.99	0.01%	0.00012	0.0%	-	-
83	2F7	2. Industrial Proc.	F. Consumption of Halocarbons and SF6; Semiconductor Manufacture			PFC	0.00	6.63	0.01%	0.00012	0.0%	-	-
84	1A4b	1. Energy	A. Fuel Combustion	4. Other Sectors; Residential	Gaseous Fuels	CH4	3.26	6.26	0.01%	0.00006	0.0%	-	-
85	2A7	2. Industrial Proc.	A. Mineral Products; Other non-specified-CO2			CO2	15.12	5.93	0.01%	0.00016	0.0%	-	-
86	1A2	1. Energy	A. Fuel Combustion	2. Manufacturing Industries and Construction	Other Fuels	N2O	2.31	5.83	0.01%	0.00006	0.0%	-	-
87	1A4c	1. Energy	A. Fuel Combustion	4. Other Sectors; Agriculture/Forestry	Liquid Fuels	N2O	4.97	5.28	0.01%	0.00001	0.0%	-	-
88	1A4a	1. Energy	A. Fuel Combustion	4. Other Sectors; Commercial/Institutional	Biomass	CH4	9.74	5.12	0.01%	0.00008	0.0%	-	-
89	1A2	1. Energy	A. Fuel Combustion	2. Manufacturing Industries and Construction	Gaseous Fuels	CH4	2.84	5.10	0.01%	0.00004	0.0%	-	-
90	2C	2. Industrial Proc.	C. Metal Production; Aluminium Foundries			SF6	0.00	4.88	0.01%	0.00009	0.0%	-	-
91	5B2	5. LULUCF	B. Cropland	2. Land converted to Cropland		N2O	6.14	4.38	0.01%	0.00003	0.0%	-	-
92	4F	4. Agriculture	F. Field Burning of Agricultural Residues			N2O	3.91	3.91	0.01%	0.00000	0.0%	-	-
93	1A4a	1. Energy	A. Fuel Combustion	4. Other Sectors; Commercial/Institutional	Gaseous Fuels	CH4	2.27	3.75	0.01%	0.00003	0.0%	-	-
94	1A1	1. Energy	A. Fuel Combustion	1. Energy Industries	Liquid Fuels	N2O	2.15	3.47	0.01%	0.00002	0.0%	-	-
95	1A4a	1. Energy	A. Fuel Combustion	4. Other Sectors; Commercial/Institutional	Biomass	N2O	1.45	3.36	0.01%	0.00003	0.0%	-	-
96	6C	6. Waste	C. Waste Incineration			CH4	4.25	2.80	0.00%	0.00002	0.0%	-	-
97	1A2	1. Energy	A. Fuel Combustion	2. Manufacturing Industries and Construction	Solid Fuels	N2O	6.57	2.76	0.00%	0.00006	0.0%	-	-
98	1A4b	1. Energy	A. Fuel Combustion	4. Other Sectors; Residential	Liquid Fuels	CH4	6.00	2.63	0.00%	0.00006	0.0%	-	-
99	2F5	2. Industrial Proc.	F. Consumption of Halocarbons and SF6; Solvents			HFC	0.00	2.37	0.00%	0.00004	0.0%	-	-

Table A – 5 continued. Key category analysis Tier 1 2010 (with LULUCF) regarding trend.

Tier 1 Key category analysis 2010 with LULUCF categories													
	A					B	C	D	E-L	E-T	F-T	M	N
No.	IPCC Source Categories and fuels if applicable (with LULUCF categories)					Direct GHG	Base Year 1990 Estimate [Gg CO2 eq]	Year 2010 Estimate [Gg CO2 eq]	Level Assessm.	Trend Assessm.	% Contrib. in Trend	Result level assessm.	Result trend assessm.
100	1A4b	1. Energy	A. Fuel Combustion	4. Other Sectors; Residential	Solid Fuels	CH4	3.71	2.28	0.00%	0.00002	0.0%	-	-
101	1A2	1. Energy	A. Fuel Combustion	2. Manufacturing Industries and Construction	Biomass	CH4	2.46	2.01	0.00%	0.00001	0.0%	-	-
102	2C5	2. Industrial Proc.	C. Metal Production; Non-ferrous metals-CO2			CO2	1.65	1.85	0.00%	0.00000	0.0%	-	-
103	1A4a	1. Energy	A. Fuel Combustion	4. Other Sectors; Commercial/Institutional	Liquid Fuels	CH4	2.96	1.57	0.00%	0.00002	0.0%	-	-
104	1A4b	1. Energy	A. Fuel Combustion	4. Other Sectors; Residential	Gaseous Fuels	N2O	0.79	1.50	0.00%	0.00001	0.0%	-	-
105	1A4c	1. Energy	A. Fuel Combustion	4. Other Sectors; Agriculture/Forestry	Liquid Fuels	CH4	1.62	1.38	0.00%	0.00000	0.0%	-	-
106	1A2	1. Energy	A. Fuel Combustion	2. Manufacturing Industries and Construction	Gaseous Fuels	N2O	0.63	1.24	0.00%	0.00001	0.0%	-	-
107	1A1	1. Energy	A. Fuel Combustion	1. Energy Industries	Gaseous Fuels	CH4	0.54	1.24	0.00%	0.00001	0.0%	-	-
108	1A1	1. Energy	A. Fuel Combustion	1. Energy Industries	Biomass	CH4	4.66	1.24	0.00%	0.00006	0.0%	-	-
109	1A3a	1. Energy	A. Fuel Combustion	3. Transport; Civil Aviation		N2O	2.46	1.20	0.00%	0.00002	0.0%	-	-
110	1A2	1. Energy	A. Fuel Combustion	2. Manufacturing Industries and Construction	Liquid Fuels	CH4	2.42	1.20	0.00%	0.00002	0.0%	-	-
111	1A5	1. Energy	A. Fuel Combustion	5. Other	Liquid Fuels	N2O	2.01	1.18	0.00%	0.00001	0.0%	-	-
112	2G	2. Industrial Proc.	G. Other			CO2	1.04	0.96	0.00%	0.00000	0.0%	-	-
113	1A4a	1. Energy	A. Fuel Combustion	4. Other Sectors; Commercial/Institutional	Gaseous Fuels	N2O	0.51	0.79	0.00%	0.00001	0.0%	-	-
114	1A1	1. Energy	A. Fuel Combustion	1. Energy Industries	Liquid Fuels	CH4	0.49	0.78	0.00%	0.00001	0.0%	-	-
115	1A3d	1. Energy	A. Fuel Combustion	3. Transport; Navigation	Gas/Diesel Oil	N2O	0.64	0.76	0.00%	0.00000	0.0%	-	-
116	5A1	5. LULUCF	A. Forest Land	1. Forest Land remaining Forest Land	Biomass Burning,	CO2	-30.07	-0.68	0.00%	0.00051	0.1%	-	-
117	1A3b	1. Energy	A. Fuel Combustion	3. Transport; Road Transportation	Diesel	CH4	1.36	0.65	0.00%	0.00001	0.0%	-	-
118	7	7. Other				CH4	0.55	0.58	0.00%	0.00000	0.0%	-	-
119	1A3d	1. Energy	A. Fuel Combustion	3. Transport; Navigation	Gasoline	N2O	0.60	0.53	0.00%	0.00000	0.0%	-	-
120	1A3d	1. Energy	A. Fuel Combustion	3. Transport; Navigation	Gasoline	CH4	0.58	0.51	0.00%	0.00000	0.0%	-	-
121	1A3c	1. Energy	A. Fuel Combustion	3. Transport; Railways	Liquid Fuels	N2O	0.38	0.49	0.00%	0.00000	0.0%	-	-
122	1A2	1. Energy	A. Fuel Combustion	2. Manufacturing Industries and Construction	Solid Fuels	CH4	0.57	0.45	0.00%	0.00000	0.0%	-	-
123	1A3b	1. Energy	A. Fuel Combustion	3. Transport; Road Transportation	Biomass	N2O	0.00	0.44	0.00%	0.00001	0.0%	-	-
124	5D1	5. LULUCF	D. Wetlands	1. Wetlands remaining Wetlands		CO2	-2.79	-0.42	0.00%	0.00004	0.0%	-	-
125	1A4c	1. Energy	A. Fuel Combustion	4. Other Sectors; Agriculture/Forestry	Biomass	N2O	0.21	0.35	0.00%	0.00000	0.0%	-	-
126	1A1	1. Energy	A. Fuel Combustion	1. Energy Industries	Gaseous Fuels	N2O	0.13	0.30	0.00%	0.00000	0.0%	-	-
127	1A3b	1. Energy	A. Fuel Combustion	3. Transport; Road Transportation	Natural Gas	CH4	0.00	0.27	0.00%	0.00000	0.0%	-	-
128	1A3a	1. Energy	A. Fuel Combustion	3. Transport; Civil Aviation		CH4	0.24	0.27	0.00%	0.00000	0.0%	-	-
129	5A1	5. LULUCF	A. Forest Land	1. Forest Land remaining Forest Land		CH4	8.19	0.19	0.00%	0.00014	0.0%	-	-
130	1A4c	1. Energy	A. Fuel Combustion	4. Other Sectors; Agriculture/Forestry	Biomass	CH4	0.80	0.18	0.00%	0.00001	0.0%	-	-
131	1A4b	1. Energy	A. Fuel Combustion	4. Other Sectors; Residential	Solid Fuels	N2O	0.29	0.18	0.00%	0.00000	0.0%	-	-
132	5A1	5. LULUCF	A. Forest Land	1. Forest Land remaining Forest Land		N2O	5.30	0.12	0.00%	0.00009	0.0%	-	-
133	1A5	1. Energy	A. Fuel Combustion	5. Other	Liquid Fuels	CH4	0.16	0.12	0.00%	0.00000	0.0%	-	-
134	1A3ei	1. Energy	A. Fuel Combustion	3. Transport; Other non-specified		CH4	0.09	0.04	0.00%	0.00000	0.0%	-	-
135	1A4c	1. Energy	A. Fuel Combustion	4. Other Sectors; Agriculture/Forestry	Gaseous Fuels	CH4	0.09	0.04	0.00%	0.00000	0.0%	-	-
136	1A3b	1. Energy	A. Fuel Combustion	3. Transport; Road Transportation	Biomass	CH4	0.00	0.04	0.00%	0.00000	0.0%	-	-
137	1A3ei	1. Energy	A. Fuel Combustion	3. Transport; Other non-specified		N2O	0.03	0.03	0.00%	0.00000	0.0%	-	-
138	1A3d	1. Energy	A. Fuel Combustion	3. Transport; Navigation	Gas/Diesel Oil	CH4	0.01	0.02	0.00%	0.00000	0.0%	-	-
139	1A4c	1. Energy	A. Fuel Combustion	4. Other Sectors; Agriculture/Forestry	Gaseous Fuels	N2O	0.02	0.01	0.00%	0.00000	0.0%	-	-
140	1A3c	1. Energy	A. Fuel Combustion	3. Transport; Railways	Liquid Fuels	CH4	0.01	0.01	0.00%	0.00000	0.0%	-	-
141	1A1	1. Energy	A. Fuel Combustion	1. Energy Industries	Solid Fuels	CO2	44.84	0.00	0.00%	0.00000	0.0%	-	-
142	1A1	1. Energy	A. Fuel Combustion	1. Energy Industries	Solid Fuels	CH4	0.10	0.00	0.00%	0.00000	0.0%	-	-
143	1A1	1. Energy	A. Fuel Combustion	1. Energy Industries	Solid Fuels	N2O	0.24	0.00	0.00%	0.00000	0.0%	-	-
144	1A2	1. Energy	A. Fuel Combustion	2. Manufacturing Industries and Construction	Other Fuels	CH4	0.00	0.00	0.00%	0.00000	0.0%	-	-
145	1A3b	1. Energy	A. Fuel Combustion	3. Transport; Road Transportation	Natural Gas	N2O	0.00	0.00	0.00%	0.00000	0.0%	-	-
146	1B2	1. Energy	B. Fugitive Emissions from Fuel	2. Oil and Natural Gas		N2O	0.00	0.00	0.00%	0.00000	0.0%	-	-
147	2C3	2. Industrial Proc.	C. Metal Production; Aluminium Production-CO2			CO2	139.26	0.00	0.00%	0.00000	0.0%	-	-
148	2C3	2. Industrial Proc.	C. Metal Production; Aluminium Production-PFC			PFC	100.17	0.00	0.00%	0.00000	0.0%	-	-
149	2F9	2. Industrial Proc.	F. Consumption of Halocarbons and SF6; Other			PFC	0.00	0.00	0.00%	0.00000	0.0%	-	-
150	6A	6. Waste	A. Solid Waste Disposal on Land			CO2	9.24	0.00	0.00%	0.00000	0.0%	-	-
151	6D	6. Waste	D. Other			CO2	0.00	0.00	0.00%	0.00000	0.0%	-	-

A1.4 KCA Tier 2 2010 without LULUCF categories.

A1.4.1 Results of Key Category Analysis Tier 2 – Level

Table A - 6 Key category analysis Tier 2 2010 (without LULUCF) regarding level.

Tier 2 Key category analysis 2010 without LULUCF categories

	A					B	C	D	E-L	E-T	F-T	M
No.	**IPCC Source Categories and fuels if applicable (without LULUCF categories)**					**Direct GHG**	**Base Year 1990 Estimate** [Gg CO2 eq]	**Year 2010 Estimate** [Gg CO2 eq]	**Level Assessm. with Uncertainty**	**Trend Assessm. with Uncertainty**	**% Contrib. in Trend**	**Result level assessm.**
1	4D3	4. Agriculture	D. Agricultural Soils; Indirect Emissions			N2O	820.73	710.51	2.08%	0.00368	7.2%	KC level
2	4D1	4. Agriculture	D. Agricultural Soils; Direct Soil Emissions			N2O	1364.15	1189.21	1.68%	0.00283	5.5%	KC level
3	1A1	1. Energy	A. Fuel Combustion	1. Energy Industries	Other Fuels	CO2	1519.73	2582.10	1.51%	0.00586	11.4%	KC level
4	2A1	2. Industrial Proc.	A. Mineral Products; Cement Production-CO2			CO2	2524.77	1928.12	1.42%	0.00472	9.2%	KC level
5	4A	4. Agriculture	A. Enteric Fermentation			CH4	2657.35	2537.97	0.86%	0.00059	1.2%	KC level
6	4B	4. Agriculture	B. Manure Management			CH4	672.00	645.25	0.65%	0.00041	0.8%	KC level
7	1A3b	1. Energy	A. Fuel Combustion	3. Transport; Road Transportation	Gasoline	CO2	11335.25	9744.97	0.46%	0.00086	1.7%	KC level
8	4B	4. Agriculture	B. Manure Management			N2O	453.87	323.52	0.43%	0.00182	3.5%	KC level
9	4D2	4. Agriculture	D. Agricultural Soils; Pasture, Range and Paddock Manure			N2O	128.10	245.40	0.38%	0.00175	3.4%	KC level
10	1A4b	1. Energy	A. Fuel Combustion	4. Other Sectors; Residential	Liquid Fuels	CO2	10226.25	8688.23	0.36%	0.00072	1.4%	KC level
11	1A3b	1. Energy	A. Fuel Combustion	3. Transport; Road Transportation	Diesel	CO2	2587.68	6154.63	0.25%	0.00142	2.8%	KC level
12	1A4b	1. Energy	A. Fuel Combustion	4. Other Sectors; Residential	Gaseous Fuels	CO2	1409.10	2661.45	0.25%	0.00110	2.2%	KC level
13	2F1	2. Industrial Proc.	F. Consumption of Halocarbons and SF6; Refrig. & AC Eq.			HFC	0.02	1011.69	0.22%	0.00219	4.3%	KC level
14	6A	6. Waste	A. Solid Waste Disposal on Land			CH4	688.16	198.00	0.21%	0.00532	10.4%	KC level
15	1A2	1. Energy	A. Fuel Combustion	2. Manufacturing Industries and Construction	Gaseous Fuels	CO2	1133.30	2216.12	0.20%	0.00096	1.9%	KC level
16	1A2	1. Energy	A. Fuel Combustion	2. Manufacturing Industries and Construction	Other Fuels	CO2	134.24	315.35	0.18%	0.00102	2.0%	KC level
17	6D	6. Waste	D. Other			CH4	27.44	95.23	0.18%	0.00122	2.4%	KC level
18	1B2	1. Energy	B. Fugitive Emissions from Fuels	2. Oil and Natural Gas		CH4	380.43	173.85	0.16%	0.00194	3.8%	KC level
19	6B	6. Waste	B. Wastewater Handling			N2O	184.72	208.89	0.15%	0.00014	0.3%	KC level
20	1A4a	1. Energy	A. Fuel Combustion	4. Other Sectors; Commercial/Institutional	Liquid Fuels	CO2	4429.39	3607.89	0.15%	0.00037	0.7%	KC level
21	1A2	1. Energy	A. Fuel Combustion	2. Manufacturing Industries and Construction	Solid Fuels	CO2	1227.96	520.65	0.15%	0.00203	4.0%	KC level
22	3	3. Solvent and Other Product Use				CO2	361.92	157.23	0.14%	0.00192	3.7%	KC level
23	1A4a	1. Energy	A. Fuel Combustion	4. Other Sectors; Commercial/Institutional	Gaseous Fuels	CO2	905.76	1409.10	0.13%	0.00044	0.9%	KC level
24	2C1	2. Industrial Proc.	C. Metal Production; Steel Production			CO2	110.80	170.57	0.13%	0.00042	0.8%	KC level
25	1A2	1. Energy	A. Fuel Combustion	2. Manufacturing Industries and Construction	Liquid Fuels	CO2	3876.46	2890.89	0.12%	0.00043	0.8%	-
26	1A3b	1. Energy	A. Fuel Combustion	3. Transport; Road Transportation	Gasoline	N2O	137.27	111.15	0.10%	0.00026	0.5%	-
27	3	3. Solvent and Other Product Use				N2O	110.14	57.33	0.08%	0.00080	1.6%	-
28	2F9	2. Industrial Proc.	F. Consumption of Halocarbons and SF6; Other			SF6	79.58	51.12	0.08%	0.00044	0.8%	-
29	1A1	1. Energy	A. Fuel Combustion	1. Energy Industries	Biomass	N2O	27.72	48.15	0.07%	0.00029	0.6%	-
30	1A1	1. Energy	A. Fuel Combustion	1. Energy Industries	Other Fuels	N2O	20.85	47.25	0.07%	0.00037	0.7%	-
31	2A3	2. Industrial Proc.	A. Mineral Products; Limestone and Dolomite Use, Emissions, CO2			CO2	103.25	72.39	0.07%	0.00031	0.6%	-
32	1A1	1. Energy	A. Fuel Combustion	1. Energy Industries	Gaseous Fuels	CO2	235.05	540.64	0.05%	0.00027	0.5%	-
33	2B	2. Industrial Proc.	B. Chemical Industry			N2O	68.13	60.26	0.05%	0.00007	0.1%	-
34	2F9	2. Industrial Proc.	F. Consumption of Halocarbons and SF6; Other			HFC	0.00	30.62	0.05%	0.00044	0.9%	-
35	1A4b	1. Energy	A. Fuel Combustion	4. Other Sectors; Residential	Biomass	CH4	95.89	38.15	0.04%	0.00068	1.3%	-
36	1A1	1. Energy	A. Fuel Combustion	1. Energy Industries	Liquid Fuels	CO2	691.23	965.28	0.04%	0.00010	0.2%	-
37	6D	6. Waste	D. Other			N2O	5.82	24.15	0.04%	0.00026	0.5%	-
38	4D4	4. Agriculture	D. Agricultural Soils; Use of sewage sludge as fertilizers			N2O	28.19	22.56	0.03%	0.00009	0.2%	-
39	7	7. Other				N2O	16.72	13.63	0.03%	0.00008	0.2%	-
40	1A4b	1. Energy	A. Fuel Combustion	4. Other Sectors; Residential	Liquid Fuels	N2O	25.94	22.06	0.03%	0.00006	0.1%	-
41	6B	6. Waste	B. Wastewater Handling			CH4	4.65	45.90	0.03%	0.00022	0.4%	-
42	2B	2. Industrial Proc.	B. Chemical Industry			CO2	109.80	121.41	0.02%	0.00002	0.0%	-
43	1A4c	1. Energy	A. Fuel Combustion	4. Other Sectors; Agriculture/Forestry	Liquid Fuels	CO2	547.00	519.96	0.02%	0.00002	0.0%	-
44	6C	6. Waste	C. Waste Incineration			N2O	16.20	25.90	0.02%	0.00007	0.1%	-
45	1A2	1. Energy	A. Fuel Combustion	2. Manufacturing Industries and Construction	Liquid Fuels	N2O	14.96	12.84	0.02%	0.00004	0.1%	-
46	1A2	1. Energy	A. Fuel Combustion	2. Manufacturing Industries and Construction	Biomass	N2O	2.44	10.79	0.02%	0.00012	0.2%	-
47	1A3b	1. Energy	A. Fuel Combustion	3. Transport; Road Transportation	Gasoline	CH4	101.15	22.34	0.02%	0.00054	1.1%	-
48	1A4b	1. Energy	A. Fuel Combustion	4. Other Sectors; Residential	Biomass	N2O	10.64	9.82	0.01%	0.00002	0.0%	-
49	1B2	1. Energy	B. Fugitive Emissions from Fuels	2. Oil and Natural Gas		CO2	91.36	74.04	0.01%	0.00003	0.1%	-
50	1A4a	1. Energy	A. Fuel Combustion	4. Other Sectors; Commercial/Institutional	Liquid Fuels	N2O	11.28	9.25	0.01%	0.00003	0.1%	-
51	2F2	2. Industrial Proc.	F. Consumption of Halocarbons and SF6; Hard Foam			HFC	0.00	13.59	0.01%	0.00012	0.2%	-
52	2F8	2. Industrial Proc.	F. Consumption of Halocarbons and SF6; Electrical Eq.			SF6	64.04	62.47	0.01%	0.00001	0.0%	-
53	4F	4. Agriculture	F. Field Burning of Agricultural Residues			CH4	10.00	10.00	0.01%	0.00000	0.0%	-
54	2C	2. Industrial Proc.	C. Metal Production; Magnesium Foundries			SF6	0.00	29.66	0.01%	0.00011	0.2%	-
55	4F	4. Agriculture	F. Field Burning of Agricultural Residues			N2O	3.91	3.91	0.01%	0.00000	0.0%	-
56	2F7	2. Industrial Proc.	F. Consumption of Halocarbons and SF6; Semiconductor Manufacture			PFC	0.00	14.56	0.01%	0.00011	0.2%	-
57	7	7. Other				CO2	10.96	13.02	0.01%	0.00001	0.0%	-
58	1A4b	1. Energy	A. Fuel Combustion	4. Other Sectors; Residential	Solid Fuels	CO2	54.59	33.60	0.01%	0.00006	0.1%	-
59	1A2	1. Energy	A. Fuel Combustion	2. Manufacturing Industries and Construction	Other Fuels	N2O	2.31	5.83	0.01%	0.00005	0.1%	-
60	6C	6. Waste	C. Waste Incineration			CO2	54.10	10.68	0.01%	0.00032	0.6%	-
61	1A4c	1. Energy	A. Fuel Combustion	4. Other Sectors; Agriculture/Forestry	Liquid Fuels	N2O	4.97	5.28	0.01%	0.00000	0.0%	-
62	1A3b	1. Energy	A. Fuel Combustion	3. Transport; Road Transportation	Diesel	N2O	5.84	18.10	0.01%	0.00005	0.1%	-
63	1A3a	1. Energy	A. Fuel Combustion	3. Transport; Civil Aviation		CO2	252.55	123.55	0.01%	0.00006	0.1%	-
64	2F7	2. Industrial Proc.	F. Consumption of Halocarbons and SF6; Semiconductor Manufacture			SF6	0.00	6.99	0.01%	0.00005	0.1%	-
65	1A1	1. Energy	A. Fuel Combustion	1. Energy Industries	Liquid Fuels	N2O	2.15	3.47	0.01%	0.00002	0.0%	-
66	1A5	1. Energy	A. Fuel Combustion	5. Other	Liquid Fuels	CO2	203.58	119.55	0.00%	0.00004	0.1%	-
67	1A4a	1. Energy	A. Fuel Combustion	4. Other Sectors; Commercial/Institutional	Biomass	N2O	1.45	3.36	0.00%	0.00003	0.1%	-
68	2F7	2. Industrial Proc.	F. Consumption of Halocarbons and SF6; Semiconductor Manufacture			PFC	0.00	6.63	0.00%	0.00005	0.1%	-
69	1A3d	1. Energy	A. Fuel Combustion	3. Transport; Navigation		CO2	111.86	116.98	0.00%	0.00000	0.0%	-
70	2B	1. Industrial Proc.	B. Chemical Industry			CH4	9.63	8.39	0.00%	0.00001	0.0%	-
71	1A3ei	1. Energy	A. Fuel Combustion	3. Transport; Other non-specified		CO2	49.01	48.71	0.00%	0.00000	0.0%	-
72	1A2	1. Energy	A. Fuel Combustion	2. Manufacturing Industries and Construction	Solid Fuels	N2O	6.57	2.76	0.00%	0.00006	0.1%	-
73	1A3b	1. Energy	A. Fuel Combustion	3. Transport; Road Transportation	Natural Gas	CO2	0.00	39.05	0.00%	0.00004	0.1%	-
74	1A4b	1. Energy	A. Fuel Combustion	4. Other Sectors; Residential	Gaseous Fuels	CH4	3.26	6.26	0.00%	0.00002	0.0%	-
75	1A3a	1. Energy	A. Fuel Combustion	3. Transport; Civil Aviation		N2O	2.46	1.20	0.00%	0.00004	0.1%	-
76	1A5	1. Energy	A. Fuel Combustion	5. Other	Liquid Fuels	N2O	2.01	1.18	0.00%	0.00002	0.0%	-
77	6C	6. Waste	C. Waste Incineration			CH4	4.25	2.80	0.00%	0.00002	0.0%	-
78	2F4	2. Industrial Proc.	F. Consumption of Halocarbons and SF6; Metered Dose Inhalers and Other			HFC	0.00	14.71	0.00%	0.00003	0.1%	-
79	1A4a	1. Energy	A. Fuel Combustion	4. Other Sectors; Commercial/Institutional	Biomass	CH4	9.74	5.12	0.00%	0.00003	0.1%	-
80	1A2	1. Energy	A. Fuel Combustion	2. Manufacturing Industries and Construction	Gaseous Fuels	CH4	2.84	5.10	0.00%	0.00001	0.0%	-
81	1A4b	1. Energy	A. Fuel Combustion	4. Other Sectors; Residential	Gaseous Fuels	N2O	0.79	1.50	0.00%	0.00001	0.0%	-
82	1A3d	1. Energy	A. Fuel Combustion	3. Transport; Navigation	Gas/Diesel Oil	N2O	0.64	0.76	0.00%	0.00000	0.0%	-
83	1A4a	1. Energy	A. Fuel Combustion	4. Other Sectors; Commercial/Institutional	Gaseous Fuels	CH4	2.27	3.75	0.00%	0.00001	0.0%	-
84	2A2	2. Industrial Proc.	A. Mineral Products; Lime Production-CO2			CO2	53.35	54.23	0.00%	0.00000	0.0%	-
85	1A2	1. Energy	A. Fuel Combustion	2. Manufacturing Industries and Construction	Gaseous Fuels	N2O	0.63	1.24	0.00%	0.00001	0.0%	-
86	2C	2. Industrial Proc.	C. Metal Production; Aluminium Foundries			SF6	0.00	4.88	0.00%	0.00002	0.0%	-
87	2F1	2. Industrial Proc.	F. Consumption of Halocarbons and SF6; Refrigeration			PFC	0.04	7.43	0.00%	0.00002	0.0%	-
88	1A3c	1. Energy	A. Fuel Combustion	3. Transport; Railways		CO2	28.69	37.77	0.00%	0.00000	0.0%	-
89	1A4c	1. Energy	A. Fuel Combustion	4. Other Sectors; Agriculture/Forestry	Gaseous Fuels	CO2	40.64	15.85	0.00%	0.00002	0.0%	-
90	1A4b	1. Energy	A. Fuel Combustion	4. Other Sectors; Residential	Liquid Fuels	CH4	6.00	2.63	0.00%	0.00002	0.0%	-
91	1A3d	1. Energy	A. Fuel Combustion	3. Transport; Navigation	Gasoline	N2O	0.60	0.53	0.00%	0.00000	0.0%	-
92	1A3c	1. Energy	A. Fuel Combustion	3. Transport; Railways	Liquid Fuels	N2O	0.38	0.49	0.00%	0.00000	0.0%	-
93	1A4b	1. Energy	A. Fuel Combustion	4. Other Sectors; Residential	Solid Fuels	CH4	3.71	2.28	0.00%	0.00001	0.0%	-
94	1A3b	1. Energy	A. Fuel Combustion	3. Transport; Road Transportation	Biomass	N2O	0.00	0.44	0.00%	0.00001	0.0%	-
95	1A4a	1. Energy	A. Fuel Combustion	4. Other Sectors; Commercial/Institutional	Gaseous Fuels	N2O	0.51	0.79	0.00%	0.00000	0.0%	-
96	1A2	1. Energy	A. Fuel Combustion	2. Manufacturing Industries and Construction	Biomass	CH4	2.46	2.01	0.00%	0.00000	0.0%	-
97	1A4a	1. Energy	A. Fuel Combustion	4. Other Sectors; Commercial/Institutional	Liquid Fuels	CH4	2.96	1.57	0.00%	0.00001	0.0%	-
98	1A4c	1. Energy	A. Fuel Combustion	4. Other Sectors; Agriculture/Forestry	Liquid Fuels	CH4	1.62	1.38	0.00%	0.00000	0.0%	-
99	1A1	1. Energy	A. Fuel Combustion	1. Energy Industries	Gaseous Fuels	CH4	0.54	1.24	0.00%	0.00000	0.0%	-

Table A – 6 continued. Key category analysis Tier 2 2010 (without LULUCF) regarding level.

