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FEDERAL OFFICE FOR THE ENVIRONMENT FOEN
SWISS GREENHOUSE GAS INVENTORY SUBMISSION 2012

NATIONAL REVIEW OF SECTOR INDUSTRIAL PROCESSES

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ABBREVIATIONS

AD	Activity Data
ChemRRV	Chemikalien Risiko Reduktions Verordnung (Chemical Risk Reduction Ordinance)
COLa	Database regarding companies that are exempt from the CO_2 levy of FOEN
CRF	Common Reporting Format
EF	Emission Factor
EMDET	Emissionen im Detail (EMIS precursor of BUWAL)
EMEP	Air pollutant emission inventory guidebook
EVU	Energy utility (Energieversorgungsunternehmen)
FOEN	Federal Office for the Environment
GHG	Greenhouse gasesNIR National Inventory Report 2012
PU	Polyurethane
Scienceindustries	Association for the chemical, pharmaceutical and biotech industries Switzerland
SGG	Synthetic greenhouse gases
SMKW	Schweizerische Meldestelle für Kälteanlagen und Wärmepumpen
StoV	Stoffverordnung (Ordinance on Environmentally Hazardous Substances)
Swissmem	Swiss Mechanical and Electrical Engineering Industries Association
SwissPRTR	Swiss pollutant release and transfer register of FOEN
XPS	Extruded Polystyrene

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ZUSAMMENFASSUNG

Der Review des Sektors Industrieprozesse gemäss Einteilung Revised 1996 IPCC Guidelines und der prozessbezogenen Treibhausgasemissionen des Schweizer Treibhausgasinventars, Submission 2012 zeigt grundsätzlich korrektes Vorgehen bei der Ermittlung der überprüften Treibhausgasemissionen CO_2, N_2O, CH_4, HFC, PFC und SF_6. Die Resultate der meisten Quellkategorien im Sektor Industrielle Prozessemissionen sind verlässlich. Substantielle Neuberechnungen sind nicht notwendig.

Die Treibhausgasemissionen des Sektors Industrielle Prozesse betragen rund 7% der totalen Schweizer Emissionen (Inventar 2010). Abweichungen von den angewandten Beurteilungskriterien der Revised 1996 IPCC Guidelines und 2006 IPCC Guidelines wurden in zahlreichen Quellkategorien identifiziert. Empfehlungen der Reviewer zur weiteren Verbesserung der Emissionsermittlung umfassen 0.2% der totalen Schweizer Treibhausgasemissionen.

Die Methodik zur Berechnung der Treibhausgasemissionen wurde für jede Quellkategorie des Sektors Industrieprozesse geprüft und wird, mit wenigen Ausnahmen, als geeignet eingestuft. AD und EF sind meist schweizspezifische Werte, welche auf Angaben von Experten und betroffenen Unternehmen fussen. Nur in Ausnahmefällen wurden Literaturwerte und Standardwerte der IPCC Guidelines verwendet.

Einige Industrieprozesse zeigen jedoch Abweichungen von den angewandten Kriterien Vollständigkeit, Methodenwahl, Korrektheit, Konsistenz sowie Transparenz der 2006 IPCC Guidelines und bedürfen einer Verbesserung. Der vorliegende Review zeigt für jeden Prozess das Verbesserungspotenzial auf und priorisiert das Vorgehen unter Berücksichtigung des Ausmasses der jeweiligen Treibhausgasemissionen.

Da im Sektor Industrieprozesse rund 64% der Treibhausgasemissionsäquivalente durch CO_2 und 29% durch HFC hervorgerufen werden, sollten Prozesse, welche insbesondere einen Einfluss auf diese Gase haben, optimiert werden.

Zu den Prozessen mit bedeutenden CO_2- und HFC-Treibhausgasemissionen, welche vordringlich korrigiert bzw. optimiert werden sollten, gehören die Quellkategorien Zementherstellung (2A1) sowie Kältetechnik und Klimaanlagen (2F1) und die Kategorie Andere (2F9).

Einflussreich aufgrund ihrer Emissionswerte sind in der Quellkategorie 2F1 insbesondere die Unterkategorien gewerbliche/industrielle Kälte, stationäre Klimaanlagen und die mobilen Klimaanlagen.

Die im Rahmen des Review zusätzlich auf Vollständigkeit überprüfte Quellkategorie Chemische Industrie (2B) zeigte keine Auslassungen von den in der 1996 IPCC Guidelines aufgeführten Unterkategorien ausser bei Coke. Die 2006 IPCC Guidelines führt jedoch Coke nicht mehr als Kategorie. In Bezug auf die in der 2006 IPCC Guidelines neu aufgeführten Quellkategorien kann die Herstellung von Acrylnitril und Industrieruss (Carbon black) in der Schweiz nicht vollständig ausgeschlossen werden. Für den Prozess Essigsäureherstellung ist es empfehlenswert, die spezifischen Herstellungsbedingungen mit den Produzenten zu klären, da diese für das Auftreten von CH_4-Emissionen bestimmend sind.

Die Einteilung des NIR im Kapitel “Industrial Processes” ist transparent und zweckmässig. Die Beschreibung der Prozesse und die Erläuterungen zu Aktivitätsdaten, Emissionsfaktoren und Unsicherheiten fallen aber teilweise sehr kurz aus (z.B. Quellkategorie 2F) und sind teilweise nicht selbsterklärend. Es wäre für den Leser und zukünftige Reviews hilfreich, im NIR eine umfassendere Beschreibung der einzelnen Quellkategorien und Datengrundlagen vorzufinden.

Die Qualität der EMIS Kommentare ist sehr unterschiedlich. Die Datengrundlage in diesen Dokumenten sollte auch für Aussenstehende nachvollziehbar, vollständig und transparent sein. Der Detaillierungsgrad sollte deshalb angepasst und die Daten gemäss Angaben im vorliegenden Review-Bericht ergänzt werden.

Der Carbotech-Bericht [2] zu PFC, HFC und SF_6-Emissionen stellt ein wichtiges Dokument für die Erklärung der Carbotech Excel-Tabellen [3] mit den Modellierungen dar. Leider werden im Bericht und in

den Excel-Tabellen wichtige Datengrundlagen teilweise separat aufgeführt, sodass nicht beide Dokumente alle Daten enthalten.. Zudem weist der Carbotech-Bericht kaum detaillierte Beschreibungen der Quellkategorien und Datengrundlagen sowie Mängel in der Formatierung auf. Eine Überarbeitung und Ergänzung des Berichtes wäre für die jährliche Bearbeitung des Inventars und für kommende Reviews sinnvoll.

Die Carbotech-Excel-Tabellen weisen wichtige Annahmen zu AD und EF aus und modellieren die Emissionen. Leider sind die in den Excel-Tabellen eingefügten Bemerkungen zur Datenherkunft oder Korrekturen unübersichtlich. Es wird empfohlen, für jede Tabelle ein separates, übersichtliches Datenblatt zu erstellen.

SUMMARY

The review of the Industrial Processes Sector according to the Revised 1996 IPCC Guidelines shows that the process-related greenhouse gas emissions of the Swiss Greenhouse Gas Inventory, Submission 2012 are based on the correct procedure for estimating the CO_2, N_2O, CH_4, HFC, PFC and SF_6 greenhouse gases emitted. The results of the source categories in the industrial processes sector are predominantly reliable. Substantial recalculations are not necessary.

The greenhouse gases from the industrial processes sector are equal to around 7% of all Swiss emissions (2010 inventory). Deviations from the assessment criteria given in the Revised 1996 IPCC Guidelines and 2006 IPCC Guidelines were identified in several source categories. The reviewers' recommendations for further improving how emissions are determined include 0.2% of all Swiss greenhouse gas emissions.

The method used to calculate the greenhouse gas emissions were checked for each source category of the industrial processes sector and, with few exceptions, considered appropriate. AD and EF are mostly Swiss-specific values, based on data from experts and related companies. Only in exceptional cases values from literature and standard values from the IPCC Guidelines were used.

Some industrial processes, however, show deviations from the criteria applied in the 2006 IPCC Guidelines with regard to completeness, choice of methods, correctness, consistency and transparency and need to be improved. This review indicates the potential improvement for each process and prioritises the process in relation to the extent of the greenhouse gas emissions.

Since, in the industrial processes sector, around 64 % of the greenhouse gas equivalents derive from CO_2 and 29% from HFC, the processes, which have a specific influence on these gases, are to be optimised.

The processes with significant CO_2 and HFC greenhouse gas emissions, which ought to be corrected and/or optimised with high priority, include the source categories of cement production (2A1) as well as refrigeration technology and air-conditioning units (2F1) and the category other (2F9).

In source category 2F1, the commercial/industrial refrigeration, stationary air-conditioning and the mobile air-conditioning unit sub-categories are particularly important, as they exert a large influence on total emissions due to their emissions values.

The chemical industry (2B) source category was additionally checked for completeness as part of the review and indicated no omissions from the sub-categories in the 1996 IPCC Guidelines, except for coke. The 2006 IPCC Guidelines, however, no longer included coke as a category. In relation to the source categories described in the 2006 IPCC Guidelines, the production of acryl nytrile and carbon black in Switzerland cannot be completely excluded. With regard to the acetic acid production process, it is recommended that he specific production conditions are to be clarified with manufacturers, since these are determinant factors in the creation of CH_4 emissions.

The breakdown of NIR in the Industrial Processes chapter is transparent and in line with the objectives. The description of the processes and the explanations of the activity data, emission factors and uncertainties are, in parts, very brief (e.g. source category 2F) and sometimes not very clear. It would be helpful for the reader or for future reviews, if there were detailed descriptions of the individual source categories and database in the NIR.

The quality of the EMIS commentaries is very patchy. The underlying data in these documents should be well-documented, complete and transparent to the outsider. The degree of detail should be appropriate and the data be extended in accordance with the details in this review report.

The Carbotech Report [2] on PFC, HFC and SF_6 emissions represents an important document in terms of explaining the Carbotech Excel tables [3] with the emission models. Unfortunately, sometimes in the report and the Excel tables, significant key data are expressed separately. In addition, the Carbotech Report includes few detailed descriptions of the source categories and original data and shows deficiecies in formatting. It would be sensible for the report to be amended for the annual compilation of the inventory and any future reviews.

The Carbotech Excel tables include important assumptions relating to AD and EF and the modelling of emissions. Unfortunately, the comments made in the Excel tables on the origin of the data or corrections are unclear. For each table, it is recommended that a separate, overall datasheet is added.

1. Introduction

Switzerland has signed and ratified both the UN framework convention on climate change and the Kyoto Protocol. A greenhouse gas inventory must be compiled for both these international agreements every year. The inventory is drawn up on the basis of the extensive guidelines of the IPCC.

Based on the UNFCCC reporting guidelines, the revised 1996 IPCC Guidelines are to be used up to and including the inventory year of 2012 (submission of April 2014). Afterwards, according to the latest revision of the UNFCCC reporting guidelines, the 2006 IPCC Guidelines take precedence. However, the 2006 Guidelines may be applied earlier, if the Party confirms that these guidelines satisfy the country-specific requirements better than the 1996 IPCC Guidelines.

The annual inventory includes:

1. a table for each year from 1990 in the Common Reporting Format (CRF) (table 2: industrial processes)
2. the National Inventory Report (NIR) as documentation of the inventory (chapter. 4 “Industrial Processes”).

The data on which the CRF tables and the NIR are based for sector 2 “Industrial Processes” are entered into the so-called EMIS database and calculated. The background data with information on the process, method, values (emission factor and annual output) and data sources are documented in the so-called EMIS commentaries (internal FOEN working documents).

Activity data and emissions on the synthetic greenhouse gases, HFC, PFC and SF_6, are expressed and modelled in separate Excel tables. In an additional report the tracking of the inventory of synthetic gases is documented annually by Carbotech AG (Carbotech Report).

The IPCC guidelines require quality assurance of the inventory. One element of the quality assurance is a so-called national review of the inventory. This report documents the national review of the process emissions in the industrial processes sector.

2. Objectives

Independent experts from CSD Ingenieure AG and Airmes AG, who are not involved in the process of compiling the inventory, even though they are fully aware of the country-specific framework conditions, were mandated for the inventory check. This meant that data and documents were assessed in detail.

The following questions relating to quality criteria were answered by the review:

- Completeness: Are all emissions included?
- Method: Are the methods used adequate and appropriate for Swiss circumstances?
- Correctness: Are the emission calculations correct?
- Consistency: Are the time series consistent throughout the period?
- Transparency: Is the documentation significant and the inventory well-documented?

3. Proceedings

3.1 General proceeding

Sector 2, Industrial processes of the Swiss greenhouse gas inventory was reviewed in accordance with the quality criteria expressed in chapter 2 of this review report. Only the emissions from the greenhouse gases CO_2, N_2O and CH_4 as well as HFC, PFC and SF_6 were taken into consideration. If processes caused biogenic CO_2 emissions, checks were carried out to find if CH_4 and N_2O also leaked.

The basis for the review was the greenhouse gas inventory submission of 15 April 2012. The inventory check was limited to the years 1990 and 2008, 2009 and 2010.

The review is based on the requirements contained in the IPCC guidelines and the guidance documents. The source categories were defined in accordance with the 1996 IPCC Guidelines, with the content assessment taking priority according to the 2006 IPCC Guidelines.

Each source category was assessed according to the 2006 IPCC Guidelines quality criteria using the following approach:

Completeness:

- Does the process exist in Switzerland?
- Are all relevant companies included?
- Is the production quantity correct for the whole of Switzerland or are there any gaps?
- Are all potentially emitted gases included?

Methodology and assumptions:

- Methodology appropriate (Tier 1, 2 and 3) and adjusted to Swiss circumstances?
- Choice of methodology according to IPCC guidelines?
- Origin and investigation method reasonable for AD and EF?
- Are EF plausible?

Verification of calculations:

- Correct and well-documented calculations of AD and EF?
- Spot check of emission values

– Is the estimation of the uncertainties reasonable and in line with IPCC guidelines?

Consistency:

– Were the AD and EF included in the same way/completely for the entire time series?

– Were any gaps bridged?

– Change of data source documented?

Transparency:

Evaluation of…

– Process description

– Method

– AD, EF

– Calculations

– Referencing

3.2 Focal points of review

The first part of the review includes greenhouse gas emissions from industrial processes, not including HFC, PFC and SF_6 in the following categories:

– Mineral products,

– Chemical industry

– Metal production

– Other production

The second part of the review includes the emissions of the synthetic greenhouse gases HFC, PFC, und SF_6 in the Production and Consumption categories of synthetic greenhouse gases.

All relevant emissions in these categories were assessed by checking the underlying sources for AD and EF, as well as by answering the questions in chapter 3.1 of this review report.

All deviations from the assessment criteria, claims and specific recommendations were listed in the respective chapters of the source categories under the heading “Remarks” for the effective improvement of the inventory.

3.3 Underlying information and documents

This review relates to documents that form the basis of the 2010 Inventory, 2012 Submission, namely:

– National Inventory Report (NIR)

– Tables in Common Reporting Format (CRF), Table 2 for industrial processes, years 1990, 2008-2010, submission 2012, v1.6

– EMIS commentaries on the Swiss air pollution database, EMIS, with background data on AD, EF and processes

– Carbotech Report 2012: Swiss Greenhouse Gas Inventory 2010 [2] with background data on AD and EF with regard to HFC, PFC and SF_6 emissions, as well as processes

– Carbotech Excel tables with modelling of HFC, PFC and SF_6 emissions [3].

PART 1: REVIEW OF INDUSTRIAL PROCESS EMISSIONS EXCEPT HFC, PFC, SF_6

4. Mineral products (2A)

4.1 Cement production (2A1)

4.1.1 General observations

Cement production is the main source of process-related CO_2-emissions in Switzerland (2010: 82 %). The emissions originate from the activities of clinker production and other operations (blasting in the quarry). In the past few years two production sites (Rekingen, 1995, and Brunnen, 2008) have been closed down due to overcapacity. Meanwhile most remaining production sites have increased their capacity. While cement consumption due to house, office and industrial building construction is fairly constant, the over-all consumption of cement is regulated by large infrastructure projects (NEAT, highway construction). Currently (2012) the demand for cement has lowered considerably, resulting in planned close-downs for at least one production site for about two months. If infrastructure projects are activated, the production will raise again. Based on this background the prediction of AD for 2020 and 2035 in the EMIS commentaries seems realistic, although the high uncertainty covers the effective variations of production data since 1995.

4.1.2 Completeness

All cement kilns still operated in the country are included in NIR. There are three sites of Holcim, two of Jura Cement and one of Vigier Cement.

The production of clinker as well as cement per year is well known for each site and given precisely by Cemsuisse (the association of all cement producers in Switzerland).

Regarding process emissions, CO_2 from carbonate containing raw material is the only relevant emission known. Methane is emitted due to effects in the production of process energy. N_2O could theoretically also be produced by the DeNOx-Systems using urea. According to the reporting guidelines, these emissions have to be reported in the energy sector (1A2).

Regarding the emissions of CO_2 from blasting the emission factor given in a national publication of 2000 is used (source specified in EMIS-comment 2012/2A1 Zementwerke übriger Betrieb).

The process description is adequate to understand the emission source.

Remark:

In EMIS-comment 2012/2A1 Zementwerke übriger Betrieb a consumption of 0.13 kg explosive/t cement is stated. In NIR this value is wrongly cited with 0.16 kg explosive/t cement.

4.1.3 Methodology and assumptions

The geogenic CO_2 emissions of the calcination process are determined by a tier 2 approach using a country specific emission factor based on the composition of the raw material. The decomposition of $MgCO_3$ is taken into account (1996 and 2006 IPPC Guidelines neglect it). For Swiss plants the cement kiln dust (CDK) correction factor is 1.00.

The choice of methodology is according to 1996 IPCC Guidelines and 2000 IPCC Good Practice Guidance using a tier 2 approach for AD and EF. There is no comment in 2006 IPCC Guidelines which do not seem to cause relevant changes. It is not part of this review to evaluate the changes between 1996 and 2006 IPCC Guidelines.

As all Swiss plants have production data and data of the CaO and MgO content of the clinker at hand, the origin of data is known and data collection is best practice with minimal uncertainties. Until 2007 data were furnished by cemsuisse, later on the data provided by cemsuisse were directly extracted from COLa.

The EF was kept constant at 0.525 t/t clinker up to 2004 (average given by cemsuisse). From 2005 to 2008 it was calculated using data supplied by cemsuisse. Between 2008 and 2010 the EF was kept constant at 0.52926 t/t clinker (based on information by cemsuisse).

The variation of EF provided by cemsuisse ranges from 0.525 to 0.5306 t/t clinker (within 1 %). The remark in EMIS-comment 2012/2A1 Zementwerke Rohmaterial that IPCC suggests an EF based on the content of CaO and MgO could not be found neither in 2000 IPCC Good Practice Guidance nor in 1996 IPCC Guidelines vol. 3 chapter 2.3 (IPCC seems to base on CaO content only).

Remarks:

2006 IPCC Guidelines state that the assumption of 100 % conversion of $CaCO_3$ to CaO rather overestimates the emission factor. The same occurs with MgO. It would be worth investigating whether data on $CaCO_3$-content in clinker are available. As the inclusion of MgO increases the emission factor by 4 % a bias might be introduced to the emission factor as soon as the conversion of $CaCO_3$ to CaO (assumed to be 100 %) is higher than 96 %.

The country specific EF (0.525 t/t clinker) is 4 % higher than the default value of 0.5071 t/t clinker given by 1996 IPCC Guidelines chapter 2.3. It could be annotated that the difference is fully accounted for by the MgO contribution to CO_2.

4.1.4 Verification of calculations

AD are production data of the industry (not calculated). The EF can be calculated for each production site (document „geogenes CO_2 2008 - 2011"). The value of 2008 given in EMIS-comment 2012/2A1 Zementwerke Rohmaterial corresponds to the calculation. The values of 2009 and 2010 are kept constant in EMIS-comment 2012/2A1 Zementwerke Rohmaterial, while the calculation in the CHE-2012-2010-v1.6 table yields values 0.5 % higher than given in the comment (well within the uncertainty of the calculation). In the table a slightly higher EF is used. The calculations of the geogenic part of the CO_2-emissions are correct for the years 1990 and 2008 to 2010 (according to CRF, CHE 2012-year v1.6, tables 2(I)s1 and 2(I)A-Gs1) although the emission factors used for the calculations differ slightly from those given in EMIS-comment 2012/2A1 Zementwerke Rohmaterial.

Uncertainties of CO_2-emissions are dominated by the uncertainty of clinker production data. In Switzerland the industry indicates the production data on plant level. In this case an uncertainty of 1 to 2 % is given in 2006 IPCC Guidelines. EMIS-comment 2012/2A1 Zementwerke Rohmaterial uses 2 % which is consistent with the 2006 IPCC Guidelines. There are no uncertainties given for the emission factors used (see EMIS-comment 2012/2A1 Zementwerke Rohmaterial, table EF CO_2 geogen: gerundete Werte und angenommene Unsicherheiten). According to 2006 IPCC Guidelines table 2.3 the chosen tier 2 approach (chemical analysis of content of CaO in clinker) has an uncertainty of 1 to 2 %. The table in the guidelines shows other contributions with uncertainties up to 3 %, which might be included (assumption that 100% CaO is from $CaCO_3$, assumption of 100% calcination of carbonate destined to become clinker).

Remarks:

The emission factor of CO_2 originating from blasting (96 g/t cement) is obviously calculated with the consumption value of 0.16 kg explosive/t cement given in NIR. Either NIR is corrected to EMIS-comment 2012/2A1 Zementwerke übriger Betrieb (0.13 kg explosive/t cement) and the emissions recalculated or the EMIS-comment is corrected (whichever is consistent with the data base). The difference changes the emissions by 19 % (NIR being higher).

The result of the emissions of blasting can be calculated and is well below 1 ‰ of the geogenic CO_2-emissions (2010: 0.2 ‰) as mentioned in NIR. According to 1996 IPCC Guidelines as well as 2006 IPCC Guidelines or 2000 IPCC Good Practice Guidance this contribution has not to be mentioned. In the CRF-result tables of the CO_2 emissions this contribution of 0.44 Gg/y (2010) is indeed not included while methodology and emission factors are given for this part of the emissions. On the other hand NIR does not state, that this contribution has not been included. Why is this part of the emissions derived (with inconsistencies as shown above) when it is not used and not stated that it is not used?