Tier 2 Key category analysis 2010 without LULUCF categories												
	A					B	C	D	E-L	E-T	F-T	M
No.	**IPCC Source Categories and fuels if applicable (without LULUCF categories)**					**Direct GHG**	**Base Year 1990 Estimate** [Gg CO2 eq]	**Year 2010 Estimate** [Gg CO2 eq]	**Level Assessm. with Uncertainty**	**Trend Assessm. with Uncertainty**	**% Contrib. in Trend**	**Result level assessm.**
100	1A1	1. Energy	A. Fuel Combustion	1. Energy Industries	Biomass	CH4	4.66	1.24	0.00%	0.00002	0.0%	-
101	1A2	1. Energy	A. Fuel Combustion	2. Manufacturing Industries and Construction	Liquid Fuels	CH4	2.42	1.20	0.00%	0.00001	0.0%	-
102	7	7. Other				CH4	0.55	0.58	0.00%	0.00000	0.0%	-
103	1A4c	1. Energy	A. Fuel Combustion	4. Other Sectors; Agriculture/Forestry	Biomass	N2O	0.21	0.35	0.00%	0.00000	0.0%	-
104	1A1	1. Energy	A. Fuel Combustion	1. Energy Industries	Gaseous Fuels	N2O	0.13	0.30	0.00%	0.00000	0.0%	-
105	1A1	1. Energy	A. Fuel Combustion	1. Energy Industries	Liquid Fuels	CH4	0.49	0.78	0.00%	0.00000	0.0%	-
106	2C5	2. Industrial Proc.	C. Metal Production; Non-ferrous metals-CO2			CO2	1.65	1.85	0.00%	0.00000	0.0%	-
107	1A3a	1. Energy	A. Fuel Combustion	3. Transport; Civil Aviation		CH4	0.24	0.27	0.00%	0.00000	0.0%	-
108	2F5	2. Industrial Proc.	F. Consumption of Halocarbons and SF6; Solvents			PFC	0.00	7.88	0.00%	0.00000	0.0%	-
109	1A3d	1. Energy	A. Fuel Combustion	3. Transport; Navigation	Gasoline	CH4	0.58	0.51	0.00%	0.00000	0.0%	-
110	1A4b	1. Energy	A. Fuel Combustion	4. Other Sectors; Residential	Solid Fuels	N2O	0.29	0.18	0.00%	0.00000	0.0%	-
111	1A2	1. Energy	A. Fuel Combustion	2. Manufacturing Industries and Construction	Solid Fuels	CH4	0.57	0.45	0.00%	0.00000	0.0%	-
112	1A3b	1. Energy	A. Fuel Combustion	3. Transport; Road Transportation	Diesel	CH4	1.36	0.65	0.00%	0.00000	0.0%	-
113	2A7	2. Industrial Proc.	A. Mineral Products; Other non-specified-CO2			CO2	15.12	5.93	0.00%	0.00000	0.0%	-
114	2G	2. Industrial Proc.	G. Other			CO2	1.04	0.96	0.00%	0.00000	0.0%	-
115	1A3b	1. Energy	A. Fuel Combustion	3. Transport; Road Transportation	Natural Gas	CH4	0.00	0.27	0.00%	0.00000	0.0%	-
116	1A4c	1. Energy	A. Fuel Combustion	4. Other Sectors; Agriculture/Forestry	Biomass	CH4	0.80	0.18	0.00%	0.00000	0.0%	-
117	2F5	2. Industrial Proc.	F. Consumption of Halocarbons and SF6; Solvents			HFC	0.00	2.37	0.00%	0.00000	0.0%	-
118	1A5	1. Energy	A. Fuel Combustion	5. Other	Liquid Fuels	CH4	0.16	0.12	0.00%	0.00000	0.0%	-
119	1A3ei	1. Energy	A. Fuel Combustion	3. Transport; Other non-specified		N2O	0.03	0.03	0.00%	0.00000	0.0%	-
120	1A3b	1. Energy	A. Fuel Combustion	3. Transport; Road Transportation	Biomass	CH4	0.00	0.04	0.00%	0.00000	0.0%	-
121	1A3ei	1. Energy	A. Fuel Combustion	3. Transport; Other non-specified		CH4	0.09	0.04	0.00%	0.00000	0.0%	-
122	1A4c	1. Energy	A. Fuel Combustion	4. Other Sectors; Agriculture/Forestry	Gaseous Fuels	CH4	0.09	0.04	0.00%	0.00000	0.0%	-
123	1A4c	1. Energy	A. Fuel Combustion	4. Other Sectors; Agriculture/Forestry	Gaseous Fuels	N2O	0.02	0.01	0.00%	0.00000	0.0%	-
124	1A3d	1. Energy	A. Fuel Combustion	3. Transport; Navigation	Gas/Diesel Oil	CH4	0.01	0.02	0.00%	0.00000	0.0%	-
125	1A3c	1. Energy	A. Fuel Combustion	3. Transport; Railways	Liquid Fuels	CH4	0.01	0.01	0.00%	0.00000	0.0%	-
126	1A1	1. Energy	A. Fuel Combustion	1. Energy Industries	Solid Fuels	CO2	44.84	0.00	0.00%	-	0.0%	-
127	1A1	1. Energy	A. Fuel Combustion	1. Energy Industries	Solid Fuels	CH4	0.10	0.00	0.00%	-	0.0%	-
128	1A1	1. Energy	A. Fuel Combustion	1. Energy Industries	Solid Fuels	N2O	0.24	0.00	0.00%	-	0.0%	-
129	1A2	1. Energy	A. Fuel Combustion	2. Manufacturing Industries and Construction	Other Fuels	CH4	0.00	0.00	0.00%	-	0.0%	-
130	1A3b	1. Energy	A. Fuel Combustion	3. Transport; Road Transportation	Natural Gas	N2O	0.00	0.00	0.00%	-	0.0%	-
131	1B2	1. Energy	B. Fugitive Emissions from Fuels	2. Oil and Natural Gas		N2O	0.00	0.00	0.00%	-	0.0%	-
132	2C3	2. Industrial Proc.	C. Metal Production; Aluminium Production-CO2			CO2	139.26	0.00	0.00%	-	0.0%	-
133	2C3	2. Industrial Proc.	C. Metal Production; Aluminium Production-PFC			PFC	100.17	0.00	0.00%	-	0.0%	-
134	2F9	2. Industrial Proc.	F. Consumption of Halocarbons and SF6; Other			PFC	0.00	0.00	0.00%	-	0.0%	-
135	6A	6. Waste	A. Solid Waste Disposal on Land			CO2	9.24	0.00	0.00%	-	0.0%	-
136	6D	6. Waste	D. Other			CO2	0.00	0.00	0.00%	-	0.0%	-

A1.4.2 Results of Key Category Analysis Tier 2 – Trend

Table A - 7 Key category analysis Tier 2 2010 (without LULUCF) regarding trend.

Tier 2 Key category analysis 2010 without LULUCF categories													
	A					B	C	D	E-L	E-T	F-T	M	N
No.	IPCC Source Categories and fuels if applicable (without LULUCF categories)					Direct GHG	Base Year 1990 Estimate [Gg CO2 eq]	Year 2010 Estimate [Gg CO2 eq]	Level Assessm. with Uncertainty	Trend Assessm. with Uncertainty	% Contrib. in Trend	Result level assessm.	Result trend assessm.
1	4D3	4. Agriculture	D. Agricultural Soils; Indirect Emissions			N2O	820.73	710.51	2.08%	0.00368	7.2%	KC level	KC trend
2	4D1	4. Agriculture	D. Agricultural Soils; Direct Soil Emissions			N2O	1364.15	1189.21	1.68%	0.00283	5.5%	KC level	KC trend
3	1A1	1. Energy	A. Fuel Combustion	1. Energy Industries	Other Fuels	CO2	1519.73	2582.10	1.51%	0.00586	11.4%	KC level	KC trend
4	2A1	2. Industrial Proc.	A. Mineral Products; Cement Production-CO2			CO2	2524.77	1928.12	1.42%	0.00472	9.2%	KC level	KC trend
5	4A	4. Agriculture	A. Enteric Fermentation			CH4	2657.35	2537.97	0.86%	0.00059	1.2%	KC level	KC trend
6	4B	4. Agriculture	B. Manure Management			CH4	672.00	645.25	0.65%	0.00041	0.8%	KC level	KC trend
7	1A3b	1. Energy	A. Fuel Combustion	3. Transport; Road Transportation	Gasoline	CO2	11335.25	9744.97	0.46%	0.00086	1.7%	KC level	KC trend
8	4B	4. Agriculture	B. Manure Management			N2O	453.87	323.52	0.43%	0.00182	3.5%	KC level	KC trend
9	4D2	4. Agriculture	D. Agricultural Soils; Pasture, Range and Paddock Manure			N2O	128.10	245.40	0.38%	0.00175	3.4%	KC level	KC trend
10	1A4b	1. Energy	A. Fuel Combustion	4. Other Sectors; Residential	Liquid Fuels	CO2	10226.25	8688.23	0.36%	0.00072	1.4%	KC level	KC trend
11	1A3b	1. Energy	A. Fuel Combustion	3. Transport; Road Transportation	Diesel	CO2	2587.68	6154.63	0.25%	0.00142	2.8%	KC level	KC trend
12	1A4b	1. Energy	A. Fuel Combustion	4. Other Sectors; Residential	Gaseous Fuels	CO2	1409.10	2661.45	0.25%	0.00110	2.2%	KC level	KC trend
13	2F1	2. Industrial Proc.	F. Consumption of Halocarbons and SF6; Refrig. & AC Eq.			HFC	0.02	1011.69	0.22%	0.00219	4.3%	KC level	KC trend
14	6A	6. Waste	A. Solid Waste Disposal on Land			CH4	688.16	198.00	0.21%	0.00532	10.4%	KC level	KC trend
15	1A2	1. Energy	A. Fuel Combustion	2. Manufacturing Industries and Construction	Gaseous Fuels	CO2	1133.30	2216.12	0.20%	0.00096	1.9%	KC level	KC trend
16	1A2	1. Energy	A. Fuel Combustion	2. Manufacturing Industries and Construction	Other Fuels	CO2	134.24	315.35	0.18%	0.00102	2.0%	KC level	KC trend
17	6D	6. Waste	D. Other			CH4	27.44	95.23	0.18%	0.00122	2.4%	KC level	KC trend
18	1B2	1. Energy	B. Fugitive Emissions from Fuels	2. Oil and Natural Gas		CH4	380.43	173.85	0.16%	0.00194	3.8%	KC level	KC trend
19	6B	6. Waste	B. Wastewater Handling			N2O	184.72	208.89	0.15%	0.00014	0.3%	KC level	-
20	1A4a	1. Energy	A. Fuel Combustion	4. Other Sectors; Commercial/Institutional	Liquid Fuels	CO2	4429.39	3607.89	0.15%	0.00037	0.7%	KC level	-
21	1A2	1. Energy	A. Fuel Combustion	2. Manufacturing Industries and Construction	Solid Fuels	CO2	1227.96	520.65	0.15%	0.00203	4.0%	KC level	KC trend
22	3	3. Solvent and Other Product Use				CO2	361.92	157.23	0.14%	0.00192	3.7%	KC level	KC trend
23	1A4a	1. Energy	A. Fuel Combustion	4. Other Sectors; Commercial/Institutional	Gaseous Fuels	CO2	905.76	1409.10	0.13%	0.00044	0.9%	KC level	KC trend
24	2C1	2. Industrial Proc.	C. Metal Production; Steel Production			CO2	110.80	170.57	0.13%	0.00042	0.8%	KC level	KC trend
25	1A2	1. Energy	A. Fuel Combustion	2. Manufacturing Industries and Construction	Liquid Fuels	CO2	3876.46	2890.89	0.12%	0.00043	0.8%	-	KC trend
26	1A3b	1. Energy	A. Fuel Combustion	3. Transport; Road Transportation	Gasoline	N2O	137.27	111.15	0.10%	0.00026	0.5%	-	-
27	3	3. Solvent and Other Product Use				N2O	110.14	57.33	0.08%	0.00080	1.6%	-	KC trend
28	2F9	2. Industrial Proc.	F. Consumption of Halocarbons and SF6; Other			SF6	79.58	51.12	0.08%	0.00044	0.8%	-	KC trend
29	1A1	1. Energy	A. Fuel Combustion	1. Energy Industries	Biomass	N2O	27.72	48.15	0.07%	0.00029	0.6%	-	-
30	1A1	1. Energy	A. Fuel Combustion	1. Energy Industries	Other Fuels	N2O	20.85	47.25	0.07%	0.00037	0.7%	-	-
31	2A3	2. Industrial Proc.	A. Mineral Products; Limestone and Dolomite Use, Emissions, CO2			CO2	103.25	72.39	0.07%	0.00031	0.6%	-	-
32	1A1	1. Energy	A. Fuel Combustion	1. Energy Industries	Gaseous Fuels	CO2	235.05	540.64	0.05%	0.00027	0.5%	-	-
33	2B	2. Industrial Proc.	B. Chemical Industry			N2O	68.13	60.26	0.05%	0.00007	0.1%	-	-
34	2F9	2. Industrial Proc.	F. Consumption of Halocarbons and SF6; Other			HFC	0.00	30.62	0.05%	0.00044	0.9%	-	KC trend
35	1A4b	1. Energy	A. Fuel Combustion	4. Other Sectors; Residential	Biomass	CH4	95.89	38.15	0.04%	0.00068	1.3%	-	KC trend
36	1A1	1. Energy	A. Fuel Combustion	1. Energy Industries	Liquid Fuels	CO2	691.23	965.28	0.04%	0.00010	0.2%	-	-
37	6D	6. Waste	D. Other			N2O	5.82	24.15	0.04%	0.00026	0.5%	-	-
38	4D4	4. Agriculture	D. Agricultural Soils; Use of sewage sludge as fertilizers			N2O	28.19	22.56	0.03%	0.00009	0.2%	-	-
39	7	7. Other				N2O	16.72	13.63	0.03%	0.00008	0.2%	-	-
40	1A4b	1. Energy	A. Fuel Combustion	4. Other Sectors; Residential	Liquid Fuels	N2O	25.94	22.06	0.03%	0.00006	0.1%	-	-
41	6B	6. Waste	B. Wastewater Handling			CH4	4.65	45.90	0.03%	0.00022	0.4%	-	-
42	2B	2. Industrial Proc.	B. Chemical Industry			CO2	109.80	121.41	0.02%	0.00002	0.0%	-	-
43	1A4c	1. Energy	A. Fuel Combustion	4. Other Sectors; Agriculture/Forestry	Liquid Fuels	CO2	547.00	519.96	0.02%	0.00002	0.0%	-	-
44	6C	6. Waste	C. Waste Incineration			N2O	16.20	25.90	0.02%	0.00007	0.1%	-	-
45	1A2	1. Energy	A. Fuel Combustion	2. Manufacturing Industries and Construction	Liquid Fuels	N2O	14.96	12.84	0.02%	0.00004	0.1%	-	-
46	1A2	1. Energy	A. Fuel Combustion	2. Manufacturing Industries and Construction	Biomass	N2O	2.44	10.79	0.02%	0.00012	0.2%	-	-
47	1A3b	1. Energy	A. Fuel Combustion	3. Transport; Road Transportation	Gasoline	CH4	101.15	22.34	0.02%	0.00054	1.1%	-	KC trend
48	1A4b	1. Energy	A. Fuel Combustion	4. Other Sectors; Residential	Biomass	N2O	10.64	9.82	0.01%	0.00002	0.0%	-	-
49	1B2	1. Energy	B. Fugitive Emissions from Fuels	2. Oil and Natural Gas		CO2	91.36	74.04	0.01%	0.00003	0.1%	-	-
50	1A4a	1. Energy	A. Fuel Combustion	4. Other Sectors; Commercial/Institutional	Liquid Fuels	N2O	11.28	9.25	0.01%	0.00003	0.1%	-	-
51	2F2	2. Industrial Proc.	F. Consumption of Halocarbons and SF6; Hard Foam			HFC	0.00	13.59	0.01%	0.00012	0.2%	-	-
52	2F8	2. Industrial Proc.	F. Consumption of Halocarbons and SF6; Electrical Eq.			SF6	64.04	62.47	0.01%	0.00001	0.0%	-	-
53	4F	4. Agriculture	F. Field Burning of Agricultural Residues			CH4	10.00	10.00	0.01%	0.00000	0.0%	-	-
54	2C	2. Industrial Proc.	C. Metal Production; Magnesium Foundries			SF6	0.00	29.66	0.01%	0.00011	0.2%	-	-
55	4F	4. Agriculture	F. Field Burning of Agricultural Residues			N2O	3.91	3.91	0.01%	0.00000	0.0%	-	-
56	2F7	2. Industrial Proc.	F. Consumption of Halocarbons and SF6; Semiconductor Manufacture			PFC	0.00	14.56	0.01%	0.00011	0.2%	-	-
57	7	7. Other				CO2	10.96	13.02	0.01%	0.00001	0.0%	-	-
58	1A4b	1. Energy	A. Fuel Combustion	4. Other Sectors; Residential	Solid Fuels	CO2	54.59	33.60	0.01%	0.00006	0.1%	-	-
59	1A2	1. Energy	A. Fuel Combustion	2. Manufacturing Industries and Construction	Other Fuels	N2O	2.31	5.83	0.01%	0.00005	0.1%	-	-
60	6C	6. Waste	C. Waste Incineration			CO2	54.10	10.68	0.01%	0.00032	0.6%	-	-
61	1A4c	1. Energy	A. Fuel Combustion	4. Other Sectors; Agriculture/Forestry	Liquid Fuels	N2O	4.97	5.28	0.01%	0.00000	0.0%	-	-
62	1A3b	1. Energy	A. Fuel Combustion	3. Transport; Road Transportation	Diesel	N2O	5.84	18.10	0.01%	0.00005	0.1%	-	-
63	1A3a	1. Energy	A. Fuel Combustion	3. Transport; Civil Aviation		CO2	252.55	123.55	0.01%	0.00006	0.1%	-	-
64	2F7	2. Industrial Proc.	F. Consumption of Halocarbons and SF6; Semiconductor Manufacture			SF6	0.00	6.99	0.01%	0.00005	0.1%	-	-
65	1A1	1. Energy	A. Fuel Combustion	1. Energy Industries	Liquid Fuels	N2O	2.15	3.47	0.01%	0.00002	0.0%	-	-
66	1A5	1. Energy	A. Fuel Combustion	5. Other	Liquid Fuels	CO2	203.58	119.55	0.00%	0.00004	0.1%	-	-
67	1A4a	1. Energy	A. Fuel Combustion	4. Other Sectors; Commercial/Institutional	Biomass	N2O	1.45	3.36	0.00%	0.00003	0.1%	-	-
68	2F7	2. Industrial Proc.	F. Consumption of Halocarbons and SF6; Semiconductor Manufacture			PFC	0.00	6.63	0.00%	0.00005	0.1%	-	-
69	1A3d	1. Energy	A. Fuel Combustion	3. Transport; Navigation		CO2	111.86	116.98	0.00%	0.00000	0.0%	-	-
70	2B	1. Industrial Proc.	B. Chemical Industry			CH4	9.63	8.39	0.00%	0.00001	0.0%	-	-
71	1A3ei	1. Energy	A. Fuel Combustion	3. Transport; Other non-specified		CO2	49.01	48.71	0.00%	0.00000	0.0%	-	-
72	1A2	1. Energy	A. Fuel Combustion	2. Manufacturing Industries and Construction	Solid Fuels	N2O	6.57	2.76	0.00%	0.00006	0.1%	-	-
73	1A3b	1. Energy	A. Fuel Combustion	3. Transport; Road Transportation	Natural Gas	CO2	0.00	39.05	0.00%	0.00004	0.1%	-	-
74	1A4b	1. Energy	A. Fuel Combustion	4. Other Sectors; Residential	Gaseous Fuels	CH4	3.26	6.26	0.00%	0.00002	0.0%	-	-
75	1A3a	1. Energy	A. Fuel Combustion	3. Transport; Civil Aviation		N2O	2.46	1.20	0.00%	0.00004	0.1%	-	-
76	1A5	1. Energy	A. Fuel Combustion	5. Other	Liquid Fuels	N2O	2.01	1.18	0.00%	0.00002	0.0%	-	-
77	6C	6. Waste	C. Waste Incineration			CH4	4.25	2.80	0.00%	0.00002	0.0%	-	-
78	2F4	2. Industrial Proc.	F. Consumption of Halocarbons and SF6; Metered Dose Inhalers and Other			HFC	0.00	14.71	0.00%	0.00003	0.1%	-	-
79	1A4a	1. Energy	A. Fuel Combustion	4. Other Sectors; Commercial/Institutional	Biomass	CH4	9.74	5.12	0.00%	0.00003	0.1%	-	-
80	1A2	1. Energy	A. Fuel Combustion	2. Manufacturing Industries and Construction	Gaseous Fuels	CH4	2.84	5.10	0.00%	0.00001	0.0%	-	-
81	1A4b	1. Energy	A. Fuel Combustion	4. Other Sectors; Residential	Gaseous Fuels	N2O	0.79	1.50	0.00%	0.00001	0.0%	-	-
82	1A3d	1. Energy	A. Fuel Combustion	3. Transport; Navigation	Gas/Diesel Oil	N2O	0.64	0.76	0.00%	0.00000	0.0%	-	-
83	1A4a	1. Energy	A. Fuel Combustion	4. Other Sectors; Commercial/Institutional	Gaseous Fuels	CH4	2.27	3.75	0.00%	0.00001	0.0%	-	-
84	2A2	2. Industrial Proc.	A. Mineral Products; Lime Production-CO2			CO2	53.35	54.23	0.00%	0.00000	0.0%	-	-
85	1A2	1. Energy	A. Fuel Combustion	2. Manufacturing Industries and Construction	Gaseous Fuels	N2O	0.63	1.24	0.00%	0.00001	0.0%	-	-
86	2C	2. Industrial Proc.	C. Metal Production; Aluminium Foundries			SF6	0.00	4.88	0.00%	0.00002	0.0%	-	-
87	2F1	2. Industrial Proc.	F. Consumption of Halocarbons and SF6; Refrigeration			PFC	0.04	7.43	0.00%	0.00002	0.0%	-	-
88	1A3c	1. Energy	A. Fuel Combustion	3. Transport; Railways		CO2	28.69	37.77	0.00%	0.00000	0.0%	-	-
89	1A4c	1. Energy	A. Fuel Combustion	4. Other Sectors; Agriculture/Forestry	Gaseous Fuels	CO2	40.64	15.85	0.00%	0.00002	0.0%	-	-
90	1A4b	1. Energy	A. Fuel Combustion	4. Other Sectors; Residential	Liquid Fuels	CH4	6.00	2.63	0.00%	0.00002	0.0%	-	-
91	1A3d	1. Energy	A. Fuel Combustion	3. Transport; Navigation	Gasoline	N2O	0.60	0.53	0.00%	0.00000	0.0%	-	-
92	1A3c	1. Energy	A. Fuel Combustion	3. Transport; Railways	Liquid Fuels	N2O	0.38	0.49	0.00%	0.00000	0.0%	-	-
93	1A4b	1. Energy	A. Fuel Combustion	4. Other Sectors; Residential	Solid Fuels	CH4	3.71	2.28	0.00%	0.00001	0.0%	-	-
94	1A3b	1. Energy	A. Fuel Combustion	3. Transport; Road Transportation	Biomass	N2O	0.00	0.44	0.00%	0.00001	0.0%	-	-
95	1A4a	1. Energy	A. Fuel Combustion	4. Other Sectors; Commercial/Institutional	Gaseous Fuels	N2O	0.51	0.79	0.00%	0.00000	0.0%	-	-
96	1A2	1. Energy	A. Fuel Combustion	2. Manufacturing Industries and Construction	Biomass	CH4	2.46	2.01	0.00%	0.00000	0.0%	-	-
97	1A4a	1. Energy	A. Fuel Combustion	4. Other Sectors; Commercial/Institutional	Liquid Fuels	CH4	2.96	1.57	0.00%	0.00001	0.0%	-	-
98	1A4c	1. Energy	A. Fuel Combustion	4. Other Sectors; Agriculture/Forestry	Liquid Fuels	CH4	1.62	1.38	0.00%	0.00000	0.0%	-	-
99	1A1	1. Energy	A. Fuel Combustion	1. Energy Industries	Gaseous Fuels	CH4	0.54	1.24	0.00%	0.00000	0.0%	-	-

Table A – 7 continued. Key category analysis Tier 2 2010 (without LULUCF) regarding trend.

Tier 2 Key category analysis 2010 without LULUCF categories													
	A					B	C	D	E-L	E-T	F-T	M	N
No.	IPCC Source Categories and fuels if applicable (without LULUCF categories)					Direct GHG	Base Year 1990 Estimate [Gg CO2 eq]	Year 2010 Estimate [Gg CO2 eq]	Level Assessm. with Uncertainty	Trend Assessm. with Uncertainty	% Contrib. in Trend	Result level assessm.	Result trend assessm.
100	1A1	1. Energy	A. Fuel Combustion	1. Energy Industries	Biomass	CH4	4.66	1.24	0.00%	0.00002	0.0%	-	-
101	1A2	1. Energy	A. Fuel Combustion	2. Manufacturing Industries and Construction	Liquid Fuels	CH4	2.42	1.20	0.00%	0.00001	0.0%	-	-
102	7	7. Other				CH4	0.55	0.58	0.00%	0.00000	0.0%	-	-
103	1A4c	1. Energy	A. Fuel Combustion	4. Other Sectors; Agriculture/Forestry	Biomass	N2O	0.21	0.35	0.00%	0.00000	0.0%	-	-
104	1A1	1. Energy	A. Fuel Combustion	1. Energy Industries	Gaseous Fuels	N2O	0.13	0.30	0.00%	0.00000	0.0%	-	-
105	1A1	1. Energy	A. Fuel Combustion	1. Energy Industries	Liquid Fuels	CH4	0.49	0.78	0.00%	0.00000	0.0%	-	-
106	2C5	2. Industrial Proc.	C. Metal Production; Non-ferrous metals-CO2			CO2	1.65	1.85	0.00%	0.00000	0.0%	-	-
107	1A3a	1. Energy	A. Fuel Combustion	3. Transport; Civil Aviation		CH4	0.24	0.27	0.00%	0.00000	0.0%	-	-
108	2F5	2. Industrial Proc.	F. Consumption of Halocarbons and SF6; Solvents			PFC	0.00	7.88	0.00%	0.00000	0.0%	-	-
109	1A3d	1. Energy	A. Fuel Combustion	3. Transport; Navigation	Gasoline	CH4	0.58	0.51	0.00%	0.00000	0.0%	-	-
110	1A4b	1. Energy	A. Fuel Combustion	4. Other Sectors; Residential	Solid Fuels	N2O	0.29	0.18	0.00%	0.00000	0.0%	-	-
111	1A2	1. Energy	A. Fuel Combustion	2. Manufacturing Industries and Construction	Solid Fuels	CH4	0.57	0.45	0.00%	0.00000	0.0%	-	-
112	1A3b	1. Energy	A. Fuel Combustion	3. Transport; Road Transportation	Diesel	CH4	1.36	0.65	0.00%	0.00000	0.0%	-	-
113	2A7	2. Industrial Proc.	A. Mineral Products; Other non-specified-CO2			CO2	15.12	5.93	0.00%	0.00000	0.0%	-	-
114	2G	2. Industrial Proc.	G. Other			CO2	1.04	0.96	0.00%	0.00000	0.0%	-	-
115	1A3b	1. Energy	A. Fuel Combustion	3. Transport; Road Transportation	Natural Gas	CH4	0.00	0.27	0.00%	0.00000	0.0%	-	-
116	1A4c	1. Energy	A. Fuel Combustion	4. Other Sectors; Agriculture/Forestry	Biomass	CH4	0.80	0.18	0.00%	0.00000	0.0%	-	-
117	2F5	2. Industrial Proc.	F. Consumption of Halocarbons and SF6; Solvents			HFC	0.00	2.37	0.00%	0.00000	0.0%	-	-
118	1A5	1. Energy	A. Fuel Combustion	5. Other	Liquid Fuels	CH4	0.16	0.12	0.00%	0.00000	0.0%	-	-
119	1A3ei	1. Energy	A. Fuel Combustion	3. Transport; Other non-specified		N2O	0.03	0.03	0.00%	0.00000	0.0%	-	-
120	1A3b	1. Energy	A. Fuel Combustion	3. Transport; Road Transportation	Biomass	CH4	0.00	0.04	0.00%	0.00000	0.0%	-	-
121	1A3ei	1. Energy	A. Fuel Combustion	3. Transport; Other non-specified		CH4	0.09	0.04	0.00%	0.00000	0.0%	-	-
122	1A4c	1. Energy	A. Fuel Combustion	4. Other Sectors; Agriculture/Forestry	Gaseous Fuels	CH4	0.09	0.04	0.00%	0.00000	0.0%	-	-
123	1A4c	1. Energy	A. Fuel Combustion	4. Other Sectors; Agriculture/Forestry	Gaseous Fuels	N2O	0.02	0.01	0.00%	0.00000	0.0%	-	-
124	1A3d	1. Energy	A. Fuel Combustion	3. Transport; Navigation	Gas/Diesel Oil	CH4	0.01	0.02	0.00%	0.00000	0.0%	-	-
125	1A3c	1. Energy	A. Fuel Combustion	3. Transport; Railways	Liquid Fuels	CH4	0.01	0.01	0.00%	0.00000	0.0%	-	-
126	1A1	1. Energy	A. Fuel Combustion	1. Energy Industries	Solid Fuels	CO2	44.84	0.00	0.00%	-	0.0%	-	-
127	1A1	1. Energy	A. Fuel Combustion	1. Energy Industries	Solid Fuels	CH4	0.10	0.00	0.00%	-	0.0%	-	-
128	1A1	1. Energy	A. Fuel Combustion	1. Energy Industries	Solid Fuels	N2O	0.24	0.00	0.00%	-	0.0%	-	-
129	1A2	1. Energy	A. Fuel Combustion	2. Manufacturing Industries and Construction	Other Fuels	CH4	0.00	0.00	0.00%	-	0.0%	-	-
130	1A3b	1. Energy	A. Fuel Combustion	3. Transport; Road Transportation	Natural Gas	N2O	0.00	0.00	0.00%	-	0.0%	-	-
131	1B2	1. Energy	B. Fugitive Emissions from Fuels	2. Oil and Natural Gas		N2O	0.00	0.00	0.00%	-	0.0%	-	-
132	2C3	2. Industrial Proc.	C. Metal Production; Aluminium Production-CO2			CO2	139.26	0.00	0.00%	-	0.0%	-	-
133	2C3	2. Industrial Proc.	C. Metal Production; Aluminium Production-PFC			PFC	100.17	0.00	0.00%	-	0.0%	-	-
134	2F9	2. Industrial Proc.	F. Consumption of Halocarbons and SF6; Other			PFC	0.00	0.00	0.00%	-	0.0%	-	-
135	6A	6. Waste	A. Solid Waste Disposal on Land			CO2	9.24	0.00	0.00%	-	0.0%	-	-
136	6D	6. Waste	D. Other			CO2	0.00	0.00	0.00%	-	0.0%	-	-

A1.5 KCA Tier 2 2010 including LULUCF categories

A1.5.1 Results of Key Category Analysis Tier 2 – Level

Table A - 8 Key category analysis Tier 2 2010 (with LULUCF) regarding level.

Tier 2 Key category analysis 2010 with LULUCF categories												
	A					B	C	D	E-L	E-T	F-T	M
No.	IPCC Source Categories and fuels if applicable (with LULUCF categories)					Direct GHG	Base Year 1990 Estimate	Year 2010 Estimate [Gg CO2 eq]	Level Assessm. with Uncertainty	Trend Assessm. with Uncertainty	% Contrib. in Trend	Result level assessm.
1	4D3	4. Agriculture	D. Agricultural Soils; Indirect Emissions			N2O	820.73	710.51	1.96%	0.00246	3.7%	KC level
2	4D1	4. Agriculture	D. Agricultural Soils; Direct Soil Emissions			N2O	1364.15	1189.21	1.58%	0.00185	2.8%	KC level
3	1A1	1. Energy	A. Fuel Combustion	1. Energy Industries	Other Fuels	CO2	1519.73	2582.10	1.42%	0.00624	9.4%	KC level
4	2A1	2. Industrial Proc.	A. Mineral Products; Cement Production-CO2			CO2	2524.77	1928.12	1.34%	0.00375	5.6%	KC level
5	5A2	5. LULUCF	A. Forest Land	2. Land converted to Forest Land		CO2	1306.70	1205.09	0.90%	0.00050	0.7%	KC level
6	4A	4. Agriculture	A. Enteric Fermentation			CH4	2657.35	2537.97	0.81%	0.00014	0.2%	KC level
7	4B	4. Agriculture	B. Manure Management			CH4	672.00	645.25	0.61%	0.00007	0.1%	KC level
8	5A1	5. LULUCF	A. Forest Land	1. Forest Land remaining Forest Land		CO2	-3771.35	-945.76	0.60%	0.01763	26.4%	KC level
9	1A3b	1. Energy	A. Fuel Combustion	3. Transport; Road Transportation	Gasoline	CO2	11335.25	9744.97	0.44%	0.00058	0.9%	KC level
10	4B	4. Agriculture	B. Manure Management			N2O	453.87	323.52	0.40%	0.00150	2.3%	KC level
11	4D2	4. Agriculture	D. Agricultural Soils; Pasture, Range and Paddock Manure			N2O	128.10	245.40	0.36%	0.00183	2.7%	KC level
12	1A4b	1. Energy	A. Fuel Combustion	4. Other Sectors; Residential	Liquid Fuels	CO2	10226.25	8688.23	0.34%	0.00050	0.7%	KC level
13	5B1	5. LULUCF	B. Cropland	1. Cropland remaining Cropland		CO2	435.28	425.31	0.29%	0.00002	0.0%	KC level
14	5E2	5. LULUCF	E. Settlements	2. Land converted to Settlements		CO2	361.84	297.07	0.26%	0.00050	0.7%	KC level
15	1A3b	1. Energy	A. Fuel Combustion	3. Transport; Road Transportation	Diesel	CO2	2587.68	6154.63	0.24%	0.00146	2.2%	KC level
16	1A4b	1. Energy	A. Fuel Combustion	4. Other Sectors; Residential	Gaseous Fuels	CO2	1409.10	2661.45	0.23%	0.00116	1.7%	KC level
17	2F1	2. Industrial Proc.	F. Consumption of Halocarbons and SF6; Refrig. & AC Eq.			HFC	0.02	1011.69	0.21%	0.00217	3.2%	KC level
18	6A	6. Waste	A. Solid Waste Disposal on Land			CH4	688.16	198.00	0.20%	0.00490	7.3%	KC level
19	1A2	1. Energy	A. Fuel Combustion	2. Manufacturing Industries and Construction	Gaseous Fuels	CO2	1133.30	2216.12	0.19%	0.00100	1.5%	KC level
20	1A2	1. Energy	A. Fuel Combustion	2. Manufacturing Industries and Construction	Other Fuels	CO2	134.24	315.35	0.17%	0.00104	1.6%	KC level
21	6D	6. Waste	D. Other			CH4	27.44	95.23	0.17%	0.00123	1.8%	KC level
22	5C2	5. LULUCF	C. Grassland	2. Land converted to Grassland		CO2	74.60	172.45	0.15%	0.00091	1.4%	KC level
23	1B2	1. Energy	B. Fugitive Emissions from Fuels	2. Oil and Natural Gas		CH4	380.43	173.85	0.15%	0.00175	2.6%	KC level
24	6B	6. Waste	B. Wastewater Handling			N2O	184.72	208.89	0.14%	0.00021	0.3%	KC level
25	5C1	5. LULUCF	C. Grassland	1. Grassland remaining Grassland		CO2	146.77	163.58	0.14%	0.00019	0.3%	KC level
26	1A4a	1. Energy	A. Fuel Combustion	4. Other Sectors; Commercial/Institutional	Liquid Fuels	CO2	4429.39	3607.89	0.14%	0.00028	0.4%	KC level
27	1A2	1. Energy	A. Fuel Combustion	2. Manufacturing Industries and Construction	Solid Fuels	CO2	1227.96	520.65	0.14%	0.00184	2.8%	KC level
28	3	3. Solvent and Other Product Use				CO2	361.92	157.23	0.14%	0.00173	2.6%	KC level
29	1A4a	1. Energy	A. Fuel Combustion	4. Other Sectors; Commercial/Institutional	Gaseous Fuels	CO2	905.76	1409.10	0.12%	0.00047	0.7%	KC level
30	2C1	2. Industrial Proc.	C. Metal Production; Steel Production			CO2	110.80	170.57	0.12%	0.00045	0.7%	KC level
31	1A2	1. Energy	A. Fuel Combustion	2. Manufacturing Industries and Construction	Liquid Fuels	CO2	3876.46	2890.89	0.11%	0.00035	0.5%	-
32	5F2	5. LULUCF	F. Other Land	2. Land converted to Other Land		CO2	97.88	121.89	0.11%	0.00025	0.4%	-
33	1A3b	1. Energy	A. Fuel Combustion	3. Transport; Road Transportation	Gasoline	N2O	137.27	111.15	0.10%	0.00020	0.3%	-
34	3	3. Solvent and Other Product Use				N2O	110.14	57.33	0.08%	0.00071	1.1%	-
35	2F9	2. Industrial Proc.	F. Consumption of Halocarbons and SF6; Other			SF6	79.58	51.12	0.07%	0.00037	0.6%	-
36	1A1	1. Energy	A. Fuel Combustion	1. Energy Industries	Biomass	N2O	27.72	48.15	0.07%	0.00030	0.5%	-
37	1A1	1. Energy	A. Fuel Combustion	1. Energy Industries	Other Fuels	N2O	20.85	47.25	0.07%	0.00039	0.6%	-
38	2A3	2. Industrial Proc.	A. Mineral Products; Limestone and Dolomite Use, Emissions, CO2			CO2	103.25	72.39	0.06%	0.00025	0.4%	-
39	1A1	1. Energy	A. Fuel Combustion	1. Energy Industries	Gaseous Fuels	CO2	235.05	540.64	0.05%	0.00028	0.4%	-
40	2B	2. Industrial Proc.	B. Chemical Industry			N2O	68.13	60.26	0.04%	0.00004	0.1%	-
41	2F9	2. Industrial Proc.	F. Consumption of Halocarbons and SF6; Other			HFC	0.00	30.62	0.04%	0.00044	0.7%	-
42	1A4b	1. Energy	A. Fuel Combustion	4. Other Sectors; Residential	Biomass	CH4	95.89	38.15	0.04%	0.00062	0.9%	-
43	1A1	1. Energy	A. Fuel Combustion	1. Energy Industries	Liquid Fuels	CO2	691.23	965.28	0.04%	0.00012	0.2%	-
44	6D	6. Waste	D. Other			N2O	5.82	24.15	0.03%	0.00026	0.4%	-
45	4D4	4. Agriculture	D. Agricultural Soils; Use of sewage sludge as fertilizers			N2O	28.19	22.56	0.03%	0.00007	0.1%	-
46	7	7. Other				N2O	16.72	13.63	0.03%	0.00006	0.1%	-
47	1A4b	1. Energy	A. Fuel Combustion	4. Other Sectors; Residential	Liquid Fuels	N2O	25.94	22.06	0.03%	0.00004	0.1%	-
48	5E1	5. LULUCF	E. Settlements	1. Settlements remaining Settlements		CO2	0.57	30.44	0.03%	0.00027	0.4%	-
49	5D2	5. LULUCF	D. Wetlands	2. Land converted to Wetlands		CO2	19.81	27.69	0.02%	0.00008	0.1%	-
50	5B2	5. LULUCF	B. Cropland	2. Land converted to Cropland		CO2	47.04	27.07	0.02%	0.00017	0.3%	-
51	6B	6. Waste	B. Wastewater Handling			CH4	4.65	45.90	0.02%	0.00022	0.3%	-
52	2B	2. Industrial Proc.	B. Chemical Industry			CO2	109.80	121.41	0.02%	0.00003	0.0%	-
53	1A4c	1. Energy	A. Fuel Combustion	4. Other Sectors; Agriculture/Forestry	Liquid Fuels	CO2	547.00	519.96	0.02%	0.00000	0.0%	-
54	6C	6. Waste	C. Waste Incineration			N2O	16.20	25.90	0.02%	0.00007	0.1%	-
55	1A2	1. Energy	A. Fuel Combustion	2. Manufacturing Industries and Construction	Liquid Fuels	N2O	14.96	12.84	0.02%	0.00002	0.0%	-
56	1A2	1. Energy	A. Fuel Combustion	2. Manufacturing Industries and Construction	Biomass	N2O	2.44	10.79	0.01%	0.00012	0.2%	-
57	1A3b	1. Energy	A. Fuel Combustion	3. Transport; Road Transportation	Gasoline	CH4	101.15	22.34	0.01%	0.00050	0.8%	-
58	1A4b	1. Energy	A. Fuel Combustion	4. Other Sectors; Residential	Biomass	N2O	10.64	9.82	0.01%	0.00001	0.0%	-
59	1B2	1. Energy	B. Fugitive Emissions from Fuels	2. Oil and Natural Gas		CO2	91.36	74.04	0.01%	0.00003	0.0%	-
60	1A4a	1. Energy	A. Fuel Combustion	4. Other Sectors; Commercial/Institutional	Liquid Fuels	N2O	11.28	9.25	0.01%	0.00002	0.0%	-
61	2F2	2. Industrial Proc.	F. Consumption of Halocarbons and SF6; Hard Foam			HFC	0.00	13.59	0.01%	0.00012	0.2%	-
62	2F8	2. Industrial Proc.	F. Consumption of Halocarbons and SF6; Electrical Eq.			SF6	64.04	62.47	0.01%	0.00000	0.0%	-
63	4F	4. Agriculture	F. Field Burning of Agricultural Residues			CH4	10.00	10.00	0.01%	0.00000	0.0%	-
64	2C	2. Industrial Proc.	C. Metal Production; Magnesium Foundries			SF6	0.00	29.66	0.01%	0.00011	0.2%	-
65	4F	4. Agriculture	F. Field Burning of Agricultural Residues			N2O	3.91	3.91	0.01%	0.00000	0.0%	-
66	2F7	2. Industrial Proc.	F. Consumption of Halocarbons and SF6; Semiconductor Manufacture			PFC	0.00	14.56	0.01%	0.00010	0.2%	-
67	7	7. Other				CO2	10.96	13.02	0.01%	0.00002	0.0%	-
68	1A4b	1. Energy	A. Fuel Combustion	4. Other Sectors; Residential	Solid Fuels	CO2	54.59	33.60	0.01%	0.00005	0.1%	-
69	1A2	1. Energy	A. Fuel Combustion	2. Manufacturing Industries and Construction	Other Fuels	N2O	2.31	5.83	0.01%	0.00005	0.1%	-
70	6C	6. Waste	C. Waste Incineration			CO2	54.10	10.68	0.01%	0.00030	0.4%	-
71	1A4c	1. Energy	A. Fuel Combustion	4. Other Sectors; Agriculture/Forestry	Liquid Fuels	N2O	4.97	5.28	0.01%	0.00001	0.0%	-
72	1A3b	1. Energy	A. Fuel Combustion	3. Transport; Road Transportation	Diesel	N2O	5.84	18.10	0.01%	0.00005	0.1%	-
73	5B2	5. LULUCF	B. Cropland	2. Land converted to Cropland		N2O	6.14	4.38	0.01%	0.00003	0.0%	-
74	1A3a	1. Energy	A. Fuel Combustion	3. Transport; Civil Aviation		CO2	252.55	123.55	0.01%	0.00005	0.1%	-
75	2F7	2. Industrial Proc.	F. Consumption of Halocarbons and SF6; Semiconductor Manufacture			SF6	0.00	6.99	0.00%	0.00005	0.1%	-
76	1A1	1. Energy	A. Fuel Combustion	1. Energy Industries	Liquid Fuels	N2O	2.15	3.47	0.00%	0.00002	0.0%	-
77	1A5	1. Energy	A. Fuel Combustion	5. Other	Liquid Fuels	CO2	203.58	119.55	0.00%	0.00003	0.0%	-
78	1A4a	1. Energy	A. Fuel Combustion	4. Other Sectors; Commercial/Institutional	Biomass	N2O	1.45	3.36	0.00%	0.00003	0.0%	-
79	2F7	2. Industrial Proc.	F. Consumption of Halocarbons and SF6; Semiconductor Manufacture			PFC	0.00	6.63	0.00%	0.00005	0.1%	-
80	1A3d	1. Energy	A. Fuel Combustion	3. Transport; Navigation		CO2	111.86	116.98	0.00%	0.00000	0.0%	-
81	2B	1. Industrial Proc.	B. Chemical Industry			CH4	9.63	8.39	0.00%	0.00001	0.0%	-
82	1A3ei	1. Energy	A. Fuel Combustion	3. Transport; Other non-specified		CO2	49.01	48.71	0.00%	0.00000	0.0%	-
83	1A2	1. Energy	A. Fuel Combustion	2. Manufacturing Industries and Construction	Solid Fuels	N2O	6.57	2.76	0.00%	0.00005	0.1%	-
84	1A3b	1. Energy	A. Fuel Combustion	3. Transport; Road Transportation	Natural Gas	CO2	0.00	39.05	0.00%	0.00003	0.1%	-
85	1A4b	1. Energy	A. Fuel Combustion	4. Other Sectors; Residential	Gaseous Fuels	CH4	3.26	6.26	0.00%	0.00002	0.0%	-
86	1A3a	1. Energy	A. Fuel Combustion	3. Transport; Civil Aviation		N2O	2.46	1.20	0.00%	0.00003	0.0%	-
87	1A5	1. Energy	A. Fuel Combustion	5. Other	Liquid Fuels	N2O	2.01	1.18	0.00%	0.00002	0.0%	-
88	6C	6. Waste	C. Waste Incineration			CH4	4.25	2.80	0.00%	0.00001	0.0%	-
89	2F4	2. Industrial Proc.	F. Consumption of Halocarbons and SF6; Metered Dose Inhalers and Other			HFC	0.00	14.71	0.00%	0.00003	0.0%	-
90	1A4a	1. Energy	A. Fuel Combustion	4. Other Sectors; Commercial/Institutional	Biomass	CH4	9.74	5.12	0.00%	0.00002	0.0%	-
91	1A2	1. Energy	A. Fuel Combustion	2. Manufacturing Industries and Construction	Gaseous Fuels	CH4	2.84	5.10	0.00%	0.00001	0.0%	-
92	1A4b	1. Energy	A. Fuel Combustion	4. Other Sectors; Residential	Gaseous Fuels	N2O	0.79	1.50	0.00%	0.00001	0.0%	-
93	1A3d	1. Energy	A. Fuel Combustion	3. Transport; Navigation	Gas/Diesel Oil	N2O	0.64	0.76	0.00%	0.00000	0.0%	-
94	1A4a	1. Energy	A. Fuel Combustion	4. Other Sectors; Commercial/Institutional	Gaseous Fuels	CH4	2.27	3.75	0.00%	0.00001	0.0%	-
95	2A2	2. Industrial Proc.	A. Mineral Products; Lime Production-CO2			CO2	53.35	54.23	0.00%	0.00000	0.0%	-
96	1A2	1. Energy	A. Fuel Combustion	2. Manufacturing Industries and Construction	Gaseous Fuels	N2O	0.63	1.24	0.00%	0.00001	0.0%	-
97	2C	2. Industrial Proc.	C. Metal Production; Aluminium Foundries			SF6	0.00	4.88	0.00%	0.00002	0.0%	-
98	2F1	2. Industrial Proc.	F. Consumption of Halocarbons and SF6; Refrigeration			PFC	0.04	7.43	0.00%	0.00002	0.0%	-
99	1A3c	1. Energy	A. Fuel Combustion	3. Transport; Railways		CO2	28.69	37.77	0.00%	0.00000	0.0%	-

Table A – 8 continued. Key category analysis Tier 2 2010 (with LULUCF) regarding level.

Tier 2 Key category analysis 2010 with LULUCF categories												
A						B	C	D	E-L	E-T	F-T	M
No.	IPCC Source Categories and fuels if applicable (with LULUCF categories)					Direct GHG	Base Year 1990 Estimate	Year 2010 Estimate [Gg CO2 eq]	Level Assessm. with Uncertainty	Trend Assessm. with Uncertainty	% Contrib. in Trend	Result level assessm.
100	1A4c	1. Energy	A. Fuel Combustion	4. Other Sectors; Agriculture/Forestry	Gaseous Fuels	CO2	40.64	15.85	0.00%	0.00002	0.0%	-
101	1A4b	1. Energy	A. Fuel Combustion	4. Other Sectors; Residential	Liquid Fuels	CH4	6.00	2.63	0.00%	0.00002	0.0%	-
102	1A3d	1. Energy	A. Fuel Combustion	3. Transport; Navigation	Gasoline	N2O	0.60	0.53	0.00%	0.00000	0.0%	-
103	1A3c	1. Energy	A. Fuel Combustion	3. Transport; Railways	Liquid Fuels	N2O	0.38	0.49	0.00%	0.00000	0.0%	-
104	1A4b	1. Energy	A. Fuel Combustion	4. Other Sectors; Residential	Solid Fuels	CH4	3.71	2.28	0.00%	0.00001	0.0%	-
105	1A3b	1. Energy	A. Fuel Combustion	3. Transport; Road Transportation	Biomass	N2O	0.00	0.44	0.00%	0.00001	0.0%	-
106	1A4a	1. Energy	A. Fuel Combustion	4. Other Sectors; Commercial/Institutional	Gaseous Fuels	N2O	0.51	0.79	0.00%	0.00000	0.0%	-
107	1A2	1. Energy	A. Fuel Combustion	2. Manufacturing Industries and Construction	Biomass	CH4	2.46	2.01	0.00%	0.00000	0.0%	-
108	1A4a	1. Energy	A. Fuel Combustion	4. Other Sectors; Commercial/Institutional	Liquid Fuels	CH4	2.96	1.57	0.00%	0.00001	0.0%	-
109	5D1	5. LULUCF	D. Wetlands	1. Wetlands remaining Wetlands		CO2	-2.79	-0.42	0.00%	0.00004	0.1%	-
110	5A1	5. LULUCF	A. Forest Land	1. Forest Land remaining Forest Land	Biomass Burning	CO2	-30.07	-0.68	0.00%	0.00031	0.5%	-
111	1A4c	1. Energy	A. Fuel Combustion	4. Other Sectors; Agriculture/Forestry	Liquid Fuels	CH4	1.62	1.38	0.00%	0.00000	0.0%	-
112	1A1	1. Energy	A. Fuel Combustion	1. Energy Industries	Gaseous Fuels	CH4	0.54	1.24	0.00%	0.00000	0.0%	-
113	1A1	1. Energy	A. Fuel Combustion	1. Energy Industries	Biomass	CH4	4.66	1.24	0.00%	0.00002	0.0%	-
114	1A2	1. Energy	A. Fuel Combustion	2. Manufacturing Industries and Construction	Liquid Fuels	CH4	2.42	1.20	0.00%	0.00001	0.0%	-
115	7	7. Other				CH4	0.55	0.58	0.00%	0.00000	0.0%	-
116	1A4c	1. Energy	A. Fuel Combustion	4. Other Sectors; Agriculture/Forestry	Biomass	N2O	0.21	0.35	0.00%	0.00000	0.0%	-
117	1A1	1. Energy	A. Fuel Combustion	1. Energy Industries	Gaseous Fuels	N2O	0.13	0.30	0.00%	0.00000	0.0%	-
118	1A1	1. Energy	A. Fuel Combustion	1. Energy Industries	Liquid Fuels	CH4	0.49	0.78	0.00%	0.00000	0.0%	-
119	2C5	2. Industrial Proc.	C. Metal Production; Non-ferrous metals-CO2			CO2	1.65	1.85	0.00%	0.00000	0.0%	-
120	1A3a	1. Energy	A. Fuel Combustion	3. Transport; Civil Aviation		CH4	0.24	0.27	0.00%	0.00000	0.0%	-
121	2F5	2. Industrial Proc.	F. Consumption of Halocarbons and SF6; Solvents			PFC	0.00	7.88	0.00%	0.00000	0.0%	-
122	1A3d	1. Energy	A. Fuel Combustion	3. Transport; Navigation	Gasoline	CH4	0.58	0.51	0.00%	0.00000	0.0%	-
123	1A4b	1. Energy	A. Fuel Combustion	4. Other Sectors; Residential	Solid Fuels	N2O	0.29	0.18	0.00%	0.00000	0.0%	-
124	1A2	1. Energy	A. Fuel Combustion	2. Manufacturing Industries and Construction	Solid Fuels	CH4	0.57	0.45	0.00%	0.00000	0.0%	-
125	5A1	5. LULUCF	A. Forest Land	1. Forest Land remaining Forest Land		CH4	8.19	0.19	0.00%	0.00010	0.1%	-
126	1A3b	1. Energy	A. Fuel Combustion	3. Transport; Road Transportation	Diesel	CH4	1.36	0.65	0.00%	0.00000	0.0%	-
127	2A7	2. Industrial Proc.	A. Mineral Products; Other non-specified-CO2			CO2	15.12	5.93	0.00%	0.00000	0.0%	-
128	2G	2. Industrial Proc.	G. Other			CO2	1.04	0.96	0.00%	0.00000	0.0%	-
129	5A1	5. LULUCF	A. Forest Land	1. Forest Land remaining Forest Land		N2O	5.30	0.12	0.00%	0.00006	0.1%	-
130	1A3b	1. Energy	A. Fuel Combustion	3. Transport; Road Transportation	Natural Gas	CH4	0.00	0.27	0.00%	0.00000	0.0%	-
131	1A4c	1. Energy	A. Fuel Combustion	4. Other Sectors; Agriculture/Forestry	Biomass	CH4	0.80	0.18	0.00%	0.00000	0.0%	-
132	2F5	2. Industrial Proc.	F. Consumption of Halocarbons and SF6; Solvents			HFC	0.00	2.37	0.00%	0.00000	0.0%	-
133	1A5	1. Energy	A. Fuel Combustion	5. Other	Liquid Fuels	CH4	0.16	0.12	0.00%	0.00000	0.0%	-
134	1A3ei	1. Energy	A. Fuel Combustion	3. Transport; Other non-specified		N2O	0.03	0.03	0.00%	0.00000	0.0%	-
135	1A3b	1. Energy	A. Fuel Combustion	3. Transport; Road Transportation	Biomass	CH4	0.00	0.04	0.00%	0.00000	0.0%	-
136	1A3ei	1. Energy	A. Fuel Combustion	3. Transport; Other non-specified		CH4	0.09	0.04	0.00%	0.00000	0.0%	-
137	1A4c	1. Energy	A. Fuel Combustion	4. Other Sectors; Agriculture/Forestry	Gaseous Fuels	CH4	0.09	0.04	0.00%	0.00000	0.0%	-
138	1A4c	1. Energy	A. Fuel Combustion	4. Other Sectors; Agriculture/Forestry	Gaseous Fuels	N2O	0.02	0.01	0.00%	0.00000	0.0%	-
139	1A3d	1. Energy	A. Fuel Combustion	3. Transport; Navigation	Gas/Diesel Oil	CH4	0.01	0.02	0.00%	0.00000	0.0%	-
140	1A3c	1. Energy	A. Fuel Combustion	3. Transport; Railways	Liquid Fuels	CH4	0.01	0.01	0.00%	0.00000	0.0%	-
141	1A1	1. Energy	A. Fuel Combustion	1. Energy Industries	Solid Fuels	CO2	44.84	0.00	0.00%	-	0.0%	-
142	1A1	1. Energy	A. Fuel Combustion	1. Energy Industries	Solid Fuels	CH4	0.10	0.00	0.00%	-	0.0%	-
143	1A1	1. Energy	A. Fuel Combustion	1. Energy Industries	Solid Fuels	N2O	0.24	0.00	0.00%	-	0.0%	-
144	1A2	1. Energy	A. Fuel Combustion	2. Manufacturing Industries and Construction	Other Fuels	CH4	0.00	0.00	0.00%	-	0.0%	-
145	1A3b	1. Energy	A. Fuel Combustion	3. Transport; Road Transportation	Natural Gas	N2O	0.00	0.00	0.00%	-	0.0%	-
146	1B2	1. Energy	B. Fugitive Emissions from Fuels	2. Oil and Natural Gas		N2O	0.00	0.00	0.00%	-	0.0%	-
147	2C3	2. Industrial Proc.	C. Metal Production; Aluminium Production-CO2			CO2	139.26	0.00	0.00%	-	0.0%	-
148	2C3	2. Industrial Proc.	C. Metal Production; Aluminium Production-PFC			PFC	100.17	0.00	0.00%	-	0.0%	-
149	2F9	2. Industrial Proc.	F. Consumption of Halocarbons and SF6; Other			PFC	0.00	0.00	0.00%	-	0.0%	-
150	6A	6. Waste	A. Solid Waste Disposal on Land			CO2	9.24	0.00	0.00%	-	0.0%	-
151	6D	6. Waste	D. Other			CO2	0.00	0.00	0.00%	-	0.0%	-

A1.5.2 Results of Key Category Analysis Tier 2 – Trend

Table A - 9 Key category analysis Tier 2 2010 (with LULUCF) regarding trend.