4.1.5 Consistency

The time series of AD and EF are documented in EMIS-comment 2012/2A1 Zementwerke Rohmaterial for the time period of 1990 to 2010. For 2007 the EF is an interpolation of the years 2006 and 2008. The other years (except 2005 and 2006) are two sets of fixed values agreed on with cemsuisse. The way these values are derived is documented in a protocol and a letter of cemsuisse.

There was no change of data source since 1990.

4.1.6 Transparency

The description of the process given in NIR indicates the relevant steps of the production leading to CO_2 emissions correctly.

The methodology is clearly documented in the NIR document with background information in EMIS-comment 2012/2A1 Zementwerke Rohmaterial.

The AD and EF as well as the origin of both are referenced in NIR and documented in EMIS-comment 2012/2A1 Zementwerke Rohmaterial.

The calculations given in the CRF tables named CHE-2012-year-v1.6 could be followed and recalculated. They are correct within 0.3 ‰. The slight difference originates from the number of digits used in the EF.

All sources of data, methodologies and guidelines are referenced.

4.2 Lime production (2A2)

4.2.1 General observations

Quicklime production is a minor source of industrial CO_2-emissions in Switzerland (2010: ≈ 2 %; fifth largest contribution). The emissions originate from the activities of production of quicklime and other operations (blasting in the quarry). There is only one production site in Switzerland. While quicklime consumption due to use as adsorbant mainly for acid gases is fairly constant, the over-all consumption of quicklime is regulated by the use in the two steel works and foundaries, the cement industry and in paper industry (declining).

4.2.2 Completeness

There is only one production site of quicklime in Switzerland.

The production of lime per year is well known and given precisely by the one company active in Switzerland (confidential data; open to the reviewer in EMIS-comment 2012/2A2 Kalkproduktion Rohmaterial).

Regarding process emissions, CO_2 is the only relevant emission known. According to the reporting guidelines, emissions related to energy production have to be reported in the energy sector (1A2).

Methane is probably not emitted, as carbon monoxyde concentrations are low in the production of process energy. N_2O is probably not produced, as the furnaces are not equipped with DeNOx-Systems. To our knowledge there are no data available for CH_4 and N_2O.

Regarding the emissions of CO_2 from blasting the emission factor given in a national publication of 2000 is used (same emission factor as for blasting in cement industry; source specified in EMIS-comment 2012/2A1 Zementwerke übriger Betrieb and cited in EMIS-comment 2012/2A2 Kalkproduktion übriger Betrieb).

The process description is adequate to understand the emission source.

Remark:

In EMIS-comment 2012/2A1 Zementwerke übriger Betrieb a consumption of 0.13 kg explosive/t cement is stated. The same value is used in EMIS-comment 2012/2A2 Kalkproduktion übriger Betrieb. As annotated in 4.1.4 the calculation is using the value of 0.16 kg explosive/t cement cited in NIR.

4.2.3 Methodology and assumptions

The geogenic CO_2 emissions of the lime production process are determined by a tier 2 approach using a country specific emission factor provided by the company's research group.

The choice of methodology is according to 2000 IPCC Good Practice Guidance for the EF. The country specific EF used in NIR differs by 0.8 % (being lower) from the default factor given for high calcium lime. Between 1996 and 2006 IPCC Guidelines the default EF reduces its value from 785 kgCO_2/t high calcium lime to 750 kgCO_2/t high calcium lime as in 2000 IPCC Good Practice Guidance.

The one Swiss plant has production data and data of the $CaCO_3$-content of the limestone and of remaining content of CO_2 in the quicklime at hand, the origin of data is known and data collection is best practice with minimal uncertainties. As the EMIS-comment 2012/2A2 Kalkproduktion Rohmaterial documents, raw lime production data are furnished by the company for the years 1990 to 2008. For 2009 and 2010 they were taken from the COLa date base.

The EF was derived by the research group of the company and kept constant for the whole time period.

Remarks:

The wording in NIR as well as in EMIS-comment 2012/2A2 Kalkproduktion Rohmaterial is not very clear. The AD is given as "Rohkalk-Produktion" which can mean "limestone" ($CaCO_3$, the input) as well as "lime" or "quicklime" (CaO, the output). While the emission factor for geogenic CO_2 is stated as tCO_2/t quicklime, the emissions derived from blasting operations are based on the limestone ($CaCO_3$) output. For the calculation of the geogenic CO_2 as well as for the emissions originating from blasting operations the same AD were used, which is not correct according to the definitions made in NIR and EMIS-comment 2012/2A2 Kalkproduktion Rohmaterial Kalkproduktion.

The country specific EF (confidential) corresponds within the uncertainty to the default EF given by 1996 IPCC Guidelines, Chapter 2.4.2 as well as that given by 2006 IPCC Guidelines, Chapter 2.3.1.2 table 2.4 (although the latter is lower and closer to the Swiss specific EF).

4.2.4 Verification of calculations

AD are production data of the industry (not calculated). The EF was derived by the research group of the company and kept constant for the years relevant to the review. The calculations of the geogenic part of the CO_2-emissions are correct for the reviewed years 1990 and 2008 to 2010 (according to CHE 2012-year v1.6, tables 2(I)s1 and 2(I)A-Gs1).

Uncertainties of CO_2-emissions are dominated by the uncertainty of the EF (5 %) which is higher than the uncertainty of AD and rather high compared to 2006 IPCC Guidelines vol.3, chapter 2.3.2 table 2.5. The only production site in Switzerland indicates the production data. In this case an uncertainty of 1 to 2 % is given in 2006 IPCC Guidelines vol.3, chapter 2.3.2 table 2.5. with the annotation that the uncertainty increases by one order of magnitude if non-marketed lime production is omitted. EMIS-comment 2012/2A2 Kalkproduktion Rohmaterial uses 2 % which is rather low compared to 2006 IPCC Guideline. Neither NIR nor EMIS-comment 2012/2A2 Kalkproduktion Rohmaterial indicates the problem of non-marketed lime (wether it occurs or is included in the data given by the production site).

Remarks:

The emission factor of CO_2 originating from blasting (96 g/t Rohkalk) is obviously calculated with the consumption value of 0.16 kg explosive/t cement given in NIR. There arises the same ambiguity as observed between NIR and EMIS-comment 2012/2A1 Zementwerke übriger Betrieb for cement production. The difference changes the emissions originating from blasting by 19 % (NIR being higher).

The result of the emissions of blasting (using same AD as for geogenic emissions) can be calculated and is well below 1 ‰ of the geogenic CO_2-emissions (2010: 0.1 ‰) as mentioned in NIR. According to 1996 IPCC Guidelines as well as 2006 IPCC Guidelines or 2000 IPCC Good Practice Guidance this contribution has not to be mentioned. In the CRF-result tables of the CO_2 emissions this contribution of 0.007 Gg/y (2010) is included.

4.2.5 Consistency

The time series of AD and EF are documented in EMIS-comment 2012/2A2 Kalkproduktion Rohmaterial for the time period of 1990 to 2010.

There was no change of data source since 1990.

4.2.6 Transparency

The description of the process given in NIR indicates the relevant steps of the production leading to CO_2 emissions correctly.

The methodology is documented in the NIR document with background information in EMIS-comment 2012/2A2 Kalkproduktion Rohmaterial.

The AD and EF as well as the origin of both are referenced in NIR and documented in EMIS-comment 2012/2A2 Kalkproduktion Rohmaterial.

The calculations given in the CRF tables named CHE-2012-year-v1.6 could be followed and recalculated. They are correct.

All sources of data, methodologies and guidelines are referenced.

4.3 Limestone and dolomite use (2A3)

4.3.1 General observations

Limestone and dolomite use is a minor source of industrial CO_2-emissions in Switzerland (2010: ≈3 %; fourth largest contribution). The emissions compile the activities of production of fine ceramics, rock wool and brick and tile.

Fine ceramics: The production in Switzerland has been decreasing between 1990 and 2009 due to shut downs of production lines and production sites. In 2010 a slight increase is observed. It is assumed that the whole production of Switzerland is parallel to the one main producer (Keramik Laufen, 85 % of production).

Rock wool production: The production of the only production plant in Switzerland shows an increasing trend from 1990 until 2010. Due to the trend to highly insulated buildings (partly due to legal regulations) and because EPS (expandable polystyrene) is suspected to promote damage when a building is burning, the production of rock wool will probably rise.

Brick and tile production: There are 10 companies with about 20 production plants in Switzerland (an internet search showed 9 companies represented by domoterra). The production of all 10 companies varies within a factor of 2 between 1990 and 2010, with a decreasing trend over this time. The demand of brick and tile is dependent on construction activities, mainly of apartment houses.

4.3.2 Completeness

Fine ceramics: There is one main production site of fine ceramics in Switzerland, which produces about 85 % of the Swiss output. A few other companies can be found, among others also dental laboratories (neglectable emissions).

The production of fine ceramics per year is only well known for the main producer and given precisely by this company for the years 1990 and then 2001 up to 2010 (EMIS-comment 2012/1A2f i & 2A3 Feinkeramik Produktion, partially confidential data open to the reviewer). These data are extrapolated to 100 % for the whole Swiss production. Missing years are interpolated linearly. As the EMIS-comment 2012/1A2f i & 2A3 Feinkeramik Produktion indicates, there are differences between the production data given by the main producer and the COLa-database (-1.5 % to +3.9 %; not concerning the years to be reviewed).

Regarding the emissions of geogenic source, CO_2 originating from raw materials of the glaze (limestone, dolomite and soda ash) is the only relevant emission known.

The process description is adequate to understand the emission source.

Rock wool production: There is only one production site of rock wool in Switzerland.

The production of rock wool per year is well known and given precisely by the one company for the years 1990 up to 2010 (EMIS-comment 2012/1A2f i & 2A3 Steinwolle Produktion).

Regarding the emissions of geogenic source, CO_2 originating from the raw material (dolomite) is the only relevant emission known.

The process description is adequate to understand the emission source.

Brick and tile production: There are about 20 production sites of brick and tile in Switzerland. According to EMIS-comment 2012/1A2f i & 2A3 Ziegeleien the data base of AD and even more of EF is difficult to obtain.

The production of brick and tile per year is only known to about 10 % precision with varying sources of the data (see EMIS-comment 2012/1A2f i & 2A3 Ziegeleien).

Regarding the emissions of geogenic source, CO_2 originating from limestone in the raw material is the only relevant emission known.

There is no process description except the remark that CO_2 originates from limestone in the raw material.

4.3.3 Methodology and assumptions

Fine ceramics: The geogenic CO_2 emissions of the fine ceramics production process are determined by a tier 2 approach using AD extrapolated from the main producer AD and emission factors provided by 2006 IPCC Guidelines, chapter 2.1, table 2.1.

The choice of methodology is according to 2006 IPCC Guidelines, chapter 2.5, equation 2.15. Between 1996 and 2006 IPCC Guidelines the default EF changes a little because of two more digits used by 2006 IPCC Guidelines.

The one main producing plant has production data and data of raw material of glaze at hand, the origin of data is known and data collection is best practice with minimal uncertainties. As the EMIS-comment 2012/1A2f i & 2A3 Feinkeramik Produktion documents, data are furnished by the leading company for the years 1990 (production data only) and 2001 up to 2009 (production and components of glaze). Production data of 1990 origin from a CO_2 audit, whereas 2010 data as well as all data regarding the glaze were taken from the COLa date base.

Remarks fine ceramics:

It is somewhat confusing that in the table of CO_2 geogen in EMIS-comment 2012/1A2f i & 2A3 Feinkeramik Produktion data of the contributions of Ulmerweiss, Dolomite and Soda are given for the years 1990 up to 2000 but the IEF is chosen to be the average of the years 2001 to 2009 and kept constant.

Rock wool production: The geogenic CO_2 emissions of the rock wool production process are determined by a tier 2 approach using AD provided by the only producer and the emission factor of dolomite provided by 2006 IPCC Guidelines, chapter 2.1, table 2.1.

The choice of methodology is according to 2006 IPCC Guidelines, chapter 2.5, equation 2.15. Between 1996 and 2006 IPCC Guidelines the default EF changes a little because of two more digits used by 2006 IPCC Guidelines.

The one producing plant has production data and consumption data of dolomite at hand, the origin of data is known and data collection is best practice with minimal uncertainties. As the EMIS-comment 2012/1A2f i & 2A3 Steinwolle Produktion documents, data of dolomite consumption are furnished by the one company for the years 2001 up to 2010, based on the ecological enterprise balance. Dolomite percentage data of 1990 until 2000 are assumed as being the average of 2001 to 2009.

Remarks rock wool production:

In EMIS-comment 2012/1A2f i & 2A3 Steinwolle Produktion Jahresleistung the use of dolomite is given together with the percentage of dolomite in the rock wool. For the years 1990 to 2000 the percentage of dolomite was used to calculate the consumption of dolomite. To calculate the EF of CO_2 geogenic per ton of rock wool, the consumption of dolomite is used (multiplying the EF of 477'320 g/t dolomite with the dolomite consumption divided by the rock wool production). For 1990 to 2000 this calculation yields the constant values shown in the table on page 6 of EMIS-comment 2012/1A2f i & 2A3 Steinwolle Produktion. For the years 2001 on the calculation is based on the dolomite production data provided by the industry. Obviously the calculation of the EF of CO_2 geogenic per ton of rock wool was not made as stated in EMIS-comment 2012/1A2f i & 2A3 Steinwolle Produktion for the years 2001 and later.

Brick and tile production: The geogenic CO_2 emissions of the brick and tile production process are determined probably by a tier 2 approach using AD provided by the industry and an emission factor (80'000 g/t of brick and tile) also provided by the industry. Compared to 2006 IPCC Guidelines, chapter 2.1, table 2.1, EF for carbonates (439'710 g/t of limestone) the value furnished by the industry implies a carbonate content of 18 % in the raw material. This is consistent with the statement in EMIS-comment 2012/1A2f i & 2A3 Ziegeleien that Swiss raw material layers contain 10 to 25 % of limestone.

The choice of methodology is according to 2006 IPCC Guidelines, chapter 2.5, equation 2.15.

The industry has production data but no data of limestone percentage in the raw material at hand. The origin of data is known and data collection is as good as possible under the circumstances regarding the brick and tile production. Instead of the percentage of limestone in the raw material an EF (0.08 t CO_2/t of product) provided by the industry is used. This EF seem reasonable although rather high compared to other countries as stated by the industry (lowest, Germany: 0.03 t CO_2/t of product, highest, Austria: 0.06 t CO_2/t of product). Therefore the CO_2 emissions might be overestimated by 30 to 267 % compared to neighbouring countries. On the other hand the used EF for Switzerland is assigned a very large uncertainty (50 %).

Remarks brick and tile production:

The main problem with the CO_2 emissions of brick and tile production is the large uncertainty in the EF and the lack of knowledge of carbonate content in the raw material.

4.3.4 Verification of calculations

Fine ceramics: AD are production data of the leading company (85 % production) extrapolated to 100 %. The EF were taken from 2006 IPCC Guidelines for the three components relevant for geogenic CO_2 emissions. The calculations of the geogenic part of the CO_2-emissions are given as a sum of limestone and dolomite use (according to CHE 2012-year v1.6, tables 2(I)s1 and 2(I)A-Gs1). Their verification is given in the last paragraph of this chapter.

Uncertainties of CO_2-emissions are dominated by the uncertainty of the extrapolated AD (10 %). The largest production site in Switzerland indicates its production data. In this case an uncertainty of 1 to 3 % is given in 2006 IPCC Guidelines vol.3, chapter 2.5.2.2. It seems reasonable to augment this value to 10 % based on the extrapolation.

The uncertainty of the EF (taken from 2006 IPCC Guidelines) is neglected as proposed by the guidelines vol.3, chapter 2.5.2.1.

Rock wool production: AD are production data of the only company in Switzerland. The EF was taken from 2006 IPCC Guidelines for the one component relevant for geogenic CO_2 emissions. The calculations of the geogenic part of the CO_2-emissions are given as a sum of limestone and dolomite use (according to CHE 2012-year v1.6, tables 2(I)s1 and 2(I)A-Gs1). Their verification is given in the last paragraph of this chapter.

Uncertainties of CO_2-emissions are about equally caused by the uncertainty of the AD (1 %) as well as that of the percentage of dolomite in the rock wool (1 % for 2001 to 2010). The only production site in Switzerland indicates its production data and the dolomite use. In this case an uncertainty of 1 to 3 % is given in 2006 IPCC Guidelines vol.3, chapter 2.5.2.2.

Remarks rock wool production:

It seems a bit odd that the uncertainty of the EF relative to rock wool production is given with 5 %, as the uncertainty of the percentage of dolomite assumed for the years 1990 to 2000 is given as 50 %, hence the dolomite use of this time period shows the same uncertainty. Therefore the EF relative to rock wool production for the years 1990 to 2000 should exhibit an uncertainty of 50 % as well.

Brick and tile production: AD are production data of the industry with an uncertainty of 10 % caused mainly by the organisation of the industry (not all companies part of domoterra). The EF is a rough estimate (± 50 %) of the industry, obviously lying above the EF's used by neighbouring countries. The calculations of the geogenic part of the CO_2-emissions are given as a sum of limestone and dolomite use (according to CHE 2012-year v1.6, tables 2(I)s1 and 2(I)A-Gs1). Their verification is given in the last paragraph of this chapter.

Uncertainties of CO_2-emissions are dominated by the uncertainty of the estimated EF (50 %). This uncertainty is much higher than that given in 2006 IPCC Guidelines vol.3, chapter 2.5.2.2 (1 to 3 %). Given the problems with data available from the industry this high uncertainty seems reasonable.

Verification of CO_2-emissions of fine ceramics, rock wool and brick & tile production (as sum):

The calculations of the geogenic part of the CO_2-emissions are correct for the reviewed years 1990 and 2008 to 2010 (according to CHE 2012-year v1.6, tables 2(I)s1 and 2(I)A-Gs1). Obviously the worksheet allows only one value of AD and EF, although three different processes are summarized in one line. As control calculation using AD values of the three processes and an AD-weighted EF show, this is the way the data were worked out. It would be helpful to annotate that an AD-weighted EF was used. The recalculation shows a slight difference of 1.1 % for the year 2010. This difference arises from a small calculation error in the AD-weighted EF.

Uncertainties of CO_2-emissions are dominated by the uncertainty of the emissions of brick and tile production (50 %) which is unfortunately the highest contribution (96 % in 2010) to the emissions summarized under limestone and dolomite use. As use of limestone and dolomite accounts only for about 3 % (2010) of the industrial CO_2 emissions, the influence of the large uncertainty affects the global result for industrial process emissions only with 1.5 % (the order of uncertainty of the main contribution, cement production).

4.3.5 Consistency

Fine ceramics: The time series of AD are documented in EMIS-comment 2012/1A2f i & 2A3 Feinkeramik Produktion for 1990 and the time period of 2001 to 2010. For 1991 to 2000 the AD is an interpolation of the years 2001 and 2010. For the IEF the same procedure is documented.

There was no change of data source (largest production site) since 1990.

Rock wool production: The time series of AD are documented in EMIS-comment 2012/1A2f i & 2A3 Steinwolle Produktion for 1990 until 2010. For 1991 to 2000 the EF is assumed to be the average of the years 2001 and 2010.

There was no change of data source (only one production site) since 1990.

Brick and tile production: The time series of AD are documented in EMIS-comment 2012/1A2f i & 2A3 Ziegeleien Jahresleistung for 1990, 2000 and the time period of 2002 to 2010. For 1991 to 1999 the AD is an interpolation of the years 1990 and 2000, for 2001 an interpolation of 2000 and 2002. For the IEF a constant value provided by the industry is used for 1990 to 2010.

There are documented changes of data source since 1990 (CO_2 audit, EnAW Data, COLa-data-base).These three data sources represent different time intervals of the same data and are therefore consistent.

4.3.6 Transparency

Use of limestone and dolomite:

The description of the processes given in NIR indicates the relevant steps of the production leading to CO_2 emissions correctly.

The methodology is documented in the NIR document with background information in EMIS-comments 2012/1A2f i & 2A3 Feinkeramik Produktion, 2012/1A2f i & 2A3 Steinwolle Produktion respectively 2012/1A2f i & 2A3 Ziegeleien.

The AD’s and EF’s as well as the origins of both are referenced in NIR and documented in EMIS-comments 2012/1A2f i & 2A3 Feinkeramik Produktion, 2012/1A2f i & 2A3 Steinwolle Produktion respectively 2012/1A2f i & 2A3 Ziegeleien.

The calculations given in the CRF tables named CHE-2012-year-v1.6 are not easy to be followed and recalculated as only the sum of fine ceramics, rock wool production and brick and tile production is given.

All sources of data, methodologies and guidelines are referenced.

4.4 Soda ash production and use (2A4)

4.4.1 General observations

Soda ash is only traded in Switzerland. As far as it could be checked by an internet research there is no production of soda ash. The CO_2 emissions of soda ash use are reported, as given by 2006 IPCC Guidelines, in the appropriate process (fine ceramics 2A3, glass production 2A7).

4.5 Asphalt roofing (2A5)

4.5.1 General observations

According to 1996 IPCC Guidelines there are no CO_2, CH_4 and N_2O emissions to be expected by this process. In 2006 IPCC Guidelines this process is not mentioned.

4.6 Road paving with asphalt (2A6)

4.6.1 General observations

According to 1996 IPCC Guidelines there are no CO_2, CH_4 and N_2O emissions to be expected by this process. In 2006 IPCC Guidelines this process is not mentioned.

4.7 Other (2A7)

4.7.1 General observations

Other uses of mineral products, following NIR these are plaster, container and tableware glass and glass wool, are a minor source of industrial CO_2-emissions in Switzerland (2010: ≈ 0.25 %; an almost negligible contribution).

4.7.2 Completeness

Plaster production: There are only two production sites of plaster in Switzerland. The emissions given for plaster production are those of blasting operations during the mining of gypsum. There are no CH_4 and N_2O emissions to be expected.

The production of plaster per year is well known for the years to be reviewed (1990, CO_2-audit; 2008 to 2010, COLa-Database) and documented in EMIS-comment 2012/2A7 Gips-Produktion übriger Betrieb. These two data sources represent different time intervals of the same data and are therefore consistent.

Container and table ware glass production: According to EMIS-comment 2012/1A2f i & 2A7 Hohlglas Produktion bzw. Glas übrige Produktion there is only one production site of each of these glass types in Switzerland. This is not correct as there is also Erie Electroverre in Romont, producing glass plates which are cut into glass supports for microscopy.

The production of container glass per year is well known and given precisely by the one company for the years 1990 up to 2010 (EMIS-comment 2012/1A2f i & 2A7 Hohlglas Produktion). Missing are the AD of another company producing special glass.

The production of table ware glass per year is well known and given precisely by the one company for the years 2006 up to 2010 (EMIS-comment 2012/1A2f i & 2A7 Glas übrige Produktion).

Regarding the emissions of geogenic source, CO_2 originating from the raw material (limestone and soda ash) is the only relevant emission known for both glass types.

There is no process description except the remark that CO_2 originates from limestone and soda ash in the raw material.

Glass wool production: There are only two production sites of glass wool in Switzerland. According to EMIS-comment 2012/1A2f i & 2A7 Glaswolle Produktion Rohprodukt the data base of AD is more precise for the larger producer, representing about 70 % of production, than for the smaller company. For the cullet ratio which is used to calculate the EF only data of the larger company are at hand. Furthermore this company submitted a whole new series of cullet ratios for the years 1990 to 2009 in the year 2010. These new data were used for NIR submission 2011

Regarding the emissions of geogenic source, CO_2 originating from the raw material (limestone and soda ash) is the only relevant emission known for both glass types.

There is no process description except the remark that CO_2 originates from limestone and soda ash in the raw material.

4.7.3 Methodology and assumptions

Plaster production: The CO_2 emissions of the plaster production process are determined by a tier 1 approach using AD of the two producers (given as mined gypsum) and an emission factor taken from blasting operations in cement industry (specified in EMIS-comment 2012/2A1 Zementwerke übriger Betrieb) which is adapted to plaster production (referenced to t of mined gypsum).

Remarks plaster production:

The emission factor is derived from the one used for blasting in cement industry (g CO_2/t cement) by multiplying it with a factor of 1.5. This factor could not be verified. The factor seems to originate from the ratio raw material = 1.5 x clinker. But there is also a factor of 1.14 between cement and clinker (see EMIS-comment 2012/2A1 Zementproduktion Rohmaterial, Emissionen aus dem Rohmaterial). Therefore the combined factor of raw material = 1.5 x clinker = 1.5 x cement/1.14 = 1.32 should rather be used to convert an emission factor referenced to cement into one referenced to raw material. Instead of an emission factor of 144 g CO_2/t rock one of 127 g CO_2/t rock should be used (difference - 12 %). Furthermore the remark on the difference between the consumption of explosive given in NIR (0.16 kg explosive/t cement) and in EMIS-comment 2012/2A1 Zementwerke übriger Betrieb (0.13 kg explosive/t cement) should be considered (see 4.1.4 remarks). The emission factor used for blasting in plaster production (calculated with the factor 1.5 between cement and rock) is based on the higher value used in NIR.

Container and table ware glass production and glass wool production:

The geogenic CO_2 emissions of the container and table glass production processes are determined by a tier 2 approach using AD provided by the producers and the respective emission factors provided by 2006 IPCC Guidelines, chapter 2.4, table 2.6. which are reduced by the factor (1 - cullet ratio).

Remarks container and table ware glass production and glass wool production:

In EMIS-comment 2012/1A2f i & 2A7 Hohlglas respectively Glas übrige Produktion respectively Glaswolle Produktion Rohprodukt effectively a Tier 1 approach is used, following 2006 IPCC Guidelines, chapter 2.4, table 2.6, using equation 2.10 (instead of equation 2.11). In NIR the methodology given is a Tier 1 approach. The way it is formulated it is only valid for container glass.

The EF's used are based on a Tier 2 method using default values given by 2006 IPCC Guidelines, chapter 2.4.1.2, table 2.6. which are reduced by the factor (1 - cullet ratio). The guidelines propose ranges of cullet ratios and the use of the midpoints of these ranges.

The EMIS-comments document cullet ratios given by the producers (or at least the main producer in the case of glass wool production) which are used to calculate yearly EF's. This is an even better approach as given by 2006 IPCC Guidelines.

The calculations according to CHE 2012-year v1.6, tables 2(I)s1 and 2(I)A-Gs1 use on the other hand indeed a Tier 2 approach, following 2006 IPCC Guidelines, chapter 2.4, equation 2.11.

4.7.4 Verification of calculations

Plaster production: AD are production data of the two existing companies. The EF was calulated using the emission factor given for blasting in cement industry and adapted to blasting in plaster production. The calculations of the CO_2-emissions are correct for the reviewed years 1990 and 2008 to 2010 (according to CHE 2012-year v1.6, tables 2(I)s1 and 2(I)A-Gs1).

Uncertainties of CO_2-emissions are dominated by the uncertainty of the emission factor (20 %), which could be too small an estimate (see remark below).

The two production sites in Switzerland indicate their production data. In this case an uncertainty of 1 to 3 % is given in 2006 IPCC Guidelines vol.3, chapter 2.5.2.2. It seems reasonable to use a value of 5 %.

The uncertainty of the EF (estimated in EMIS-comment 2012/2A7 Gips-Produktion übriger Betrieb) is reasonable if it has not to account for the possible systematic errors given in the remark below.

Remark plaster production:

The EF may have a systematic error of 12 % (being too high due to conversion of cement to rock) and another systematic error of 19 % (NIR being higher than the EMIS-comment due to different data given for the consumption of explosive).

Container and table ware glass and glass wool production: AD are production data of the companies active in the field in Switzerland. The EF were taken from 2006 IPCC Guidelines, chapter 2.4, table 2.6, and corrected with the cullet ratio of each year. The calculations of the geogenic part of the CO_2-emissions are given as a sum of the three types of glass produced (according to CHE 2012-year v1.6, tables 2(I)s1 and 2(I)A-Gs1). Their verification is given in the last paragraph of this chapter.

Uncertainties of CO_2-emissions arise from the uncertainties of AD and cullet ratio which change between 5 and 30 % with time. For container glass the uncertainties are 30 % for AD and 10 % for cullet ratio in 1990 and drop to 5 % each for the time period 2008 to 2010. For table glass the uncertainties of AD are constant for 1990 and 2008 to 2010 (5 %) whereas the cullet ratio is given an uncertainty of 20 % in 1990 and 10 % for the other years to be reviewed. For glass wool there are uncertainties of AD of 20 % for AD for 1990 to 1997 and 5 % for 2004 to 2010, wheras for the cullet ratio no uncertainty is shown for this type of glass.

The production sites in Switzerland indicate their production data. In this case an uncertainty of 5 % is given in 2006 IPCC Guidelines vol.3, chapter 2.4.2.2. It seems reasonable to use a higher value for the earlier years and approach the value of 5 % for recent years, as changes in production sites (closing down of sites) and availability of data is not complete for all sites.

The uncertainties of the EF's are reasonable compared to 2006 IPCC Guidelines, chapter 2.4.2.1 (10 %).

Verification of CO_2-emissions of container and table ware glass and glass wool production (as sum):

The calculations of the geogenic part of the CO_2-emissions are correct for the reviewed years 1990 and 2008 and 2009 (according to CHE 2012-year v1.6, tables 2(I)s1 and 2(I)A-Gs1). Obviously the worksheet allows only one value of AD and EF, although three different processes are summarized in one line. As control calculations using AD values of the three processes and an AD-weighted EF show, this is the way the data were worked out. It would be helpful to annotate that an AD-weighted EF was used.

The recalculation shows a significant difference of 4.1 % or 5.4 % for the year 2010. Part of this deviation arises from EMIS-comment 2012/1A2f i & 2A7 Hohlglas Produktion EF CO_2 geogen of the year 2010 where a cullet-ratio of 81 % is given. According to the equation given to calculate the EF CO_2 geogen it should read (1 - 0.81) x 210 kg/t Hohlglas = 39.9, while the table gives 40.6 kg CO_2/t Hohlglas. According to the recalculation the total AD of the three glass production processes is correct. The difference arises from the EF value of 0.03789879 in the table CHE 2012-2010 v1.6, table 2(I)A-Gs1. The AD weighted value of the EF's is either 0.04004653 (using the wrong value of EMIS-comment 2012/1A2f i & 2A7 Hohlglas Produktion), or 0.03950959 using the value calculated using the cullet-ratio of 81 % and the default EF.

Uncertainties of CO_2-emissions are dominated by the uncertainty of the emissions of container glass production, which contributes 78 % (in 2010) to the emissions summarized under glass production and 77 % of the emissions summarized under 2A7. As 2A7 accounts only for about 0.25 % (2010) of the process-related CO_2 emissions, any uncertainties to be attributed to the group 2A7 are negligible.

4.7.5 Consistency

Plaster production: The time series of AD are documented in EMIS-comment 2012/2A7 Gips-Produktion übriger Betrieb for 1900 to 2010.
There is no change of data source (producers) since 1990.
The methodology is the same for the evaluated time period.

Container and table ware glass production: The time series of AD are documented in EMIS-comment 2012/1A2f i & 2A7 Hohlglas Produktion respectively Glas übrige Produktion for 1990 until 2010. The EF's are documented for the same time period in the case of container glass production. For table ware glass production there are EF's available only for 1990, 2000 and 2007 to 2011.
There are documented changes of data source since 1990 (CO_2 audit, Vereinigung Schweizerischer Glasfabriken, COLa-database). These three data sources represent different time intervals of the same data and are therefore consistent.
The methodology is the same for the evaluated time period.

Glass wool production: The time series of AD are documented in EMIS-comment 2012/1A2f i & 2A7 Glaswolle Produktion Rohprodukt Jahresleistung for 1990 to 2010. For the smaller company, contributing less than 30 % of total production, the AD's are mostly estimates and sometimes an interpolation.
There are documented changes of data source since 1990 (CO_2 audit, Umweltbericht, COLa-database). These three data sources represent different time intervals of the same data and are therefore consistent.
The methodology is the same for the evaluated time period.

4.7.6 Transparency

Plaster, container and table ware glass and glass wool production:

There are no descriptions of the processes given in NIR because CO_2 emissions arise from blasting or raw material only, which is indicated correctly.

The methodology is documented in the NIR document with background information in EMIS-comments 2012/1A2f i & 2A7 Hohlglas Produktion, 2012/1A2f i & 2A7 Glas übrige Produktion respectively 2012/1A2f i & 2A7 Glaswolle Produktion Rohprodukt. For glass production only the equation for container glass is given. Correctly the equation should be written as a sum, along the lines of 2006 IPCC Guidelines, chapter 2.4, equation 2.11.

The AD's and EF's as well as the origins of both are referenced in NIR and documented in EMIS-comments 2012/1A2f i & 2A7 Hohlglas Produktion, 2012/1A2f i & 2A7 Glas übrige Produktion respectively 2012/1A2f i & 2A7 Glaswolle Produktion Rohprodukt.

The calculations given in the CRF tables named CHE-2012-year-v1.6 are not easy to be followed and recalculated in the case of glass production as only the sum of container and table ware glass and glass wool production is given.

All sources of data, methodologies and guidelines are referenced.

5. Chemical industry (2B)

5.1 Ammonia production (2B1)

5.1.1 General observations

Ammonia is a significant basic chemical and the most significant produced nitrogenous chemical. Ammonia is used as a fertiliser, in heat treatment, paper production, nitric acid and the production of nitrate, in the explosives industry and as a refrigerant. Known derivatives also include amines, amides or carbamides.

In Switzerland, only the company Lonza AG is known to be a manufacturer of ammonia. This company synthesises ammonia through the catalytic reaction of synthetic hydrogen with atmospheric nitrogen in a manufacturing network. The hydrogen reactant is created through the thermal cracking of liquid petroleum gas (propane/butane) and light gasoline. For production reasons it is not possible to attribute greenhouse gases to individual products of the entire production line. Therefore, the relevant CO_2 is completely assigned to the primary product ethene (i.e. the first resulting product of the cracker) and reported under category 2B5.

5.1.2 Completeness

The ammonia production process can be found in Switzerland. In one single plant, ammonia is produced in association with other products such as ethene, ethyne, prussic acid and CO_2.

Internet searches carried out by the reviewer, trawling the FOEN SwissPRTR register of hazardous substances (2007-2010) and the data from the association scienceindustries confirm the fact that only Lonza AG in Visp operates an ammonia production plant.

The amount of ammonia produced is designated in the EMIS commentary 2012/2B1 Ammonia production and is supported by the data provided by the manufacturing company. Annual data are documented from 1997.

The relevant CO_2 climate gas is, however, not included in the EMIS commentary 2012/2B1 Ammonia production, since it is fully assigned to the production of ethene. It is, therefore, included in the EMIS commentary 2012/2B5 Ethylene production.

The process description is complete and credible.

Remarks:

Whether or not ammonia production occurred from 1991 to 1996 is not mentioned in the EMIS commentary 2012/2B1 Ammonia production. It should be noted if no company data is available for this period.

5.1.3 Methodology and assumptions

Since all CO_2 emissions from ammonia production are reported within 2B5 ethylene production, the method is also described there. Since it is not possible to assign the reactants and CO_2 emissions to ammonia, this method of selection according to 2006 IPCC Guidelines is accepted.

The EF are reported/referenced in the NIR correctly under 2B5 Ethylene production and described in the EMIS commentary 2012/2B5 Ethylene production (also see Chapter 5.5.2).

AD are designated as company-specific measurements. This procedure is in accordance with the good practice embedded in the 2006 IPCC Guidelines and is reasonable.

5.1.4 Verification of calculations

The AD are production figures provided by the only ammonia manufacturer (not calculated).

The EF are included and commented on in the EMIS commentary 2012/2B5 Ethylene production, cracker process (see Chapter 5.5.2).

The AD and EF in the CRF tables 2(I)s1, 2(I).A-Gs1, v. 1.6 for the years 1990, 2008-2010 are not included for reasons of confidentiality (AD) or correctly designated as “included elsewhere” (EF) (under 2B5 Ethylene).

During the years under observation, the emissions were also correctly designated as “included elsewhere” (EF) (under 2B5 ethylene). The emission calculations are verified in this review under 2B5 ethylene (see Chapter 5.5.2).

Since the emissions are reported under 2B5 Ethylene, the uncertainty of the parameters is also included in the NIR and described in the EMIS commentary 2012/2B5 Ethylene production (see Chapter 5.5.2).

5.1.5 Consistency

The AD were taken in the same way from the entire time series between 1990 and 2010 and described in the EMIS commentary 2012/2B1 Ammonia production.

The EF are described and commented on in the EMIS commentary 2012/2B5 Ethylene production, cracker process (see Chapter 5.5.2).

There are no changes to the data source (company data) to be designated.

Remarks:

The EMIS commentary 2012/2B1 Ammonia production provides no data on AD for the period 1991-1996. It is unclear whether or not the AD over these years is interpolated or if no production occurred.

5.1.6 Transparency

The ammonia production process is summarised in the NIR under heading 2B1. The process is satisfactorily and clearly described in the EMIS commentary 2012/2B1 Ammonia production and in the NIR.

The method is described in the NIR under section 2B5 ethylene Production and the reasons for this are given in the NIR and the EMIS commentary.

The AD are not provided in CRF tables 2(I)s1, 2(I).A-Gs1, v1.6 for reasons of confidentiality and are only mentioned in commentary 2012/2B1 Ammonia production. The EF are summarised in EMIS commentary 2012/2B5 Ethylene production, Cracker process and referenced in the NIR.

The CO_2 emission calculations can only be found in CRF tables 2(I)s1, 2(I).A-Gs1, v1.6 for the years 1990, 2008-2010 in section 2B5 Other/Ethylene. Section 2B1 ammonia production correctly states that emissions are “included elsewhere”.

All data sources are included and referenced in EMIS commentary 2012/2B1 Ammonia production.

Remarks:

The AD are given only in EMIS commentary 2012/2B1 Ammonia production. The NIR does not contain any data on AD.

5.2 Nitric acid production (2B2)

5.2.1 General observations

Nitric acid is mainly used as a basic chemical and raw material in the production of nitrogen fertilisers. Other applications include the production of adipic acid and blasting agents, metal strips and in the preparation of ferrous metals. To 2008, the world market for industrial chemicals based on nitric acid grew by an average of 7% [11].

There are two known ways of producing nitric acid, namely single-pressure and dual-pressure systems. In dual-pressure systems, the absorption and oxidation process steps operate at different pressures. In order to manufacture nitric acid, ammonia together with atmospheric oxygen is converted into NO which is oxidised into NO_2 and absorbed in water, thereby creating a 60% nitric acid.

In Switzerland, nitric acid production depends much on the demand for manufacturing fertiliser. For other applications, most of the nitric acid is imported from abroad and, for this reason, nitric acid is currently only manufactured by one company, Lonza AG in Visp.

5.2.2 Completeness

According to EMIS commentary 2012/2B2 Nitric acid production, only one company in Switzerland is known to have a plant used to manufacture nitric acid.

Research carried out by the reviewer into potential other manufacturers of nitric acid in Switzerland (BASF, CABB), gathering information from the SwissPRTR register of the FOEN (2007-2010) and data from the association scienceindustries has confirmed that only Lonza AG in Visp is operating a nitric acid production plant and is, therefore, included as the only relevant company.

The production quantities of nitric acid described in the EMIS commentary for the period 1990-2010 is based on the annual production data issued by Lonza AG. No gaps can be identified.

N_2O is identified as a relevant climate gas in EMIS commentary 2012/2B2 Nitric acid production. This is conclusive and correct.

The relevant details of the process description for nitric acid production are included in the EMIS commentary 2012/2B2 Nitric acid production.

5.2.3 Methodology and assumptions

Since 1990, N_2O emissions have been calculated using a tier 2 approach with plant-specific data of the sole Swiss production plants. This method corresponds to the 2006 IPCC Guidelines and the Swiss circumstances.

AD and N_2O emissions are company-specific measurements. AD were compiled on an annual basis. The EF was calculated once, based on measurements in 2009, and assumed to be constant for the entire time series. Since there have been no technical changes to the production system since 1990, this procedure is reasonable and good practice according to the 2006 IPCC Guidelines.

The constant EF of 3.0 kg N_2O/t HNO_3 (100%) is plausible. The corresponding default value in the 2006 IPCC Guidelines is 2.5 kg N_2O/t HNO_3 (100%).

5.2.4 Verification of calculations

The AD are production data of the sole nitric acid manufacture (not calculated). The EF was, on one occasion, determined by the manufacturer by measuring emissions (2009), kept constant and included in the EMIS commentary 2012/2B2 Nitric acid production.

For reasons of confidentiality, the AD and EF are not included in the NIR.

The AD and EF for 1990 and 2008-2010 are also not mentioned in CRF tables 2(I)s1, 2(I).A-Gs1, v1.6 for reasons of confidentiality. The calculations of the emissions in the years under consideration are correct and included in these tables.

The uncertainty of the EF for the years 1990-2010 was assumed to be 10% and corresponds to the data of the 2006 IPCC Guidelines. The uncertainty of the manufacturer's AD was low, at 1%, and reasonable (branch data). According to the 2006 IPCC Guidelines, it is preferable to take company and branch data into consideration. The IPCC default value is 2%. Uncertainty was given at 100% nitric acid , thereby representing good practice.

5.2.5 Consistency

The AD and EF were compiled in the same way for the entire time series from 1990 to 2010 and included in the EMIS commentary 2012/2B2 Nitric acid production. As (an) EF, the value of 2009 was applied for the entire time series from 1990 to 2010. This is also described in the EMIS commentary.

There are no gaps and changes to the data source.

5.2.6 Transparency

The nitric acid production process is summarised in the NIR under the heading 2B2. The process is satisfactory and clearly described in EMIS commentary 2012/2B2 Nitric acid production and in the NIR.

The tier 2 method is repeated in the NIR and briefly described.

For reasons of confidentiality, the AD and EF are not included in the NIR and CRF tables 2(I)s1, 2(I).A-Gs1, v1.6, but referenced in the NIR. Both AD and EF are included in tabular form in the EMIS commentary 2012/2B2 Nitric acid production.

The calculations of the emissions are documented and correct in CRF tables 2(I)s1, 2(I).A-Gs1, v1.6 for the years 1990 and 2008-2010.

All relevant data sources, methods and guidelines are referenced in EMIS commentary 2012/2B2 Nitric acid production and NIR.

5.3 Adipic acid production (2B3)

5.3.1 General observations

Globally the bulk of adipic acid is used for the production of Nylon 6,6 in form of direct acid use and, further processed, as hexamethylene diamine. Smaller amounts of adipic acid are used for the production of coatings, plastics (plasticizer), urethane foam, elastomers and synthetic lubricants.

A cyclohexanone/cyclohexanol mixture is oxidized by nitric acid in the presence of a catalyst to form adipic acid. N_2O is generated as an unintended by-product of the nitric acid oxidation stage. Adipic acid is a significant source of atmospheric N_2O if not abated. This can be done through e.g. thermal or catalytic destruction.

5.3.2 General observations

According to the association scienceindustries [10], adipic acid is not produced in Switzerland only traded (e.g. Radici Group, Evonik International AG, Merck (Schweiz) AG). In addition, no production plants are known, which used to operate in Switzerland and could potentially result in N_2O emissions. A leading producer of adipic acid (BASF AG) operates plants in Switzerland, but the adipic acid is manufactured in Germany. EMS Chemie AG has been a leading manufacturer of polyamides since the Fifties and processes adipic acid [12]. The register SwissPRTR, however, does not include EMS Chemie AG as a company emitting N_2O. Research into adipic acid providers in Switzerland in the international directory of B2B companies (www.kompass.com) only uncovered trading companies for Switzerland. Here again, EMS Chemie AG is only listed as a producer of polyamides.

For the reasons given, it seems likely that, in the period 1990-2010, adipic acid was not produced in Switzerland and is correctly described in the inventory as “NO/not occurring”.