Tier 2 Key category analysis 2010 with LULUCF categories												
	A					B	C	D	E-L	E-T	F-T	M
No.	IPCC Source Categories and fuels if applicable (with LULUCF categories)					Direct GHG	Base Year 1990 Estimate	Year 2010 Estimate [Gg CO2 eq]	Level Assessm. with Uncertainty	Trend Assessm. with Uncertainty	% Contrib. in Trend	Result level assessm.
1	4D3	4. Agriculture	D. Agricultural Soils; Indirect Emissions			N2O	820.73	710.51	1.96%	0.00246	3.7%	KC level
2	4D1	4. Agriculture	D. Agricultural Soils; Direct Soil Emissions			N2O	1364.15	1189.21	1.58%	0.00185	2.8%	KC level
3	1A1	1. Energy	A. Fuel Combustion	1. Energy Industries	Other Fuels	CO2	1519.73	2582.10	1.42%	0.00624	9.4%	KC level
4	2A1	2. Industrial Proc.	A. Mineral Products; Cement Production-CO2			CO2	2524.77	1928.12	1.34%	0.00375	5.6%	KC level
5	5A2	5. LULUCF	A. Forest Land	2. Land converted to Forest Land		CO2	1306.70	1205.09	0.90%	0.00050	0.7%	KC level
6	4A	4. Agriculture	A. Enteric Fermentation			CH4	2657.35	2537.97	0.81%	0.00014	0.2%	KC level
7	4B	4. Agriculture	B. Manure Management			CH4	672.00	645.25	0.61%	0.00007	0.1%	KC level
8	5A1	5. LULUCF	A. Forest Land	1. Forest Land remaining Forest Land		CO2	-3771.35	-945.76	0.60%	0.01763	26.4%	KC level
9	1A3b	1. Energy	A. Fuel Combustion	3. Transport; Road Transportation	Gasoline	CO2	11335.25	9744.97	0.44%	0.00058	0.9%	KC level
10	4B	4. Agriculture	B. Manure Management			N2O	453.87	323.52	0.40%	0.00150	2.3%	KC level
11	4D2	4. Agriculture	D. Agricultural Soils; Pasture, Range and Paddock Manure			N2O	128.10	245.40	0.36%	0.00183	2.7%	KC level
12	1A4b	1. Energy	A. Fuel Combustion	4. Other Sectors; Residential	Liquid Fuels	CO2	10226.25	8688.23	0.34%	0.00050	0.7%	KC level
13	5B1	5. LULUCF	B. Cropland	1. Cropland remaining Cropland		CO2	435.28	425.31	0.29%	0.00002	0.0%	KC level
14	5E2	5. LULUCF	E. Settlements	2. Land converted to Settlements		CO2	361.84	297.07	0.26%	0.00050	0.7%	KC level
15	1A3b	1. Energy	A. Fuel Combustion	3. Transport; Road Transportation	Diesel	CO2	2587.68	6154.63	0.24%	0.00146	2.2%	KC level
16	1A4b	1. Energy	A. Fuel Combustion	4. Other Sectors; Residential	Gaseous Fuels	CO2	1409.10	2661.45	0.23%	0.00116	1.7%	KC level
17	2F1	2. Industrial Proc.	F. Consumption of Halocarbons and SF6; Refrig. & AC Eq.			HFC	0.02	1011.69	0.21%	0.00217	3.2%	KC level
18	6A	6. Waste	A. Solid Waste Disposal on Land			CH4	688.16	198.00	0.20%	0.00490	7.3%	KC level
19	1A2	1. Energy	A. Fuel Combustion	2. Manufacturing Industries and Construction	Gaseous Fuels	CO2	1133.30	2216.12	0.19%	0.00100	1.5%	KC level
20	1A2	1. Energy	A. Fuel Combustion	2. Manufacturing Industries and Construction	Other Fuels	CO2	134.24	315.35	0.17%	0.00104	1.6%	KC level
21	6D	6. Waste	D. Other			CH4	27.44	95.23	0.17%	0.00123	1.8%	KC level
22	5C2	5. LULUCF	C. Grassland	2. Land converted to Grassland		CO2	74.60	172.45	0.15%	0.00091	1.4%	KC level
23	1B2	1. Energy	B. Fugitive Emissions from Fuels	2. Oil and Natural Gas		CH4	380.43	173.85	0.15%	0.00175	2.6%	KC level
24	6B	6. Waste	B. Wastewater Handling			N2O	184.72	208.89	0.14%	0.00021	0.3%	KC level
25	5C1	5. LULUCF	C. Grassland	1. Grassland remaining Grassland		CO2	146.77	163.58	0.14%	0.00019	0.3%	KC level
26	1A4a	1. Energy	A. Fuel Combustion	4. Other Sectors; Commercial/Institutional	Liquid Fuels	CO2	4429.39	3607.89	0.14%	0.00028	0.4%	KC level
27	1A2	1. Energy	A. Fuel Combustion	2. Manufacturing Industries and Construction	Solid Fuels	CO2	1227.96	520.65	0.14%	0.00184	2.8%	KC level
28	3	3. Solvent and Other Product Use				CO2	361.92	157.23	0.14%	0.00173	2.6%	KC level
29	1A4a	1. Energy	A. Fuel Combustion	4. Other Sectors; Commercial/Institutional	Gaseous Fuels	CO2	905.76	1409.10	0.12%	0.00047	0.7%	KC level
30	2C1	2. Industrial Proc.	C. Metal Production; Steel Production			CO2	110.80	170.57	0.12%	0.00045	0.7%	KC level
31	1A2	1. Energy	A. Fuel Combustion	2. Manufacturing Industries and Construction	Liquid Fuels	CO2	3876.46	2890.89	0.11%	0.00035	0.5%	-
32	5F2	5. LULUCF	F. Other Land	2. Land converted to Other Land		CO2	97.88	121.89	0.11%	0.00025	0.4%	-
33	1A3b	1. Energy	A. Fuel Combustion	3. Transport; Road Transportation	Gasoline	N2O	137.27	111.15	0.10%	0.00020	0.3%	-
34	3	3. Solvent and Other Product Use				N2O	110.14	57.33	0.08%	0.00071	1.1%	-
35	2F9	2. Industrial Proc.	F. Consumption of Halocarbons and SF6; Other			SF6	79.58	51.12	0.07%	0.00037	0.6%	-
36	1A1	1. Energy	A. Fuel Combustion	1. Energy Industries	Biomass	N2O	27.72	48.15	0.07%	0.00030	0.5%	-
37	1A1	1. Energy	A. Fuel Combustion	1. Energy Industries	Other Fuels	N2O	20.85	47.25	0.07%	0.00039	0.6%	-
38	2A3	2. Industrial Proc.	A. Mineral Products; Limestone and Dolomite Use, Emissions, CO2			CO2	103.25	72.39	0.06%	0.00025	0.4%	-
39	1A1	1. Energy	A. Fuel Combustion	1. Energy Industries	Gaseous Fuels	CO2	235.05	540.64	0.05%	0.00028	0.4%	-
40	2B	2. Industrial Proc.	B. Chemical Industry			N2O	68.13	60.26	0.04%	0.00004	0.1%	-
41	2F9	2. Industrial Proc.	F. Consumption of Halocarbons and SF6; Other			HFC	0.00	30.62	0.04%	0.00044	0.7%	-
42	1A4b	1. Energy	A. Fuel Combustion	4. Other Sectors; Residential	Biomass	CH4	95.89	38.15	0.04%	0.00062	0.9%	-
43	1A1	1. Energy	A. Fuel Combustion	1. Energy Industries	Liquid Fuels	CO2	691.23	965.28	0.04%	0.00012	0.2%	-
44	6D	6. Waste	D. Other			N2O	5.82	24.15	0.03%	0.00026	0.4%	-
45	4D4	4. Agriculture	D. Agricultural Soils; Use of sewage sludge as fertilizers			N2O	28.19	22.56	0.03%	0.00007	0.1%	-
46	7	7. Other				N2O	16.72	13.63	0.03%	0.00006	0.1%	-
47	1A4b	1. Energy	A. Fuel Combustion	4. Other Sectors; Residential	Liquid Fuels	N2O	25.94	22.06	0.03%	0.00004	0.1%	-
48	5E1	5. LULUCF	E. Settlements	1. Settlements remaining Settlements		CO2	0.57	30.44	0.03%	0.00027	0.4%	-
49	5D2	5. LULUCF	D. Wetlands	2. Land converted to Wetlands		CO2	19.81	27.69	0.02%	0.00008	0.1%	-
50	5B2	5. LULUCF	B. Cropland	2. Land converted to Cropland		CO2	47.04	27.07	0.02%	0.00017	0.3%	-
51	6B	6. Waste	B. Wastewater Handling			CH4	4.65	45.90	0.02%	0.00022	0.3%	-
52	2B	2. Industrial Proc.	B. Chemical Industry			CO2	109.80	121.41	0.02%	0.00003	0.0%	-
53	1A4c	1. Energy	A. Fuel Combustion	4. Other Sectors; Agriculture/Forestry	Liquid Fuels	CO2	547.00	519.96	0.02%	0.00000	0.0%	-
54	6C	6. Waste	C. Waste Incineration			N2O	16.20	25.90	0.02%	0.00007	0.1%	-
55	1A2	1. Energy	A. Fuel Combustion	2. Manufacturing Industries and Construction	Liquid Fuels	N2O	14.96	12.84	0.02%	0.00002	0.0%	-
56	1A2	1. Energy	A. Fuel Combustion	2. Manufacturing Industries and Construction	Biomass	N2O	2.44	10.79	0.01%	0.00012	0.2%	-
57	1A3b	1. Energy	A. Fuel Combustion	3. Transport; Road Transportation	Gasoline	CH4	101.15	22.34	0.01%	0.00050	0.8%	-
58	1A4b	1. Energy	A. Fuel Combustion	4. Other Sectors; Residential	Biomass	N2O	10.64	9.82	0.01%	0.00001	0.0%	-
59	1B2	1. Energy	B. Fugitive Emissions from Fuels	2. Oil and Natural Gas		CO2	91.36	74.04	0.01%	0.00003	0.0%	-
60	1A4a	1. Energy	A. Fuel Combustion	4. Other Sectors; Commercial/Institutional	Liquid Fuels	N2O	11.28	9.25	0.01%	0.00002	0.0%	-
61	2F2	2. Industrial Proc.	F. Consumption of Halocarbons and SF6; Hard Foam			HFC	0.00	13.59	0.01%	0.00012	0.2%	-
62	2F8	2. Industrial Proc.	F. Consumption of Halocarbons and SF6; Electrical Eq.			SF6	64.04	62.47	0.01%	0.00000	0.0%	-
63	4F	4. Agriculture	F. Field Burning of Agricultural Residues			CH4	10.00	10.00	0.01%	0.00000	0.0%	-
64	2C	2. Industrial Proc.	C. Metal Production; Magnesium Foundries			SF6	0.00	29.66	0.01%	0.00011	0.2%	-
65	4F	4. Agriculture	F. Field Burning of Agricultural Residues			N2O	3.91	3.91	0.01%	0.00000	0.0%	-
66	2F7	2. Industrial Proc.	F. Consumption of Halocarbons and SF6; Semiconductor Manufacture			PFC	0.00	14.56	0.01%	0.00010	0.2%	-
67	7	7. Other				CO2	10.96	13.02	0.01%	0.00002	0.0%	-
68	1A4b	1. Energy	A. Fuel Combustion	4. Other Sectors; Residential	Solid Fuels	CO2	54.59	33.60	0.01%	0.00005	0.1%	-
69	1A2	1. Energy	A. Fuel Combustion	2. Manufacturing Industries and Construction	Other Fuels	N2O	2.31	5.83	0.01%	0.00005	0.1%	-
70	6C	6. Waste	C. Waste Incineration			CO2	54.10	10.68	0.01%	0.00030	0.4%	-
71	1A4c	1. Energy	A. Fuel Combustion	4. Other Sectors; Agriculture/Forestry	Liquid Fuels	N2O	4.97	5.28	0.01%	0.00001	0.0%	-
72	1A3b	1. Energy	A. Fuel Combustion	3. Transport; Road Transportation	Diesel	N2O	5.84	18.10	0.01%	0.00005	0.1%	-
73	5B2	5. LULUCF	B. Cropland	2. Land converted to Cropland		N2O	6.14	4.38	0.01%	0.00003	0.0%	-
74	1A3a	1. Energy	A. Fuel Combustion	3. Transport; Civil Aviation		CO2	252.55	123.55	0.01%	0.00005	0.1%	-
75	2F7	2. Industrial Proc.	F. Consumption of Halocarbons and SF6; Semiconductor Manufacture			SF6	0.00	6.99	0.00%	0.00005	0.1%	-
76	1A1	1. Energy	A. Fuel Combustion	1. Energy Industries	Liquid Fuels	N2O	2.15	3.47	0.00%	0.00002	0.0%	-
77	1A5	1. Energy	A. Fuel Combustion	5. Other	Liquid Fuels	CO2	203.58	119.55	0.00%	0.00003	0.0%	-
78	1A4a	1. Energy	A. Fuel Combustion	4. Other Sectors; Commercial/Institutional	Biomass	N2O	1.45	3.36	0.00%	0.00003	0.0%	-
79	2F7	2. Industrial Proc.	F. Consumption of Halocarbons and SF6; Semiconductor Manufacture			PFC	0.00	6.63	0.00%	0.00005	0.1%	-
80	1A3d	1. Energy	A. Fuel Combustion	3. Transport; Navigation		CO2	111.86	116.98	0.00%	0.00000	0.0%	-
81	2B	1. Industrial Proc.	B. Chemical Industry			CH4	9.63	8.39	0.00%	0.00001	0.0%	-
82	1A3ei	1. Energy	A. Fuel Combustion	3. Transport; Other non-specified		CO2	49.01	48.71	0.00%	0.00000	0.0%	-
83	1A2	1. Energy	A. Fuel Combustion	2. Manufacturing Industries and Construction	Solid Fuels	N2O	6.57	2.76	0.00%	0.00005	0.1%	-
84	1A3b	1. Energy	A. Fuel Combustion	3. Transport; Road Transportation	Natural Gas	CO2	0.00	39.05	0.00%	0.00003	0.1%	-
85	1A4b	1. Energy	A. Fuel Combustion	4. Other Sectors; Residential	Gaseous Fuels	CH4	3.26	6.26	0.00%	0.00002	0.0%	-
86	1A3a	1. Energy	A. Fuel Combustion	3. Transport; Civil Aviation		N2O	2.46	1.20	0.00%	0.00003	0.0%	-
87	1A5	1. Energy	A. Fuel Combustion	5. Other	Liquid Fuels	N2O	2.01	1.18	0.00%	0.00002	0.0%	-
88	6C	6. Waste	C. Waste Incineration			CH4	4.25	2.80	0.00%	0.00001	0.0%	-
89	2F4	2. Industrial Proc.	F. Consumption of Halocarbons and SF6; Metered Dose Inhalers and Other			HFC	0.00	14.71	0.00%	0.00003	0.0%	-
90	1A4a	1. Energy	A. Fuel Combustion	4. Other Sectors; Commercial/Institutional	Biomass	CH4	9.74	5.12	0.00%	0.00002	0.0%	-
91	1A2	1. Energy	A. Fuel Combustion	2. Manufacturing Industries and Construction	Gaseous Fuels	CH4	2.84	5.10	0.00%	0.00001	0.0%	-
92	1A4b	1. Energy	A. Fuel Combustion	4. Other Sectors; Residential	Gaseous Fuels	N2O	0.79	1.50	0.00%	0.00001	0.0%	-
93	1A3d	1. Energy	A. Fuel Combustion	3. Transport; Navigation	Gas/Diesel Oil	N2O	0.64	0.76	0.00%	0.00000	0.0%	-
94	1A4a	1. Energy	A. Fuel Combustion	4. Other Sectors; Commercial/Institutional	Gaseous Fuels	CH4	2.27	3.75	0.00%	0.00001	0.0%	-
95	2A2	2. Industrial Proc.	A. Mineral Products; Lime Production-CO2			CO2	53.35	54.23	0.00%	0.00000	0.0%	-
96	1A2	1. Energy	A. Fuel Combustion	2. Manufacturing Industries and Construction	Gaseous Fuels	N2O	0.63	1.24	0.00%	0.00001	0.0%	-
97	2C	2. Industrial Proc.	C. Metal Production; Aluminium Foundries			SF6	0.00	4.88	0.00%	0.00002	0.0%	-
98	2F1	2. Industrial Proc.	F. Consumption of Halocarbons and SF6; Refrigeration			PFC	0.04	7.43	0.00%	0.00002	0.0%	-
99	1A3c	1. Energy	A. Fuel Combustion	3. Transport; Railways		CO2	28.69	37.77	0.00%	0.00000	0.0%	-

Table A – 9 continued. Key category analysis Tier 2 2010 (with LULUCF) regarding trend.

Tier 2 Key category analysis 2010 with LULUCF categories												
A						B	C	D	E-L	E-T	F-T	M
No.	IPCC Source Categories and fuels if applicable (with LULUCF categories)					Direct GHG	Base Year 1990 Estimate	Year 2010 Estimate [Gg CO2 eq]	Level Assessm. with Uncertainty	Trend Assessm. with Uncertainty	% Contrib. in Trend	Result level assessm.
100	1A4c	1. Energy	A. Fuel Combustion	4. Other Sectors; Agriculture/Forestry	Gaseous Fuels	CO2	40.64	15.85	0.00%	0.00002	0.0%	-
101	1A4b	1. Energy	A. Fuel Combustion	4. Other Sectors; Residential	Liquid Fuels	CH4	6.00	2.63	0.00%	0.00002	0.0%	-
102	1A3d	1. Energy	A. Fuel Combustion	3. Transport; Navigation	Gasoline	N2O	0.60	0.53	0.00%	0.00000	0.0%	-
103	1A3c	1. Energy	A. Fuel Combustion	3. Transport; Railways	Liquid Fuels	N2O	0.38	0.49	0.00%	0.00000	0.0%	-
104	1A4b	1. Energy	A. Fuel Combustion	4. Other Sectors; Residential	Solid Fuels	CH4	3.71	2.28	0.00%	0.00001	0.0%	-
105	1A3b	1. Energy	A. Fuel Combustion	3. Transport; Road Transportation	Biomass	N2O	0.00	0.44	0.00%	0.00001	0.0%	-
106	1A4a	1. Energy	A. Fuel Combustion	4. Other Sectors; Commercial/Institutional	Gaseous Fuels	N2O	0.51	0.79	0.00%	0.00000	0.0%	-
107	1A2	1. Energy	A. Fuel Combustion	2. Manufacturing Industries and Construction	Biomass	CH4	2.46	2.01	0.00%	0.00000	0.0%	-
108	1A4a	1. Energy	A. Fuel Combustion	4. Other Sectors; Commercial/Institutional	Liquid Fuels	CH4	2.96	1.57	0.00%	0.00001	0.0%	-
109	5D1	5. LULUCF	D. Wetlands	1. Wetlands remaining Wetlands		CO2	-2.79	-0.42	0.00%	0.00004	0.1%	-
110	5A1	5. LULUCF	A. Forest Land	1. Forest Land remaining Forest Land	Biomass Burning	CO2	-30.07	-0.68	0.00%	0.00031	0.5%	-
111	1A4c	1. Energy	A. Fuel Combustion	4. Other Sectors; Agriculture/Forestry	Liquid Fuels	CH4	1.62	1.38	0.00%	0.00000	0.0%	-
112	1A1	1. Energy	A. Fuel Combustion	1. Energy Industries	Gaseous Fuels	CH4	0.54	1.24	0.00%	0.00000	0.0%	-
113	1A1	1. Energy	A. Fuel Combustion	1. Energy Industries	Biomass	CH4	4.66	1.24	0.00%	0.00002	0.0%	-
114	1A2	1. Energy	A. Fuel Combustion	2. Manufacturing Industries and Construction	Liquid Fuels	CH4	2.42	1.20	0.00%	0.00001	0.0%	-
115	7	7. Other				CH4	0.55	0.58	0.00%	0.00000	0.0%	-
116	1A4c	1. Energy	A. Fuel Combustion	4. Other Sectors; Agriculture/Forestry	Biomass	N2O	0.21	0.35	0.00%	0.00000	0.0%	-
117	1A1	1. Energy	A. Fuel Combustion	1. Energy Industries	Gaseous Fuels	N2O	0.13	0.30	0.00%	0.00000	0.0%	-
118	1A1	1. Energy	A. Fuel Combustion	1. Energy Industries	Liquid Fuels	CH4	0.49	0.78	0.00%	0.00000	0.0%	-
119	2C5	2. Industrial Proc.	C. Metal Production; Non-ferrous metals-CO2			CO2	1.65	1.85	0.00%	0.00000	0.0%	-
120	1A3a	1. Energy	A. Fuel Combustion	3. Transport; Civil Aviation		CH4	0.24	0.27	0.00%	0.00000	0.0%	-
121	2F5	2. Industrial Proc.	F. Consumption of Halocarbons and SF6; Solvents			PFC	0.00	7.88	0.00%	0.00000	0.0%	-
122	1A3d	1. Energy	A. Fuel Combustion	3. Transport; Navigation	Gasoline	CH4	0.58	0.51	0.00%	0.00000	0.0%	-
123	1A4b	1. Energy	A. Fuel Combustion	4. Other Sectors; Residential	Solid Fuels	N2O	0.29	0.18	0.00%	0.00000	0.0%	-
124	1A2	1. Energy	A. Fuel Combustion	2. Manufacturing Industries and Construction	Solid Fuels	CH4	0.57	0.45	0.00%	0.00000	0.0%	-
125	5A1	5. LULUCF	A. Forest Land	1. Forest Land remaining Forest Land		CH4	8.19	0.19	0.00%	0.00010	0.1%	-
126	1A3b	1. Energy	A. Fuel Combustion	3. Transport; Road Transportation	Diesel	CH4	1.36	0.65	0.00%	0.00000	0.0%	-
127	2A7	2. Industrial Proc.	A. Mineral Products; Other non-specified-CO2			CO2	15.12	5.93	0.00%	0.00000	0.0%	-
128	2G	2. Industrial Proc.	G. Other			CO2	1.04	0.96	0.00%	0.00000	0.0%	-
129	5A1	5. LULUCF	A. Forest Land	1. Forest Land remaining Forest Land		N2O	5.30	0.12	0.00%	0.00006	0.1%	-
130	1A3b	1. Energy	A. Fuel Combustion	3. Transport; Road Transportation	Natural Gas	CH4	0.00	0.27	0.00%	0.00000	0.0%	-
131	1A4c	1. Energy	A. Fuel Combustion	4. Other Sectors; Agriculture/Forestry	Biomass	CH4	0.80	0.18	0.00%	0.00000	0.0%	-
132	2F5	2. Industrial Proc.	F. Consumption of Halocarbons and SF6; Solvents			HFC	0.00	2.37	0.00%	0.00000	0.0%	-
133	1A5	1. Energy	A. Fuel Combustion	5. Other	Liquid Fuels	CH4	0.16	0.12	0.00%	0.00000	0.0%	-
134	1A3ei	1. Energy	A. Fuel Combustion	3. Transport; Other non-specified		N2O	0.03	0.03	0.00%	0.00000	0.0%	-
135	1A3b	1. Energy	A. Fuel Combustion	3. Transport; Road Transportation	Biomass	CH4	0.00	0.04	0.00%	0.00000	0.0%	-
136	1A3ei	1. Energy	A. Fuel Combustion	3. Transport; Other non-specified		CH4	0.09	0.04	0.00%	0.00000	0.0%	-
137	1A4c	1. Energy	A. Fuel Combustion	4. Other Sectors; Agriculture/Forestry	Gaseous Fuels	CH4	0.09	0.04	0.00%	0.00000	0.0%	-
138	1A4c	1. Energy	A. Fuel Combustion	4. Other Sectors; Agriculture/Forestry	Gaseous Fuels	N2O	0.02	0.01	0.00%	0.00000	0.0%	-
139	1A3d	1. Energy	A. Fuel Combustion	3. Transport; Navigation	Gas/Diesel Oil	CH4	0.01	0.02	0.00%	0.00000	0.0%	-
140	1A3c	1. Energy	A. Fuel Combustion	3. Transport; Railways	Liquid Fuels	CH4	0.01	0.01	0.00%	0.00000	0.0%	-
141	1A1	1. Energy	A. Fuel Combustion	1. Energy Industries	Solid Fuels	CO2	44.84	0.00	0.00%	-	0.0%	-
142	1A1	1. Energy	A. Fuel Combustion	1. Energy Industries	Solid Fuels	CH4	0.10	0.00	0.00%	-	0.0%	-
143	1A1	1. Energy	A. Fuel Combustion	1. Energy Industries	Solid Fuels	N2O	0.24	0.00	0.00%	-	0.0%	-
144	1A2	1. Energy	A. Fuel Combustion	2. Manufacturing Industries and Construction	Other Fuels	CH4	0.00	0.00	0.00%	-	0.0%	-
145	1A3b	1. Energy	A. Fuel Combustion	3. Transport; Road Transportation	Natural Gas	N2O	0.00	0.00	0.00%	-	0.0%	-
146	1B2	1. Energy	B. Fugitive Emissions from Fuels	2. Oil and Natural Gas		N2O	0.00	0.00	0.00%	-	0.0%	-
147	2C3	2. Industrial Proc.	C. Metal Production; Aluminium Production-CO2			CO2	139.26	0.00	0.00%	-	0.0%	-
148	2C3	2. Industrial Proc.	C. Metal Production; Aluminium Production-PFC			PFC	100.17	0.00	0.00%	-	0.0%	-
149	2F9	2. Industrial Proc.	F. Consumption of Halocarbons and SF6; Other			PFC	0.00	0.00	0.00%	-	0.0%	-
150	6A	6. Waste	A. Solid Waste Disposal on Land			CO2	9.24	0.00	0.00%	-	0.0%	-
151	6D	6. Waste	D. Other			CO2	0.00	0.00	0.00%	-	0.0%	-

Annex 2: Detailed discussion of methodology and data for estimating CO_2 emissions from fossil fuel combustion

A2.1 Carbon Dioxide (CO_2)

Net calorific values and CO_2 emission factors of fuels

The main sources for calculating CO_2 emissions of Switzerland are:

a) net calorific values NCV of the fuels (SFOE 2001, Intertek 2008)

b) CO_2 emission factors of the fuels (SFOE 2001, Intertek 2008)

c) Swiss overall energy statistics 2010 (SFOE 2011).

All parameters of fuels are assumed to be constant for the period 1990 to 2010. The value for natural gas also holds for CNG (compressed natural gas). The NCV originate from SFOE (2001). An extended measurement campaign, commissioned by FOEN and carried out by Intertek (2008) compared measured values with former measurements (EMPA 1999) and showed that the assumption of constant NCV and emission factor is widely fulfilled for fuels sold in Switzerland. The authors write in their report, that only small deviations were found, which are hardly larger than the uncertainties of the measurements. Further measurements in 2011 confirmed that the values do not deviate significantly from the values used (Intertek 2012). Measurements will be repeated periodically and the values will be adjusted if a systematic difference should emerge. The NCV of wood depends on the wood product used as fuel, i.e. wood chips, pellets etc.

Table A - 10 NCV and CO_2 emission factors (EMPA 1999, SFOE 2001, Intertek 2008) of fossil and biofuels. The CO_2 emission factor of fossil fuels is assumed to be constant from 1990 to 2010.

Fuel	Net calorific values (NCV)	CO2 Emission Factors 1990-2010		Data sources
	GJ / t	t CO_2 / TJ	t CO_2 / t	
Diesel Oil	42.8	73.6	3.15	SFOE (2001), Intertek (2008)
Gas Oil	42.6	73.7	3.14	SFOE (2001), Intertek (2008)
Gasoline	42.5	73.9	3.14	SFOE (2001), Intertek (2008)
Lignite	20.1	96.1	2.26	FOEN (2011k)
Bituminous Coal	26.3	92.7	2.36	FOEN (2011k)
Jet Kerosene	43.0	73.2	3.15	SFOE (2001), Intertek (2008)
Natural Gas	46.5	55.0	2.56	SFOE (2001)
Propane/Butane (LPG)	46.0	65.5	---	SFOE (2001)
Residual Fuel Oil	41.2	77.0	3.17	SFOE (2001), Intertek (2008)
	GJ/t	t CO2 / TJ	t CO2 / t	
Biodiesel		73.6		EMIS (2012/1A3b)
Bioethanol		73.9		EMIS (2012/1A3b)
Biogas		55.0		EMIS (2012/1A3b)
Vegetable oil		73.6		EMIS (2012/1A3b)
Wood	11.7-15.3 GJ/t	92.0		EMIS (2012/1A solid fuels/wood) SFOE (2001, 2011b)

A2.2 Sulphur Dioxide (SO2)

Table A - 11 Sulphur content and SO_2 emission factors. For explanations see next page.

year	maximum legal limit of sulphur content					
	Diesel oil	Gasoline	Gas oil	Natural gas	Res. fuel oil	Coal
	ppm	ppm	ppm	ppm	%	%
1990	1400	200	2000	190	1.0	1.0
1991	1300	200	2000	190	1.0	1.0
1992	1200	200	2000	190	1.0	1.0
1993	1000	200	2000	190	1.0	1.0
1994	500	200	2000	190	1.0	1.0
1995	500	200	2000	190	1.0	1.0
1996	500	200	2000	190	1.0	1.0
1997	500	200	2000	190	1.0	1.0
1998	500	200	2000	190	1.0	1.0
1999	500	200	2000	190	1.0	1.0
2000	350	150	2000	190	1.0	1.0
2001	350	150	2000	190	1.0	1.0
2002	350	150	2000	190	1.0	1.0
2003	350	150	2000	190	1.0	1.0
2004	350	150	2000	190	1.0	1.0
2005-2010	50	50	2000	190	1.0	1.0

year	Effective sulphur content					
	Diesel oil	Gasoline	Gas oil	Natural gas	Res. fuel oil	Coal
	ppm	ppm	ppm	ppm	%	%
1990	1400	200	1600	11.6	0.97	0.9
1991	1300	200	1300	11.6	0.89	0.9
1992	1200	200	1200	11.6	0.86	0.9
1993	1000	200	1000	11.6	0.87	0.9
1994	434	200	1350	11.6	0.77	0.9
1995	341	200	1170	11.6	0.78	0.9
1996	372	200	1160	11.6	0.78	0.9
1997	353	200	1250	11.6	0.70	0.9
1998	402	200	926	11.6	0.83	0.9
1999	443	200	650	11.6	0.62	0.9
2000	272	142	680	11.6	0.66	0.9
2001	250	121	830	11.6	0.82	0.9
2002	235	101	798	11.6	0.82	0.9
2003	200	81	700	11.6	0.79	0.9
2004	10.0	8.0	700	11.6	0.76	0.9
2005-2010	10.0	8.0	700	11.6	0.76	0.9

year	Effective SO_2 emission factor					
	Diesel oil	Gasoline	Gas oil	Natural gas	Res. fuel oil	Coal
	kg/TJ					
1990	65.4	9.4	75.1	0.50	473	350
1991	60.7	9.4	61.0	0.50	432	350
1992	56.1	9.4	56.3	0.50	417	350
1993	46.7	9.4	46.9	0.50	422	350
1994	20.3	9.4	63.4	0.50	374	350
1995	15.9	9.4	54.9	0.50	377	350
1996	17.4	9.4	54.5	0.50	379	350
1997	16.5	9.4	58.7	0.50	340	350
1998	18.8	9.4	43.5	0.50	403	350
1999	20.7	9.4	30.5	0.50	301	350
2000	12.7	6.7	31.9	0.50	320	350
2001	11.7	5.7	39.0	0.50	398	350
2002	11.0	4.8	37.5	0.50	398	350
2003	9.3	3.8	32.9	0.50	383	350
2004	0.47	0.38	32.9	0.50	369	350
2005-2010	0.47	0.38	32.9	0.50	369	350

Explanation to Table A - 11

- For liquid and solid fuels the SO_2 emission factors are determined by the sulphur content. The upmost lines in Table A - 11 "maximum legal limit on sulphur content" show the maximum values as defined in the Federal Ordinance on Air Pollution Control OAPC (Swiss Confederation 1985).
- The lines in the middle part of Table A - 11 contain the effective sulphur contents. They are based on measurements: Summary and annual reports of the Swiss Petroleum Association (EV), reports by the Federal Administration of Customs (OZD) since 2000.
- The lines at the bottom part of Table A - 11 give the emission factors in kg/TJ. They are calculated from the sulphur content S, the net calorific value NCV and the quotient of the molar masses of S and SO_2

$$\frac{M_{SO_2}}{M_S}\frac{S}{NCV} = 2\frac{S}{NCV}$$

- Coal: Note that the legal limit of sulphur content depends on the size of the heat capacity of the combustion system. The value shown in the table above (1%, 350 kg/TJ SO_2) holds for heat capacity below 1 MW; see OAPC Annex 4, §513 (Swiss Confederation 1985). For larger capacities the value is 3% (OAPC Annex 5, §2, Swiss Confederation 1985). For industrial combustion plants, the limit for the exhaust emissions actually sets the corresponding maximum sulphur content to 1.4% (500 kg/TJ).
- Residual fuel oil: OAPC Annex 5, §11, lit.2 sets 2.8% for the legal limit. Simultaneously, OAPC dispenses from emission control measurements if residual fuel oil is used with sulphur content of maximum 1% (see OAPC Annex 3, §421, lit. 2, Swiss Confederation 1985), which holds for most combustion plants.

Annex 3: Other detailed methodological descriptions for individual source or sink categories

A3.1 Sector Energy

A3.1.1 Swiss Energy Flow

The diagrams show a summary of the Swiss energy flow 2010 and 1990 as published by the Swiss Federal Office of Energy (SFOE 2011). Diagram languages are German and French.