5.4 Carbide production (2B4)

5.4.1 General observations

Carbide production comprises graphite and silicon carbide production. According to NIR 2012 only silicon carbide production is taken into account. In NIR 2012 CH_4 emissions of silicon carbide production are taken into account for the first time.

The silicon carbide production is the sixth-largest contributor of process-related CO_2 emissions in Switzerland (2010: ≈ 1 %; in absolute numbers a minor contribution). Regarding process-related CH_4-emissions of Switzerland it is one of the only two sources considered with a contribution of 25 % in 2010.

NIR chapter 4.3.6 states that no source-specific improvements are planned. According to EMIS-comment 2012/2B4 Graphit und Siliziumkarbid Produktion separate emission factors for graphite and silicon carbide production are planned for 2013.

5.4.2 Completeness

According to EMIS-comment 2012/2B4 Graphit und Siliziumkarbid Produktion there is only one production site of graphite and silicon carbide in Switzerland. According to our knowledge there is a second company producing catalysts based on silicon carbide (HUG Engineering, Elsau). Therefore the emissions are rather underestimated. The following review and remarks consider only the one production site of which data are presented in EMIS-comment 2012/2B4 Graphit und Siliziumkarbid Produktion.

The production of graphite and silicon carbide per year is well known and given precisely by the one company beeing the main producer in Switzerland (confidential data; open to the reviewer in EMIS-comment 2012/2B4 Graphit und Siliziumkarbid Produktion).

Regarding the emissions of geogenic source, CO_2 and CH_4 are the relevant emissions known. N_2O is not known to be produced (there are no data available for N_2O).

Regarding the emissions of CH_4 NIR showed no data until 2011 as neither revised 1996 nor 2006 IPCC Guidelines provide emission factors for methane from the use of anthracite or coking coal. Meanwhile it turned out that instead of coking coal petroleum coke is used. For NIR 2012 the emission factor of 11.6 $kgCH_4$/t of SiC according to 1996 IPCC Guidelines chapter 2.1.11 is used (EMIS-comment 2012/2B4 Graphit und Siliziumkarbid Produktion).

The process description is adequate to understand the emission source.

Remarks:

NIR chapter 4.3.2.3 b shows a wrong reference to EMIS-comment 2012/**2B2** Graphit und Siliziumkarbid Produktion instead of EMIS-comment 2012/**2B4** Graphit und Siliziumkarbid Produktion.

5.4.3 Methodology and assumptions

The choice of methodology is according to 2006 IPCC Guidelines using a tier 2 approach for AD and default EF’s for CO_2 (only 1990) and CH_4 emissions of the silicon carbide production process. Although graphite is produced, the emissions of this part of the production (0.65 tCO_2/t graphite) are not taken into account in NIR 2012 (they had been in the earlier NIR reports).

For CO_2 a country specific emission factor provided by the company is used. For 1990 to 2005 the company provided separate emission factors for silicon carbide and graphite production. Since 2008 only the emission factor of silicon carbide is provided as it is not clear, whether the CO_2 emissions of graphite production arise from the production process itself or from machines using diesel fuel (already considered in 1A2fii). For the submission 2013 the two production processes are planned to be split in cooperation with the one company (eventually two) active in Switzerland.

For CH_4 the EF according to the 1996 IPCC Guidelines for petroleum coke is used. The EF is referenced to the production of silicon carbide.

Remarks:

It is not completely clear whether the use of default emission factors without plant level data of carbon content is consistent with a tier 2 approach (see 2006 IPCC Guidelines 3.6.2.1.), although it is more than a tier 1 method.

NIR 2012 should make clear that the formerly included emissions of graphite production are no more included in the actual NIR.

5.4.4 Verification of calculations

AD are production data of the one company active in Switzerland. The calculations of the CO_2 as well as the CH_4 emissions are correct for the years 1990 and 2008 to 2010 (according to CHE 2012-year v1.6, tables 2(I)s1 and 2(I)A-Gs1).

Uncertainties of CO_2 and CH_4 emissions are dominated by the uncertainty of the EF (10 %) which is higher than the uncertainty of AD (5 %). The uncertainties follow 2006 IPCC Guidelines.

Remarks:

EMIS-comment 2012/2B4 Graphit und Siliziumkarbid Produktion gives information on graphite production which subsequently is not used for any emission calculations. It is also not clear, how the data „EF component X (gerundet) t/t" are derived and which is their relation to the data „EF component X t/tSiC". For calculations obviously the latter data are used.

5.4.5 Consistency

The time series of AD and EF and their adjustments to new data respectively the introduction of new EF are documented in EMIS-comment 2012/2B4 Graphit und Siliziumkarbid Produktion for the time period of 1990 to 2010.

There was no change of data source since 1990.

Remarks:

NIR shows no indication of the change in methodology from EF common for silicon carbide and graphite production to the fact that the actual NIR considers only the emissions of silicon carbide. There is also no remark on the fact that NIR 2012 considers for the first time CH_4 emissions.

There is no indication that AD have changed due to new data provided by the industry. There are no interpolated data between 1990 and 1995. There is only a constant AD for 1990, 1995 and 1996. 1995 could be considered as an interpolation but then the corresponding sentence in NIR should read „... activity data base on industry data for 1990 and 199**6**...."

5.4.6 Transparency

The description of the process given in NIR indicates the relevant steps of the production leading to CO_2 and CH_4 emissions correctly.

The methodology is documented in the NIR document with background information in EMIS-comment 2012/2B4 Graphit und Siliziumkarbid Produktion.

The AD and EF as well as the origin of both are referenced in NIR and documented in EMIS-comment 2012/2B4 Graphit und Siliziumkarbid Produktion.

The calculations given in the CRF tables named CHE-2012-year-v1.6 could be followed and recalculated. They are correct.

All sources of data, methodologies and guidelines are referenced.

Remarks:

It would be easier to follow the origin of the CO_2 default EF of 2.62 t/t SiC (used for 1990, 1995, 2000, 2005, 2007, 2011, 2020 and 2035) if it were referenced to 2006 IPCC Guidelines table 3.7 where it can explicitly be found. In the given reference (1996 IPCC Guidelines chapter 2.11.1.) a value of 2.3 t/t of petroleum coke is given. There is no hint how these two different values are related (how petroleum coke converts into SiC).

5.5 Other (2B5)

5.5.1 Acetic acid production

5.5.1.1 General observations

Most acetic acid is produced industrially synthetically and is regarded as basic chemical for numerous derivatives. However, production in Switzerland has been in decline during the last years. However, the change has not been substantial and AD do not need to be adjusted for the time being.

Most acetic acid is produced by methanol carbonylation. In this process, methanol and carbon monoxide react to produce acetic acid. The process involves iodomethane as an intermediate, and occurs in three steps. A catalyst, metal carbonyl, is needed for the carbonylation. The Monsanto process uses Rhodium catalysts; the so-called Cativa process is based on an iridium-containing catalyst.

The second-most-important manufacturing method, although it is usually uncompetitive with the carbonylation of methanol is the oxidation of acetaldehyde.

The acetaldehyde may be produced via oxidation of butane or light naphtha, or by hydration of ethylene. When butane or light naphtha is heated with air in the presence of various metal ions, including those of manganese, cobalt, and chromium, peroxides form and then decompose to produce acetic acid.

Based on the review and comments of the association scienceindustries there are only three producers of acetic acid in Switzerland with an overall production capacity of <50’000 t/year.

Neither the 1996 nor the 2006 IPCC Guidelines describe an “Acetic acid production” process. The EMEP-guidebook encompasses also processes of the organic chemical industry incl. acetic acid production (bulk production).

5.5.1.2 Completeness

According to EMIS commentary 2012/2B5 Acetic acid production, three companies are known to produce acetic acid in Switzerland. Research by the reviewers has shown that these are Lonza AG, CABB AG (previously SF Chem AG) and DSM Nutritional Products AG (previously Roche AG). The SwissPRTR register, however, only describes DSM Nutritional Products AG as emitting CH_4, with emission quantities significantly below the total quantity described in the greenhouse gas inventory. It is however not clear if these emissions occur from acetic acid production. The association scienceindustries confirmed that acetic acid evolves only as by-product at DSM which is immediately transformed into a secondary product [14].

Therefore, all relevant manufacturing companies have been included.

The production quantities of acetic acid described in the EMIS commentary are based on the production data from 1995. The production quantity has, since then, been considered to be constant in accordance with the association data (scienceindustries) and a slight adjustment in 2007 due to some economic decline. No gaps are detectable.

CH_4 is classified as a climate gas in the EMIS commentary. The significant climate gas is included.

Remarks:

It is unclear why the EMIS commentary 2012/2B5 Acetic acid production includes no total production quantities for the years 2008, 2009 and 2010.

Since acetic acid, as described in 5.5.1.1, can be produced using different processes, it is important to describe the industrial processes in practice in Switzerland. Unfortunately, neither the NIR nor the EMIS commentary 2012/2B5 Acetic acid production contains information on the industrial process implemented by the companies in question.

5.5.1.3 Methodology and assumptions

A country-specific approach was adopted when calculating CH_4 emissions, with the annual production quantity being multiplied by the corresponding emission factor. Since no IPCC data on the process are available, this process is reasonable.

The acetic acid production AD for the years 1990-1995 derive from EMDET, the forerunner of EMIS. Whether these AD take branch data or company-specific values into consideration is not specified in the EMIS commentary. For 2001 and 2004, the same AD as 1995 were used. This procedure is reasonable given how the sector has evolved and the lack of current data.

Remarks:

How methane emerges from the production of acetic acid is unclear and depends on the industrial production process. EMIS commentary 2012/2B5 Acetic acid production refers to documents (EMDET, 1997) that were the precursor of the EMIS commentaries, which include the EF. According to the data they contain, these EF derive from foreign sources of literature [7]. This publication could not be consulted, but should be examined and, if necessary, the EF updated.

The IPCC EF database does not include a comparative value for CH_4 in acetic acid production. In addition, a country comparison based on the UNFCCC synthesis and assessment report 2011 produced no EF comparative values.

It is unclear why the EMIS commentary 2012/2B5 Acetic acid production does not include any AD for the years 2002, 2003, 2005, 2006 and 2008-2010 and only includes EF for 1990 and 1995. The reasons might be listed in the EMIS commentary.

5.5.1.4 Verification of calculations

The AD are based on association data or EMDET commentaries, the EF coming from a foreign source [7]. The process for calculating the EF arise from the EMIS commentary 2012/2B5 Acetic acid production.

The AD tally with the data in the NIR. The EF are not included in the NIR.

The activity data and emission factors included in CRF tables 2(I)s1, 2(I).A-Gs1, v1.6 for the years 1990 and 2008-2010 are in line with the values in EMIS commentary 2012/2B5 Acetic acid production. The emission calculations for the years in consideration are correct (assuming an EF of 12.5 kg/t for 1990 and 10 kg/t for 2008-2010).

For non-key categories, the NIR provides qualitative data on uncertainties (low, medium, high) and a quantitative relative uncertainty is assigned to each category of uncertainty. The NIR, however, does not include any uncertainties for the production of acetic acid. In addition, comparative IPCC values are not available. The uncertainty of CH_4 emissions is dominated by the uncertainty of 20% given for CH_4 EF in the EMIS commentary. This appears to be high. The AD uncertainties, 1% for the years 1990-1995 and 20% for 2007-2010, were estimated at 10% from the year 2007.

Remarks:

The high increase in the AD uncertainty from 1995 should be explained in the EMIS commentary 2012/2B5 Acetic acid production.

5.5.1.5 Consistency

According to the NIR, the AD are based on data from industry and statements made by experts. From 1995 to 2006, the AD were constant due to the lack of industry data and adjusted in 2007 according to association data (scienceindustries).

Similarly, the EF was compiled the same for the entire time series and remained constant from 1995.

There are no gaps or changes to the data source to be reported.

5.5.1.6 Transparency

The acetic acid production process is summarised in the NIR in the 2B5 Other section.

The method is described in the NIR albeit simplified. No information on tier classification is provided, due to the lack of specifications in the IPCC guidelines.

The AD are included in tabular format in the NIR and EMIS commentary 2012/2B5 Acetic acid production.

The emission calculations are documented and correct in CRF tables 2(I)s1, 2(I).A-Gs1, v1.6 for the years 1990 and 2008-2010.

All data sources for the AD and EF are referenced in the EMIS commentary 2012/2B5 Acetic acid production.

Remarks:

The NIR and EMIS commentary 2012/2B5 Acetic acid production do not further specify which industrial process is used to produce acetic acid. There is no information on how CH_4 emissions are generated.

The EF are only described and commented on in EMIS commentary 2012/2B5 Acetic acid production. Primary literature, on which is based the precursor of the EMIS commentary, is not referenced in the EMIS commentary.

In CRF tables 2(I)s1, 2(I).A-Gs1, v1.6 for the years 1990 and 2008-2010 acetic acid is included together with sulphuric acid, in the "Organic chemicals production" section. Since sulphuric acid is an inorganic acid, this should be assigned to a new section.

5.5.2 Ethylene production

5.5.2.1 General observations

Ethylene is the basic chemical most often produced by the petrochemical industry and is principally used in the production of plastics. In the packaging sector, it is mainly used for PET bottles and films. The financial crisis meant that, in 2009, there was a massive fall in production quantities, which also had an influence on Switzerland. New developments and studies [9] indicate that, in 2017, the worldwide usage of ethylene will again reach the levels of the record year of 2008.

In Switzerland, ethylene production includes the thermal cracking of liquid petroleum gas (propane/butane) and light petrol. According to the data provided by the association scienceindustries [8] only one cracker is operated in Switzerland, by Lonza AG, which uses the cracker products as raw materials for the production of ammonia or prussic acid, or for chemical synthesis. The process characteristics mean that it is not possible to assign the CO_2 process emissions from the process line to the various individual products. This is why the emissions are fully assigned to the production of ethene.

5.5.2.2 Completeness

According to EMIS commentary 2012/2B5 Ethene production, Cracker process and data from the association scienceindustries, there is only one company in Switzerland known to use a cracker to manufacture ethene. The relevant company is, therefore, included.

The production quantity of ethene designated in the EMIS commentary for the period 1990-2010 is based on the annual production data from Lonza AG. No gaps could be found.

CO_2 is designated as a relevant climate gas in the EMIS commentary. This is conclusive and correct.

The ethene production process is described in detail and practically in EMIS commentary 2012/2B5 ethene production, Cracker process and also includes information on the relevant by- products, whilst referring to other EMIS commentaries.

5.5.2.3 Methodology and assumptions

The CO_2 emissions are calculated from 1990 using a tier 3 approach, with system specific data from the only Swiss production plant. This method corresponds to the 2006 IPCC Guidelines.

AD and CO_2 emissions are company-specific measurement values, which are used to calculate the EF. Values are available for the period 2000-2010. For the years 1990-1999, the mean value for the 2000-2009 period was used, as there were no data relating to CO_2 emissions. This procedure is good practice as defined by the 2006 IPCC guidelines and is reasonable.

Since this is a tier 3 approach and various reactants, such as propane/butane and light gasoline are used, it is not possible to make a comparison with the default EF provided for tier 1 in the 2006 IPCC Guidelines or to provide a country comparison. However, since the production process does not highlight any anomalies and the difference of EF of subsequent years is rather small (no outlier), the values seem to be plausible.

Remarks:

The 2006 IPCC Guidelines, Chapter 3, Section 3.9.2, state, under the tier 3 approach, that also CO_2 emissions, which leak from thermal energy for the process, should be designated as production emissions, if the process cannot be operated self-sufficiently in terms of energy. This should be considered in future inventories.

5.5.2.4 Verification of calculations

The AD are production figures from the sole manufacturer of ethene (not calculated). The EF were correctly calculated using measured emissions and AD and included in the EMIS commentary 2012/2B5 Ethene production, Cracker process.

The AD and EF are not included in the NIR for reasons of confidentiality.

The AD and EF in CRF tables 2(I)s1, 2(I).A-Gs1, v1.6 for the years 1990 and 2008-2010 are also not included for reasons of confidentiality. The calculations for the emissions in the years under consideration are correct and are included in these tables.

The uncertainty of the measured EF for the period 2000-2009 was assumed to be 5%, in accordance with the information contained in the 2006 IPCC Guidelines. EF uncertainty for years with no emission values was, at 30%, higher than the 2006 IPCC Guidelines. The uncertainty of the AD measured was low (1%) and reasonable. No comparison values are given in the IPCC guidelines.

5.5.2.5 Consistency

The AD were derived for the entire time series from 1990 to 2010 and the EF from 2000 to 2010 the same way and included in EMIS commentary 2012/2B5 Ethene production, Cracker process. Due to the lack of measured emission values, the mean value for 2000-2009 was used for the EF of 1990-1999. This is also described in the EMIS commentary.

There are no gaps and no change in the data source (company information).

5.5.2.6 Transparency

The ethylene production process is summarised in the NIR under the heading 2B5 Other. The process is satisfactorily and clearly described in the EMIS commentary 2012/2B5 Ethene production, Cracker process and in the NIR.

The method is described in simple terms in the NIR. Although the procedure represents a tier 3 approach in accordance with the 2006 IPCC Guidelines, no information has been made available on tier classification in the NIR or EMIS commentary 2012/2B5 Ethene production, Cracker process.

The AD and EF are not included in the NIR or CRF tables 2(I)s1, 2(I).A-Gs1, v1.6 for reasons of confidentiality, but they are referenced in the NIR. EMIS commentary 2012/2B5 Ethene production, Cracker process includes both the AD and EF in tabular form.

The calculations relating to emissions are correct and well-documented in CRF tables 2(I)s1, 2(I).A-Gs1, v1.6 for the years 1990 and 2008-2010.

All relevant data sources, methods and guidelines are referenced in EMIS commentary 2012/2B5 Ethene production, Cracker process and the NIR.

5.5.3 Caprolactam

5.5.3.1 General observations

Caprolactam is a global bulk chemical intermediate. Most of it is used as momomer in the production of polyamide nylon-6 from which a significant fraction is used in the carpet production. All commercial processes for the manufacture of caprolactam are based on benzene or toluene for the formation of cyclohexanone. Other reactants are NH_3, CO_2 and SO_2. Production of caprolactam can give rise to emissions of N_2O from the ammonia oxidation step.

According to the B2B-copany database (www.kompass.com) only trading companies for caprolactam are located in Switzerland. These are the following: Plinio Guscio S.A. (Geneva), Fista Handels- und Recycling AG (Zollikon), Sinpro SA (Lausanne). As listed in chapter 5.3 EMS Chemie AG is the important Swiss producer of polyamide. However, there is no indication that EMS Chemie AG has produced Caprolactam itself during the reporting period of the GHG inventory. According to historical data of EMS Chemie AG the company stopped its Caprolactam production in 1970. SwissPRTR shows no N_2O emissions from EMS Chemie AG since the year 2007. BASF a major producer of Caprolactam worldwide has subsidiaries in Switzerland. However, BASF's Caprolactam production sites are located outside Switzerland in Germany, Belgium and USA.

Based on this information there is no indication that Caprolactam is produced in Switzerland. No industrial source of Caprolactam and N_2O emissions from its manufacture is known.

5.5.4 Carbon black

5.5.4.1 General observations

Within the carbon black industry primary fossil fuels (natural gas, petroleum, coal) are used for non-fuel purposes in the production. The use of these primary fossil fuels may involve combustion of part of the hydrocarbon content for heat-rising and the production of secondary fuels that results in CO_2 and CH_4 emissions.

According to the association scienceindustries [13] carbon black is not produced in Switzerland. The association also evaluated import/export statistics for cross-check and verification. The import amounts of carbon black are more than ten times higher than the export figures. This is another indication that the processing of carbon black in Switzerland is based on foreign suppliers. Nevertheless, the company Timcal SA in Bodio produces primary synthetic graphite, aqueous graphite dispersions and silicon carbide and is registered on the B2B-company database (www.kompass.com) as supplier of carbon black. However, no information is available if the company imports the product for trade.

It is therefore assumed that carbon black is not manufactured in Switzerland on industrial scale and related CO_2 emissions do not occur.

5.5.5 Dichloroethylene

5.5.5.1 General observations

Dichloroethylene (1,2-Dichloroethene) is not produced in Switzerland according to the Swiss association scienceindustries [13].

On the B2B-company database (www.kompass.com) no enterprises are registered in Switzerland that produce or trade dichloroethylene.

In the 2006 IPCC Guidelines dichloroethylene production is not listed as source category any more.

Therefore reporting in the GHG inventory is redundant.

5.5.6 Styrene

5.5.6.1 General observations

According to the association scienceindustries [13] no styrene production is located in Switzerland. No related emissions of GHG are known for Switzerland.

According to Annex 3 of 2006 IPCC Guidelines "improvements since 1996" styrene production is no longer included in the guideline document 2006. Therefore reporting in the GHG inventory is redundant.

5.5.7 Methanol

5.5.7.1 General observations

According to 2006 IPCC Guidelines most of methanol is made by way of steam reforming of natural gas. The steam reforming produces synthesis gas comprised of CO_2, carbon monoxide and hydrogen. The natural gas to methanol production process produces methanol and by-product CO_2, CO and hydrogen from the synthesis gas.

According to the association scienceindustries [13] methanol is not produced in Switzerland. The association also evaluated import/export statistics for cross-check and verification. The import amounts of methanol are more than ten times higher than the export figures.

On the B2B-company database (www.kompass.com) registered enterprises are only traders or processors of methanol. No manufaturers are registered.

It is therefore assumed that methanol is not manufactured in Switzerland on industrial scale and related CO_2 and CH_4 emissions do not occur.

5.5.8 Coke

5.5.8.1 General observations

In the 2006 IPCC Guidelines coke production is not listed any more in chapter 3, chemical industry emissions. The 1996 IPCC Guidelines mentioned this substance. It seems that in the meantime no relevant emissions of CH_4 occur from this process.

According to the association scienceindustries [13] coke is not produced in Switzerland. The association also evaluated import/export statistics for cross-check and verification. The import amounts of coke are more than ten times higher than the export figures. However, according to the Swiss mineral oil association (annual report 2011) an amount of 235,500 t/a mineral oil products was used by Swiss refineries for their own operation and 66,015 t/a petroleum coke were produced by the refineries for other consumers in Switzerland. The total share of petroleum coke for refinery needs is not clear.

On the B2B-company database (www.kompass.com) registered enterprises for coke that may have potentially produced coke are Timcal SA, Bodio and Petroplus AG with refinery in Cressier (petroleum coke). The Cressier refinery, however, was sold to the company Varo Holding in 2012 due to bankruptcy of Petroplus. Tamoil refinery in Collombey is not registered as coke producer.

As mentioned above in chapter 5.5.4.1 Timcal SA produces among other substances calcined coke and could have been a potential source of CH_4.

5.5.9 New categories 2006

The present GHG inventory review is focused on 1996 IPCC Guidelines categories. However, in the following an expert estimate for the new categories under 2006 IPCC Guidelines is provided.

Ethylene Dichloride/Vinyl Chloride Monomer:

No production in Switzerland: Ethylene Dichloride is made by way of chlorination of ethen. No ethylene dichloride is available from the only ethen producer of Switzerland, Lonza AG. Vinyl chloride production is combined with ethylene dichloride production.

Ethylene oxide:

No production in Switzerland: Ethylene oxide is manufactured by catalytic reacting ethylene with oxygen. No ethylene oxide is available from the only ethen producer of Switzerland, Lonza AG. Other companies like DSM Nutritional Products or Chemische Fabrik Schärer&Schläpfer AG which are listed in the SwissPRTR database as ethylene oxide sources are only ethylene oxide processors not manufacturers.

Acrylonitrile:

Small production volume possible: DSM Nutritional Products AG in Kaiseraugst is registered in the B2B-company database (www.kompass.com) as supplier and may have production capacity and plants. Other listed companies are traders only.

Titanium dioxide:

No production in Switzerland: There is no evidence of production of titanium dioxide in the B2B-company database (www.kompass.com) as all registered companies are traders. Titanium dioxide is the most important white pigment in the market. Pigment producers with plants in Switzerland like BASF are focused mainly on organic pigments.

Glyoxal/Glyoxilic acid:

No production in Switzerland: There is no evidence of production of glyoxal or glyoxilic acid in the B2B-company database (www.kompass.com). Glyoxal is used as crosslinking agent for vinyl acetate/acryilic resins, disinfectant, gelatine, textile finishing agent; glyoxilic acid is used for the production of synthetic aromas, agrochemicals and pharmaceutical intermediates. Although several companies like BASF, Clariant or DSM Nutrional Products AG may produce these substances of wide use within their plants the Swiss circumstances (small capacity, no acetaldehyde source) are not favourable for the bulk manufacture of these chemicals.

6. Metal production (2C)

6.1 Iron and steel production (2C1)

6.1.1 General observations

The iron and steel production in Switzerland has two main production sites (Stahl Gerlafingen AG, a member of the Beltrame group and Swiss Steel AG, formerly Von Moos Stahl AG, a member of the Schmolz & Bickenbacher group). At least another small electric arc furnace (EAF) is operated only occasionally by Stadler Stahlguss AG, Biel. In addition there are three production sites operating cupola furnaces (Nottaris AG, Oberburg, Giesserei Erzenberg, Liestal and Von Roll Choindez, Choindez) used to produce cast iron. There is a number of companies producing ferroalloys using electric, inductive or gas fired furnaces which produce no process emissions of the three gases to be reviewed.

6.1.2 Completeness

According to NIR iron and steel production comprises also the production of ferroalloys (source category 2C2). The two steel production sites using electric arc furnaces produce 99.9 % of the Swiss steel production.

The production of steel per year is well known and given precisely by the two main production sites in Switzerland (see EMIS-comment 2012/2C1 Stahlproduktion Elektroschmelzöfen). The production of cast iron is given by the association of Swiss foundaries and well known as well.

Regarding the emissions CO_2 is the only relevant emission known. Methane, indicated as emitted by EAF in IPCC 2006 Guidelines vol. 3 chapter 4 figure 4.5. is not emitted by Swiss EAF according to NIR. This statement is reasonable, as Stahl Gerlafingen has a post-combustion which also burns eventually present CH_4. Swiss Steel on the other hand uses much cleaner scrap to produce highly alloyed steel. The CH_4 produced in cupola furnaces (about one third of total VOCs) can be neglected, as their production amounts only to about 1.5 % of Swiss steel and iron production in 2010 and because the total VOC-

emissions are at least three orders of magnitude smaller than CO_2 emissions.
To our knowledge there is no emission of N_2O in steel production.

The process description is not adequate to understand the emission source. In NIR the description is too little detailed, in EMIS-comment 2012/2C1 Stahlproduktion Elektroschmelzöfen there is no description at all.

Remarks:

In EMIS-comment 2012/2C1 Stahlproduktion Elektroschmelzöfen the table with AD indicates the total of the steel production of Stahl Gerlafingen AG, Swiss Steel AG (former Von Moos Stahl AG) and steel foundaries as Swiss Steel AG, which is only correct for some years. Furthermore it should be checked whether the production of steel foundaries produces CO_2-emissions (no EAF's, probably no cupola furnaces) and whether the (high) emission factor used for the two main steel producers is not overestimating the emissions of the small steel foundaries. The influence on the CO_2-emissions of steel production is less than 2 ‰, therefore the small steel foundaries could also be neglected in the AD table.

According to EMIS-comment 2012/2C1 Stahlproduktion Elektroschmelzöfen the CO_2 emission factor according to measurements in 1990 is 100 kg/t steel. The default value according to IPCC 2006 Guidelines chapter 4.2.2.3 table 4.1 is 80 kg/t steel. The 1990 Swiss value is therefore comparable to the default value and assumed to remain the same for the time period of 1991 to 1998. In 1998 new measurements at the Stahl Gerlafingen plant resulted in a significantly higher value of 170 kg/t steel. The reason for this increase is explained by increasing impurities in the scrap and the newly installed post combustion chamber at Stahl Gerlafingen. It should be verified:

- whether the gas consumption of the post combustion chamber (max. 1'800 m^3 gas/h, equivalent to max. 36 $kgCO_2$/t steel) is not yet accounted for in the process energy.

- whether the gas consumption of the gas preheater in front of the post combustion chamber (max. 300 m^3gas/h, equivalent to max. 7 $kgCO_2$/t steel) is not yet accounted for in the process energy.

- whether the gas consumption of the oxygen-gas burners in the EAF (ca. 700 m^3gas/h, equivalent to max. 14 $kgCO_2$/t steel) is not yet accounted for in the process energy. This contribution has to be considered as process energy, as it helps to reduce the tap to tap time, i.e. supports the energy introduced across the electrodes.

The basic question is, whether the gas consumption of Stahl Gerlafingen is split into heating, shaping and EAF (split into furnace burners, support and post-combustion burners). A second question is, whether post-combustion is process energy or process emission. A hint to solve this question could be the comparison with emissions arising from printing plants (often equipped with post-combustion systems).

6.1.3 Methodology and assumptions

The anthropogenic CO_2 emissions of the iron and steel production processes are determined by a tier 1 approach using a country specific emission factor based on measurements at the two main production sites. The choice of methodology is according to IPCC 2006 Guidelines. It is likely that the country specific emission factor overestimates the process related emissions of CO_2.

The two main production sites and the association of Swiss foudaries supply production data. The origin of data is known and data collection is best practice with minimal uncertainties.

6.1.4 Verification of calculations

AD are production data of the industry. The EF was derived by measurements and adjusted to the new situation after environmental improvements of the Stahl Gerlafingen plant. The calculations of the anthropogenic part of the CO_2-emissions are correct for the reviewed years 1990 and 2008 to 2010 (according to CHE 2012-year v1.6, tables 2(I)s1 and 2(I)A-Gs2).

Uncertainties of CO_2-emissions are dominated by the uncertainty of the EF (20 %) which is higher than the uncertainty of AD (5 %). The uncertainty of both contributions is lower than the values given in IPCC 2006 Guidelines vol.3, chapter 4.2.3 table 4.4. Nevertheless the uncertainties given in EMIS-comment 2012/2C1 Stahlproduktion Elektroschmelzöfen are reasonable, as the AD are almost on tier 3 level, while EF are better than tier 1 and less than tier 2.

Remark:

In NIR chapter 4.4.3.1 the uncertainty of EF is given as 40 %. This does not correspond to the uncertainty given in EMIS-comment 2012/2C1 Stahlproduktion Elektroschmelzöfen, except for the forecast since the latest measurements of EF available.

6.1.5 Consistency

The time series of AD and EF are documented in EMIS-comment 2012/2C1 Stahlproduktion Elektroschmelzöfen for the time period of 1990 to 2010.

There was no change of data source since 1990, except that the steel production aside the two main production sites is included since 2002.

6.1.6 Transparency

The description of the processes given in NIR could be more detailed. The lack of detail may have led to a double counting of part of the CO_2 emissions of Stahl Gerlafingen AG. Furthermore it cannot be excluded that the minor contribution of steel production aside the two main production sites is actually zero.

The methodology is documented in the NIR document with background information in EMIS-comment 2012/2C1 Stahlproduktion Elektroschmelzöfen.

The AD and EF as well as the origin of both are referenced in NIR and documented in EMIS-comment 2012/2C1 Stahlproduktion Elektroschmelzöfen.

The calculations given in the CRF tables named CHE-2012-year-v1.6 could be followed and recalculated. They are correct.

All sources of data, methodologies and guidelines are referenced.

Remarks:

In NIR chapter 4.4.2.1 iron and steel production section b) and c) EF's and AD's are given for iron, steel, battery recycling and non-ferrous metals, AD even for aluminium production. As these other processes are treated in chapters 4.4.2.2. to 4.4.2.4 it would be easier to follow the processes if either the tables would be placed at the end of chapter 4.4.2 or split and presented in the appropriate subchapter.

6.2 Ferroalloys production (2C2)

6.2.1 General observations

Ferroalloys production is included in 2C1 as it is considered to produce none of the three greenhouse gases to be reviewed. This does not correspond to IPCC 2006 Guidelines vol. 3, chapter 4.3. where emission factors of CO_2 and CH_4 are given for different ferroalloys. On the other hand there is no ferroalloys production in EAF in Switzerland.

6.3 Aluminium production (2C3)

6.3.1 General observations

Since April 2006 there is no more aluminium production in Switzerland. Therefore NIR 2012 presents a historical view for the time 1990 to 2006. The following review covers only 1990.

Most carbon dioxide emissions result from the electrolysis reaction of the carbon anode with aluminium oxide. The reactions leading to carbon dioxide are well understood and the emissions are directly connected to the tonnes of aluminium produced through the fundamental electrochemical equations for aluminium oxide reduction at a carbon anode and oxidation from thermal processes.

During electrolysis aluminium oxide is dissolved in a fluoride melt comprising cryolite. PFC (CF_4 and C_2F_6) are formed from the reaction of the carbon anode with the cryolite melt during a process upset condition known as anode effect.

6.3.2 Completeness

In 1990 only one company was producing aluminium in Switzerland (Alcan AG).

The AD is based on data of the production company.

The process description is adequate to understand the emission source.

The production amount is correct and was derived from aluminium industry for the years 1990-1996 and for 1997-2006 from the Swiss aluminium association according to NIR. No gaps were discovered.

CO_2 and PFC (CF_4 and C_2F_6) are the only relevant GHG process emissions from aluminium production.

6.3.3 Methodology and assumptions

The EF for CO_2 is country specific based on measurements by the industry. The value for 1990 was assumed to be constant over the time series. It happens to be identical with the default emission factor given in IPCC 2006 Guidelines Vol. 3 chapter 4.4.2.2 table 4.10 for the prebake technology. Although not stated, something like a tier 1 method was used for the calculation of CO_2 emissions.

The EF for PFC have been monitored periodically by the industry for selected years. Own measurements were provided in 1990, 1999 and 2000 yielding smaller EF than the European average. These EF seems to be plausible because a low emission point feed prebake technology (PFPB) was used in Switzerland. For years without measurements a general reduction factor of 4 was adopted based on the average European values as reported by the European aluminium association. The ratio of 90% to 10% for CF_4 to C_2F_6 emissions seems to be plausible.

For the calculation of PFC emissions a tier 3 approach was chosen according to IPCC Guidelines 2006.

Origin of AD is reasonable.

6.3.4 Verification of calculations

AD are production data of the industry. The EF for CO_2 and PFC were derived from measurements by the industry for the year 1990. The calculation of the CO_2- and PFC-emission is correct for the year 1990 (according to CHE 2012-1990 v1.6, tables 2(I)s1, 2(I)A-Gs2, 2(II)s1, 2(II)s2 and 2(II).C). For the other years covered by the review (2008 to 2010) there was no more production in Switzerland.

Uncertainties of CO_2- and PFC-emissions are not given in NIR, probably due to the fact that no source is operational. In the Carbotech-report, chapter 4 an overall uncertainty of 12.6% is listed for total F-gas emissions of metal production. However, it is not clear if this includes aluminium production, aluminium foundries and magnesium foundries together. 2006 IPCC Guidelines mention for PFC an uncertainty of +-

15% for measured tier 3 coefficients, however references for total uncertainty for CO_2- and PFC-emissions are not provided in the guidelines.

Remark:

The uncertainty of CO_2- and PFC-emissions of aluminium production has to be verified.

6.3.5 Consistency

This review covers only one year (1990), therefore the consistency of methodology, AD and EF is irrelevant. Nevertheless, NIR informs that for years without measured PFC EF (e.g. 2001-2006) EF have been interpolated from European EF considering a correction factor of 0.25 as a low emission point feed prebake technology (PFPB) was used in Switzerland.

Remark:

The NIR and Carbotech-report do not inform about the reason for the PFC EF interpolation from European data for the years with no measured emission data available instead of using measured EF of Switzerland as basis for interpolation.

6.3.6 Transparency

EMIS-comment 2012/1A2b & 2C3 Aluminium Produktion only makes the definition that emissions partly originate from aluminium electrolyses and partly from electrode production which is on site.

The methodology is documented in the NIR document with background information in EMIS-comment 2012/1A2b & 2C3 Aluminium Produktion.

The AD and EF as well as the origin of both are referenced in NIR and documented in EMIS-comment 2012/1A2b & 2C3 Aluminium Produktion and Carbotech-Excel-table.

The calculations given in the CRF table named CHE-2012-1990-v1.6 could be followed and recalculated. They are correct.

All sources of data, methodologies and guidelines are referenced.

Remarks:

There is no process description in NIR or EMIS-comment 2012/1A2b & 2C3 Aluminium Produktion indicating the relevant steps of the production leading to CO_2 emissions. Also no description of the processes leading to PFC emissions is available in the Carbotech-report (chapter 3.1.1).

No description of methodology, AD and EF of PFC from aluminium production is provided in the Carbotech-report.

6.4 SF_6 used in aluminium and magnesium foundries (2C4)

6.4.1 General observations

SF_6 is used together with other carrier gases like nitrogen or air as inert gas during melting and casting of magnesium and magnesium alloys and aluminium cleaning. The inert gas builds a protection layer on the surface and prevents oxidation and ignition of the metal cast in the case of magnesium.

In 2010 only one magnesium foundry is known in Switzerland. There is no use of SF_6 in aluminium foundries according to the Swiss foundry association (GVS).

However, an internet search showed that Düdal aluminium foundry in Düdingen and turgibega aluminium foundry in Turgi, seem to use SF_6 in some of their production.

6.4.2 Completeness

As stated in the NIR, the use of SF_6 in aluminium and magnesium foundries is derived in an indirect manner using import data of SF_6 and the assumption that the average imported amount of the actual year of NIR reporting and the previous year has been emitted to 100%.

The process description is adequate to understand the emission source. The aluminium and magnesium casting processes are found in Switzerland.

There is only SF_6 relevant which is considered for these applications.

6.4.3 Methodology and assumptions

The emissions of SF_6 by aluminium and magnesium foundries are determined by a tier 1 approach using the default emission factor of IPCC 2006 Guidelines and AD based on import data of SF_6. Considering the lack of company specific data this approach is reasonable.

6.4.4 Verification of calculations

SF_6 emissions in the Carbotech-Excel-table were calculated correctly.

For the use (eventually AD and EF combined) an overall uncertainty of 20% according to a Monte Carlo simulation of the emissions is stated in NIR.

Remarks:

The process 2C4 leads to emissions in Switzerland. In NIR EF and AD are given. In the calculation tables zero emissions are indicated due to a lack of significant digits in the result. According to the Carbotech-Excel-table and Carbotech-report SF_6 emissions are still occurring from magnesium casting and before the year 2009 from aluminium foundries as well.

According to IPCC 2006 Guidelines Vol. 3 chapter 4.5.3 an uncertainty of 30 % for the SF_6 emissions of a typical magnesium casting process is proposed. It is not clear why 20 % is assumed in NIR. In the Carbotech-report an uncertainty of 12.6% for SF_6 emissions of metal production is listed, however, it is not clear if this value does also encompass aluminium and magnesium casting.

- there is no information given in NIR regarding the relative amounts of SF_6 import for the one magnesium foundry active in Switzerland and the at least two aluminium foundries stating SF_6 casting.
- in the calculation tables (CHE 2012-year v1.6, tables 2(I)s1, 2(I)A-Gs2, 2(II)s1 and 2(II)s2) zero emissions are indicated due to a lack of significant digits in the result; therefore uncertainty is irrelevant.

6.4.5 Consistency

According to NIR 2012 a methodological change was introduced for the inventory report 2011. The import amount for aluminium cleaning was extrapolated from an estimate value provided by an import company in the year 2003.

The AD for magnesium casting and EF for magnesium casting and aluminium cleaning have been derived the same way for the entire time series. No gaps of data source are known.

Remarks:

In the Carbotech-Excel-table a linear extrapolation of AD for aluminium cleaning from 2003 until 2009 as stated in NIR is not obvious and should be verified.

It is not clear if SF_6 AD for magnesium casting has been derived from FOEN import data or from Swissmem statistics. This has to be described in NIR and the Carbotech-report.

Although the Carbotech-Excel-table documents SF_6 AD values for years before 2003 for aluminium cleaning NIR states that no data are available for later years. The source of these data is not clear.

6.4.6 Transparency

NIR includes a chapter treating the process of SF_6 use in aluminium and magnesium foundries but finally zero emissions are listed within the digits provided by the CHE-2012-year v1.6 tables. More significant digits (up to digits not equal to 0) would increase the transparency.

The description of the process given in NIR indicates the relevant steps of the production leading to SF_6 emissions and therefore to emissions of CO_2 equivalents.

The methodology is documented in the NIR document.

The AD and EF as well as the origin of both are referenced in NIR.

The methodology and IPCC guidelines are referenced in NIR only.

Remarks:

The calculations for SF_6 in the category 2C4 given in the CRF tables named CHE-2012-year-v1.6 yield zero emissions within the number of digits presented in the table (with more digits the emissions occurring would become noticeable).

Not all sources of AD for aluminium cleaning and magnesium casting are mentioned in NIR and the Carbotech-report, appendix 5.

The process descriptions are very short and the methodology is not listed in the Carbotech-report.

6.5 Other (2C5)

6.5.1 General observations

The recycling efforts of Batrec AG are more and more extended into other materials charged with mercury (charcoal, spent catalyst). This may influence the process in a way that it is no more primarily a process of metal industry.

6.5.2 Completeness

Battery recycling:

The amount of batteries recycled per year is well known and given precisely by the one company active in Switzerland for the years 2000, 2003, 2004, 2006 - 2010 (EMIS-comment 2012/2C5e Batterie-Recycling). The AD of 1990 to 1999 as well as 2001 and 2002 are based on the assumption that they were the same as that of the year 2000 and kept constant. The AD of 2005 is probably an interpolation of the previous and the following year (not declared).

Regarding the emissions of the battery recycling process CO_2 is the only relevant emission known. Methane is probably not emitted, although high carbon monoxyde concentrations are produced during pyrolisation (probably therefore also methane) and this furnace gas used as process energy (to heat pyrolising furnaces) and subsequently burnt in the post-combustion chambers. N_2O is probably not produced, as the process is not equipped with a DeNOx-system. To our knowledge there are no data available for CH_4 and N_2O.

The process description is adequate to understand the emission source.

Remarks:

It is not clear whether the furnace gas used to heat the pyrolising furnaces should be considered as process energy and subsequently reported there. Furthermore a part of the CO_2-emissions arises from burning of oil as source of process energy to heat the pyrolising furnaces. If post-combustion is considered as process energy (see also 6.1.2.) all CO_2-emissions should be reported as process energy.

In the pyrolising furnaces, originally designed to recycle batteries, nowadays also contaminated activ charcoal is treated. Some of the CO_2-emissions therefore do not originate from battery recycling.

Non-ferrous metals:

There are at least eight non-ferrous heavy metal, two magnesium and 29 aluminium foundaries in Switzerland.

The production per year is well known and given precisely by the association of Swiss foundaries.

As furnaces using electricity as process energy are used, there are no emissions of CO_2, methane or N_2O to be expected.

There is no explicit process description in NIR.

6.5.3 Methodology and assumptions

Battery recycling:

The anthropogenic CO_2 emissions of battery recycling are determined by a tier 2 approach (not declared) using a country specific emission factor derived from measurements and AD provided by the one company active in Switzerland.

IPCC 2006 Guidelines give no methodology for battery recycling.

There is no similar process used elsewhere in Europe.

Non-ferrous metals:

As there are no emissions of CO_2, CH_4 or N_2O in this process there is no methodology to be reviewed. IPCC 2006 Guidelines Vol. 3 does not mention non-ferrous metal production.

6.5.4 Verification of calculations

Battery recycling:

AD are production data of the industry. The EF was derived from emission measurements. There are different EF’s for 1990 (0.55 t/t, not declared in NIR 2012) and the remaining period relevant for this review (2008 - 2010, 0.56 t/t due to increased production capacity of the plant). The calculations of the anthropogenic CO_2-emissions are correct for the reviewed years 1990 and 2008 to 2010 (according to CHE 2012-year v1.6, tables 2(I)s1 and 2(I)A-Gs2).

Uncertainties of CO_2-emissions are qualitatively estimated and documented in NIR. They are estimated as „medium”, which translates into 10 % uncertainty.