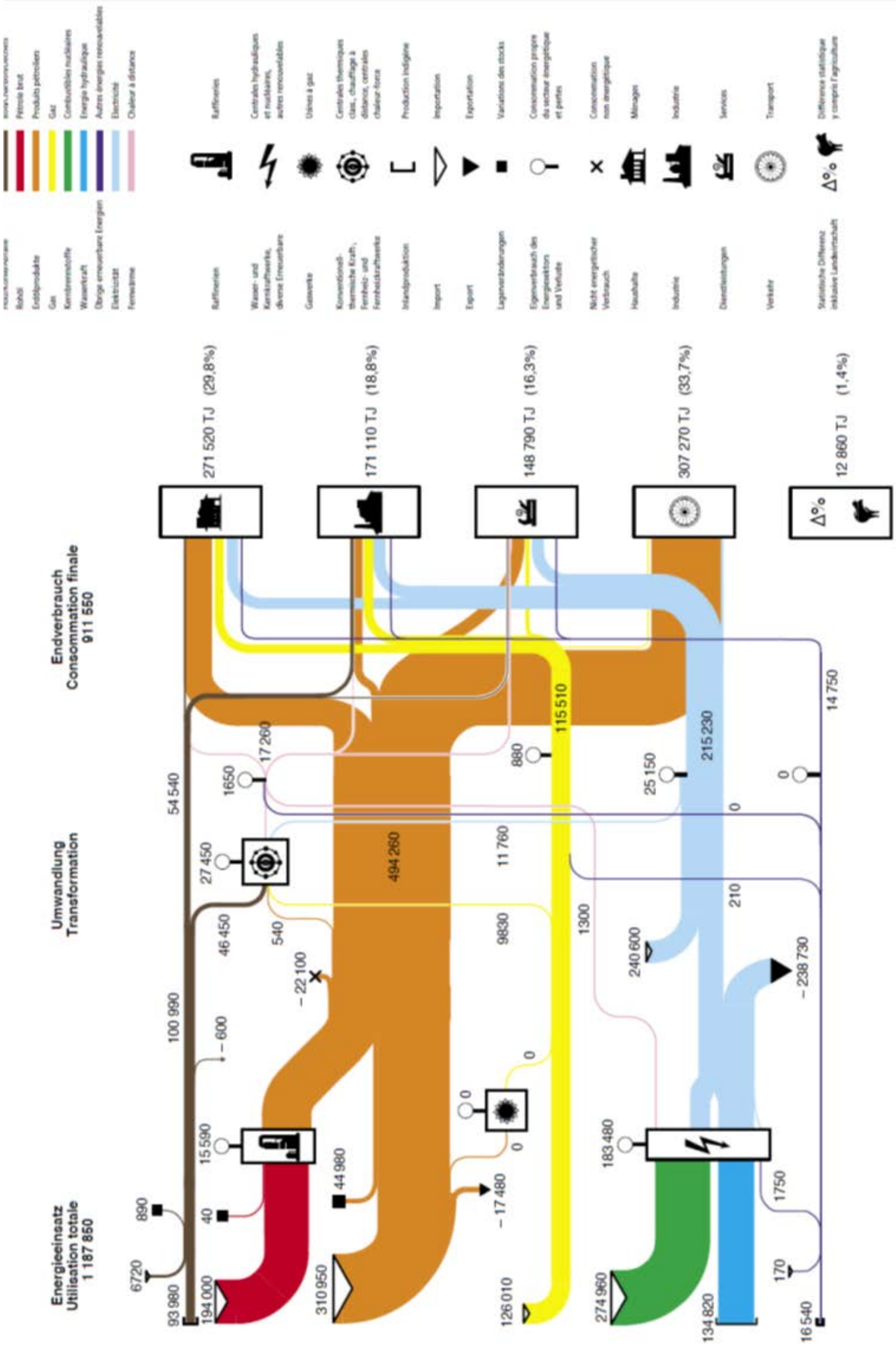


Figure A - 1 Energy flow in Switzerland 2010 (SFOE 2011)

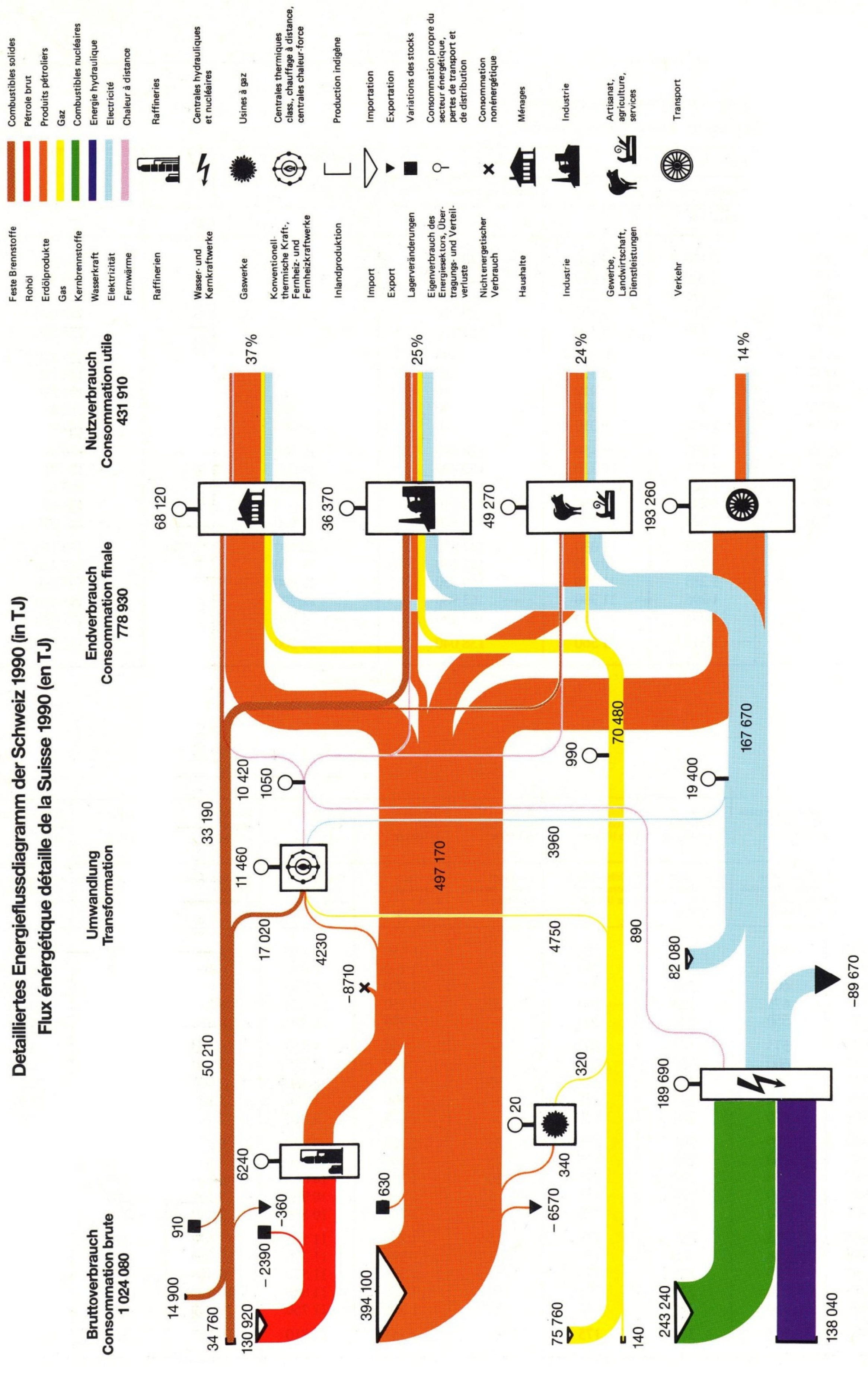


Figure A - 2 Energy flow in Switzerland 1990 (SFOE 1991)

A3.1.2 Emissions from Fuel Consumption: Disaggregation of Fuel Consumption

Swiss overall energy statistics 2010

The consumption of Solid, Liquid, Gaseous and Other Fuels in the Swiss overall energy statistics 2010 (SFOE 2011) are the basis for the calculations of GHG emissions in source category 1A “Energy”. The statistics provide annual aggregated consumption data for different fuels for categories of sources. The categories in the Swiss overall energy statistics are more aggregated than in CRF (e.g. the energy statistics provide data for "industry" as a whole, whereas the CRF differentiate between different industrial activities in source categories 1A2a to 1A2f).

The aggregated data on fuel consumption in the Swiss overall energy statistics are derived from the following sources:

- "Carbura" and Swiss Petroleum Association for data on import, export, sales, stocks of oil products and for processing of crude oil in refineries
- Annual import data for natural gas from Swiss gas industry association
- Annual customs import data for coal
- Measurements and data provided by industry associations

For a first disaggregation of fuel consumption data in the three categories (i) Energy Industries, (ii) industry, services and institutional and (iii) households, estimates based on selected surveys in industry and households, modelling, and expert judgments are used, including

- Survey on consumption of light fuel oil (“Erdöl Panel”); based on the survey, stocks are estimated; however, larger uncertainties about stock changes remain.
- Survey on consumption of natural gas to differentiate the consumption for heat, power and co-generation purposes.
- Survey with suppliers on amount and type of newly installed wood boilers and data on buildings. This data is then fed into a model that provides estimates of annual wood consumption.

Models for fuel consumption in industry and services/institutional

As the Swiss overall energy statistics provide only the sum of the combined fuel consumption in industry, services and institutional sector, SAEFL/FOEN mandated the companies/institutions *Basics* and *CEPE* to model the disaggregation and to estimate consumption in source categories 1A2a-f and 1A4a. In the years from 2000-2008 *Basics* modelled the industry sector while *CEPE* assessed the commercial/institutional sectors. For the submission 2009, the same model of disaggregation has been used as in the previous submissions but the modelling work was conducted by *Prognos* (for industry sector) and *TEP* (for commercial/institutional sectors). For this submission, the same model of disaggregation has been used and the modelling was realized by the companies Prognos and Basics.

Modelling of fuel consumption in Manufacturing Industries and Construction (*Prognos*)

The modelling of fuel consumption in Manufacturing Industries and Construction in Switzerland from 1990 to 2010 by *Prognos* and *Basics* (Prognos/Basics 2011) is based on several long- and short-term bottom-up energy-economic models. Starting from individual industrial processes, the fuel consumption of 16 branches of industry is calculated as the product of activity data (e.g. tons of chocolate produced) and a specific fuel consumption factor (e.g. kWh natural gas per ton of chocolate). The model is adjusted and scaled to fit available energy data and statistics, including the Swiss overall energy statistics, the statistics of the large energy consumers (Energiekonsumenten-Verband EKV; for 1990-1998), data from soundings of Helbling Ltd. (since 1999), data from Cemsuisse for 1990 and

2000 to 2010, industry data from annual reports, fuel supply data from CARBURA for 1985 to 2010, data on full-time-jobs and on industrial production from SFSO, as well as expert estimates.

For the context of the Swiss GHG inventory, the *Basics*-model output provides annual consumption (in TJ) for light fuel oil (gas oil), heavy fuel oil, coal, natural gas, and biomass in the source categories 1A2a to 1A2f:

F_{1A2a}^{Model}, F_{1A2b}^{Model}, F_{1A2c}^{Model}, F_{1A2d}^{Model}, F_{1A2e}^{Model}, F_{1A2f}^{Model}, and total consumption $F_{1A2}^{Model} = \sum_{i=a}^{f} F_{1A2i}^{Model}$.

Modelling of fuel consumption in services/institutional (TEP)

Modelling work at Prognos and Basics (Prognos/Basics 2011) provided the basis to estimate the fuel consumption of the services and institutional sector in Switzerland from 1990 to 2010. The model calculates heat and electricity demand on the basis of heated building area. Seven fuels/heating systems are distinguished: Light fuel oil (gas oil), natural gas, electric heaters, fuel wood, district heating, electric heat pumps, and solar energy. When estimating the specific heat demand for different branches, the following factors are taken into account: changes in the cohort of buildings, changes in the efficiency of heating systems, substitution between fuels (e.g. fuel oil vs. natural gas), as well as changes in the typical behaviour of users.

For the context of the Swiss GHG inventory, the TEP-model output provides annual consumption (in TJ) for light fuel oil, natural gas, and biomass in the source category “Services/Institutional” 1A4a:

F_{1A4a}^{Model} .

Application of model results to disaggregate fuel consumption between industry and services/institutional

With the exception of the year 2004, for which the models have been normalized, the total annual fuel consumption resulting from the two models do not exactly tally with the corresponding actual fuel consumption data in the Swiss overall energy statistics. The model output is used as a proxy to distribute the total consumption from the Swiss overall energy statistics between CRF source categories in the following steps:

1. The Swiss overall energy statistics provide the aggregated fuel consumption in industries (1A2) and in the services/institutional sector (1A4a) in TJ, F_{1A2+4a} .

2. The aggregated fuel consumption in the statistics, F_{1A2+4a} , are distributed proportional to the model outputs between the categories Industries (1A2) and Services/Institutional (1A4a):

(1) $$F_{1A2} = F_{1A2+4a} \cdot \frac{F_{1A2}^{Model}}{F_{1A2}^{Model} + F_{1A4a}^{Model}}$$

(2) $$F_{1A4a} = F_{1A2+4a} \cdot \frac{F_{1A4a}^{Model}}{F_{1A2}^{Model} + F_{1A4a}^{Model}}$$

3. The following equations have been used to disaggregate emissions related to the combustion of light fuel oil, natural gas, biomass, residual fuel oil and coal from Manufacturing Industries based on the outputs of the *Basics*-model:

(3) $$F_{1A2a} = F_{1A2a}^{Model}\ ;\ \ F_{1A2b} = F_{1A2b}^{Model}\ ;\ \ F_{1A2c} = F_{1A2c}^{Model}\ ;\ \ F_{1A2d} = F_{1A2d}^{Model}\ ;\ \ F_{1A2e} = F_{1A2e}^{Model}$$

(4) $$F_{1A2f} = F_{1A2} - \sum_{i=a}^{e} F_{1A2i}^{Model}$$

I.e. source category 1A2f “Other” serves as a buffer to offset inconsistencies between the statistical data and the model outputs. With this, the overall consumption of light fuel oil, residual fuel oil, coal, natural gas, and biomass reported in 1A2 is consistent with the Swiss overall energy statistics.

A3.1.3 Emission from Manufacturing Industries and Construction

The precursors of the emission factors from Table 3-22 in 3.2.7.2 are as follows:

Table A - 12 Precursors of the emission factors from Manufacturing Industries and Construction

1A2 Emission factors mixted between bottom-up and top-down approach (modelling) for Precursors	**NO_x**		**CO**		**NMVOC**		**SO_2**	
	kg/TJ	kg/t	kg/TJ	kg/t	kg/TJ	kg/t	kg/TJ	kg/t
1A2a Iron and Steel								
Iron and Steel		0.075		0.142		0.003		0.020
boilers								
Light fuel oil	33		8		2		2	
Heavy fuel oil (included petrolkoks)	75		9		2		2	
Coal	219		4'045		24		24	
Natural gas	42		3		2		2.0	
1A2b Non-Ferrous Metals								
Aluminium and metal		0.007		2.100		0.420		0.004
boilers								
Light fuel oil	33		263		53		53	
Heavy fuel oil (included petrolkoks)	125		15		4		4	
Natural gas	19		10		2		2.0	
1A2c Chemicals								
Light fuel oil	33		8		2		2	
Heavy fuel oil	115		14		4		4	
Coal	200		100		10		10	
Natural gas	19		10		2		2.0	
1A2d Pulp, Paper and Print								
Light fuel oil	33		8		2		2	
Heavy fuel oil (included petrolkoks)	125		15		4		4	
Natural gas	19		10		2		2.0	
1A2e Food Processing, Beverages and Tobacco								
Light fuel oil	33		8		2		2	
Heavy fuel oil (included petrolkoks)	113		14		4		4	
Coal	200		100		10		10	
Natural gas	19		10		2		2.0	
1A2fi Other								
Light fuel oil	33		8		2		2	
Heavy fuel oil (included petrolkoks)	125		15		4		4	
Coal	200		100		10		10	
Natural gas	22		10		2		2.0	
Biomass	151		308		8		8	
Other fuels (waste incineration in cement industry)	IE		IE		IE		IE	
Fuels, not itemized (fiber construction board, fine ceramics, glass, glass wool, bottle glas, lime, asphalt, rock wool, brick, cement)	603		1096		52		52	
	NO_x		**CO**		**NMVOC**		**SO_2**	
		kg/h		kg/h		kg/h		kg/h
1A2fii Diesel and gasoline for construction and industrial machinery		504		830		86		0.5

A3.1.4 Civil Aviation

This paragraph contains further information to the emission modelling. More complete information will be available in FOCA (2006, 2007, 2008, 2009, 2010, 2011) and on request for reviewers by FOCA.

Emission factors

Table A - 13 Aircraft cruise factors, used for cruise emission calculation (extract of list of 881 aircraft) GKL_ICAO = ICAO seat categories. Mass emissions are given in kilograms or grams per nautical mile (NM).

Aircraft Cruise _Factors						
Aircraft_ ICAO	GKL_ICAO	Cruise_D_Source	kg_fuel_NM	kg_NO_x_NM	g_VOC_NM	g_CO_NM
AA1	0	P002FOCA	0.21	0.0098	1.79	61.7
AA5	0	P002FOCA	0.21	0.0098	1.79	61.7
AC11	0	P002FOCA	0.21	0.0098	1.79	61.7
AC14	0	P002FOCA	0.21	0.0098	1.79	61.7
AC50	0	P001FOCA	0.77	0.021	4.14	364.17
AC68	0	P001FOCA	0.77	0.0075	4.14	364.17
AC6T	1	FOCAINV95-03.2T	1.58	0.021	0.87	2.9
AC90	1	FOCAINV95-03.2T	1.58	0.021	0.87	2.9
AC95	1	FOCAINV95-03.2T	1.58	0.021	0.87	2.9
AEST	0	P001FOCA	0.77	0.021	4.14	364.17
AJET	0	FOCAEDBJ014	2.92	0.0146	8.53	63
ALO2	0	FOCAHeli	1.91	0.024	0.42	2.1
ALO3	0	FOCAHeli	1.91	0.024	0.42	2.1
AN12	0	AN26*2	5.36	0.0062	143	348
AN2	0	FOCA/91/DC3	0.82	0.0002	13.7	1000
AN22	6	FOCAINV95-03.2T*2	3.16	0.042	1.74	5.8
AN24	2	AN26	2.68	0.0031	71.7	174
AN26	1	500	2.68	0.0031	71.7	174
AN72	2	FOCAINV95-03.2J	6.4	0.1	0.83	10
AR7	0	P002FOCA	0.21	0.0098	1.79	61.7
AR7A	0	P002FOCA	0.21	0.0098	1.79	61.7
AS02	0	P002FOCA	0.21	0.0098	1.79	61.7
AS16	0	P002FOCA	0.21	0.0098	1.79	61.7
AS20	0	P002FOCA	0.21	0.0098	1.79	61.7
AS24	0	P002FOCA	0.21	0.0098	1.79	61.7
AS25	0	P002FOCA	0.21	0.0098	1.79	61.7
AS26	0	P002FOCA	0.21	0.0098	1.79	61.7
AS2T	0	FOCAEDBT758	0.95	0.005	1.8	12
AS30	0	FOCAHeli*2	3.82	0.048	0.82	4.2
AS32	1	FOCAHeli*2	3.82	0.048	0.82	4.2
AS33	0	FOCAHeli*2	3.82	0.048	0.82	4.2
AS35	0	FOCAHeli	1.91	0.024	0.42	2.1
AS50	0	FOCAHeli*2	3.82	0.048	0.82	4.2

AS55	0	FOCAHeli*2	3.82	0.048	0.82	4.2
AS65	0	FOCAHeli*2	3.82	0.048	0.82	4.2
ASK1	0	P002FOCA	0.21	0.0098	1.79	61.7
ASTA	0	FOCAINV95-03.B	3.016	0.046	0.3	2.8
ASTR	0	FOCAINV95-03.B	3.016	0.046	0.3	2.8
ASTRA	0	FOCAINV95-03.B	3.016	0.046	0.3	2.8
AT42	1	FOCAINV95-03.2T	1.58	0.021	0.87	2.9
AT43	1	500	1.6	0.013	0	15

Activity data

Table A - 14 LTO-cycle times (minutes). ICAO standard cycle times were originally designed for emissions certification, not for emissions modelling. Today, they do generally not match real world aircraft LTO operations. Swiss FOCA has therefore adjusted some of the ICAO standard cycle times for different aircraft categories. For jets, the mean time for taxi-in and taxi-out at Swiss airports has been determined 20 minutes instead of the standard 26 minutes. For jets, business jets, turboprops, piston engines and helicopters, the times in mode are shown in the table and are based on ICAO, US EPA and Swiss FOCA data "Type" is a classification variable. J = Jet, T = Turboprop, P = Piston, H = Helicopter, B = Business jet, SJ = Supersonic Jet. The number in "Type" stands for the number of engines. For Jet Aircraft, the cycle times and associated thrust settings still lead to an overestimation of LTO emissions (FOCA 2007b).

LTO Cycle				
Type	Time_Take_Off	Time_Climbout	Time_Approach	Zeit_Taxi
1J	0.7	2.2	4	20
1T	0.5	2.5	4.5	13
1P	0.3	2.5	3	12
1H	0	6.5	6.5	7
2B	0.4	0.5	1.6	13
3B	0.4	0.5	1.6	13
2T	0.5	2.5	4.5	13
4T	0.5	2.5	4.5	13
2J	0.7	2.2	4	20
3J	0.7	2.2	4	20
4J	0.7	2.2	4	20
2P	0.3	2.5	3	12
3P	0.3	2.5	3	12
4P	0.3	2.5	3	12
2H	0	6.5	6.5	7
4SJ	1.2	2	2.3	20
3H	0	6.5	6.5	7
4H	0	6.5	6.5	7
4B	0.4	0.5	1.6	13

Table A - 15 Aircraft-Engine Combinations and associated codes for SWISS FOCA emissions database. (Extract from list of more than 26'000 individual aircraft)

Aircraft Engine Combinations							
Engine Name	Aircraft Name	Aircraft Registr.	No. Eng.	Code	Type	Aircr. ICAO	Source
V2527-A5	AIRBUS A320-232	ECHXA	2	J220	2J	A320	1IA003
CF34-3B1	BOMBARDIER CRJ200ER (CL-600-2B19)	ECHXM	2	J090	2J	CRJ2	1GE034
CFM56-3C1	BOEING 737-4K5	ECHXT	2	J022	2J	B734	1CM007
TPE331-11U-611G	FAIRCHILD (SWEARIN-GEN) SA227AC METR	ECHXY	2	T310	2T	SW4	FOI
CFM56-5B4/P	AIRBUS A320-214	ECHYC	2	J067	2J	A320	3CM026
CFM56-5B4/P	AIRBUS A320-214	ECHYD	2	J067	2J	A320	3CM026
CF34-3B1	BOMBARDIER CRJ200ER (CL-600-2B19)	ECHYG	2	J090	2J	CRJ2	1GE034
CFEC-FE738-1-1B	DASSAULT FALCON 2000	ECHYI	2	B130	2B	F2TH	FOI-Ho-neywell
GA TPE331-11U-612G		ECHZH	2	T310	2T	FA3	FOI
CF34-3B1	BOMBARDIER CRJ200ER (CL-600-2B19)	ECHZR	2	J090	2J	CRJ2	1GE034
CFM56-7B27B1	BOEING 737-86Q (WINGLETS)	ECHZS	2	J075	2J	B738	3CM034
CFM56-5B4/P	AIRBUS A320-214	ECHZU	2	J067	2J	A320	3CM026
CF34-3B1	BOMBARDIER CRJ200ER (CL-600-2B19)	ECIAA	2	J090	2J	CRJ2	1GE034
FJ44-1A	CESSNA 525 CITATIONJET	ECIAB	2	B001	2B	C525	FOCA
CFM56-5B4/P	AIRBUS A320-214	ECIAG	2	J067	2J	A320	3CM026
V2527-A5	AIRBUS A320-232	ECIAZ	2	J220	2J	A320	1IA003
BRBR700-710A2-20	BOMBARDIER BD-700-1A10 GLOBAL EX-PRE	ECIBD	2	J854	2J	GLEX	4BR009
PT6A-60A	BEECH-CRAFT KING AIR 350 (RAYTHEON B	ECIBK	2	T738	2T	B350	FOI
CF34-3B1	BOMBARDIER CRJ200ER (CL-600-2B19)	ECIBM	2	J090	2J	CRJ2	1GE034
CFM56-7B27B1	BOEING 737-81Q (WINGLETS)	ECICD	2	J075	2J	B738	3CM034
CFM56-5B4/P	AIRBUS A320-214	ECICK	2	J067	2J	A320	3CM026

Emissions

The output of the FOCA emission modelling consists of tables with the following structure:

Table A - 16 Extract of the output file of FOCA emission and fuel consumption modelling. Upper part: LTO, lower part: cruise (example for 2004). Emissions and fuel consumption in tons.

Airport	Distance	Type Traffic	Move-ments	Type	Aircraft ICAO	Engine Name	Fuel (LTO) tons	Emissions (LTO) in tons					
	Km		No.					CO_2	H_2O	SO_2	NO_x	VOC	CO
LSGG	181501.69	Taxi	165	2B	C550	JT15D-4	5673.492	17871.5	6978.395	5.673	26.04	139	359.2
LSGG	164165.197	Taxi	77	2J	B752	RB211-535E4	47470.5	149532.1	58388.72	47.47	554.91	0	361.47
LSGG	133166.837	Taxi	118	2B	F2TH	CFE738-1-1B	6164.2728	19417.46	7582.056	6.164	87.539	40.59	185.53
LSGG	117228.943	Taxi	99	3B	F900	TFE731-60-1C	5668.542	17855.91	6972.307	5.669	46.937	28.13	163.44
LSGG	114258.902	Taxi	134	2B	LJ45	TFE731-20R	4725.108	14884.09	5811.883	4.725	31.31	53.62	169.01
LSGG	112510.267	Taxi	100	2B	F2TH	CFE738-1-1B	5223.96	16455.47	6425.471	5.224	74.186	34.4	157.23
LSGG	107945.477	Taxi	96	2B	C560	JT15D-5D	3795.3216	11955.26	4668.246	3.795	16.959	271.6	287.98
Airport	Distance km	Type Traffic	Move-ments	Type	Aircraft ICAO	Engine Name	Fuel (cruise) tons	Emissions (cruise) in tons					
LSGG	181501.69	Taxi	165	2B	C550	JT15D-4	307732.68	969357.9	378511.2	307.7	4513	29.43	274.71
LSGG	164165.197	Taxi	77	2J	B752	RB211-535E4	673698.47	2122150	828649.1	673.7	7986.4	647.8	1038.2
LSGG	133166.837	Taxi	118	2B	F2TH	CFE738-1-1B	225781.85	711212.8	277711.7	225.8	3311.2	21.59	201.55
LSGG	117228.943	Taxi	99	3B	F900	TFE731-60-1C	298139.18	939138.4	366711.2	298.1	4372.3	28.52	266.14
LSGG	114258.902	Taxi	134	2B	LJ45	TFE731-20R	193723.81	610230	238280.3	193.7	2841	18.53	172.93
LSGG	106761.289	Taxi	100	2B	F2TH	CFE738-1-1B	181011.75	570187	222644.4	181	2654.6	17.31	161.58
LSGG	103217.159	Taxi	96	2B	C560	JT15D-5D	175002.74	551258.6	215253.4	175	2566.5	16.74	156.22

A3.1.5 Road Transportation

Emission factors

The derivation of the emission factors for road vehicles is described in detail in INFRAS 2010 (this report is available in English). Some important features of the emission factor methodologies are summarised in this paragraph.

The emission factors have to be differentiated according to the vehicle categories. Each category contains a number of vehicle classes, which differ by emission concepts. The next table illustrates the classes of the passenger cars. Similar “segmentations” hold for the other vehicle categories too. Emission factors for vehicle classes are combined to average emission factors for vehicles categories weighted according to the fleet composition, which varies from year to year (see below).

Table A - 17 Vehicle segmentation of the passenger cars. Each segment is subdivided into three cubic capacities: <1.4 litre, 1.4-2.0 litres, > 2.0 litres (INFRAS 2010).

Fuel type	Vehicle segment
Gasoline	<ECE
	AGV82 (CH)
	PreEuro 3WayCat <1987
	PreEuro 3WayCat 1987-90
	ECE-15'00
	ECE-15'01/02
	ECE-15'03
	Euro-1
	Euro-2
	Euro-3
	Euro-4
	Euro-5
	Euro-6
Diesel	<1986
	1986-1988
	Euro-1
	Euro-2
	Euro-3
	Euro-4
	Euro-5 Diesel Particle Filter
	Euro-6 Diesel Particle Filter

The emission factors published in the handbook (CD ROM, INFRAS 2010) are classified by “traffic situations”. The scheme (see Table below) distinguishes the traffic situations along 4 dimensions: urban/rural areas, 5 functional road types, speed limit and 4 levels of service. This leads to the definition of 276 different traffic situations in total. A traffic situation is primarily characterised by the type of road which induces a typical driving behaviour. (Because driving behaviour is not independent of the amount of traffic on that particular road, on the same segment different driving patterns may exist.) For the handbook several typical traffic situations have been defined, based on driving behaviour studies in Germany and in Switzerland (see e.g. SAEFL 1995, Chpt. 4).

Table A - 18 Traffic situation-scheme in HBEFA 3.1. (INFRAS 2010). Every traffic situation is characterised by a typical driving pattern (i.e. a speed-time curve)

			Speed Limit [km/h]											
Area	**Road type**	**Levels of service**	30	40	50	60	70	80	90	100	110	120	130	>130
Rural	**Motorway-Nat.**	**4 levels of service**						■	■	■	■	■	■	■
	Semi-Motorway	**4 levels of service**							■		■			
	TrunkRoad/Primary-Nat.	**4 levels of service**				■	■	■	■	■	■			
	Distributor/Secondary	**4 levels of service**			■	■	■	■	■	■				
	Distributor/Secondary(sinuous)	**4 levels of service**			■	■	■	■	■	■				
	Local/Collector	**4 levels of service**			■	■	■	■						
	Local/Collector(sinuous)	**4 levels of service**			■	■	■	■						
	Access-residential	**4 levels of service**	■	■	■									
Urban	**Motorway-Nat.**	**4 levels of service**						■	■	■	■	■	■	
	Motorway-City	**4 levels of service**				■	■	■	■	■	■			
	TrunkRoad/Primary-Nat.	**4 levels of service**					■	■	■	■	■			
	TrunkRoad/Primary-City	**4 levels of service**			■	■	■	■	■					
	Distributor/Secondary	**4 levels of service**			■	■	■	■						
	Local/Collector	**4 levels of service**			■	■								
	Access-residential	**4 levels of service**	■	■	■									

Traffic situations are defined independently of vehicle categories (LDV, HDV, 2-wheelers). But behind the same traffic situation each vehicle category may know its own “driving pattern” which may be expressed as a speed curve (i.e. speed time series). Emission factors originally are derived for these underlying driving patterns based on measurements performed on laboratory test benches. Emission factors per traffic situation then are calculated by attributing the driving patterns to different traffic situations (based on statistical analysis).

Emission factors for Switzerland are shown in the next table (FOEN 2010i). They represent weighted averages over all traffic situations. The year indicates the date when the corresponding vehicle class appears in the market. E.g. “Euro-3” standard came into force on 1 Jan, 2001, but the first vehicles with Euro-3 standard already appeared in 1999.

Table A - 19 Mean emission factors of passenger cars (PC), light duty vehicles (LDV), heavy duty vehicles (HDV), coaches, urban buses (Bus) and Motorcycles (MC) in grams per kilometre, incl. cold starts and evaporation. (FOEN 2010i). CO_2 (rep.) refers to the fossil part, CO_2 (total) includes fossil and biomass.

Emission	Year	PC	LDV	HDV	Coach	Bus	MC
	grams per vehicle kilometre, incl. cold starts and evaporation						
CH_4	1990	0.084	0.09	0.02	0.017	0.053	0.236
CH_4	1995	0.053	0.065	0.017	0.016	0.046	0.159
CH_4	2000	0.033	0.039	0.013	0.014	0.034	0.12
CH_4	2005	0.02	0.02	0.009	0.011	0.018	0.103
CH_4	2010	0.013	0.01	0.004	0.006	0.007	0.094
CO	1990	10.43	20.16	2.37	2.09	5.99	14.7
CO	1995	5.94	14.6	2.16	2.01	5.68	14.14
CO	2000	3.72	8.86	1.75	1.84	4.64	13.62
CO	2005	2.48	4.39	1.63	1.73	2.92	11.68
CO	2010	1.62	2.27	1.47	1.7	1.48	8.02
CO_2 (rep.)	1990	236	249	809	871	1,194	82
CO_2 (rep.)	1995	236	252	804	860	1,199	90
CO_2 (rep.)	2000	226	254	763	833	1,162	92
CO_2 (rep.)	2005	210	246	800	823	1,127	94
CO_2 (rep.)	2010	189	238	776	812	1,087	97
CO_2 (total)	1990	236	249	809	871	1,194	82
CO_2 (total)	1995	236	252	804	860	1,199	90
CO_2 (total)	2000	226	255	764	834	1,163	92
CO_2 (total)	2005	210	246	803	826	1,131	94
CO_2 (total)	2010	193	242	785	821	1,103	99
VOC	1990	1.69	2.02	0.83	0.7	2.2	3.69
VOC	1995	0.98	1.38	0.73	0.66	1.93	2.65
VOC	2000	0.59	0.77	0.55	0.6	1.42	2.08
VOC	2005	0.36	0.38	0.38	0.47	0.73	1.64
VOC	2010	0.23	0.2	0.18	0.26	0.57	1.16
N_2O	1990	0.009	0.005	0.008	0.008	0.003	0.002
N_2O	1995	0.012	0.007	0.009	0.008	0.003	0.002
N_2O	2000	0.011	0.009	0.009	0.008	0.003	0.002
N_2O	2005	0.005	0.007	0.008	0.007	0.002	0.002
N_2O	2010	0.003	0.006	0.026	0.014	0.001	0.002
NMVOC	1990	1.607	1.93	0.814	0.681	2.151	3.451
NMVOC	1995	0.931	1.32	0.711	0.64	1.88	2.489
NMVOC	2000	0.555	0.735	0.532	0.582	1.383	1.964
NMVOC	2005	0.336	0.362	0.372	0.459	0.714	1.538
NMVOC	2010	0.213	0.194	0.177	0.259	0.265	1.063
NO_x	1990	1.179	2.084	11.274	11.465	16.948	0.147
NO_x	1995	0.865	1.742	10.382	10.824	16.42	0.196
NO_x	2000	0.664	1.534	9.116	9.969	14.999	0.212
NO_x	2005	0.481	1.297	7.615	8.68	12.351	0.222
NO_x	2010	0.345	1.085	5.158	6.642	9.749	0.2
SO_2	1990	0.04	0.093	0.719	0.774	1.061	0.01
SO_2	1995	0.031	0.041	0.174	0.186	0.26	0.011
SO_2	2000	0.022	0.034	0.132	0.144	0.201	0.008
SO_2	2005	0.001	0.001	0.005	0.005	0.007	0
SO_2	2010	0.001	0.001	0.005	0.005	0.007	0.001

Activity Data

Activity data for the emission model are the mileages of the vehicle categories per traffic situation. To that aim, three steps must be carried out.

1. Vehicle turnover: The vehicle fleet is built up for each year accounting for the stock changes. This vehicle turnover is modelled on the basis of new registrations and by applying survival probabilities. Trends in traffic volume per vehicle category, including structural changes (size distributions, shares of diesel vehicles) are then combined to draw the continual substitution of older technologies by new ones altering constantly the fleet composition or mileage by emission concepts in all vehicle categories (see following Figure).

2. The total mileage is calculated by vehicle stock multiplied with the specific mileage per vehicle and annum. The latter data are derived from household surveys and from specific odometer readings during vehicle inspections (ARE 2002).

3. Assignment of the mileage to the traffic situations for all vehicle categories. This step requires the adoption of the traffic model: Each road segment carries its mileage and its traffic, which allows the assignment sought.

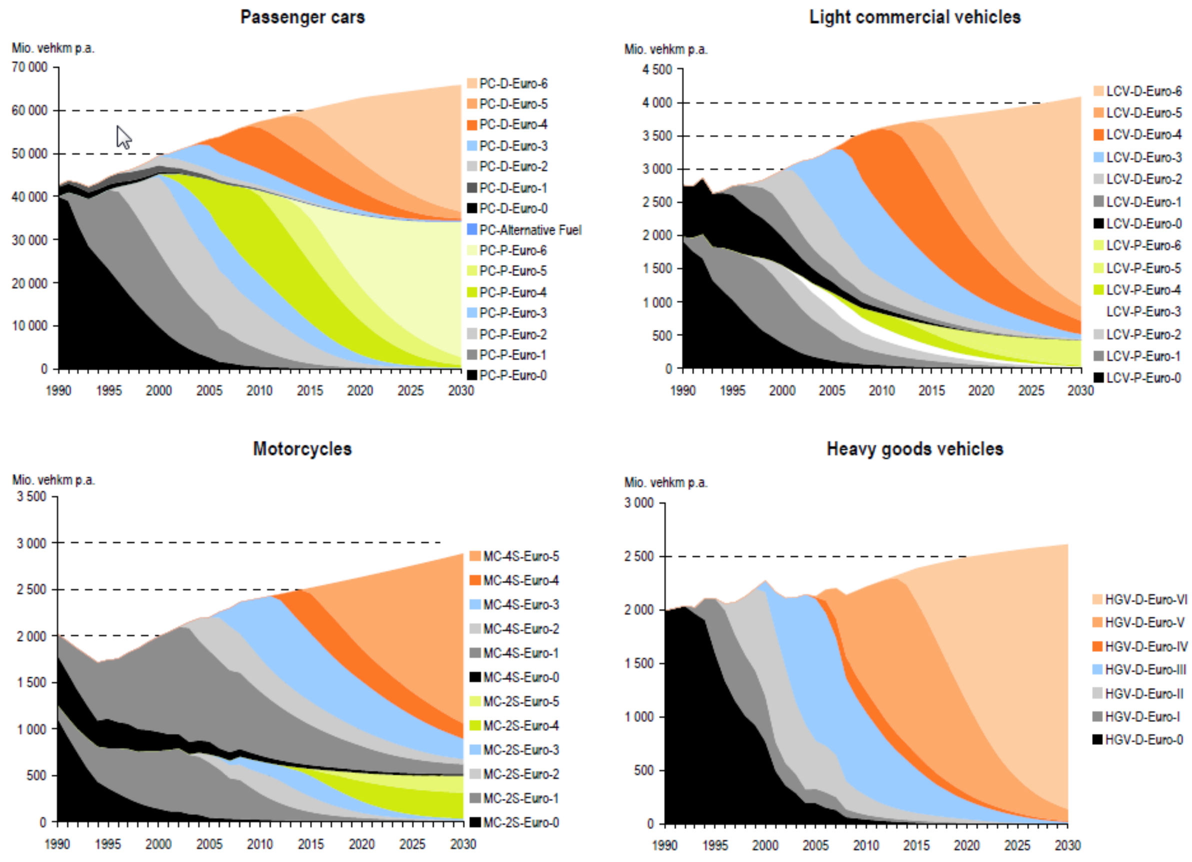


Figure A - 3 Mileage composition by emission concept (in million vehicle kilometres per year), FOEN 2010i.

Modelling hot exhaust emissions

As a next step in the modelling process, the mileage classified by vehicle segments and traffic situations is multiplied with the emission factors resulting in hot exhaust emissions.

The results do not yet contain the emissions from tank tourism. For this purpose a special procedure is carried out (described in section 3.2.2c), providing the fuel consumption of tank tourism. From that, the emissions are calculated by multiplication with mean emission factors.

Cold start and evaporative emissions

The handbook also contains emission factors for modelling cold start excess emissions and evaporative emissions (diurnal and hot/warm soak and running losses). For a technical description the reader may be referred to INFRAS (2010).

Results show that for CO_2 the hot exhaust emissions contribute to 97% of the total. Only 3% stem from cold start excess emissions. For CH_4 however, the picture is much different. Only about 40% of the emission total is hot exhaust. More than 59% are cold start excess emissions, the rest results evaporative emissions. For N_2O, no cold start emissions or evaporative emissions are taken into account due to lack of data.

A3.1.6 Off-road Vehicles

Methodology

The emissions of the whole off-road sector have for submission 2010 undergone a complete revision. The emissions are calculated with a Tier 2 method. Activity data and emission factors have been updated and the results for the emissions have been used for the previous and current inventory. The modelling is carried out in a database that is structured in analogy to the on-road database (INFRAS 2008). For this submission the off-road sector has been split and reallocated from 1A5 to 1A2 or 1A4 with only military offroad remaining in 1A5.

The modelling of the emission and of the fuel consumption are carried out by using the formula

$$E^{g}_{i,j,t,\tau} = N_{i,j,t} \cdot T_{i,j,t} \cdot \omega_{t-\tau} \cdot P_{i,j} \cdot L_{i,j} \cdot \nu_{t-\tau} \cdot \varepsilon^{g}_{i,j,\tau}$$

E: Emission and fuel consumption
N: number of vehicles
T: average operating hours per year
ω: age dependency
P: motor power in kW
L: load factor
ν: degradation factor (due to aging)
ε: emission factor in g/kWh
indices: g: gas (CH_4, N_2O, CO, NO_x, SO_2) and fuel consumption,
i off-road family (railway, navigation etc.),
j size class,
t: year (1980, 1985, 1990, 1995, 2000, … , 2020)
τ: year of construction (note: t - τ = age of vehicle)

Note that the emissions are only calculated in steps of 5 years. Emissions for years in-between like 1991, 1992 etc. are interpolated linearly.

Emission and fuel consumption factors for off-road vehicles

The CO_2 emission factors are derived from fuel type and fuel consumption (see tables below). The emission factors for CH_4 and N_2O are only specified by the fuel type.

Table A - 20 CH_4 (TTM 2006a) and N_2O (TTM 2006b) emission factors used in the off-road model (INFRAS 2008).

Gas	Diesel	Gasoline	
		4-stroke	2-stroke
	mg/kWh		
CH_4	6	500	4000
N_2O	30	50	--

The values differ from default values (IPCC 1996, vol III, tbl 1-7, 1-8, conversion factor used: 1 g/kWh = 278 kg/TJ): For CH_4 IPCC recommends 18 mg/kWh for diesel oil, 72 mg/kWh for gasoline 4-stroke, 210 mg/kWh gasoline 2-stroke. For N_2O IPCC gives 2 mg/kWh (diesel oil and gasoline 4-stroke) and 6 mg/kWh (gasoline 2-stroke).

Table A - 21 Emission and consumption factors for diesel engines (without ships and rail vehicles). PreEU-A etc. indicate emission standards.

Basic emission factors of diesel engines (g/kWh)					
power class	**PreEU-A <1996**	**PreEU-B 1996**	**EU-I 2002/2003**	**EU-II 2003/2004**	**EU-IIIA 2007/2008**
Carbon monoxide (CO)					
<18 kW	6.71	6.71	2.90	2.90	2.90
18-37 kW	6.71	6.71	2.76	2.42	2.06
37-75 kW	4.68	4.68	1.87	1.63	1.39
75-130 kW	3.62	3.62	1.28	1.01	0.86
>130 kW	3.62	3.62	1.04	0.91	0.77
VOC					
<18 kW	2.28	2.28	1.60	1.00	0.59
18-37 kW	2.41	2.41	0.92	0.56	0.37
37-75 kW	1.33	1.33	0.65	0.46	0.33
75-130 kW	0.91	0.91	0.45	0.35	0.28
>130 kW	0.91	0.91	0.43	0.3	0.22
Nitrogen oxides (NOx)					
<18 kW	10.31	8.2	5.95	5.95	5.95
18-37 kW	10.31	8.2	6.34	6.34	6.34
37-75 kW	12.4	9.87	8.95	6.56	3.90
75-130 kW	12.52	9.96	8.44	5.67	3.32
>130 kW	12.52	9.96	8.19	5.66	3.38
Fuel consumption (FC)					
<18 kW	248	248	248	248	248
18-37 kW	248	248	248	248	248
37-75 kW	248	248	248	248	248
75-130 kW	223	223	223	223	223
>130 kW	223	223	223	223	223

Table A - 22 Emission and consumption factors for gasoline 4-stroke engines. PreEU-A etc. indicate emission standards.

Basic emission factors of equipment with 4-stroke gasoline engines (g/kWh).					
power class	**PreEU-A <1995**	**PreEU-B 1995**	**PreEU-C 2000**	**EU-I 2004**	**EU-II 2005/2007**
Carbon monoxide (CO)					
<66 ccm	645	640	620	519	500
66-100 ccm	645	640	600	550	550
100-225 ccm	350	350	350	350	300
>225 ccm	350	350	350	350	350
VOC					
<66 ccm	260	250	150	45	45
66-100 ccm	260	250	150	35	35
100-225 ccm	20	20	20	12	12
>225 ccm	20	20	20	9	8
Nitrogen oxides (NOx)					
<66 ccm	1.5	2	3	5	5
66-100 ccm	1.5	2	3	5	5
100-225 ccm	3.5	3.5	3.5	3.5	3.5
>225 ccm	3.5	3.5	3.5	3.5	3.5
Fuel consumption (FC)					
<66 ccm	678	670	650	640	630
66-100 ccm	678	670	650	640	630
100-225 ccm	460	460	460	460	460
>225 ccm	460	460	460	460	460

Table A - 23 Emission and consumption factors for gasoline 2-stroke engines. PreEU-A etc. indicate emission standards.

Basic emission factors of equipment with 2-stroke gasoline engines (g/kWh)				
gas/fuel consumption	**PreEU-A <1995**	**PreEU-B 1995**	**PreEU-C 2000**	**EU-I 2004**
Carbon monoxide (CO)	645	640	620	600
VOC	260	250	150	100
Nitrogen oxides (NOx)	1.5	2	3	5
Fuel consumption (FC)	678	670	650	640

Table A - 24 Emission and consumption factors for rail vehicles with diesel engines. PreEU etc. indicate emission standards.

Basic emission factors of rail vehivles (g/kWh)				
power class	**PreEU <2000**	**UIC I 2000**	**UIC II 2003**	**EU IIIa 2007/2009**
Carbon monoxide (CO)				
<560 kW	3.1	3	2.5	3.5
>560 kW	4	4	3	3
VOC				
<560 kW	1.3	0.8	0.6	0.4
>560 kW	2.5	1.6	0.8	0.8
Nitrogen oxides (NOx)				
<560 kW	14.3	12	6	3.6
>560 kW	20	15	12	9.5
Fuel consumption (FC)				
<560 kW	285	283	283	283
>560 kW	285	285	283	283

Table A - 25 Emission and consumption factors for ships with diesel engines. PreSAV etc. indicate emission standards.

Basal emission factors of diesel-driven ships (g/kWh)					
power class	**PreSAV <1995**	**SAV I 1995**	**SAV II 1997**	**EU I 2005**	**EU II 2010**
Carbon monoxide (CO)					
<18 kW	5	5	5	2.3	2.3
18-37 kW	5	5	4	1.9	1.9
37-75 kW	5	5	2.2	1.7	2
75-130 kW	5	4.9	1.64	1.7	2
>130 kW	2	2	1.3	1	0.5
Volatile organic compounds (VOC)					
< 100 kW	10	10	10	5	5
>130 kW	5	5	5	5	5
Nitrogen oxides (NOx)					
< 100 kW	15	15	10	9.8	5
>130 kW	15	15	10	6.5	4.5
Fuel consumption (FC)					
<18 kW	400	400	400	400	360
18-37 kW	400	380	380	380	360
37-75 kW	380	350	350	350	350
75-130 kW	400	330	330	330	330
>130 kW	300	300	300	300	300

Table A - 26 Emission and consumption factors for boats with diesel engines. PreSAV etc. indicate emission standards.

Basal emission factors of diesel-driven boats (gkWh)					
power class	PreSAV <1995	SAV I 1995I	EU 1997	PreSAV 2005	SAV II 2010
Carbon monoxide (CO)					
<4.4 kW	5	5	5	2.6	2.6
4.4-7.4 kW	5	5	5	2.3	2.3
7.4-37 kW	5	5	4	1.9	1.9
37-74 kW	5	5	2.2	1.7	2
74-100 kW	5	4.9	1.64	1.7	2
>100 kW	2	2	1.3	1	0.5
Volatile organic compounds (VOC)					
< 100 kW	10	10	10	5	5
>100 kW	5	5	5	5	5
Nitrogen oxides (NOx)					
< 100 kW	15	15	10	9.8	5
>100 kW	15	15	10	6.5	4.5
Fuel consumption (FC)					
<4.4 kW	400	400	400	400	360
4.4-7.4 kW	400	400	400	400	360
7.4-37 kW	400	380	380	380	360
37-74 kW	380	350	350	350	350
74-100 kW	400	330	330	330	330
>100 kW	300	300	300	300	300

Table A - 27 Emission and consumption factors for boats with gasoline engines. PreSAV etc. indicate emission standards.

Basic emission factors of gasoline engine boats (g/kWh)						
power class	2-stroke gasoline engine			4-stroke gasoline engine		
	PreSAV <1997	SAV II 1997	EU 2005	PreSAV <1997	SAV II 1997	EU 2005
Carbon monoxide (CO)						
<4.4 kW	650	300	300	300	162	162
4.4-7.4 kW	650	245	245	245	125	125
7.4-37 kW	650	128	128	256	107	107
37-74 kW				80	29.5	29.5
74-100 kW				64.3	21.9	21.9
>100 kW				120	40	40
VOC						
<4.4 kW	250	20	20	20	12	12
4.4-7.4 kW	250	17	17	17	9.3	9.3
7.4-37 kW	250	9.2	9.2	18.4	8	8
37-74 kW				6.1	2.2	2.2
74-100 kW				4.9	1.64	1.64
>100 kW				8.2	2.6	2.6
Nitrogen oxides (NOx)						
<4.4 kW	2	2	2	15	8	5
4.4-7.4 kW	2	2	2	15	7.6	5
7.4-37 kW	2	2	2	30	12.4	10
37-74 kW				15	5.1	5
74-100 kW				15	5.1	5
>100 kW				30	10	10
Fuel consumption (FC)						
<4.4 kW	700	400	400	400	500	500
4.4-7.4 kW	700	400	400	400	500	500
7.4-37 kW	650	380	380	760	980	940
37-74 kW				350	460	440
74-100 kW				330	450	430
>100 kW				600	840	840

Table A - 28 Emission and consumption factors (FC) for ships with steam engines (gas oil). steam 1 etc. indicate emission standards.

Basic emission factors of steam (gas oil) engine ships (g/kWh)							
pollutant	steam 1 <1950	steam 2 1950	steam 3 1980	steam 4 1990	steam 5 1995	steam 6 2005	steam 7 2005
CO	0.3	0.3	0.3	0.09	0.09	0.09	0.09
HC	0.45	0.45	0.45	0.33	0.33	0.33	0.33
NOx	2.34	2.34	2.34	1.77	1.56	1.26	1.03
PM	0.033	0.024	0.015	0.009	0.006	0.006	0.006
FC	1406	1012	787	703	703	703	703

Activity data off-road vehicles

The activity data are described in detail in INFRAS (2008). Aggregated numbers are shown in the following tables.

Table A - 29 Number of vehicles per off-road family (INFRAS 2008)

Family	1990	1995	2000	2005	2010
	no. of vehicles				
Construction	56'070	52'443	47'995	47'354	45'849
Industry	13'947	18'372	22'748	22'748	22'599
Agriculture	324'567	324'047	337'869	339'948	342'230
Forestry	13'844	13'357	13'055	12'749	11'945
Garden/Hobby	659'828	719'118	779'052	763'881	748'708
Navigation	93'395	89'042	82'674	82'647	82'622
Railway	1'300	1'305	1'255	1'255	1'255
Military	1'340	1'340	1'340	1'340	1'340
Sum	**1'164'291**	**1'219'024**	**1'285'988**	**1'271'922**	**1'256'548**

Table A - 30 Operating hours per vehicle per year and (million) operating hours per off-road family (INFRAS 2008).

Family	1990	1995	2000	2005	2010
	operating hours per veh. per year				
Construction	299	353	383	386	387
Industry	628	648	660	660	660
Agriculture	119	118	112	108	104
Forestry	199	201	203	202	202
Garden/Hobby	22	25	27	27	27
Navigation	40	39	40	40	40
Railway	612	627	616	616	616
Military	51	53	54	52	49

Family	1990	1995	2000	2005	2010
	mio. of operating hours				
Construction	16.70	18.50	18.40	18.30	17.80
Industry	8.80	11.90	15.00	15.00	14.90
Agriculture	38.80	38.20	37.70	36.60	35.50
Forestry	2.80	2.70	2.60	2.60	2.40
Garden/Hobby	14.40	17.70	21.10	20.80	20.50
Navigation	3.70	3.50	3.30	3.30	3.30
Railway	0.80	0.82	0.77	0.77	0.77
Military	0.07	0.07	0.07	0.07	0.07
Sum	**86.00**	**93.40**	**99.00**	**97.40**	**95.20**

Table A - 31 Fuel consumption of several off-road activities in 1'000 t/a (INFRAS 2008).

Fuel	Family	1990	1995	2000	2005	2010
		Fuel consumption in 1000 t/a				
Diesel	Construction	91.1	105.5	112.7	116.9	119.3
Diesel	Industry	33.5	40.6	47.7	48.3	46.6
Diesel	Agriculture	113.8	119.5	124.8	125.8	126.2
Diesel	Forestry	5.6	5.9	6.5	7.6	8.5
Diesel	Navigation	16.5	16.2	17.9	18.4	19.2
Diesel	Railway	9.1	10.3	10.6	11.3	12.0
Diesel	Military	1.1	1.1	1.2	1.1	1.1
Diesel	**Sum**	**270.7**	**299.2**	**321.5**	**329.5**	**332.8**
Gasoline	Construction	3.0	3.1	2.8	2.6	2.4
Gasoline	Industry	1.2	1.7	2.2	2.2	2.1
Gasoline	Agriculture	24.0	22.0	19.8	18.8	18.0
Gasoline	Forestry	3.4	3.2	3.1	2.3	1.9
Gasoline	Garden/Hobby	8.3	10.0	11.5	10.5	9.8
Gasoline	Navigation	16.5	15.4	14.5	14.3	14.3
Gasoline	Military	0.0	0.0	0.0	0.0	0.0
Gasoline	**Sum**	**56.4**	**55.4**	**53.7**	**50.6**	**48.5**
Gas Oil	**Navigation**	**2.6**	**3.3**	**3.5**	**3.8**	**3.8**
CNG	**Industry**	**3.4**	**5.1**	**6.8**	**6.8**	**6.9**

A3.2 Industrial Processes

Illustrative Example of modelling Mobile Air-Conditioning / Cars

Table A - 32 Model structure and assumptions for calculating emissions from mobile air conditioning in cars. The example represents current data for the year 2010 as used for this submission. Some of the basic parameters have changed for the present inventory (e.g. product life is now assumed to be 15 instead of 12 years).

Parameters for Car Air-Conditioning		
Initial charge in kg	1994	0.81
	2002	0.70
	Other years inter-/extrapolated	
All units are imported with refrigerant charged		
Emission factor 1995	Annual loss	8.5%
	Share recharged regularly	6.0%
	Share not recharged	2.5%
Charge at end of life		58%
Disposal emissions	up to 1999	100%
	from 2000	50%
Export of second hand cars		50%
Reuse of recovered refrigerant (estimate value)		80%
Servicing emission factor		10%
Product lifetime		15
Market growth rate		1.0%

Year	**New registered vehicles**	**Vehicles in use**	**Disposed vehicles**	**AC units in new registered cars**			**Stock - AC units in use**		**Disposal**	**Initial charge**
0	(VSAI, EFKO)	(B. f. Statistik)		Portion of vehicles with air-cond. [%]	R134a as refrigerant [%]	AC units with R134	Portion of vehicles with R134a [%]	Units with R134	Units AC with R134	kg / vehicle
1989	335'094	2'895'842		5	0	0	0	0	0	0.85
1990	327'456	2'985'399	237'899	6	0	0	0	0	0	0.84
1991	314'824	3'057'800	242'423	7	10	2'204	0	2'204	0	0.83
1992	296'009	3'091'230	262'579	9	30	7'992	0	10'196	0	0.83
1993	262'814	3'109'524	244'520	14	66	24'284	1	34'480	0	0.82
1994	270'009	3'165'043	214'490	19	90	46'172	3	80'652	0	0.81
1995	272'897	3'229'169	208'771	24	100	65'495	5	146'147	0	0.78
1996	269'529	3'268'073	230'625	38	100	102'421	8	248'568	0	0.77
1997	272'441	3'323'421	217'093	52	100	141'669	12	390'237	0	0.76
1998	297'336	3'383'275	237'482	68	100	202'188	18	592'426	0	0.75
1999	317'985	3'467'275	233'985	75	100	238'489	24	830'914	0	0.73
2000	315'398	3'545'247	237'426	77	100	242'856	30	1'073'771	0	0.72
2001	317'126	3'629'713	232'660	85	100	269'557	37	1'343'328	0	0.71
2002	295'109	3'704'822	220'000	87	100	256'745	43	1'600'073	0	0.70
2003	271'541	3'754'000	222'363	89	100	241'671	49	1'841'744	0	0.70
2004	269'211	3'811'351	211'860	91	100	244'982	55	2'086'726	0	0.70
2005	259'426	3'863'807	206'970	92	100	238'672	60	2'325'398	0	0.70
2006	269'421	3'899'917	233'311	96	100	258'644	66	2'582'409	1'633	0.70
2007	284'674	3'955'787	228'804	96	100	273'287	72	2'849'519	6'178	0.70
2008	288'525	4'030'965	213'347	96	100	276'984	77	3'106'789	19'713	0.70
2009	266'018	4'051'569	245'414	96	100	255'377	82	3'320'201	41'966	0.70
2010	294'239	4'119'370	226'438	96	100	282'469	86	3'548'325	54'345	0.70
2011	297'181	4'160'564	255'988	96	100	285'294	90	3'736'344	97'275	0.70

R 134a	Activity			Emissions				Recharge	Reuse
	Input with vehicles	Stock	Disposed	Stock incl. Recharge	Disposal	Servicing	Total	import in bulk	recovered
	[t]	[t]	[t]	[t]	[t]	[t]	[t]	[t]	[t]
1990	0	0	0.0	0	0.0	0	0	0	0.0
1991	2	2	0.0	0	0.0	0	0	0.06	0.0
1992	7	8	0.0	0	0.0	0	0	0.3	0.0
1993	20	28	0.0	2	0.0	0	2	1.1	0.0
1994	37	65	0.0	4	0.0	0	4	2.8	0.0
1995	51	115	0.0	8	0.0	0	8	5.4	0.0
1996	79	191	0.0	14	0.0	1	14	9.2	0.0
1997	107	294	0.0	23	0.0	2	25	14.6	0.0
1998	151	437	0.0	35	0.0	4	39	21.9	0.0
1999	175	599	0.0	49	0.0	5	54	31.1	0.0
2000	176	757	0.0	65	0.0	8	73	40.7	0.0
2001	192	924	0.0	82	0.0	11	93	50.4	0.0
2002	180	1'072	0.0	100	0.0	15	115	59.9	0.0
2003	169	1'201	0.0	114	0.0	18	132	68.2	0.0
2004	171	1'326	0.0	125	0.0	18	143	75.8	0.0
2005	167	1'444	0.0	137	0.0	19	156	83.1	0.0
2006	181	1'571	0.8	146	0.2	18	164	90.5	0.2
2007	191	1'706	3.0	156	0.7	17	174	98.3	0.6
2008	194	1'839	9.5	168	2.4	17	187	106.4	1.9
2009	179	1'947	19.9	178	5.0	17	199	113.6	4.0
2010	198	2'061	24.8	188	6.2	18	213	120.2	5.0
2011	200	2'168	43.7	199	10.9	19	229	126.9	8.7

A3.3 Agriculture

Additional data for estimating enteric fermentation emission factors for cattle

Table A - 33 Data for estimating enteric fermentation emission factors for cattle. Reference: IPCC 1997c, p 4.31 – 4.33

Data for estimating enteric fermentation emission factors for cattle in Switzerland										
Type	Age[a]	Weight[a] kg	Weight Gain[a] kg/day	Feeding Situation / Further	Milk[b] kg/day	Work hrs/day	Pregnant[a] %	Digestibility of Feed %[d]	CH_4 Conversion[d] %	Em. Factor kg/head/year[e]
Mature Dairy Cattle	NA	650	0		16.1 - 22.5 [c]	0	305 days of lactation	60	6.00	122.29
Mature Non-Dairy Cattle	NA	550	0		8.2	0		60	6.00	80.71
Fattening Calves	0-98 days	60-200	1.43	Rations of unskimmed milk and supplement feed when life weight exceeds 100 kg. Rations are apportioned on two servings per day.	0	0	0	65	0.00	0.00
Pre-Weaned Calves	0-10 month	60-325	1	"Natura beef" production, milk from mother cow and additional feed.	0	0	0	65	6.00	18.03
Breeding Calves	0-4 month	50-120	0.8	Feeding plan for a dismission with 14 to 15 weeks. Milk, feed concentrate (100kg in total), hay (80 kg in total).	0	0	0	65	6.00	26.58
Breeding Cattle (4-12 months)	4-12 month	120-300	0.8	Premature race (Milk-race)	0	0	0	60	6.00	
Breeding Cattle (> 1 year)	12-28/30 month	300-600	0.8	Premature race (Milk-race)	0	0	0	60	6.00	50.79
Fattening Calves (0-4 months)	0-4 month	70-175	0.86	Diet based on milk or milk-powder and feed concentrate, hay and/or silage	0	0	0	65	6.00	40.78
Fattening Cattle (4-12 months)	4-12 month	175-550	1.3	Feeding recommendations for fattening steers, concentrate based	0	0	0	60	6.00	
a data source: RAP 1999 and calculations according to Soliva 2006										
b Milk production in kg/day is calculated by dividing the average annual milk production per head by 305 days (lactation period).										
c data source: Swiss farmers union (SBV 2011).										
d data source: IPCC 1997c and IPCC 2000										
e For better comparability emission factors of young cattle have been converted to kg/head/year although the time span of most of the individual categories is less than 365 days.										

Additional data for estimating manure management CH_4 emission factors

Table A - 34 Data for estimating manure management CH_4 emission factors. Reference: IPCC 1997c, Tables B-1-B-7.