Remarks:

The estimate is only partly consistent with the uncertainties given in EMIS-comment 2012/2C5e Batterie-Recycling. The 1990 AD is assigned a 30 %, 2008 to 2010 a 5 % uncertainty. The EF’s are based on measurements assigned an uncertainty of 5 % for CO_2 concentration and volumetric flow rate. Therefore the uncertainties could be calculated and should arise to 31 % in 1990 and 9 % for 2008 - 2010. The latter is consistent with the estimate.

Non-ferrous metals:

AD are production data of the industry. The AD values in NIR and in the calculation tables correspond (CHE 2012-year v1.6, tables 2(I)s1 and 2(I)A-Gs2).

As there are no EF's, hence no emissions, there is also no need for uncertainty budgets.

6.5.5 Consistency

Battery recycling:

The time series of AD and EF are documented in EMIS-comment 2012/2C5e Batterie-Recycling for the time period of 1990 to 2010. Gaps in AD were closed either by the assumption of constant AD or by interpolation. There are only two different EFs for the whole period.

There was no change of data source since 1990.

Remark:

It is somewhat strange to present data for 1990, as the process exists only since 1994. For this year an EF could be derived based on the first measurements available.

Non-ferrous metals:

The time series of AD and EF (NA) are documented in NIR for the time period of 1990 to 2010 without gaps in the AD for this period of time.

There was no change of data source since 1990.

6.5.6 Transparency

Battery recycling:

The description of the process given in NIR indicates the relevant steps of the production leading to CO_2 emissions correctly.

The methodology is documented in the NIR document with background information in EMIS-comment 2012/2C5e Batterie-Recycling.

The AD and EF as well as the origin of both are referenced in NIR and documented in EMIS-comment 2012/2C5e Batterie-Recycling.

The calculations given in the CRF tables named CHE-2012-year-v1.6 could be followed and recalculated. They are correct.

All sources of data, methodologies and guidelines are referenced.

Non-ferrous metals:

There is no description of the process given in NIR as there are no emissions of CO_2, CH_4 or N_2O.

There is no methodology to be documented in the NIR, as there are no emissions of CO_2, CH_4 or N_2O.

The AD and EF as well as the origin of both are documented in NIR.

The AD given in the CRF tables named CHE-2012-year-v1.6 are correct.

All sources of data, methodologies and guidelines are referenced.

7. Other production (2D)

7.1 Pulp and paper (2D1)

7.1.1 General observations

According to IPCC 1996 Guidelines there are no CO_2, CH_4 and N_2O emissions to be expected by pulp and paper production as well as chipboard-fibreboard production. Cellulose production ceased in 2008.

In IPCC 2006 Guidelines Vol. 4 chapter 12.1 states that all CO_2 originating from harvested wood products is dealt with under the section agriculture, forestry and other land use. Therefore pulp and paper, as well as chipboard-fibreboard productions are not part of this review.

Accordingly the tables CHE 2012-year v1.6, tables 2(I)s2 and 2(I)A-Gs2 show no emissions.

7.2 Food and drink (2D2)

7.2.1 General observations

According to IPCC 1996 Guidelines there are no CO_2, CH_4 and N_2O emissions to be expected by food and drink production.

In IPCC 2006 Guidelines no hints to food and drink production could be found. A search for emission factors of CO_2, CH_4 and N_2O in the emission factor database of IPCC yielded no results.

A search in EMEP/CORINAIR emissions inventory guidebook 2006, group 4, production processes chapters B465 and B466 showed that CO_2 is produced in fermentation (B466, chapter 3.3.2), but only emission factors for NMVOC are presented.

The following EMIS-comments 2012/2D2 include emission factors for ***biogenic*** CO_2:

- EMIS-comments 2012/2D2 Bierbrauereien

- EMIS-comments 2012/2D2 Wein Produktion

- EMIS-comments 2012/2D2 Brot Produktion

- EMIS-comments 2012/2D2 Branntwein Produktion

As biogenic CO_2 emissions are not treated by NIR, these contributions are not object of this review.

Accordingly the tables CHE 2012-year v1.6, tables 2(I)s2 and 2(I)A-Gs2 exhibit no emissions.

Remarks:

Methane is not expected in these processes, as they are aerobic. Only anaerobic fermentation would produce methane and probably also hydrogen sulfide which would deteriorate the taste of the product.

The following processes might lead to non-biogenic CO_2 production:

- production of bakery products using baking soda; it should be checked whether the production of baking soda uses fossile sources (carbonates)

- production of sparkling mineral waters; it seems that most of the industrial CO_2 production originates from fossil fuel use (generator gas).

8. Other (2G)

8.1 Blasting and shooting (2G1)

8.1.1 General observations

Blasting is a minor source of process-related CO_2-emissions in Switzerland (2010: ≈ 0.4 ‰; an almost negligible contribution).

8.1.2 Completeness

The emissions are calulated based on statistics of use of explosives for civil and military purposes. They do no more (not being clear since when) include the emissions due to shooting, as military authorities do not respond to requests. The AD of explosives derived this way are corrected for the use in source categories cement production (2A1), lime production (2A2) and plaster production (2A7) to avoid double counting of the emissions.

Due to the chemical properties of explosives there is no CH_4 or N_2O emitted.

8.1.3 Methodology and assumptions

The CO_2 emissions are calculated using a country specific method (probably tier 2) using AD derived from Federal statistics of use of explosives and EF based on a publication of BUWAL in 2000 (reference see EMIS-comment 2012/2G Sprengen und Schiessen, reference [2]). The EF is an average of EF's for civil and military explosives which differ. Furthermore a model calculation is used to convert the different products (emulsions, fuses etc.) into TNT equivalents.

IPCC 2006 Guidelines give only general methodologies for non-listed industrial processes.

8.1.4 Verification of calculations

The calculation of AD could be followed and is reasonable. The calculation of the EF for CO_2 could not be followed in detail, as the calculation is based on an internal work sheet of BAFU.

The calculations of the CO_2-emissions from blasting are correct for the reviewed years 1990 and 2008 to 2010 (according to CHE 2012-year v1.6, tables 2(I)s2 and 2(I)A-Gs2).

Uncertainties of CO_2-emissions are qualitatively estimated and documented in NIR. They are estimated as „medium", which translates into 10 % uncertainty.

Remarks:

The correction of the use of explosives with the use in industrial processes already mentioned in other sectors bases on 0.13 kg explosive/t of cement. In NIR an emission factor based on 0.16 kg explosive/t of cement is mentioned and used for the calculations. With the higher consumption factor the correction would amount to 740 t instead of 600 t to be deducted. This would reduce the CO_2 emissions calculated for blasting by 6 % respectively leads to a double counting of 6 % of the emissions of this process

8.1.5 Consistency

The time series of AD are documented in NIR for the time period of 1990 to 2010 and in EMIS-comment 2012/2G Sprengen und Schiessen for 1990 and 1995 to 2010. There is only one EF assumed to be valid for the whole period.

The methodology was the same for the whole time period.

There is a change of data source since 1995, when statistics on use of explosives became available. This change in source is documented. Unfortunately the source of the data for the previous years is not documented.

Remarks:

The source of AD for 1990 to 1995 is not given in NIR or EMIS-comment 2012/2G Sprengen und Schiessen.

8.1.6 Transparency

The methodology is documented in the NIR document with background information in EMIS-comment 2012/2G Sprengen und Schiessen.

The AD for the years 1995 on and the EF as well as the origin of both are given in NIR and further explained in EMIS-comment 2012/2G Sprengen und Schiessen.

The calculations given in the CRF tables named CHE-2012-year-v1.6 could be followed and recalculated. They are correct.

All sources of data, methodologies and guidelines are referenced.

PART 2: REVIEW OF HFC, PFC AND SF_6-EMISSIONS

9. Production of halocarbons and SF_6 (2E)

9.1 General observations

During the reporting period no halocarbons or SF_6 were produced in Switzerland. A review of the SwissPRTR register confirmed this for the period 2007 to 2010. No companies were found to include SGG in their production portfolio.

The Carbotech report [2] also confirms that there had been no Swiss production of these substances in the past.

Enquiries carried out by the reviewer have shown that only Solvay AG, which is one of the leading producers of HFC and SF_6 and could potentially be involved in production, has for a long time operated a plant in Zurzach, Switzerland. However, no halocarbons or SF_6 have been manufactured on the Swiss site. Currently, Solvay, in Switzerland, is primarily a trading company. Research by the association scienceindustries has confirmed this view. For this reason source category 2E incl. By-product emissions (2E1), Fugitive emissions (2E2) and Other (2E3) correctly states in the Swiss greenhouse gas inventory that there are no SGG emissions.

10. Consumption of halocarbons and SF_6 (2F)

To help evaluate this section, instead of the FOEN EMIS commentaries, only Excel worksheets [3] and a summary report [2] from those responsible for compiling the greenhouse gas inventory of PFC, HFC and SF_6 (Carbotech AG) are available. These were subsequently corroborated by data in the NIR and the CRF tables.

10.1 Refrigeration and air conditioning equipment (2F1)

10.1.1 Domestic refrigeration

10.1.1.1 General observations

The domestic refrigeration sector of application is responsible for around 1% of the calculated emissions of synthetic greenhouse gases in Switzerland (CO_2 equivalent percentage) [5]. Currently, in Switzerland, around 50 companies make up the domestic appliances sector, which includes both importers and manufacturers of domestic electrical appliances. These offer sales and service networks throughout Switzerland. However, currently only the company Forster Kühltechnik AG in Arbon manufactures domestic refrigeration products in Switzerland. The domestic appliance sector is characterised by competition that is usually fierce, with this same competition being the reason why these appliances are being constantly renewed. The majority of companies have organised themselves into the Association of Electrical Appliances for the Domestic and Commercial Markets, Switzerland (FEA). Each year, this association publishes statistics on the number of sold refrigerators, freezers and air-conditioning units. Since 2008, there has been a significant increase of 4-10 % in the figures relating to refrigerators and freezers sales.

According to the Swiss ChemRRV [1], since 2005, there has been a ban on “materials that are stable in air” in domestic refrigerators and freezers, dehumidifiers and air-conditioning equipment. This includes the production, marketing and importing, for private purposes, of appliances and machines. Exceptions may be allowed.

10.1.1.2 Completeness

This sector is extensive throughout Switzerland, with more than 250,000 refrigerators and 110,000 freezers sold annually.

According to the information supplied by the Association of Electrical Appliances for the Domestic and Commercial Markets, Switzerland (FEA), all relevant importers and the one known manufacturer (Forster Kühltechnik AG) have been included in the Carbotech Report 2012 [2].

The quantity of SGG in the appliances was calculated by breaking down the import quantities against the number of appliances, taking the charges into consideration and is, therefore, fully documented.

The relevant synthetic gas used in refrigerators and freezers (HFC134a) was taken into consideration.

The specific values for lifespan, capacity and emission factors in the NIR tally with the data in the Carbotech Report.

Remarks:

The quantities of SGG in sold appliances only reached the level of 0% in 2009, even though there had been a prohibition on manufacture and importation since 2005, according to ChemRRV. Clarification is sought on whether or not there were exceptions to this regulation up to 2009.

The area of application and the appliances it covers were not specified in more detail in the Carbotech Report.

10.1.1.3 Methodology and assumptions

The SGG emissions were calculated using a tier 2 approach and satisfy the 2006 IPCC Guidelines. The EF applied were specific to Switzerland and take into consideration refrigerant emissions and emissions from insulation foams.

The EF values appear to be plausible and are within the EF default area defined in the 2006 IPCC Guidelines, Chapter 7.5.2.2. Experts' statements were taken into consideration when calculating these levels. EF were taken into consideration for the operation and disposal of cooling devices. The AD are based on data from manufacturers and vary within the default values in the 2006 IPCC Guidelines, Chapter 7.5.2.2. Both AD in cooling devices (production, operation and disposal) and SGG in insulation foams are included. Different quantities of cooling devices returns are taken into consideration in the AD (to 2002 80%, from 2003 90%).

The bottom-up approach selected for calculating the EF and AD are in accordance with the 2000 IPCC Good Practice Guidance.

The basic data used to calculate the emissions included a device lifespan of 12 years (2009 inventory submission), which was increased to 16 years (2010 inventory submission). This is in line with expert opinion and tallies with the 2006 IPCC Guidelines.

Remarks:

No EF was considered for manufacturing although one Swiss manufacturer of domestic refrigeration appliances is known (Forster AG, Arbon).

10.1.1.4 Verification of calculations

The AD, EF, device lifespan and capacities in the Carbotech Excel tables [3] tally with the data in the NIR.

The AD and EF in the CRF tables 2(II).F v1.6 for the years 1990 and 2008-2010 are in line with the values in the Carbotech Excel table [3]. The calculations of the emissions from stocks and disposals are correct for the years under consideration. For manufacturing refer to “Remarks”.

In order to determine the uncertainties of the model calculations using a tier 2 approach, a Monte Carlo analysis was carried out in accordance with 2000 IPCC Good Practice Guidance. This defined the uncertainties of all significant parameters such as capacities, EF and import/export levels. The listed uncertainties are plausible.

Remarks:

How the AD is calculated (percentage of refrigerant?) in the Carbotech Excel table [3] in the “Domestic refrigeration” section is unclear. Sometimes the units are missing from the relevant columns, which makes checking difficult.

The derivation of stock and disposal emission factors should be explained in the Carbotech Excel tables, particularly the combination of refrigerant emissions and emissions of insulation foams.

No AD was considered for manufacturing although one Swiss manufacturer of domestic refrigeration appliances is known (Forster AG, Arbon). This should be verified.

10.1.1.5 Consistency

The AD and EF were compiled in the same manner for the entire time series between 1990 and 2010. There are no gaps and no change to the data source in the Carbotech Excel table [3]. The disposal quantity HFC134a was calculated too low for 1990 and subsequent years (one-tenth of actual value). This was recognised and retrospectively correctedin 2007 for all years.

10.1.1.6 Transparency

The domestic refrigeration process is summarised in the NIR under the heading 2F1 Refrigeration and Air Conditioning Equipment. It is not specified in more detail which devices fall under this heading.

The method is clearly described in the NIR.

AD and EF are included in the NIR and the Carbotech Report [2] in tabular format and documented in the Carbotech Excel table [3]. The AD and EF in the CRF tables 2(II).F v1.6 for the years 1990 and 2008-2010 are comprehensible and well-documented.

The calculations of activity data and emissions are included in the Carbotech Excel table [3] and are well-documented.

Remarks:

The references were not explicitly stated in the Carbotech Report [2] for the domestic refrigeration area of application. Annex A4 with data sources is not referenced in Chapter 3.3.2.1 Domestic refrigeration. It is hard to understand the origins of the basic data with regard to EF, AD and lifespan. The Carbotech Excel table [3] contains only source data on lifespan. Data sources for EF are not given in the Carbotech Excel table.

The description of the tier 1 and tier 2 method is included in Carbotech Report [2] in Annex A6. Chapter 3.3.2.1 of the Carbotech Report does not include any cross-reference regarding to the annex or method.

10.1.2 Commercial refrigeration and Industrial refrigeration

10.1.2.1 General observations

The SGG, which were used in the commercial and industrial sectors, used to be calculated by the Swiss Inventory using the difference between the total import quantities of refrigerants and refrigerants that were used in the other areas of application. For this reason, the two areas of application, commercial and industrial, have not been assessed separately and are also summarised in the review report.

The commercial refrigeration section, according to the 2006 IPCC Guidelines includes cooling devices that are used in the retail business and may encompass as well centrally-installed cooling devices e.g. in supermarkets.

Commercial refrigeration cooling devices are used to keep retail goods and foodstuffs in particular, fresh and cool. They are mainly installed in foodstuff outlets, restaurants, market gardens and large kitchens (hotels, canteens, etc.). Different versions occur, depending on the area of application and the purpose. There are thousands of such devices in operation in Switzerland, the refrigerants in which represent a significant proportion of the SGG used.

The commercial refrigeration devices are broken down as follows:

– Plug-in devices
– Decentralised individual devices (refrigerant condensation outside sales room)
– Multi-compressor refrigeration systems (cooling devices with several parallel-switched compressors).

Multi-compressor refrigeration systems are the largest source of HFC emissions in the commercial refrigeration area of application. Therefore, steps taken to reduce emissions are particularly significant in terms of this application.

In accordance with the 2006 IPCC Guidelines the industrial refrigeration area of application includes coolers, cold stores and industrial heat pumps, which are mainly used in the foodstuffs and petrochemicals industries as well as other industrial sectors.

HFC are negligible in the foodstuffs industry in terms of their use as refrigerants and are not required as alternative refrigerants exist. This is the result of its low level of profitability in this area of application. The halogen-free refrigerants used in the chemical and pharmaceutical industries, apart from special applications, are state of the art. In cold stores with cooling devices > 1 MW, ammonia, not SGG, is used as a standard refrigerant. Even in smaller stores (cooling devices < 500 kW), cooling devices using ammonia or ammonia/CO_2 are currently state of the art. However, older equipment may still contain SGG.

Both commercial and industrial refrigeration areas of application are responsible for around 47% of the calculated emissions of synthetic greenhouse gases in Switzerland (percentage CO_2 equivalent 2009). They are the most significant source of SGG emissions.

10.1.2.2 Completeness

The commercial and industrial refrigeration areas of application are widespread in Switzerland. Since the dimensions of the devices and the capacities can differ greatly, the quantities of refrigerant can only currently be differentiated in the inventory by calculating the difference between the total import quantity of the refrigerant and the other areas of application, which require refrigerant.

Significant adjustments were made with regard to the recovery and recycling of refrigerants, with various expert information being taken into consideration. In addition, the corrections made to the mobile and stationary air-conditioning areas of application have swelled the refrigerant import figures for commercial and industrial refrigeration.

For the quantitative calculation of the refrigerant quantity within the commercial and industrial refrigeration areas of application a quality check was included in the 2010 inventory, which should indicate a significant deviation from the quantity of SGG included in the model calculations (in addition, the other areas of application of the SGG were also included in this quality check). Therefore, comparative values from Germany, IPCC default values and data from the Swiss registration office for cooling devices and heat pumps (SMKW) were used. The evaluation indicated a 4% deviation from the emission results calculated according to the IPCC default values. This deviation is acceptable in light of the data obtained from the model calculation (differentiation from other areas of application). However, the deviations from the values from Germany and SMKW are significantly higher (>10% SMKW).

In essence, it is correct that the SMKW data are currently not considered to be correct and, therefore, they are not used as concrete comparable values. The SMKW include neither the majority of devices with >3kg capacities or devices with <3kg refrigerant. It is, however, recommended that this database is developed further, verified and being used when the data will be more exact.

The differentiation between the quantity of refrigerants from commercial and industrial refrigeration for all HFC, which are used in the usual areas of application may be used to assume all gases that may potentially be included. These include HFC32, HFC125, HFC134a, HFC143a, HFC124, HFC152a, PFC218 and HFC23.

Remarks:

It is not clear whether or not the German comparative value for refrigerant storage quantities in the Carbotech Report [3], Chapter 3.3.2.2, Quality check on the range between 15,350 t HFC (2002) and 20,000 t HFC (2010) was used or if only one tenth of it was used.

The quality check is only mentioned in the NIR in general terms and not in relation to the area of application. This needs to be described in more detail.

The descriptions of the area of application in the NIR and Carbotech Report [2] are very brief and do not describe the relevant types of plants.

10.1.2.3 Methodology and assumptions

The SGG emissions are calculated using a tier 2 approach, corresponding to the data in the 2006 IPCC Guidelines. The emission factors applied are specific to Switzerland and, as such, were compared with German and Austrian EF for reasons of quality. The values are comparable with these countries. The EF provide average values for both the commercial and industrial refrigeration areas of application.

The values for the EF involved in production, usage and disposal appear to be plausible and are within the default EF of the 2006 IPCC Guidelines, Chapter 7.5.2.2 (for exceptions see “Remarks”). Experts’ statements were taken into consideration when defining the values. The various disposal methods in Switzerland were correctly taken into consideration when discussing the disposal of devices (SENS, in situ extraction).

The AD are based on the differentiation between import data (FOEN) and consumer data from other areas of application of cooling devices. The resulting residue is added to the new devices from the commercial and industrial refrigeration areas of application. The average system capacity was, therefore, not calculated. For the afore-mentioned reasons relating to the highly variable capacities for the devices this addition appears to be reasonable. In addition, the 2006 IPCC Guidelines, Chapter 7.5.2.2 highlight highly variable capacities of between 0.2 kg and 10.000 kg. For the first time in 2010, the inventory included calculations of the quantities of refrigerant recycled, which were calculated retrospectively, based on data from experts. It was noted that HCFC22 was currently being recycled at 70% due to the prohibition on CFC currently imposed on operators (maintaining existing devices). This appears to be plausible.

Remarks:

The usage EF falls from 12% in 1995 to 5% in 2020. It is not clear how this reduction of EF to 5% occurred.It should be documented what the underlying assumption for this reduction is.

Since the industrial refrigeration sector uses fewer SGG as a refrigerant than the commercial refrigeration sector, it would be sensible not to use the pure average values of both areas of application, but to weight them. More information on the SGG share of industrial and commercial appliances in Switzerland might provide SMKW.

The Carbotech Report [2] states that recycling of HFC134a and HFC404a refrigerant is around 10-20%. It should be clarified whether or not this is a mean value.

In the 2010 basic data for calculating emission, a device lifespan was defined as 10 years. This is in line with the 2006 IPCC Guidelines for commercial refrigeration. Devices within the industrial refrigeration area of application, however, have a much longer lifespan of 15-30 years. In the future, this should be taken into consideration in calculations.

It was assumed that 20% of the bulk import quantities of refrigerant used in devices was imported. This is not immediately obvious in either the Carbotech Report [2] or the Carbotech Excel tables [3], on which this assumption is based.

10.1.2.4 Verification of calculations

The calculation of the AD from the difference between the refrigerant import data and the quantities used from the other areas of application of the refrigerant was checked using spot tests in both the Carbotech Excel table and the import statistics for climate-related materials [4] and found to be correct.

The AD, EF and device lifespan in the Carbotech Excel tables [3] tally with the data in the NIR.

The AD and EF in the CRF tables 2(II).F v1.6 for the years 1990 and 2008-2010 are in line with the values contained in the Carbotech Excel table [3] (for exceptions see “Remarks”). The calculations of emissions from manufacturing, stocks and disposal are correct for the years under consideration.

In order to determine the uncertainties of module calculations according to tier 2, a Monte Carlo analysis was performed in accordance with the 2000 IPCC Good Practice Guidance. For this the uncertainties of all significant parameters, like filled and imported devices, EF and lifespan were determined. The uncertainties relating to these sources detected in the Carbotech Report [2] appear to be plausible. Chapter 4 of the Carbotech Report provides information on the calculated values of the Monte Carlo analysis with regard to the commercial refrigeration and industrial refrigeration areas of applicable, giving a total uncertainty of 19.4%. The NIR confirms this value.

Remarks:

The EF of 0.5% in equipment production, as expressed in the Carbotech Excel table [3], does not tally with the EF in the Carbotech Report [2] (1%).

The device disposal EF is expressed in the Carbotech Excel tables and the NIR at 15%. However, this EF is not explicitly confirmed in the Carbotech Report [2].

The origin and derivation of the EF for stock and disposal should generally be explained comprehensibly in the Carbotech Excel table [3] as well as in the Carbotech Report [2].

The product manufacturing (C_3F_8, HFC23) and product life (HFC23) EF in the CRF tables 2(II).F v1.6 for the years 2010, 2009 and 2008 do not tally with the values in the Carbotech Excel table [3] and should be checked.

It is not clear if the refrigerant quantity, which was exported in devices, is taken into consideration separately. It is recommended that this happens in future.

10.1.2.5 Consistency

The AD and EF were essentially recorded in the same way for the entire time series from 1990 to 2010. Adjustments were made to the commercial refrigeration and industrial refrigeration AD by taking into consideration the recycling from 2002 onwards. Further adjustments were made to the AD by correcting the mobile air conditioning and stationary air-conditioning areas of application. These corrections were calculated using a higher resultant imported quantity of refrigerant for the commercial refrigeration and industrial refrigeration areas of application. This approach is plausible and the recalculation made is correct.

Adjustments were made to the EF for the operation of devices.The EF for 1995 (12%) was reduced to 5% in 2020 linearly. There are no gaps and no changes to the data source in the Carbotech Excel table [3].

Remarks:

The Carbotech Report should include the year the AD adjustment was made with regard to recycling (2002).

The disposal EF was adjusted in line with the assumption that, currently, 90% of devices are disposed of professionally. This EF was used for the total time series, also before professional disposal services were introduced. Checks must be carried out to find if this has resulted in significantly lower emissions and the EF, particularly in the Nineties, must be adjusted to represent the situation at the time.

10.1.2.6 Transparency

The commercial refrigeration and industrial refrigeration areas of application are summarised in the NIR under the heading 2F1 Refrigeration and Air Conditioning Equipment. In the NIR, it is not specified which devices fall under this heading.

The method used for the commercial refrigeration and industrial refrigeration areas of application is defined in the NIR. Information on the selected method, as described in Annex A6 of the Carbotech Report [2], is unclear. The reference in Annex A6 to the Refrigeration and air-conditioning chapter is incorrect.

The basis for AD (device capacities) and EF is described in tabular form in the NIR and Carbotech Report [2] and documented in detail, together with the AD and the emission calculations in the Carbotech Excel table [3].

Remarks:

The Carbotech report does not include a description of the devices in the commercial refrigeration and industrial refrigeration areas of application. It would have been preferable to have an overview available.

In CRF tables 2(II).F v1.6 for the years 1990 and 2008-2010, the commercial refrigeration and industrial refrigeration areas of application are dealt with separately, but the accumulated data are only assigned to the Commercial refrigeration section. It would be beneficial, if a footnote were to be included regarding the overall calculation of both areas of application.

As in other areas of application of SGG, the cross-referencing in the Carbotech Report [2] is not consequently included in the commercial refrigeration and industrial refrigeration areas of application. Annex A5 with data sources (expert) is not referenced in Chapter 3.3.2.2. It is very difficult to detect the origins of the basic EF data. The Carbotech Report and the Carbotech Excel table [3] only contain source data for EF comparison (Federal Environment Agency, Germany).

The so-called working procedure in the Carbotech Excel table contains useful data on changes and inclusions in the current 2010 inventory. Unfortunately, some of the data is not fully comprehensible to the outside, since it is not fully described.

The tables in the Carbotech Report [2], Chapter 3.3.2.2, Quality check/Statistics are not numbered. There are no units at all in Table 17, Chapter 6.

Some of the table descriptors in the Carbotech Excel table do not include units and, therefore, calculation errors cannot be excluded.

10.1.3 Transport refrigeration

10.1.3.1 General observations

This category includes cooling devices, in accordance with the 2006 IPCC Guidelines, which are built into trucks (freight area), containers, refrigerator ships and refrigerated railway carriages. The percentage for this area of application, for 2009 and in terms of the greenhouse gas inventory, lies at around 2% of the total SGG emissions in the industrial processes sector and is fairly insignificant. In recent years, the refrigerated truck sector has almost reached saturation point. Currently, around 14 dealers in Switzerland offer transport refrigeration systems for commercial vehicles. If recent rail freight decline is taken into consideration, the number of cooling systems in rail traffic could soon be at a standstill.

10.1.3.2 Completeness

The figures of approximately 8000 trucks and delivery vehicles, as well as 4700 trailers with refrigeration units and over 200 railway carriages with refrigeration units indicate that it is widely used in refrigerated transportation in Switzerland.

The greenhouse gas inventory only covers cooled trucks, delivery vans, trailers and semi-trailers. No information is provided, either in the Carbotech Report [2] or the Carbotech Excel table (transport refrigeration) [3], about the total number of containers and possible refrigerated vessels (Rhine shipping). Vessels, however, are estimated to be few.

The storage quantities of trucks and delivery vehicles reported in the Carbotech Excel table and imported quantities in new systems are based on the vehicle statistics provided by INFRAS. The calculated quantities of SGG are correct. It is not clear how the number of semi-trailers and trailers has been estimated, since the INFRAS report does not contain any data. The new and storage quantities of SGG in railway carriages were taken into consideration, but it is unclear how the quantities were obtained (number of wagons).

The relevant synthetic gases used in the refrigeration units (HFC134a, HFC143a, HFC125 and PFC128) were taken into consideration. The HFC404a and HFC403b mixtures were categorised with individual substances.

Remarks:

Although experts, according to the 2001 Carbotech Excel table, also reported the refrigerants HFC410a and HFC407C these were not quantified separately.

The description of the area of application in the NIR and Carbotech Report [2] is very brief and barely describes the relevant vehicles. The information in the work log of the Carbotech Excel table (transport refrigeration) [3] are partly not reproducible (extrapolations, export).

10.1.3.3 Methodology and assumptions

The SGG emissions are calculated using a tier 2 approach, which corresponds to the 2006 IPCC Guidelines. Emission factors are used, which take into consideration data from the German Federal Environment Agency (UBA).

The method used to calculate AD by means of vehicle numbers and capacities appears reasonable.

The EF values relating to the operation and disposal of cooling devices for trucks and railway carriages appear to be plausible. They lie within the range of default EF as defined in the 2006 IPCC Guidelines, Chapter 7.5.2.2. The disposal EF is around 10% below the minimum 2006 IPCC Guidelines EF value. Statements from experts were taken into consideration when calculating the EF.

The AD in the truck/delivery vehicle/trailer section are based on the information provided by manufacturers and fall within the range of default values in the 2006 IPCC Guidelines, Chapter 7.5.2.2 (capacities).

The bottom-up approach selected for calculating EF and AD is also in line with the 2000 IPCC Good Practice Guidance.

The basic data used to calculate emissions defined the device lifespan as being 12 years (railway) and 10 years (trucks/delivery vehicles/trailers) (2010 inventory). This lies below the maximum lifespan of the default values according to the 2006 IPCC Guidelines. However, expert opinion confirms that the lower figures are now the effective values.

Remarks:

Data on the capacities of railway wagon cooling devices are not included in the Carbotech Report or the Carbotech Excel table [3].

10.1.3.4 Verification of calculations

The AD of refrigerants in commercial vehicles, trailers and railway carriages are correctly calculated and well-documented.

The AD, emission factors, device lifespan and capacities in the Carbotech Excel tables [3] are in line with the data contained in the NIR.

The AD and EF in the CRF tables 2(II).F v1.6 for the years 1990 and 2008-2010 tally with the values in the Carbotech Excel table [3]. The calculations of emissions from stocks and disposals are correct for the years under consideration.

A Monte Carlo analysis was used to calculate the uncertainties of model calculations using a tier 2 approach, in accordance with 2000 IPCC Good Practice Guidance. Therefore, the uncertainties of all significant parameters such as capacities, emission factors and import/export quantities were calculated. The uncertainties of these sources expressed in the Carbotech Report [2] seem to be plausible. Chapter

4 of the Carbotech Report provides information on the values calculated using the Monte Carlo analysis for the Transport Refrigeration area of application, with a total uncertainty value of 22%. The NIR also confirms this value.

Remarks:

The origin or derivation of the emission factors for stock and disposal in trucks/delivery vehicles and railway carriages should be explained in the Carbotech Excel table [3] as well as in the Carbotech Report [2].

Conspicuous is the anomalous EF for stocks for HFC125, HFC134a and HFC143a as well as the disposal EF for HFC134a for the years 1990 and 2008-2010 in the CRF-tables from the default figures of 15% (stocks) and 20% (disposal). The anomalies with regard to the values published in the NIR lie between 4% and 6% and are probably due to the influence of emissions from railway carriages.

10.1.3.5 Consistency

The AD and EF were included for the entire time series from 1990 to 2010 in the same way and published in the Carbotech Excel table [3]. There are no gaps and no changes to the data source in the Carbotech Excel tables.

10.1.3.6 Transparency

The transport refrigeration process is summarised in the NIR under the heading 2F1 Refrigeration and Air Conditioning Equipment. The NIR does not define which devices fall under this heading. The description of utility vehicles in the Carbotech Report is insufficient.

The method used for the transport refrigeration is clearly described in the NIR. However, the details of the method selected in Annex A6 of the Carbotech Report [2] are unclear.

The bases for AD (system capacities) and EF are expressed in tabular form in the NIR and Carbotech Report [2] and documented together with the AD in the Carbotech Excel table [3]. The AD and EF in the CRF tables 2(II).F v1.6 for the years 1990 and 2008-2010 are comprehensible and well-documented.

The calculations of the AD and emissions are included in the Carbotech Excel table [3] and are well-documented. This also provides a useful table for annual consultations/checks on the values.

Remarks:

The transport refrigeration area of application in the Carbotech Report [2] is not consequently cross-referenced with the sources. Annex A5 with data sources is not referenced in Chapter 3.3.2.3 Transport refrigeration and the Fröhlich Transklima AG source is not included. It is hard to determine the origin of the basic EF data. The Carbotech Excel table [3] only contains source data on EF comparisons (German Federal Environment Agency). The data sources for EF are not included in the Carbotech Report [2] or the Carbotech Excel table.

Chapter 3.3.2.3 of the Carbotech Report does not include any cross-referencing to Annex A6 or the tier 2 method for transport refrigeration.

The so-called work log in the Carbotech Excel table contains useful information on the changes to and inclusions in the current 2010 inventory. Unfortunately, some of the information is not well-documented for external reviewers.

10.1.4 Stationary Air-conditioning

10.1.4.1 General observations

According to the 2006 IPCC Guidelines, this area of application includes permanently-installed air/air systems, heat pumps and coolers for air-conditioning in commercial buildings and dwellings. Fixed air-conditioning devices do not qualify as installations but devices in Switzerland according to the ChemRRV.

The emission percentage of this area of application was, in 2009 and according to the greenhouse gas inventory, around 9% of the total SGG emissions for the industrial processes sector.

The author is unaware of any production of stationary air-conditioning devices in Switzerland. All devices are being imported. It is possible that the appliances are modified to meet local requirements, which would mean partial filling in Switzerland at the fitting stage. At the start of 2012, the Swiss Registry for Cooling Devices and Heat Pumps (SMKW) had registered 20,567 devices with refrigerant capacities >3kg. The actual number of stationary air-conditioning devices could however be significantly higher due to failures to register and devices with capacities <3kg. In the future, SGG emissions will increase since the market for these devices is growing and they are only slowly being replaced with natural refrigerants.

10.1.4.2 Completeness

The thousands of stationary air-conditioning devices mean that they are widespread throughout Switzerland.

The numbers of users and the quantity of SGG used in air-conditioning systems (without heat pumps) was quantitatively determined based on a new device statistics for the period from 1995 to 1997. It is estimated that the annual increase in refrigerant used will be 2%. This was defined in the Carbotech Report [2]. The increase was correctly calculated and the quantity of refrigerants in new devices included in the Carbotech Excel table. The basis on which the market increase was calculated was not given. The modelling correctness was checked using statements made by experts. Based on the information regarding new devices, as supplied by CTA AG, comparable calculations were carried out for 2010, the results of which closely resemble the statistical values for refrigerants in direct or indirect cooling devices (1.3% deviation). The 1995-1997 new device statistics will further be used since the average capacities for the various stationary air-conditioning categories are not known.

The quantity of refrigerant that is used for the first time in heat pumps and is stored, is calculated in the device statistics, which are published annually by the Swiss Society for Heat Pumps (FWS). The quantity of SGG used in heat pumps appears to be complete.

The HFC134a, HFC125, HFC32 and HFC143a SGG used in direct air-conditioning systems and heat pumps were taken into consideration. The HFC404a, HFC407c and HFC410a mixture of refrigerants were broken down into the individual substances and taken into consideration. In addition, the use of HCFC (R22) was taken into consideration and documented.

The specific values with regard to lifespan, capacity and emission factors of the heat pumps in the NIR are in accordance with the data in the Carbotech Report.

Remarks:

The origins of the new device statistics for 1995-1997 are unclear, with no sources given in the Carbotech Report or the Carbotech Excel table.

The comparative calculations that include data on the number of appliances of CTA AG were carried out using refrigerant capacities of 30kg for indirectly cooled appliances. It is not documented why this value was used, although the SMKW includes an average capacity of 20.86 kg per device with a capacity >3 kg.

The lifespan of direct and indirect air-conditioning systems is defined as 15 years in the NIR and Carbotech Report. However, the Carbotech Excel table includes the information that room air-conditioning appliances have a lifespan of 10 years, whereas other, larger, directly-cooled air-conditioning appliances have a lifespan of over 15 years.

The specific values for the air-conditioning unit capacities were described as being “not relevant” in the NIR. This needs to be explained in greater detail.

The EF described in the NIR do not always tally with the data in the Carbotech Report: there is no sign of the manufacturing EF for direct cooling systems in the Carbotech Report. The product life emission factor for direct cooling systems is different at various points in the NIR: 10% (1995) and 3% (2010) instead of 10% (1995) and 4% (2010) in the Carbotech Report.

It is unclear why, in the Carbotech Report, the “Heat pumps” section includes the refrigerant HFC417 (2008), even though this is not included in the calculations of the Carbotech Excel table [3].

10.1.4.3 Methodology and assumptions

The SGG emissions in the stationary air-conditioning area of application are calculated using a tier 2 approach, in accordance with the 2006 IPCC Guidelines.

Switzerland-specific emission factors for the operation and disposal of directly and indirectly cooled devices are used. The EF used in operating the devices fall linearly from 1995 to 2010 in accordance with the information supplied by the German Federal Environment Agency (UBA) and statements made by experts from CTA AG. This procedure is in accordance with the 2006 IPCC Guidelines.

EF for the assembly, operation and disposal of air-conditioning units and heat pumps were taken into consideration. The EF values for assembled and operated stationary air-conditioning units appear to be plausible and are within the default EF of the 2006 IPCC Guidelines, Chapter 7.5.2.2. The same is also true for heat pumps EF for operation (cf. Remarks relating to anomalies). Experts’ statements were also taken into consideration.

AD for model calculations are based on statistical values from 1995 to 1997, with subsequent years’ values being calculated by applying an annual adjustment of +2% for market growth. This method of calculation appears to be reasonable, since the unit capacity has to be known before calculating the AD for a quantity of new devices. This is not the case according to the Carbotech Report. Due to the wide range of capacities in this area of application, the uncertainty of any average value would be significant. It is, however, unclear how market growth has been estimated. The proportion of charging in Switzerland and abroad was taken into consideration for all air-conditioning units and heat pumps.

The selected bottom-up approach that uses experts’ statements to calculate the EF and AD is in line with 2000 IPCC Good Practice Guidance.

The basic data used to calculate emissions defines the average unit lifespan as being 15 years. This is in line with experts’ comments and the information on lifespan contained in the 2006 IPCC Guidelines.

Remarks:

The Carbotech Report, in Chapter 3.3.2.4 Stationary air-conditioning, does not contain any details of the method. The relevant Annex A6 of the Carbotech Report (UNFCCC Methodology for calculations), under tier 2, defines Refrigeration and air-conditioning as a complete section. Unfortunately, the chapter number is incorrect (3.3.1.3 instead of 3.3.2.4).

At 10 %, the EF for the professional decommissioning of stationary air-conditioning units is under the minimum 20 % default value proposed by the 2006 IPCC Guidelines. The EF applied to the assembly of heat pumps, at 3%, is above the maximum default value of 1 % proposed by the 2006 IPCC Guidelines

The assumed average capacities of stationary air-conditioning units is based on manufacturers' data and are within the default values defined by the 2006 IPCC Guidelines, Chapter 7.5.2.2. The 2010 statistical AD are checked using these capacities multiplied by the number of units declared by CTA AG in 2010. Although it is mentioned in the Carbotech Report [2] that the average capacities of the stationary air-conditioning units are not known, this procedure is designated as a quality check. If the capacities provided by CTA AG are actually representative, it is recommended that, in the future, the AD are calculated in the same way. This bottom-up approach corresponds to the 2000 IPCC Good Practice Guidance.

10.1.4.4 Verification of calculations

The AD and EF in the CRF tables 2(II).F v1.6 for the years 1990 and 2008-2010 are in line with the values contained in the Carbotech Excel table [3]. The calculations of the manufacturing, stocks and disposal emissions in the CRF tables are correct for the years in question and are in line with those of the Carbotech Excel table.

The EF for stationary air-conditioning units, including heat pumps, are based on experts' statements and were not calculated. The emission factors for the operation of direct cooling systems were increased from 3% to 4% (2010) for the 2010 inventory, because the original value was found to be optimistic. The reduction from 10% (1995) to 4% (2010) was correctly interpolated in a linear way.

The AD for direct and indirect cooling systems are based on the new unit statistics for 1995-1997 and were correctly calculated at an annual market growth of 2 %. The refrigerant composition used to calculate the AD comes from experts and associations (heat pumps). The heat pump capacities, which have changed over the years, were taken into consideration and correctly calculated. The proportion of air-conditioning units and heat pumps manufactured abroad were correctly taken into consideration and calculated.

Monte Carlo analysis was carried out, in line with 2000 IPCC Good Practice Guidance, in order to determine the uncertainties of the model calculations using a tier 2 approach. Therefore, the uncertainties of all significant parameters, such as capacities, number of units, lifespan, disposal quantities and emission factors have been defined. In the Carbotech Report [2], these uncertainties were qualitatively calculated. Essentially, only a medium uncertainty was assumed, where comparison with the information provided by the German Federal Environment Agency (UBA) was possible. This seems to be plausible.

Remarks:

It is unclear why, for indirect units, the EF in the Carbotech Excel table (characteristics box) are listed in the "direct" column. This should be corrected as there might be a mix-up.

The calculations of the emissions for both direct and indirect cooling systems have to be checked, since sampling highlighted slightly anomalous emission values (e.g. 1996, HFC407c).

The uncertainty of market growth in stationary air-conditioning units was designated as "high" at 2 % per annum. It is recommended that these values are checked with experts and the Swiss Association for Air-Conditioning Technology (SVK), so that the uncertainty can be reduced. It is also noticeable that the uncertainty of the import rates for heat pumps is defined as low, although these are not taken into consideration with regard to air-conditioning units.

The EF given in the NIR for decommissioned stationary air-conditioning units of 28% (direct) and 19% (indirect) are only included in the Carbotech Excel table indicatively and the calculations are not comprehensibly documented.

10.1.4.5 Consistency

The AD and EF for the entire time series from 1990 to 2010 were calculated in the same way. Adjustments to the AD of stationary air-conditioning units, since 1997, have already been mentioned above and are at 2% per annum, to make allowances for market growth.

The EF for operating directly and indirectly cooled units were linearly reduced from 1995 (direct 10%) to 2010 (direct 4%). There are no gaps and no changes to the data source in the Carbotech Excel table [3].

In the Carbotech Report [2], it is noted that the import quantities of SGG used to fill air-conditioning units in Switzerland are significantly lower than the last time they were compiled. The percentage of SGG in imported products was, therefore, increased for both direct and indirect cooling systems. These new import values of 95% (direct systems) and 77% (indirect systems) are in line with the values in the Carbotech Excel table and were taken into consideration in the model calculations

The import quantity of HFC407c for 2010 was higher than the quantity required for filling new units in Switzerland and to maintain stationary air-conditioning units. It was assumed that, in addition, HCFC22 was replaced in the commercial/industrial refrigeration area of application and the surplus was assigned to this area of application.

Remarks:

The Carbotech Report does not indicate how the recalculations were achieved using the adjusted import quantities. It is also unclear how the average capacity of 40kg stated in the Carbotech Report was calculated (direct or indirect systems, how are they calculated?).

The assignment of HFC407c to the commercial/industrial refrigeration area of application to the possible replacement of HCFC22 is sensible, however the import surplus could also be arrived at by increased stock-keeping. This evolution must continue to be observed.

10.1.4.6 Transparency

The stationary air-conditioning process is briefly summarised in the NIR under the heading 2F1 Refrigeration and air-conditioning equipment.

The method is clearly described in the NIR.

The principles for AD (only unit capacities for heat pumps) and EF are expressed in tabular format in the NIR and Carbotech Report [2] and documented together with the AD in the Carbotech Excel table [3]. The AD and EF in the CRF tables 2(II).F v1.6 for the years 1990 and 2008-2010 are comprehensible and well-documented.