Data for estimating Manure Management CH_4 emission factors in Switzerland							
Type	**Weight kg [a]**	**Digestibility of Feed % [b]**	**Energy Intake MJ/day**	**Feed Intake kg/day**	**% Ash Dry Basis [b]**	**VS kg/head/day**	**B_0 m^3 CH_4/kg VS [b]**
Mature Dairy Cattle	650	60	258-311	15.07 [c]	8	5.15-6.20	0.24
Mature Non-Dairy Cattle	550	60	205.1	10.96 [c]	8	4.09	0.24
Fattening Calves	60 – 200	65	47.6	2.02 [a]	8	0.83	0.17
Pre-Weaned Calves	60 – 325	65	55.7	2.98 [a]	8	0.97	0.17
Breeding Calves	50 – 120	65	26.9	1.5 [a]	8	0.47	0.17
Breeding Cattle (4-12 months)	120 – 300	60	89.2	4.88 [a]	8	1.78	0.17
Breeding Cattle (> 1 year)	300 – 600	60	129.1	7.78 [a]	8	2.57	0.17
Fattening Calves (0-4 months)	70 – 175	65	55.6	3.27 [a]	8	0.97	0.17
Fattening Cattle (4-12 months)	175 – 550	60	124.6	6.82 [a]	8	2.48	0.17
Sheep	Not determined	60	21-24	1.09-1.24 [c]	8	0.40 [b]	0.19
Goats	Not	60	29-35	1.21-1.25 [c]	8	0.28 [b]	0.17
Horses	Not	70	132-175	7.73-7.83 [c]	4	1.72 [b]	0.33
Mules and Asses	Not	70	96-127	Not	4	0.94 [b]	0.33
Swine	Not	75	33-40	Not	2	0.50 [b]	0.45
Poultry	Not	Not	1.1-1.3 [d]	Not	Not	0.10 [b]	0.32
[a] RAP 1999							
[b] IPCC 1997c and IPCC 2000							
[c] FAL/RAC 2001							
[d] based on metabolizable energy (ME)							

Additional data for N_2O emission calculation of agricultural soils

Table A - 35 Additional data for N_2O emission calculation of agricultural soils.

2010	Total crop production Crop(O) and Crop(BF) (kg DM)	Nitrogen incorporated with crop residues F(CR) (t N)	N2O emissions from crop residues (t N2O)	N fixed per kg crop DM (kg N/kg crop)	N fixed (kg N)	N2O emissions from N fixation (t N2O)
1. Cereals						
Wheat	431'375'000	3'214	63.14			
Barley	147'985'000	841	16.53			
Maize	121'975'000	1'022	20.08			
Oats	7'565'000	57	1.11			
Rye	11'645'000	95	1.86			
Other:						
Triticale	49'555'000	583	11.45			
Spelt	13'940'000	125	2.45			
Mix of Fodder Cereals	765'000	4	0.09			
Mix of Bread Cereals	85'000	1	0.01			
2. Pulse						
Dry Beans	765'000	30	0.60	0.0521	39'825	0.78
Peas (Eiweisserbsen)	12'325'000	290	5.70	0.0388	478'500	9.40
Soybeans	2'635'000	109	2.14	0.0672	177'072	3.48
Other:						
Leguminous Vegetables	3'229'461	331	6.51	0.0985	317'978	6.25
3. Tuber and Root						
Potatoes	92'620'000	403	7.91			
Other:						
Fodder Beet	14'550'000	136	2.67			
Sugar Beet	286'452'100	2'704	53.12			
5. Other						
Fruit	45'365'010	181	3.56			
Grass	6'251'473'982	22'266	437.36	0.0051	31'982'853	628.23
Green Corn	101'519'060	46	0.91			
Non-Leguminous Vegetables	68'177'510	1'065	20.93			
Rape	58'140'000	904	17.77			
Renewable Energy Crops	4'941'000	77	1.51			
Silage Corn	597'170'940	375	7.36			
Sunflowers	9'010'000	191	3.75			
Tobacco	1'183'000	31	0.60			
Vine	26'115'600	157	3.08			
Total Non-leguminous	2'090'134'220	12'212	239.88			
Total Leguminous	18'954'461	761	14.94		1'013'375	19.9
Total excluding grass	2'109'088'681	12'973	254.82		1'013'375	19.9
Total including grass	8'360'562'663	35'238	692.18		32'996'228	648.1

Table A - 36 Additional data for N_2O emission calculation of agricultural soils.

2010	Residue/ Crop ratio	Dry matter (dm) fraction of residue	Nitrogen content of residues
1. Cereals			
Wheat	1.25	0.85	0.0060
Barley	1.08	0.85	0.0052
Maize	1.19	0.85	0.0071
Oats	1.27	0.85	0.0059
Rye	1.36	0.85	0.0060
Other :			
Triticale	1.33	0.85	0.0088
Spelt	1.50	0.85	0.0060
Mix of Fodder Cereals	1.08	0.85	0.0052
Mix of Bread Cereals	1.25	0.85	0.0060
2. Pulse			
Dry Beans	1.13	0.85	0.0353
Peas (Eiweisserbsen)	1.00	0.85	0.0235
Soybeans	1.00	0.85	0.0414
Other:			
Leguminous Vegetables	4.62	0.22	0.0182
3. Tuber and Root			
Potatoes	0.48	0.14	0.0143
Other :			
Fodder Beet	0.44	0.15	0.0233
Sugar Beet	0.77	0.15	0.0200
5. Other			
Fruit	NA	0.17	0.0040
Grass	0.26	NA	0.0215
Green Corn	0.05	0.32	0.0091
Non-Leguminous Vegetables	0.40	0.15	0.0521
Rape	1.86	0.85	0.0089
Renewable Energy Crops	1.86	0.85	0.0089
Silage Corn	0.05	0.32	0.0126
Sunflowers	2.00	0.60	0.0150
Tobacco	1.20	NA	0.0217
Vine	NA	0.20	0.0060

Annex 4: CO_2 Reference Approach and comparison with Sectoral Approach, and relevant information on the national energy balance

No supplementary information to the statements given in Chapter 3.2.1 Comparison Sectoral Approach - Reference Approach.

Annex 5: Assessment of completeness and (potential) sources and sinks of greenhouse gas emissions and removals excluded

No supplementary information to the statements given in Chapter 1.8 Completeness Assessment.

Annex 6: Additional information to be considered as part of the NIR submission (where relevant) or other useful reference information

A6.1 Independent verification of the National Swiss Inventory for F-gases

Introduction:

Since 2000 the Swiss Federal Laboratories for Materials Science and Technology (Empa) performs continuous measurements of halogenated greenhouse gases at the high-Alpine site of Jungfraujoch (3580 m asl). These measurements are used for the independent estimation of hydrofluorocarbon (HFC) emissions from Switzerland and neighbouring countries and can serve as a verification tool for their Swiss emissions. For this verification the so-called tracer-ratio method is applied, where HFC pollution events are scaled to concurrent pollution events of carbon monoxide (CO) and then multiplied by the Swiss CO emission inventory. Other methods that rely on atmospheric observations are also being developed at Empa for future usage. Similar approaches are also used for independent verification of greenhouse gas emissions in the United Kingdom (UK MetOffice – using measurements from Mace Head, Ireland) and in Australia (CSIRO – using measurements from Cape Grim, Tasmania).

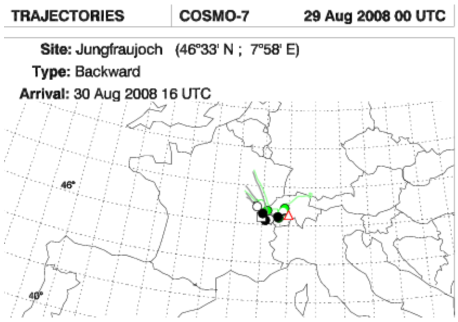
Method description:

For estimates of Swiss emissions of HFCs based on data from Jungfraujoch, only periods are used when the air masses at the high-Alpine station of Jungfraujoch are predominantly influenced by emissions from Switzerland. The number of events which can be used each year depends on the meteorological conditions and is between 7-12 days per year. The process to select these periods is shown in Figure A-4 and shortly described here. First, the trajectories from the COSMO-model from MeteoSwiss are screened for periods when the Jungfraujoch site has been under the influence of air masses which were within the Swiss boundary layer for the last 48 hours. Second, for these periods mixing ratios of HFCs are compared with those of CO. Periods which show a concurrent increase for both groups of compounds are selected for the independent verification of Swiss emissions, as this is taken as an indication of thorough mixing of Swiss emissions during the transport to the measurement site. Third, the emissions are calculated for each case/day using the formula in Figure A-4. The resulting emissions are only used for the annual emission estimate if they are within three standard deviations of the average (Grubbs test). This criterion is met by approximately 90% of the selected data. Finally, annual emissions are estimated as the median from these individual cases. These annual estimates are merged to a 3-year annual average centred over a 3-year period (e.g. the estimate for 2009 emissions is calculated by using data from 2008–2010). The error of the estimates based on data from Jungfraujoch has been assessed to be 20%. An additional absolute error could occur if the Swiss emissions of CO are over/underestimated by the inventory. This would linearly be transmitted to the emissions of the fluorinated greenhouse gases.

Figure A -4 Description of the procedure to estimate annual emissions of HFCs from Switzerland by using continuous measurements of HFCs at Jungfraujoch (Switzerland).

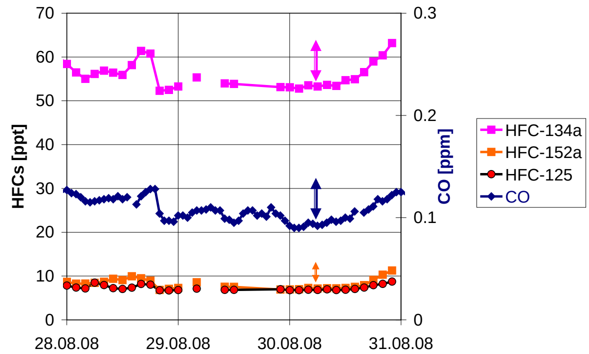
1st step:

Selection of periods with Swiss influence 2 days prior to the measurements by using COSMO trajectories from MeteoSwiss



2nd step:

Confine selected periods by using only periods with concurrent enhancement of CO and HFCs



$$E_H = E_{CO} \times \frac{\Delta H}{\Delta CO}$$

E_H = Swiss emission HFC

E_{CO} = Swiss Emission of CO (in 2010: 249 kt)

ΔH = HFC concentration enhancement

ΔCO = CO concentration enhancement

Swiss-emission estimation:

Median of all cases per year

3-year average

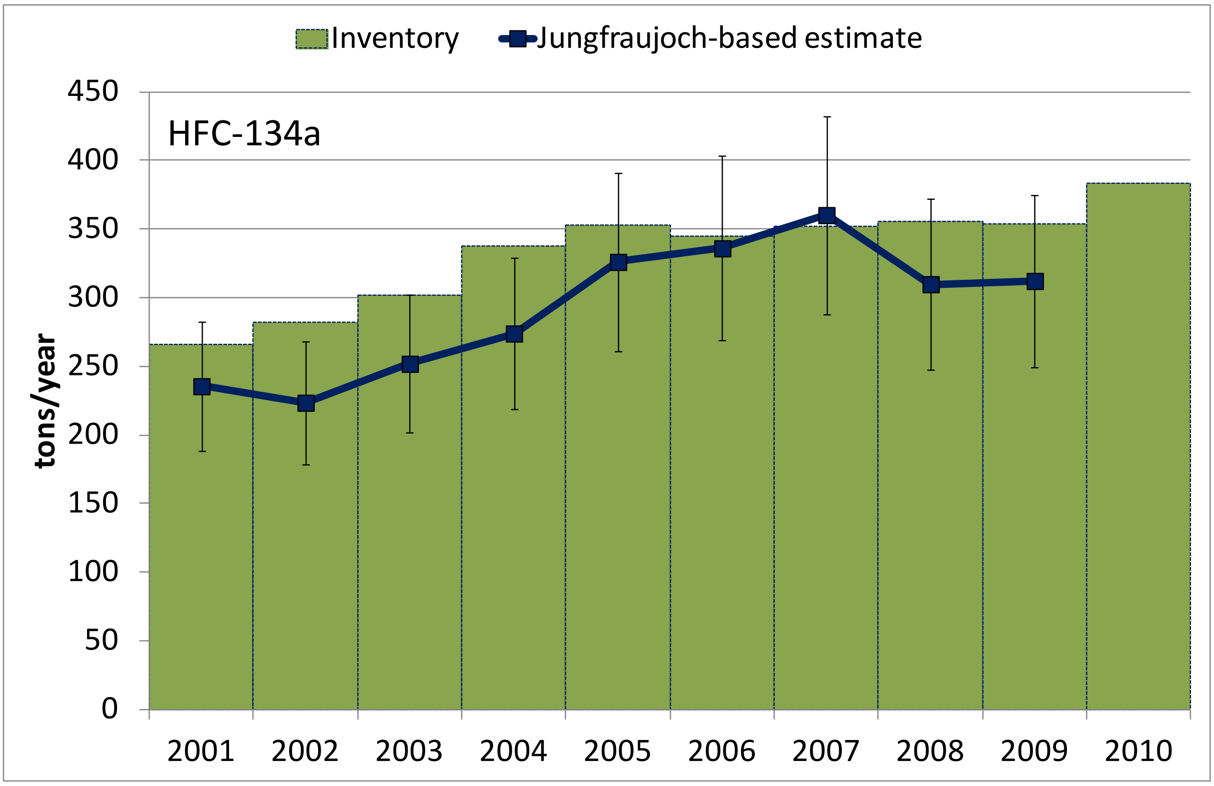
Results and Discussion:

In the following, Swiss emissions of three HFCs (HFC-134a, HFC-125, HFC-152a) estimated based on data from Jungfraujoch are compared to the emission estimate of the Swiss greenhouse gas inventory. Data availability for other HFCs (e.g. HFC-32, 143a and 227ea) and SF_6 is currently still limited as these measurements have been launched at Jungfraujoch only in 2008. However, further emission estimates for other HFC's will be added in future National Inventory Reports (NIR) upon availability.

HFC-134a

HFC-134a is the most important anthropogenic HFC. Its main source is the diffuse emission from its usage as cooling agent in mobile air conditioners (MACs). Estimated emissions based on measurements at Jungfraujoch agree fairly well with the emission estimates of the Swiss greenhouse gas inventory. The emissions according to the inventory are slightly higher than the ones based on measurements. But in recent years, the data agree within the estimated uncertainty of 20%.

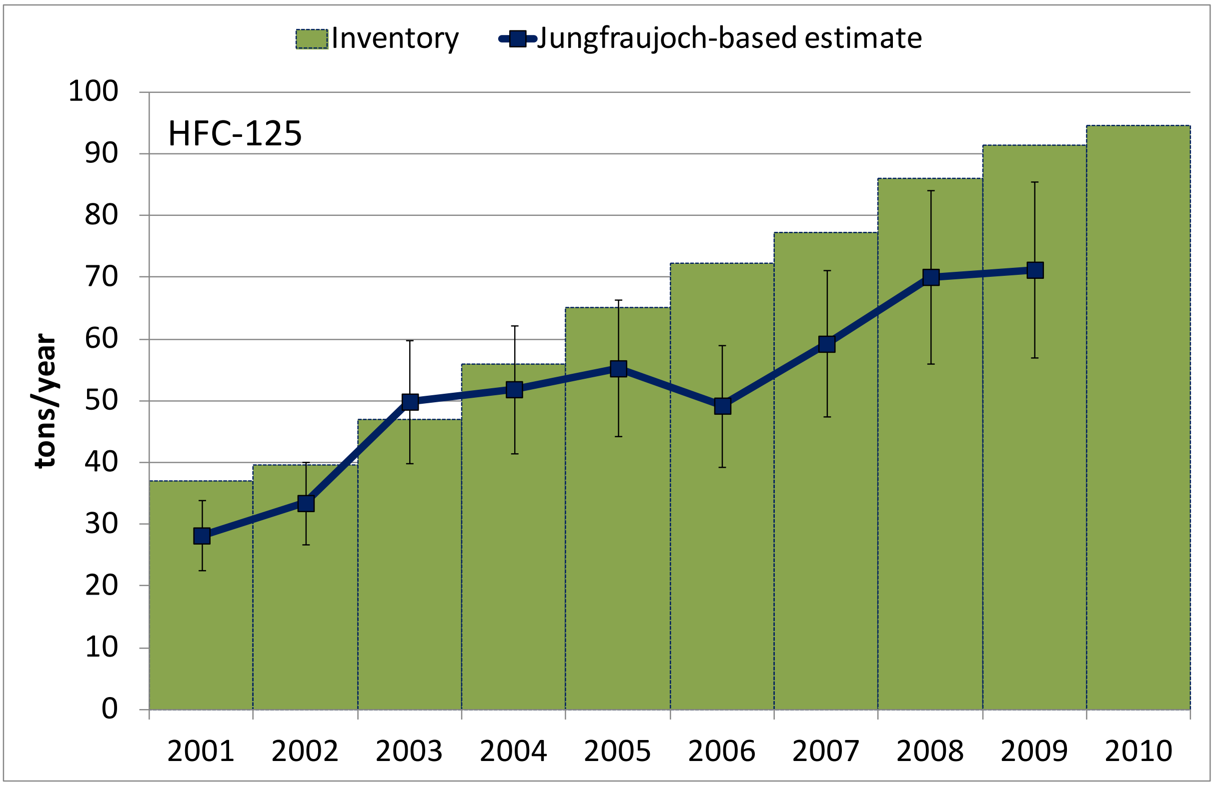
Figure A -5 Comparison of HFC-134a emissions from Switzerland: Inventory and estimates from measurements at Jungfraujoch.



HFC-125

HFC-125 is mainly used as cooling agent in air conditioners. Estimated emissions from Jungfraujoch measurement data are in fairly good agreement with emissions provided by the inventory. However, in recent years, the inventory emissions seem to systematically exceed the estimates based on data from Jungfraujoch.

Figure A -6 Comparison of HFC-125 emissions from Switzerland: Inventory and estimates from measurements at Jungfraujoch.



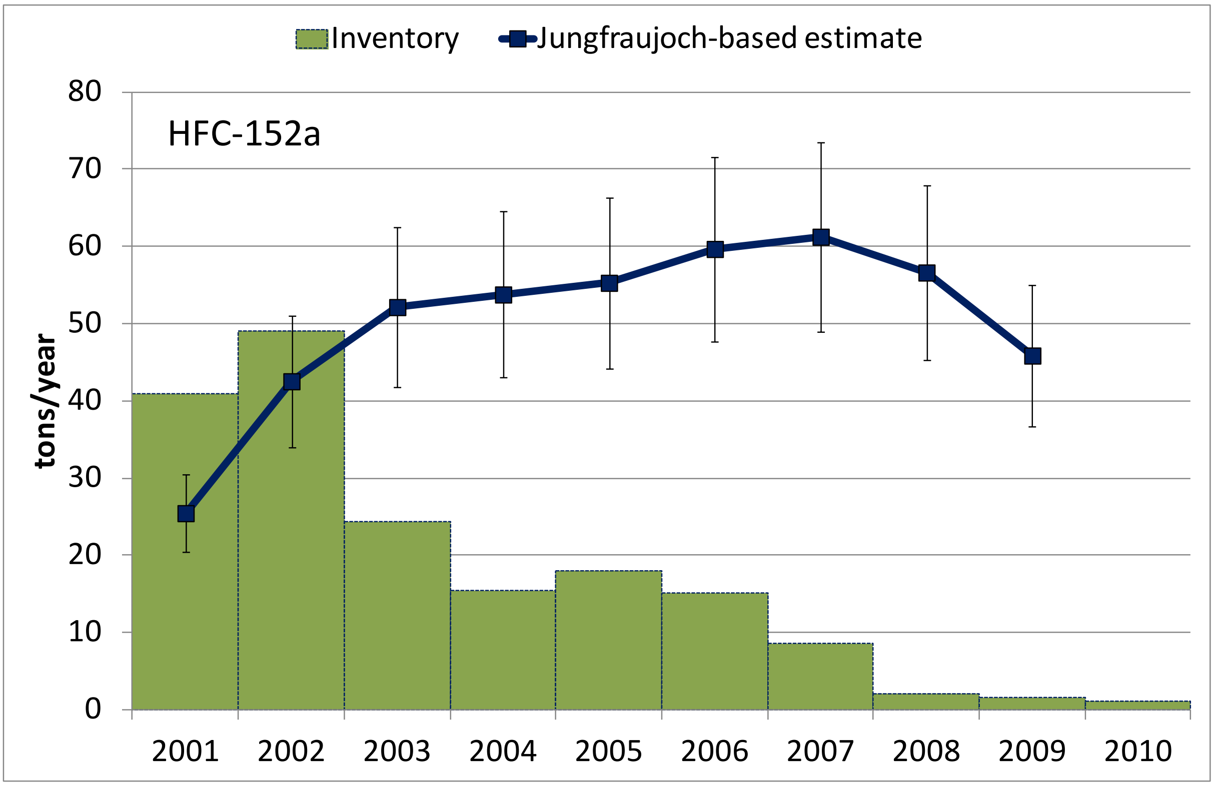
HFC-152a

HFC-152a is mainly used as a blowing agent. It has been used in open-cell polyurethane (PU) foams, in closed cell PU-Sprays and closed-cell extruded polystyrene (XPS) foams. In open cell foams, 100% of emissions are related to the blowing process. In closed cell foams a portion of the blowing agent remains in the product, emissions occur continuously over the lifetime, depending on the cell- and molecular-structure of the blowing agent. Unlike for other blowing agents, experts assume that within the first year of the foam lifetime 95-100% of HFC-152a is emitted. The emissions of the first year are commonly allocated to the country of production (according to UNFCCC good practice guidance). These assumptions and allocation are also applied for the model used in the Swiss inventory for estimating HFC-152a emissions under source category 2F2 Foam Blowing.

HFC-152a emissions from foams in the inventory are mainly related to the production and consumption of PU-Spray. Most of other foam products are imported and consequently these emissions are allocated to the country of origin. The reported decrease in the inventory since 2003 reflects the replacement of HFC-152a in PU-Spray.

Up to the year 2002 estimated emissions from Jungfraujoch measurement data are lower than reported in the inventory and from then onwards they are higher. This can be explained by the UNFCCC practice to allocate HFC-152a emissions of the first year to the country of production of foams (which is except for PU-Spray mainly outside Switzerland). However, in reality a fraction of these first year emissions actually occur during usage of the products (e.g. for insulation) in Switzerland and therefore are reflected in the measurements but are not reflected by definition in the inventory[20].

Figure A -7 Comparison of HFC-152a emissions from Switzerland: Inventory and estimates from measurements at Jungfraujoch.



[20] Nonetheless it is important to apply the UNFCCC approach in the inventory as otherwise double counting may occur when allocating the total emissions to the country of origin and the country of product use.

Annex 7: Supplementary Information on the Uncertainty Analysis

A7.1 Uncertainty Evaluation Tier 1

A quantitative **Tier 1** analysis (following Good Practice Guidance; IPCC 2000: p. 6.13ff) was used to estimate uncertainties in the NIR. First, uncertainties of activity data and emission factors were estimated separately. The combined uncertainty for each source was then calculated using a Rule B approximation (IPCC 2000 p. 6.12). Furthermore, the Rule A approximation was used to arrive at the overall uncertainty in national emissions and the trend in national emissions between the base year and the current year. With the same uncertainty estimates for the different source categories also a Tier 2 uncertainty analysis was conducted.

Uncertainties of activity data and emission factors are derived from a mixture of empirical data and expert judgment. All uncertainties are consistently defined as half the 95% confidence interval.

A7.2 Uncertainty evaluation Tier 2 (Monte Carlo)

A7.2.1 Detailed Source Category data on Monte Carlo Analysis

Table A - 37 Tier 2 trend uncertainty results for sources in Switzerland 1990-2010 including LULUCF (IPCC 2000, Table 6.2). LULUCF uncertainty estimates are shaded, as they are not included in the total (in bold) shown on the last row (excl. LULUCF).

A					B	C	D	E	F	G	H	I	J
IPPC Source Category					Gas	Base year (1990) emissions	Year t emissions	Uncertainty in year t emissions as % of emissions in the category		Uncertainty introduced on national total in year t	% change in emissions between year t and base year	Range of likely % change between year t and base year	
						(Gg CO2 equivalent)	(Gg CO2 equivalent)	% below (2.5 percentile)	% above (97.5 percentile)	(%)	(%)	% below (2.5 percentile)	% above (97.5 percentile)
1A1	1. Energy	A. Fuel Combusti	1. Energy Industries	Biomass	CH4	4.66	1.24	70%	130%	0.001%	-73.5%	-136%	-11%
1A1	1. Energy	A. Fuel Combusti	1. Energy Industries	Biomass	N2O	27.72	48.15	20%	180%	0.144%	73.7%	-84%	227%
1A1	1. Energy	A. Fuel Combusti	1. Energy Industries	Gaseous Fuels	CO2	235.05	540.64	95%	105%	0.102%	130.0%	107%	155%
1A1	1. Energy	A. Fuel Combusti	1. Energy Industries	Gaseous Fuels	CH4	0.54	1.24	70%	130%	0.001%	130.0%	72%	189%
1A1	1. Energy	A. Fuel Combusti	1. Energy Industries	Gaseous Fuels	N2O	0.13	0.30	20%	180%	0.001%	130.0%	-25%	292%
1A1	1. Energy	A. Fuel Combusti	1. Energy Industries	Liquid Fuels	CO2	691.23	965.28	98%	102%	0.081%	39.6%	40%	40%
1A1	1. Energy	A. Fuel Combusti	1. Energy Industries	Liquid Fuels	CH4	0.49	0.78	70%	130%	0.001%	58.6%	-1%	117%
1A1	1. Energy	A. Fuel Combusti	1. Energy Industries	Liquid Fuels	N2O	2.15	3.47	21%	180%	0.010%	61.3%	-111%	228%
1A1	1. Energy	A. Fuel Combusti	1. Energy Industries	Other Fuels	CO2	1'519.73	2'582.10	69%	132%	3.065%	69.9%	70%	70%
1A1	1. Energy	A. Fuel Combusti	1. Energy Industries	Other Fuels	N2O	20.85	47.25	20%	180%	0.142%	126.6%	-19%	292%
1A1	1. Energy	A. Fuel Combusti	1. Energy Industries	Solid Fuels	CO2	44.84	0.00	-	-	0.000%	-100.0%	-100%	-100%
1A1	1. Energy	A. Fuel Combusti	1. Energy Industries	Solid Fuels	CH4	0.10	0.00	-	-	0.000%	-100.0%	-159%	-43%
1A1	1. Energy	A. Fuel Combusti	1. Energy Industries	Solid Fuels	N2O	0.24	0.00	-	-	0.000%	-100.0%	-252%	62%
1A2	1. Energy	A. Fuel Combusti	2. Manufacturing Industries and C	Biomass	CH4	2.46	2.01	70%	130%	0.002%	-18.1%	-83%	44%
1A2	1. Energy	A. Fuel Combusti	2. Manufacturing Industries and C	Biomass	N2O	2.44	10.79	20%	180%	0.032%	342.9%	197%	497%
1A2	1. Energy	A. Fuel Combusti	2. Manufacturing Industries and C	Gaseous Fuels	CO2	1'133.30	2'216.12	95%	105%	0.416%	95.5%	96%	96%
1A2	1. Energy	A. Fuel Combusti	2. Manufacturing Industries and C	Gaseous Fuels	CH4	2.84	5.10	70%	130%	0.006%	79.1%	20%	135%
1A2	1. Energy	A. Fuel Combusti	2. Manufacturing Industries and C	Gaseous Fuels	N2O	0.63	1.24	19%	180%	0.004%	95.5%	-57%	248%
1A2	1. Energy	A. Fuel Combusti	2. Manufacturing Industries and C	Liquid Fuels	CO2	3'876.46	2'890.89	98%	102%	0.244%	-25.4%	-25%	-25%
1A2	1. Energy	A. Fuel Combusti	2. Manufacturing Industries and C	Liquid Fuels	CH4	2.42	1.20	70%	130%	0.001%	-50.5%	-110%	6%
1A2	1. Energy	A. Fuel Combusti	2. Manufacturing Industries and C	Liquid Fuels	N2O	14.96	12.84	19%	181%	0.039%	-14.1%	-168%	142%
1A2	1. Energy	A. Fuel Combusti	2. Manufacturing Industries and C	Other Fuels	CO2	134.24	315.35	69%	132%	0.374%	134.9%	135%	135%
1A2	1. Energy	A. Fuel Combusti	2. Manufacturing Industries and C	Other Fuels	N2O	2.31	5.83	20%	180%	0.017%	152.2%	-1%	318%
1A2	1. Energy	A. Fuel Combusti	2. Manufacturing Industries and C	Other Fuels	CH4	0.00	0.00	-	-	0.000%	-	-	-
1A2	1. Energy	A. Fuel Combusti	2. Manufacturing Industries and C	Other Fuels	CH4	0.00	0.00	-	-	0.000%	-	-	-
1A2	1. Energy	A. Fuel Combusti	2. Manufacturing Industries and C	Solid Fuels	CO2	1'227.96	520.65	85%	116%	0.299%	-57.6%	-58%	-58%
1A2	1. Energy	A. Fuel Combusti	2. Manufacturing Industries and C	Solid Fuels	CH4	0.57	0.45	70%	130%	0.001%	-21.6%	-80%	33%
1A2	1. Energy	A. Fuel Combusti	2. Manufacturing Industries and C	Solid Fuels	N2O	6.57	2.76	20%	181%	0.008%	-57.9%	-207%	100%
1A3a	1. Energy	A. Fuel Combusti	3. Transport; Civil Aviation		CO2	252.55	123.55	98%	102%	0.012%	-51.1%	-51%	-51%
1A3a	1. Energy	A. Fuel Combusti	3. Transport; Civil Aviation		CH4	0.24	0.27	40%	160%	0.001%	10.1%	-113%	126%
1A3a	1. Energy	A. Fuel Combusti	3. Transport; Civil Aviation		N2O	2.46	1.20	21%	188%	0.004%	-51.1%	-366%	240%
1A3b	1. Energy	A. Fuel Combusti	3. Transport; Road Transportatio	Biomass	CH4	0.00	0.04	40%	160%	0.000%	-	-	-
1A3b	1. Energy	A. Fuel Combusti	3. Transport; Road Transportatio	Biomass	N2O	0.00	0.44	21%	188%	0.002%	-	-	-
1A3b	1. Energy	A. Fuel Combusti	3. Transport; Road Transportatio	Diesel	CH4	1.36	0.65	80%	120%	0.000%	-52.6%	-53%	-53%
1A3b	1. Energy	A. Fuel Combusti	3. Transport; Road Transportatio	Diesel	CO2	2'587.68	6'154.63	98%	102%	0.516%	137.8%	138%	138%
1A3b	1. Energy	A. Fuel Combusti	3. Transport; Road Transportatio	Diesel	N2O	5.84	18.10	78%	122%	0.015%	210.1%	210%	210%
1A3b	1. Energy	A. Fuel Combusti	3. Transport; Road Transportatio	Gasoline	CH4	101.15	22.34	63%	137%	0.031%	-77.9%	-78%	-78%
1A3b	1. Energy	A. Fuel Combusti	3. Transport; Road Transportatio	Gasoline	N2O	137.27	111.15	50%	150%	0.209%	-19.0%	-19%	-19%
1A3b	1. Energy	A. Fuel Combusti	3. Transport; Road Transportatio	Gasoline	CO2	11'335.25	9'744.97	97%	103%	0.941%	-14.0%	-14%	-14%
1A3b	1. Energy	A. Fuel Combusti	3. Transport; Road Transportatio	Natural Gas	CH4	0.00	0.27	70%	130%	0.000%	-	-	-
1A3b	1. Energy	A. Fuel Combusti	3. Transport; Road Transportatio	Natural Gas	CO2	0.00	39.05	95%	105%	0.007%	-	-	-
1A3b	1. Energy	A. Fuel Combusti	3. Transport; Road Transportatio	Natural Gas	N2O	0.00	0.00	-	-	0.000%	-	-	-
1A3c	1. Energy	A. Fuel Combusti	3. Transport; Railways	Liquid Fuels	CH4	0.01	0.01	70%	130%	0.000%	28.2%	-28%	88%
1A3c	1. Energy	A. Fuel Combusti	3. Transport; Railways	Liquid Fuels	N2O	0.38	0.49	21%	188%	0.002%	28.6%	-266%	316%
1A3c	1. Energy	A. Fuel Combusti	3. Transport; Railways		CO2	28.69	37.77	98%	102%	0.003%	31.6%	32%	32%
1A3d	1. Energy	A. Fuel Combusti	3. Transport; Navigation	Gas/Diesel Oil	CH4	0.01	0.02	70%	130%	0.000%	2.4%	-55%	53%
1A3d	1. Energy	A. Fuel Combusti	3. Transport; Navigation	Gas/Diesel Oil	N2O	0.64	0.76	21%	188%	0.003%	18.1%	-300%	315%
1A3d	1. Energy	A. Fuel Combusti	3. Transport; Navigation	Gasoline	CH4	0.58	0.51	70%	130%	0.001%	-12.5%	-73%	47%
1A3d	1. Energy	A. Fuel Combusti	3. Transport; Navigation	Gasoline	N2O	0.60	0.53	21%	188%	0.002%	-11.8%	-318%	275%
1A3d	1. Energy	A. Fuel Combusti	3. Transport; Navigation		CO2	111.86	116.98	98%	102%	0.010%	4.6%	5%	5%
1A3ei	1. Energy	A. Fuel Combusti	3. Transport; Other non-specified		CO2	49.01	48.71	95%	105%	0.009%	-0.6%	49%	49%
1A3ei	1. Energy	A. Fuel Combusti	3. Transport; Other non-specified		CH4	0.09	0.04	50%	150%	0.000%	-60.2%	25663%	25663%
1A3ei	1. Energy	A. Fuel Combusti	3. Transport; Other non-specified		N2O	0.03	0.03	20%	180%	0.000%	-0.6%	86924%	86924%
1A4a	1. Energy	A. Fuel Combusti	4. Other Sectors; Commercial/Ins	Biomass	CH4	9.74	5.12	70%	130%	0.006%	-47.4%	-108%	7%
1A4a	1. Energy	A. Fuel Combusti	4. Other Sectors; Commercial/Ins	Biomass	N2O	1.45	3.36	20%	180%	0.010%	131.2%	-39%	284%
1A4a	1. Energy	A. Fuel Combusti	4. Other Sectors; Commercial/Ins	Gaseous Fuels	CO2	905.76	1'409.10	95%	105%	0.264%	55.6%	56%	56%
1A4a	1. Energy	A. Fuel Combusti	4. Other Sectors; Commercial/Ins	Gaseous Fuels	CH4	2.27	3.75	70%	130%	0.004%	65.2%	6%	122%
1A4a	1. Energy	A. Fuel Combusti	4. Other Sectors; Commercial/Ins	Gaseous Fuels	N2O	0.51	0.79	20%	180%	0.002%	55.6%	-101%	216%
1A4a	1. Energy	A. Fuel Combusti	4. Other Sectors; Commercial/Ins	Liquid Fuels	CO2	4'429.39	3'607.89	98%	102%	0.303%	-18.5%	-19%	-19%
1A4a	1. Energy	A. Fuel Combusti	4. Other Sectors; Commercial/Ins	Liquid Fuels	CH4	2.96	1.57	70%	130%	0.002%	-47.1%	-105%	11%
1A4a	1. Energy	A. Fuel Combusti	4. Other Sectors; Commercial/Ins	Liquid Fuels	N2O	11.28	9.25	20%	180%	0.028%	-18.0%	-182%	138%
1A4b	1. Energy	A. Fuel Combusti	4. Other Sectors; Residential	Biomass	CH4	95.89	38.15	39%	166%	0.091%	-60.2%	-60%	-60%
1A4b	1. Energy	A. Fuel Combusti	4. Other Sectors; Residential	Biomass	N2O	10.64	9.82	20%	179%	0.029%	-7.7%	-169%	151%
1A4b	1. Energy	A. Fuel Combusti	4. Other Sectors; Residential	Gaseous Fuels	CO2	1'409.10	2'661.45	95%	105%	0.501%	88.9%	89%	89%
1A4b	1. Energy	A. Fuel Combusti	4. Other Sectors; Residential	Gaseous Fuels	N2O	0.79	1.50	20%	181%	0.005%	88.9%	89%	89%
1A4b	1. Energy	A. Fuel Combusti	4. Other Sectors; Residential	Gaseous Fuels	CH4	3.26	6.26	70%	130%	0.007%	91.6%	92%	92%
1A4b	1. Energy	A. Fuel Combusti	4. Other Sectors; Residential	Liquid Fuels	CH4	6.00	2.63	70%	130%	0.003%	-56.1%	-56%	-56%
1A4b	1. Energy	A. Fuel Combusti	4. Other Sectors; Residential	Liquid Fuels	CO2	10'226.25	8'688.23	98%	102%	0.735%	-15.0%	-15%	-15%
1A4b	1. Energy	A. Fuel Combusti	4. Other Sectors; Residential	Liquid Fuels	N2O	25.94	22.06	20%	180%	0.066%	-15.0%	-15%	-15%
1A4b	1. Energy	A. Fuel Combusti	4. Other Sectors; Residential	Solid Fuels	N2O	0.29	0.18	19%	180%	0.001%	-38.5%	-38%	-38%
1A4b	1. Energy	A. Fuel Combusti	4. Other Sectors; Residential	Solid Fuels	CH4	3.71	2.28	70%	130%	0.003%	-38.5%	-38%	-38%
1A4b	1. Energy	A. Fuel Combusti	4. Other Sectors; Residential	Solid Fuels	CO2	54.59	33.60	85%	116%	0.019%	-38.5%	-38%	-38%
1A4c	1. Energy	A. Fuel Combusti	4. Other Sectors; Agriculture/Fore	Biomass	CH4	0.80	0.18	70%	130%	0.000%	-76.9%	-77%	-77%
1A4c	1. Energy	A. Fuel Combusti	4. Other Sectors; Agriculture/Fore	Biomass	N2O	0.21	0.35	20%	180%	0.001%	64.6%	65%	65%
1A4c	1. Energy	A. Fuel Combusti	4. Other Sectors; Agriculture/Fore	Gaseous Fuels	CH4	0.09	0.04	70%	130%	0.000%	-61.0%	-61%	-61%
1A4c	1. Energy	A. Fuel Combusti	4. Other Sectors; Agriculture/Fore	Gaseous Fuels	CO2	40.64	15.85	95%	105%	0.003%	-61.0%	-61%	-61%
1A4c	1. Energy	A. Fuel Combusti	4. Other Sectors; Agriculture/Fore	Gaseous Fuels	N2O	0.02	0.01	20%	180%	0.000%	-61.0%	-61%	-61%
1A4c	1. Energy	A. Fuel Combusti	4. Other Sectors; Agriculture/Fore	Liquid Fuels	CH4	1.62	1.38	70%	130%	0.002%	-14.9%	-15%	-15%
1A4c	1. Energy	A. Fuel Combusti	4. Other Sectors; Agriculture/Fore	Liquid Fuels	CO2	547.00	519.96	98%	102%	0.044%	-4.9%	-5%	-5%
1A4c	1. Energy	A. Fuel Combusti	4. Other Sectors; Agriculture/Fore	Liquid Fuels	N2O	4.97	5.28	19%	180%	0.016%	6.2%	6%	6%
1A5	1. Energy	A. Fuel Combusti	5. Other	Liquid Fuels	CO2	203.58	119.55	98%	102%	0.010%	-41.3%	-41%	-41%
1A5	1. Energy	A. Fuel Combusti	5. Other	Liquid Fuels	N2O	2.01	1.18	21%	188%	0.004%	-41.2%	-41%	-41%
1A5	1. Energy	A. Fuel Combusti	5. Other	Liquid Fuels	CH4	0.16	0.12	70%	130%	0.000%	-24.4%	-24%	-24%
1B2	1. Energy	B. Fugitive Emissi	2. Oil and Natural Gas		CH4	380.43	173.85	50%	150%	0.325%	-54.3%	-54%	-54%
1B2	1. Energy	B. Fugitive Emissi	2. Oil and Natural Gas		CO2	91.36	74.04	90%	110%	0.028%	-19.0%	-19%	-19%
1B2	1. Energy	B. Fugitive Emissi	2. Oil and Natural Gas		N2O	0.00	0.00	-	-	0.000%	-	-	-

(cont'd)

2A1	2. Industrial Proc.	A. Mineral Products; Cement Production-CO2			CO2	2'524.77	1'928.12	60%	140%	2.888%	-23.6%	-24%	-24%
2A2	2. Industrial Proc.	A. Mineral Products; Lime Production-CO2			CO2	53.35	54.23	98%	102%	0.004%	1.7%	2%	2%
2A3	2. Industrial Proc.	A. Mineral Products; Limestone and Dolomite Use, emissions, CO2			CO2	103.25	72.39	50%	152%	0.139%	-29.9%	-30%	-30%
2A7	2. Industrial Proc.	A. Mineral Products; Other non-specified-CO2			CO2	15.12	5.93	98%	102%	0.000%	-60.8%	-61%	-61%
2B	1. Industrial Proc.	B. Chemical Industry			CH4	9.63	8.39	70%	130%	0.009%	-12.9%	-13%	-13%
2B	2. Industrial Proc.	B. Chemical Industry			N2O	68.13	60.26	59%	141%	0.093%	-11.5%	-12%	-12%
2B	2. Industrial Proc.	B. Chemical Industry			CO2	109.80	121.41	90%	110%	0.046%	10.6%	11%	11%
2C	2. Industrial Proc.	C. Metal Production; Aluminium Foundries			SF6	0.00	4.88	80%	120%	0.004%	-	-	-
2C	2. Industrial Proc.	C. Metal Production; Magnesium Foundries			SF6	0.00	29.66	80%	120%	0.022%	-	-	-
2C1	2. Industrial Proc.	C. Metal Production; Steel Production			CO2	110.80	170.57	60%	141%	0.258%	53.9%	54%	54%
2C3	2. Industrial Proc.	C. Metal Production; Aluminium Production-CO2			CO2	139.26	0.00	-	-	0.000%	-100.0%	-100%	-100%
2C3	2. Industrial Proc.	C. Metal Production; Aluminium Production-PFC			PFC	100.17	0.00	-	-	0.000%	-100.0%	-100%	-100%
2C5	2. Industrial Proc.	C. Metal Production; Non-ferrous metals-CO2			CO2	1.65	1.85	90%	110%	0.001%	12.4%	12%	12%
2F1	2. Industrial Proc.	F. Consumption of Halocarbons and SF6; Refrigeration			PFC	0.04	7.43	88%	112%	0.003%	17378.8%	17379%	17379%
2F1	2. Industrial Proc.	F. Consumption of Halocarbons and SF6; Refrig. & AC Eq.			HFC	0.02	1'011.69	88%	112%	0.455%	4490645%	4490645%	4490645%
2F2	2. Industrial Proc.	F. Consumption of Halocarbons and SF6; Hard Foam			HFC	0.00	13.59	51%	149%	0.025%	-	-	-
2F4	2. Industrial Proc.	F. Consumption of Halocarbons and SF6; Metered Dose Inhalers and			HFC	0.00	14.71	89%	111%	0.006%	-	-	-
2F4	2. Industrial Proc.	F. Consumption of Halocarbons and SF6; Other			PFC	0.00	0.00	-	-	0.000%	-	-	-
2F5	2. Industrial Proc.	F. Consumption of Halocarbons and SF6; Solvents			HFC	0.00	2.37	98%	102%	0.000%	-	-	-
2F5	2. Industrial Proc.	F. Consumption of Halocarbons and SF6; Solvents			PFC	0.00	7.88	98%	102%	0.001%	-	-	-
2F7	2. Industrial Proc.	F. Consumption of Halocarbons and SF6; Semiconductor Manufactur			PFC	0.00	6.63	60%	140%	0.010%	-	-	-
2F7	2. Industrial Proc.	F. Consumption of Halocarbons and SF6; Semiconductor Manufactur			SF6	0.00	6.99	60%	140%	0.010%	-	-	-
2F8	2. Industrial Proc.	F. Consumption of Halocarbons and SF6; Electrical Eq.			SF6	64.04	62.47	90%	110%	0.023%	-2.4%	-2%	-2%
2F9	2. Industrial Proc.	F. Consumption of Halocarbons and SF6; Other			SF6	79.58	51.12	20%	180%	0.154%	-35.8%	-36%	-36%
2F9	2. Industrial Proc.	F. Consumption of Halocarbons and SF6; Other			HFC	0.00	30.62	19%	180%	0.092%	-	-	-
2F9	2. Industrial Proc.	F. Consumption of Halocarbons and SF6; Semiconductor Manufactur			PFC	0.00	14.56	60%	140%	0.022%	-	-	-
2G	2. Industrial Proc.	G. Other			CO2	1.04	0.96	90%	110%	0.000%	-8.1%	-8%	-8%
3	3. Solvent and Other Product Use				CO2	361.92	157.23	50%	150%	0.296%	-56.6%	-57%	-57%
3	3. Solvent and Other Product Use				N2O	110.14	57.33	20%	180%	0.172%	-47.9%	-48%	-48%
4A	4. Agriculture	A. Enteric Fermentation			CH4	2'657.35	2'537.97	82%	118%	1.721%	-4.5%	-4%	-4%
4B	4. Agriculture	B. Manure Management			N2O	453.87	323.52	29%	172%	0.864%	-28.7%	-29%	-29%
4B	4. Agriculture	B. Manure Management			CH4	672.00	645.25	46%	154%	1.298%	-4.0%	-4%	-4%
4D1	4. Agriculture	D. Agricultural Soils; Direct Soil Emissions			N2O	1'364.15	1'189.21	19%	186%	3.735%	-12.8%	-13%	-13%
4D2	4. Agriculture	D. Agricultural Soils; Pasture, Range and Paddock Manure			N2O	128.10	245.40	32%	190%	0.665%	91.6%	92%	92%
4D3	4. Agriculture	D. Agricultural Soils; Indirect Emissions			N2O	820.73	710.51	24%	214%	4.175%	-13.4%	-13%	-13%
4D4	4. Agriculture	D. Agricultural Soils; Use of sewage sludge as fertilizers			N2O	28.19	22.56	19%	181%	0.068%	-20.0%	-20%	-20%
4F	4. Agriculture	F. Field Burning of Agricultural Residues			CH4	10.00	10.00	40%	160%	0.022%	0.0%	0%	0%
4F	4. Agriculture	F. Field Burning of Agricultural Residues			N2O	3.91	3.91	22%	188%	0.014%	0.0%	0%	0%
5A1	*5. LULUCF*	*A. Forest Land*	*1. Forest Land remaining Forest L*	*Biomass Burning*	*CO2*	*30.07*	*0.68*	*39%*	*161%*	*0.002%*	*-97.7%*	*80%*	*80%*
5A1	*5. LULUCF*	*A. Forest Land*	*1. Forest Land remaining Forest Land*		*CH4*	*8.19*	*0.19*	*29%*	*171%*	*0.000%*	*-97.7%*	*-98%*	*-98%*
5A1	*5. LULUCF*	*A. Forest Land*	*1. Forest Land remaining Forest Land*		*N2O*	*5.30*	*0.12*	*29%*	*171%*	*0.000%*	*-97.7%*	*-98%*	*-98%*
5A1	*5. LULUCF*	*A. Forest Land*	*1. Forest Land remaining Forest Land*		*CO2*	*-3'771.35*	*-945.76*	*136%*	*63%*	*1.291%*	*-74.9%*	*-75%*	*-75%*
5A2	*5. LULUCF*	*A. Forest Land*	*2. Land converted to Forest Land*		*CO2*	*-1'306.70*	*-1'205.09*	*143%*	*57%*	*1.943%*	*-7.8%*	*-8%*	*-8%*
5B1	*5. LULUCF*	*B. Cropland*	*1. Cropland remaining Cropland*		*CO2*	*435.28*	*425.31*	*61%*	*139%*	*0.625%*	*-2.3%*	*-2%*	*-2%*
5B2	*5. LULUCF*	*B. Cropland*	*2. Land converted to Cropland*		*CO2*	*47.04*	*27.07*	*49%*	*151%*	*0.051%*	*-42.5%*	*-42%*	*-42%*
5B2	*5. LULUCF*	*B. Cropland*	*2. Land converted to Cropland*		*N2O*	*6.14*	*4.38*	*10%*	*190%*	*0.015%*	*-28.6%*	*-29%*	*-29%*
5C1	*5. LULUCF*	*C. Grassland*	*1. Grassland remaining Grassland*		*CO2*	*146.77*	*163.58*	*49%*	*151%*	*0.311%*	*11.5%*	*11%*	*11%*
5C2	*5. LULUCF*	*C. Grassland*	*2. Land converted to Grassland*		*CO2*	*74.60*	*172.45*	*49%*	*151%*	*0.332%*	*131.2%*	*131%*	*131%*
5D1	*5. LULUCF*	*D. Wetlands*	*1. Wetlands remaining Wetlands*		*CO2*	*-2.79*	*-0.42*	*205%*	*-5%*	*0.002%*	*-84.8%*	*-85%*	*-85%*
5D2	*5. LULUCF*	*D. Wetlands*	*2. Land converted to Wetlands*		*CO2*	*19.81*	*27.69*	*49%*	*151%*	*0.053%*	*39.8%*	*40%*	*40%*
5E1	*5. LULUCF*	*E. Settlements*	*1. Settlements remaining Settlements*		*CO2*	*0.57*	*30.44*	*49%*	*151%*	*0.058%*	*5249.6%*	*5250%*	*5250%*
5E2	*5. LULUCF*	*E. Settlements*	*2. Land converted to Settlements*		*CO2*	*361.84*	*297.07*	*48%*	*151%*	*0.571%*	*-17.9%*	*-18%*	*-18%*
5F2	*5. LULUCF*	*F. Other Land*	*2. Land converted to Other Land*		*CO2*	*97.88*	*121.89*	*48%*	*152%*	*0.235%*	*24.5%*	*25%*	*25%*
6A	6. Waste	A. Solid Waste Disposal on Land			CH4	688.16	198.00	41%	159%	0.435%	-71.2%	3%	3%
6A	6. Waste	A. Solid Waste Disposal on Land			CO2	9.24	0.00	-	-	0.000%	-100.0%	260%	260%
6B	6. Waste	B. Wastewater Handling			N2O	184.72	208.89	60%	140%	0.313%	13.1%	13%	13%
6B	6. Waste	B. Wastewater Handling			CH4	4.65	45.90	70%	130%	0.052%	887.4%	516%	516%
6C	6. Waste	C. Waste Incineration			CO2	54.10	10.68	60%	140%	0.016%	-80.3%	44%	44%
6C	6. Waste	C. Waste Incineration			N2O	16.20	25.90	60%	140%	0.039%	59.9%	148%	148%
6C	6. Waste	C. Waste Incineration			CH4	4.25	2.80	40%	160%	0.006%	-34.0%	565%	565%
6D	6. Waste	D. Other			CH4	27.44	95.23	23%	178%	0.277%	247.1%	88%	88%
6D	6. Waste	D. Other			N2O	5.82	24.15	20%	180%	0.072%	314.9%	412%	412%
6D	6. Waste	D. Other			CO2	0.00	0.00	-	-	0.000%	-	-	-
7	7. Other				CO2	10.96	13.02	60%	140%	0.019%	18.8%	219%	219%
7	7. Other				N2O	16.72	13.63	61%	161%	0.042%	-18.5%	144%	144%
7	7. Other				CH4	0.55	0.58	40%	160%	0.001%	3.7%	4331%	4331%
	Total (excl. LULUCF)				**CO2 eq**	**53'057**	**54'247**	**96.2%**	**104.2%**	**3.967%**	**102.2%**	**-1.2%**	**5.3%**

A7.2.2 Assumptions for probability distribution and correlations

Table A - 38Probability distribution assigned to activity data, emission factors and emissions (1990 and 2010) for the remaining categories, normal probability distributions have been assigned to the emission uncertainties.

IPCC Source Category				**Fuel**	**Gas**	**Probability Distribution**		
						AD	**EF**	**Emission**
1A3a	1. Energy	A. Fuel Combustion	3. Transport; Civil Aviation		N2O	normal	normal	triangle
1A3b	1. Energy	A. Fuel Combustion	3. Transport; Road Transportatio	Biomass	N2O	normal	normal	triangle
1A3c	1. Energy	A. Fuel Combustion	3. Transport; Railways	Liquid Fuels	N2O	normal	normal	triangle
1A3d	1. Energy	A. Fuel Combustion	3. Transport; Navigation	Gas/Diesel Oi	N2O	normal	normal	triangle
1A3d	1. Energy	A. Fuel Combustion	3. Transport; Navigation	Gasoline	N2O	normal	normal	triangle
1A5	1. Energy	A. Fuel Combustion	5. Other	Liquid Fuels	N2O	normal	normal	triangle
4D2	4. Agriculture	D. Agricultural Soils; Pasture, Range and Paddock Manure			N2O	normal	triangle	-
4D3	4. Agriculture	D. Agricultural Soils; Indirect Emissions			N2O	normal	triangle	-
4F	4. Agriculture	F. Field Burning of Agricultural Residues			N2O	normal	normal	triangle
6D	6. Waste	D. Other			CH4	normal	normal	triangle
7	7. Other				N2O	normal	normal	triangle

Table A - 39 Estimated correlation coefficients of activity data (for a better readability, most categories without any correlations have been hidden)

	ADt_1A1Gaseous FuelsCO2 (Monte Carlo T2)	ADt_1A1Liquid FuelsCO2 (Monte Carlo T2)	ADt_1A1Other FuelsCO2 (Monte Carlo T2)	ADt_1A2Gaseous FuelsCO2 (Monte Carlo T2)	ADt_1A2Liquid FuelsCO2 (Monte Carlo T2)	ADt_1A2Other FuelsCO2 (Monte Carlo T2)	ADt_1A3bDieselCO2 (Monte Carlo T2)	ADt_1A4aGaseous FuelsCO2 (Monte Carlo T2)	ADt_1A4aLiquid FuelsCO2 (Monte Carlo T2)	ADt_1A4bGaseous FuelsCO2 (Monte Carlo T2)	ADt_1A4bLiquid FuelsCO2 (Monte Carlo T2)	ADt_1A4cGaseous FuelsCO2 (Monte Carlo T2)	ADt_1A4cLiquid FuelsCO2 (Monte Carlo T2)	ADt_4ACH4 (Monte Carlo T2)	ADt_4BCH4 (Monte Carlo T2)	ADt_4D1N2O (Monte Carlo T2)	ADt_4D2N2O (Monte Carlo T2)	ADt_4D3N2O (Monte Carlo T2)	ADt_4D4N2O (Monte Carlo T2)	EMt_4BN2O (Monte Carlo T2)
ADt_1A1Gaseous FuelsCO2 (Monte Carlo T2)	1.0																			
ADt_1A1Liquid FuelsCO2 (Monte Carlo T2)		1.0																		
ADt_1A1Other FuelsCO2 (Monte Carlo T2)			1.0																	
ADt_1A2Gaseous FuelsCO2 (Monte Carlo T2)	-0.6			1.0																
ADt_1A2Liquid FuelsCO2 (Monte Carlo T2)		-0.6			1.0															
ADt_1A2Other FuelsCO2 (Monte Carlo T2)			-0.4			1.0														
ADt_1A3bDieselCO2 (Monte Carlo T2)		-0.8			-0.8		1.0													
ADt_1A4aGaseous FuelsCO2 (Monte Carlo T2)								1.0												
ADt_1A4aLiquid FuelsCO2 (Monte Carlo T2)							-0.8		1.0											
ADt_1A4bGaseous FuelsCO2 (Monte Carlo T2)								-0.8		1.0										
ADt_1A4bLiquid FuelsCO2 (Monte Carlo T2)							-0.8		-0.8		1.0									
ADt_1A4cGaseous FuelsCO2 (Monte Carlo T2)								-0.8		-0.8		1.0								
ADt_1A4cLiquid FuelsCO2 (Monte Carlo T2)							-0.8		-0.8		-0.8		1.0							
ADt_4ACH4 (Monte Carlo T2)														1.0						
ADt_4BCH4 (Monte Carlo T2)														1.0	1.0					
ADt_4D1N2O (Monte Carlo T2)														0.4	0.4	1.0				
ADt_4D2N2O (Monte Carlo T2)														0.4	0.4		1.0			
ADt_4D3N2O (Monte Carlo T2)														0.4	0.4	1.0		1.0		
ADt_4D4N2O (Monte Carlo T2)														0.4	0.4		0.4	0.4	1.0	
EMt_4BN2O (Monte Carlo T2)														0.4	0.4	0.4	-1.0	0.4		1.0

Additionally the following correlations of 1 (full positive correlation) have been introduced:

- Diesel AD for Road Transportation (1A3b1) for CO_2, CH_4, N_2O
- Gasoline AD for Road Transportation (1A3b1) for CO_2, CH_4, N_2O.

Table A - 40 Estimated correlation coefficients of emission factors (for a better readability, most categories without any correlations are hidden

	EFt_1A1Liquid FuelsCO2 (Monte Carlo T2)	EFt_1A2Liquid FuelsCO2 (Monte Carlo T2)	EFt_1A4aLiquid FuelsCO2 (Monte Carlo T2)	EFt_1A4bLiquid FuelsCO2 (Monte Carlo T2)	EFt_1A4cLiquid FuelsCO2 (Monte Carlo T2)	EFt_1A5Liquid FuelsCO2 (Monte Carlo T2)	EFt_1A1Other FuelsCO2 (Monte Carlo T2)	EFt_1A2Other FuelsCO2 (Monte Carlo T2)	ADt_1A2Solid FuelsCO2 (Monte Carlo T2)	EFt_1A4bSolid FuelsCO2 (Monte Carlo T2)	EMb_1A1BiomassN2O (Monte Carlo T2)	EFt_4D1N2O (Monte Carlo T2)	EFt_4D2N2O (Monte Carlo T2)	EFt_4D3N2O (Monte Carlo T2)	EFt_4D4N2O (Monte Carlo T2)
EFt_1A1Liquid FuelsCO2 (Monte Carlo T2)	1.0														
EFt_1A2Liquid FuelsCO2 (Monte Carlo T2)	0.8	1.0													
EFt_1A4aLiquid FuelsCO2 (Monte Carlo T2)	0.8	0.8	1.0												
EFt_1A4bLiquid FuelsCO2 (Monte Carlo T2)	0.8	0.8	0.8	1.0											
EFt_1A4cLiquid FuelsCO2 (Monte Carlo T2)	0.8	0.8	0.8	0.8	1.0										
EFt_1A5Liquid FuelsCO2 (Monte Carlo T2)	0.8	0.8	0.8	0.8	0.8	1.0									
EFt_1A1Other FuelsCO2 (Monte Carlo T2)							1.0								
EFt_1A2Other FuelsCO2 (Monte Carlo T2)							0.4	1.0							
ADt_1A2Solid FuelsCO2 (Monte Carlo T2)									1.0						
EFt_1A4bSolid FuelsCO2 (Monte Carlo T2)									0.8	1.0					
EMb_1A1BiomassN2O (Monte Carlo T2)											1.0				
EFt_4D1N2O (Monte Carlo T2)												1.0			
EFt_4D2N2O (Monte Carlo T2)												0.4	1.0		
EFt_4D3N2O (Monte Carlo T2)												0.4	0.4	1.0	
EFt_4D4N2O (Monte Carlo T2)															1.0

Additionally the following correlations of 1 (full positive correlation) are introduced:

- CO_2 EF for road transportation (1A3b1) and railways (1A3c1).
- CO_2 EF for gaseous fuels residential (1A4b1), commercial (1A4a1), manufacturing industries (1A21) and forestry (1A4c1).

Table A - 41 Estimated correlation coefficients of emissions (for a better readability, most categories without any correlations have been hidden).

	EMt_7CH4 (Monte Carlo T2)	EMt_7N2O (Monte Carlo T2)
EMt_7CH4 (Monte Carlo T2)	1.0	
EMt_7N2O (Monte Carlo T2)	0.6	1.0

In the modelling of the **trend uncertainty** note that

- the emission factors of each source are positively correlated (r = 0.8) between 1990 and 2010.
- Also, the activity data of each source is positively correlated between 1990 and 2010 (r = 0.4).
- For sources for which no separate emission factor and activity data is available, the emissions between 1990 and 2010 are correlated with r = 0.6.

A7.2.3 Relation between simulated and inventory values

The Monte Carlo simulation simulates a probability distribution for which all relevant statistical parameters are determined: mean, standard deviation and percentiles. The simulated mean value may slightly differ from the reported CRF value. This occurs due to the following reasons:

- Restricted number of simulations (99’999) due to memory overflow of computing hardware
- The use of asymmetric distribution functions may lead to differences between the simulated and the mean value.

Note that it is not a relevant issue for the uncertainty analysis since the relative uncertainties are used for reporting, but it may be confusing for readers and reviewers who carefully study the numbers. For transparency reasons, the numbers are explained in Table A - 42.

The absolute percentiles generated by the simulation are expressed as relative numbers (the simulated mean is set to 100%). The relative numbers hold for the emissions as reported in the CRF tables, and they are applied to derive the absolute uncertainties (see Table A - 42).

Table A - 42 Mean values, 2.5% and 97.5% percentiles of the Monte Carlo simulation and corresponding values of the CRF emissions.

Parameters	Unit	Emission (excl. LULUCF)	Lower bound 2.5 percentile	Upper bound 97.5 percentile	Lower uncertainty	Upper uncertainty
1990						
simulated values						
absolute	Gg CO_2 eq	53'593	51'345	56'018	-2'248	2'425
relative	%	100.00%	95.80%	104.52%	-4.20%	4.52%
values of CRF						
absolute	Gg CO_2 eq	53'057	50'831	55'458	-2'226	2'401
relative	%	100.00%	95.80%	104.52%	-4.20%	4.52%
2010						
simulated values						
absolute	Gg CO_2 eq	54'696	52'628	56'968	-2'069	2'271
relative	%	100.00%	96.22%	104.15%	-3.78%	4.15%
values of CRF						
absolute	Gg CO_2 eq	54'247	52'196	56'500	-2'052	2'253
relative	%	100.00%	96.22%	104.15%	-3.78%	4.15%

Annex 8: Supplementary Information under Article 7, paragraph 1 of the Kyoto Protocol

No supplementary information under this item.