The emission calculations are included and well-documented in the Carbotech Excel table [3].

The changes to the model calculations and additional calculations are included in the Carbotech Report, both for direct and indirect cooling systems and heat pumps.

Remarks:

The Carbotech Report [2] devotes a separate chapter to heat pumps. In fact, this should be part of the Stationary air-conditioning area of application in Chapter 3.3.2.4.

In the Carbotech Report [2], Chapter 3.3.2.4 Stationary air-conditioning there is no cross-reference to the method in Annex 6.

The description of the area of application in the NIR and the Carbotech Report [2] is fairly brief and barely describes the relevant devices. The definition of the stationary air-conditioning and the indirect cooling and direct cooling categories are nowhere to be found.

Why the unit capacities for the direct and indirect cooling systems come from investigations in 1998 and data of the German UBA from 2005 and the data from the CTA AG were not considered is not correctly explained and not transparently described. Why the uncertainty of both filling capacities is given as “high” is not clear. In addition, the description of the AD of cooling systems is not clear in the Carbotech Excel table [3].

The data in the work log of the Carbotech Excel table (stationary air-conditioning) [3] are partially not comprehensible (unit capacity, prognosis).

It is sometimes difficult to find the source information in the annex of the Carbotech Report, since the list of references does not include full details on associations, companies and persons. For example, experts’ statements on uncertainties are not further referenced that it is unclear which experts are saying what.

10.1.5 Mobile air conditioning

10.1.5.1 General observations

In accordance with the 2006 IPCC Guidelines, this category includes all air-conditioning units built into cars, truck cabins, buses and railway units. Car air-conditioning is advanced in terms of mobile air-conditioning technology. The CO_2 car air-condition unit is currently ready for mass-production. However, the EU has ruled that, from 2011, no new vehicle with air-conditioning >GWP 150 may be sold and that after 2017 no new vehicles with refrigerant >GWP150 may be brought into circulation. Natural refrigerants are still not stipulated. The mobile air-conditioning unit area of application is a significant one. For example, in 2009, it was responsible for 28% of all CO_2eq emissions from HFC, with the largest percentage coming from cars. However, filling capacities are fairly low in the vehicle air-conditioning sector.

10.1.5.2 Completeness

The mobile air conditioning process is relevant to Switzerland, as several million vehicles are driving around with an AC percentage of over 90% in the automobile sector.

The relevant amount of cars and commercial vehicles (trucks and delivery vehicles, buses) were compiled by the Swiss Federal Statistical Office and the association of Swiss car importers and included in the Carbotech Report [2] with a low degree of uncertainty. The number of railway carriages, which include an air-conditioning unit, is not specified in more detail. However, quantitatively, the air-conditioning levels of the largest railways companies in Switzerland (SBB, BLS, and RhB) are included and documented. The storage quantity in these categories is correct and credibly documented and there are no gaps (cf. Remarks).

The HFC134a, HFC125, and HFC143a SGG used in the mobile air conditioning area of application were all taken into consideration.

The specific values for lifespan, capacities and emission factors for mobile air-conditioning are included in the NIR and are partly in line with the data in the Carbotech Report (exceptions cf. Remarks).

Remarks:

It is unclear whether or not the refrigerants in the air-conditioning units of trams were taken into consideration with railways. Urban traffic operations are not quoted anywhere as a source. The question also remains about whether refrigerated and passenger ships working or registered in Switzerland use a significant quantity of refrigerants and, therefore, must be recorded separately.

The initial charge of mobile air-conditioning (cars) in the NIR (0.84 kg in 1990) is not in line with the Carbotech Report (0.83 kg in 1990).

The disposal loss EF in the NIR for mobile air-conditioning (cars) of 100% up to 2005 and 50% since 2005 are not in line with the Carbotech Report (100% to 2000 and then 50%).

The 58% charge at end of life recorded in the NIR (%initial charge of new product) for mobile air-conditioning (cars) do not tally with the figure of 0.45 kg (64 %) in the Carbotech Report.

The 35% charge at end of life recorded in the NIR (% initial charge of new product) for mobile air-conditioning (trucks) does not tally with the figure of 0.7 kg (64 %) in the Carbotech Report.

The 35% charge at end of life recorded in the NIR (%initial charge of new product) for mobile air-conditioning (buses) does not tally with the figure of 5.5 kg (73 %) in the Carbotech Report.

The 12-year lifespan recorded in the NIR for mobile air-conditioning (buses) does not tally with the lifespan in the Carbotech Report (10 years).

The lifespan of 13 years recorded in the NIR and the initial charge of 20 kg for mobile air-conditioning (railway) are not included in the Carbotech Report.

It is unclear why the HFC404a refrigerant mixture is included in the Carbotech Excel tables, but not in the CRF tables.

10.1.5.3 Methodology and assumptions

The SGG emissions are calculated using a tier 2 approach, which corresponds to the 2006 IPCC Guidelines. The emission factors used are specific to Switzerland. Where necessary, EF are used in accordance with German guidelines (mobile air-conditioning (cars)).

The values for the EF appear to be plausible and are within the range of default EF in the 2006 IPCC Guidelines, Chapter 7.5.2.2 (exceptions cf. Remark). Experts' statements were also taken into consideration when calculating the values. EF for the operation and disposal of air-conditioning units were also taken into consideration.

The AD are based on manufacturers' data relating to the capacities of air-conditioning units. These fall within the range of default values in the 2006 IPCC Guidelines, Chapter 7.5.2.2, with busses and railways forming exceptions. The capacities of these areas of application were, however, supplied for Swiss users (Postauto AG, SBB). AD were only provided for refrigerants and not devices (operation and disposal). Air-conditioning units are manufactured abroad, so that production-related values for Switzerland are irrelevant. Various return quantities of cooling devices were taken into consideration in the AD, as well as refilling during the lifespan. The whole of the calculation method appears to be reasonable.

The 2010 inventory was the first one to take into consideration the refill quantities of SGG in mobile air-conditioning (cars) and the increased lifespan of 15 years. The refrigerant stock level was therefore recalculated.

Remarks:

The EF (operation) for mobile air-conditioning (cars) and mobile air-conditioning (railway) are below the default EF as defined in the 2006 IPCC Guidelines, Chapter 7.5.2.2. Lower values of 5.3 % to 10.6 % are only in line with the guidelines for the second generation of mobile European air-conditioning units from 1996.

In terms of mobile air-conditioning (cars), the percentage of recaptured refrigerant was calculated and assigned to the commercial and industrial refrigeration area of application. It is not clear how this is calculated with regard to buses, commercial vehicles and the railway.

It is not clear how the forecast growth of vehicles categories such as cars, trucks, buses and railways, as given in the Carbotech Excel tables [3] were calculated, since the new admissions depend on effective statistical data. This should be explained.

10.1.5.4 Verification of calculations

The AD for the air-conditioning units of cars, commercial vehicles and buses are correct and the calculations well-documented. The refill levels of refrigerant for cars, buses and commercial vehicles were again taken into consideration in the 2010 inventory for modelling and recalculations made. Originally, a calculation formula was incorrectly used to calculate the AD for commercial vehicles, in Carbotech Excel tables [3] (delivery vehicle percentage). This error was however removed from the 2010 inventory. According to the work log, the AD for railway carriages were provided by the leading rail operators and appear to be reliable.

The EF are based on experts' statements. No information is available in the Carbotech Excel tables on how the EF were calculated.

The AD and EF in the CRF tables 2(II).F v1.6 for the years 1990 and 2008-2010 are in line with the values contained in the Carbotech Excel tables [3]. The calculations of the stocks and disposals emissions are correct for the years in question. New units are full when they are imported.

A Monte Carlo analysis was used to determine the uncertainties of the model calculations using a tier 2 approach in accordance with 2000 IPCC Good Practice Guidance, with the uncertainties for all significant parameters such as capacities, emissions factors and import/export quantities being determined. The uncertainties expressed in the Carbotech Report [2] for the parameters appear to be plausible in relation to the car, commercial vehicle, bus and railway categories.

Chapter 4 of the Carbotech Report provides information on the values calculated using the Monte Carlo analysis for the mobile air-conditioning area of application, with a total uncertainty level of 19.8%. The NIR also includes this value. The adjustment of vehicles' lifespan has a major influence on the results of the Monte Carlo analysis. This was taken into consideration in the Carbotech report.

Remarks:

The origin and derivation of the stock and disposal EF for cars and commercial vehicles (trucks/delivery vehicles) should be included in both the Carbotech Excel table [3] and the Carbotech Report [2].

The uncertainties of the lifespan, EF, AD and import/export figure parameters are only qualitatively listed in the other SGG areas of application in the Carbotech Report.

10.1.5.5 Consistency

The AD and EF for all categories of mobile air-conditioning were included in the same way for the entire time series from 1990 to 2010. Changes were made to the AD for the mobile air-conditioning of cars, commercial vehicles and buses through adjustments to refrigerant refills, lifespan and emissions during unit operation. The AD were recalculated for the entire time series from 1990-2010.

The emission factors for operating mobile air-conditioning in commercial vehicles and buses were reduced in a linear way between 2000 (10 %) and 2010 (8.5 %).

There are no gaps in and no changes to the data sources in the Carbotech Excel table [3].

Remarks:

It is not clear why an export percentage of 50% for second-hand cars is included in the calculations contained in the Carbotech Excel tables, but the export of commercial vehicles and buses are not included.

The Carbotech Excel table [3] includes an EF for mobile air-conditioning (railway) of 5.5% (operation). The Carbotech Report and the NIR give an EF of only 4%.

10.1.5.6 Transparency

The mobile air-conditioning process is summarised in the NIR under the heading 2F1 Refrigeration and air-conditioning equipment. It is not further specified in the NIR, which vehicles are covered by this heading. The definition of commercial vehicles in the Carbotech Report (trucks, delivery vehicles) is unsatisfactory.

The method for the mobile air-conditioning area of application is clearly described in the NIR. The details of the method selected in Annex A6 of the Carbotech Report [2] are unclear.

The bases for the AD (filling capacities) and EF are expressed in tabular format in the NIR and Carbotech Report [2] and documented together with the AD in the Carbotech Excel table [3]. The AD sources of railway air-conditioning units are expressed in the Carbotech Excel table.

The AD and EF in the CRF tables 2(II).F v1.6 for the years 1990 and 2008-2010 are comprehensive and well-documented.

The calculations of AD and emissions for cars, commercial vehicles are buses are expressed and well-documented in the Carbotech Excel table [3].

Remarks:

The referencing of sources is partially insufficient. Parameters such as EF, charge and lifespan are not referenced in tables 4, 5, 7 and 9 in Chapter 3.3.2.6 of the Carbotech Report. Source data on these parameters are only found in the uncertainty description tables.

The principles used to estimate the export percentages of rejected vehicles and the disposal EF for cars are unclear. In addition, the sources for the experts' statements on EF in commercial vehicles and buses are not referenced in the Carbotech Report.

In Chapter 3.3.2.6 of the Carbotech Report, the buses section mentions the change in the inventory (consideration of the added refrigerant during operation, larger EF during disposal). Therefore, it is stated that the trends in AC for commercial vehicles and cars are similar. However, the section in question relates to buses and not commercial vehicles.

Chapter 3.3.2.6 of the Carbotech Report does not include any cross-reference to Annex A6 or the tier 2 method for mobile air-conditioning.

As with other SGG area of application, the so-called work log in the Carbotech Excel table contains useful information on changes and assumptions in the current 2010 inventory. Unfortunately, some of the information is not fully comprehensible for external readers.

10.2 Foam blowing (2F2)

10.2.1 General observations

This area of application, in accordance with 2006 IPCC Guidelines, include all open-cell and closed-cell foams, for which SGG are used as foaming agents. Open-cell foams are characterised by the open cell structure, which results in all foaming agent leaking when manufacturing these products. There are currently no manufacturers in Switzerland, who use these open-celled products, with all products being imported.

Open-celled foams are used as components of cushions, mattresses, car seats, steering wheels and office furniture. Closed-cell foams are mainly used as thermal insulation materials and are dependent on developments of foam use in the construction industry.

Closed-cell foams are used in Switzerland in the form of XPS and PU rigid foam. Also polyurethane construction foam belongs to this group. These products contain a high level of SGG during its entire lifespan until it is destroyed.

In Switzerland, SGG are no longer used in the production of rigid foam, since environmentally-friendly alternatives are commercially available, including pentane and CO_2 in particular. Certain specific applications like, for example, the production of sandwich elements and coated boards still require SGG. The future market of foams is on the increase through the construction sector, although SGG emissions are stagnating with the use of alternative foaming agents.

The foam blowing area of application in 2009 was responsible for around 2% of the total CO_2eq emissions from SGG in Switzerland [5].

10.2.2 Completeness

Foam blowing is a significant process for Switzerland, since, especially in the construction sector, large amounts of PU and XPS foam insulation materials exist and are used as construction materials. In addition, in Switzerland, increased levels of PU spray are manufactured and used. The NIR and the Carbotech Report [2] both correctly state that, in Switzerland, there is no production of open-cell foam. For this reason, only closed-cell PU and XPS foams, PU spray applications, sandwich elements and layered plates are included in the greenhouse gas inventory.

All relevant manufacturing companies and importers are included in the Carbotech Report. Amongst these are Rathor AG (the only PU spray manufacturer in Switzerland), OMYA AG (greenhouse gas importer), Alcopor (PU rigid foam manufacturer) and DOW (XPS rigid foam manufacturer).

The production levels of PU and XPS rigid foams were ideally derived directly from the producers and compared with the FOEN import statistics. Since the import statistics demonstrate an HFC surplus, a new category was created in 2003 (integral foam), which covered unknown special applications such as insulation board, sandwich elements and domestic appliance manufacture and was assigned the level of the HFC surplus. This process appears to be plausible and the designated production and storage quantities are reliable and do not contain any gaps.

The SGG used in the foam blowing area of application and potentially emitted HFC134a, HFC152a, HFC227ea, HCFC142b and HCFC22 were included, although HCFC142b and HCFC22 were correctly not taken into consideration for the greenhouse gas inventory.

The specific values for lifespan, charge and EF of the foam blowing area of application are expressed in the NIR and partially tally with the information in the Carbotech Report (exception cf. Remark).

Remarks:

The NIR, in the description of the area of application, does not contain any information on layered boards, although the Carbotech Report refers to them.

It is recommended that more exact details are provided with regard to the “Integral foam” category, particularly the manufacture and importing of these materials.

The unclear information in the Carbotech Excel table relates to the greenhouse gas HFC356mfc. In accordance with the 2006 IPCC Guidelines, HFC365mfc was used as a propellant.

The CRF tables 2(II).F v1.6 for the years 1990, 2008, 2009 and 2010 do not refer to the greenhouse gas HFC365mfc, although the Carbotech Excel table includes activity data relating to this material. This is because HFC365mfc is not listed in the currently still effective IPCC Guidelines. However, any allocation to HFC134a and HFC152a must be corrected, since HFC365mfc is an individual material (1,1,1,3,3-pentafluorobutane).

The NIR and Carbotech Report do not mention that CFC and HCFC in PU rigid foam production were substituted at an early stage in Switzerland.

10.2.3 Methodology and assumptions

The SGG emissions are calculated using a tier 2 approach. This is in line with the 2006 IPCC Guidelines. EF are used that are specific to Switzerland (expert data, PU spray). Where necessary, EF are used in accordance with German Guidelines (Federal Environment Agency, PU and XPS rigid foam).

The AD are based on manufacturers' data on the charge and production capacities for PU spray as well as on the import quantities of XPS rigid foams (PU rigid foam is irrelevant due to HCFC and pentane foam). In order to calculate integral foam (sandwich elements, insulation boards, etc.), the difference with the FOEN import statistics was determined. The AD of open-cell foams, which are only manufactured abroad, were not taken into consideration, since these are irrelevant to Switzerland due to complete gas release during production. The procedure for compiling the AD is in line with good practice according to the 2006 IPCC Guidelines and appears to be wholly reasonable.

Remarks:

The values for the EF from XPS rigid foam differ significantly from the default values of the 2006 IPCC Guidelines (IPCC XPS HFC134a: 25% first year loss, 0.75% annual loss, end-of-life loss 37.5%; IPCC XPS HFC152a: 50% first year loss, 25% annual loss, end-of-life loss 0%). The Carbotech Report and NIR with regard to HFC134a refer only to 10% first year loss, 0.7% annual loss and 36% end-of-life loss and with regard to HFC152a 100% first year loss, 0% annual loss and 0 % end-of-life loss. This has to be verified.

The EF from PU spray correspond to the 2006 IPCC Guideline default values for the so-called One Component Foam (OCF). If this is correct has to be clarified with the manufacturers, Rathor AG. Essentially, the EF, in the first year, for closed-cell products appear to be very high. It is recommended that the EF in the sources (German Federal Environment Agency, Rathor AG) are verified.

10.2.4 Verification of calculations

The AD of PU spray, PU and XPS rigid foams and integral foams are correctly calculated and are well-documented (exceptions, see Remarks).

The EF are based on experts' statements (PU spray) and the information in literature (UBA Germany for PU/XPS rigid foam). There are no data on the calculation of EF in the Carbotech Excel table [3].

The AD and EF in the CRF tables 2(II).F v1.6 for the years 1990 and 2008-2010 are in line with the values contained in the Carbotech Excel table [3]. The calculations of the emissions from manufacturing, stocks and disposal are correct in the years under consideration.

In order to determine the uncertainties of model calculations using a tier 2 approach, a Monte Carlo analysis was carried out in accordance with 2000 IPCC Good Practice Guidance. The uncertainties of all significant parameters such as production levels, emissions factors, lifespan, storage quantities and charges of new products are determined. The uncertainties of these parameters in the Carbotech Report [2] expressed for the PU/XPS rigid foam, PU spray and integral foam (sandwich elements, insulation boards, etc.) categories appear to be plausible.

Chapter 4 of the Carbotech Report provides information on the Monte Carlo analysis used for the mobile air-conditioning area of application, with a total uncertainty of 48.6%. The NIR also includes this value. Factors with relatively large degrees of uncertainty are the import and export rates of PU spray and incomplete information regarding the volumes and propellant gas percentage of imported PU sprays as well as the high EF in the first year the product is used. The Carbotech Report however does not go into these influences.

Remarks:

The origins and derivation of the EF for manufacturing, stock and, in the future, disposal with regard to PU/XPS rigid foam should, where these deviate from the data in literature, be explained in the Carbotech Excel table [3] as well as in the Carbotech Report [2].

The uncertainties of the lifespan, EF, AD, charge and consumption parameters, as in other areas of application of the SGG, is only included in the Carbotech Report in qualitative terms.

It is unclear, in the Carbotech Excel table [3], how the import figures for PU spray was used together with the production quantities for Switzerland.

It is unclear why the Carbotech Report mentions that HFC is no longer used in PU rigid foams, although, in the Carbotech Excel table, only HCFC and pentane are expressed as propellants.

If the new information contained in the Carbotech Report regarding the years 2005-2010 (1-2% thermal insulation made from XPS) is taken into consideration for XPS rigid foam AD, it is not clear in the Carbotech Excel table.

How the quantities of HFC152 for PU spray not used and exported in the years 2007 and 2008 were considered is not included in the Carbotech Excel table.

10.2.5 Consistency

The AD and EF of the various sub-categories for the foam blowing area of application were included in the same way for the entire time series from 1990 to 2010. Any changes to the PU spray AD were achieved through adjusting the HFC import quantities in 2010.

There are no gaps in and no changes to the data sources in the Carbotech Excel table [3] or the Carbotech Report [2].

Remarks:

It is unclear why NIR includes an EF for XPS rigid foam of 100% for product life, which is not confirmed in the Carbotech Report.

It is also unclear why the Carbotech Report includes an EF of 95% for PU spray in the first year in the “Assembly” section, since this is an EF from the usage phase. However, there is no manufacturing EF for PU spray in the Carbotech Report.

The product life EF for sandwich elements in the NIR (0.7%) do not tally with the value in the Carbotech Report (0.5 %).

10.2.6 Transparency

The foam blowing process is summarised in NIR under heading 2F2. It is satisfactorily specified in the NIR that only closed-cell foams i.e. PU sprays, PU/XPS rigid foams and integral foams (sandwich elements, insulation materials, etc.) come under this heading. The definition of the foam blowing area of application and its sub-categories contained in the Carbotech Report is also satisfactory.

The method used for the foam blowing area of application is clearly described in the NIR. The data on the method selected in Annex A6 of the Carbotech Report [2] are unclear (foam blowing under the tier 1 heading).

The bases for the AD (product charges) and EF are included in tabular format in the NIR and Carbotech Report [2] and well-documented together with the AD in Carbotech Excel table [3]. The source for the AD of PU spray, PU and XPS rigid foam are included in the Carbotech Excel table and in the Carbotech Report.

The AD and EF in CRF tables 2(II).F v1.6 for the years 1990 and 2008-2010 and the calculations in the Carbotech Excel table are comprehensible and well-documented.

Remarks:

The bases on which the import and export percentages are estimated under the PU spray heading in the Carbotech Excel tables [3] and the Carbotech Report are unclear. In addition, the sources of the experts' statements relating to the EF and charge for PU and XPS rigid foam are not referenced in the Carbotech Report.

Chapter 3.3.1 of the Carbotech Report does not include any cross-referencing to Annex A6 and the tier 2 method for foam blowing.

10.3 Fire extinguishers (2F3)

10.3.1 General observations

According to the 2006 IPCC Guidelines, this area of application includes two types of fire extinguishers, which indicate HFC and/or PFC as a partial substitute for halons. These are portable fire extinguishers and fixed, stationary (floating) units.

The use of HFC, PFC and SF_6 in fire extinguishers is meanwhile prohibited in Switzerland through the Ordinance on Environmentally Hazardous Substances (StoV), Appendix 4.16. Exceptions are allowed where fire extinguishers are used in aircraft, special army vehicles and nuclear plants.

The Carbotech Report [2] indicates that, in Switzerland, the afore-mentioned substances are not in use in aircraft or for military applications. Therefore, there are no further details of this area of application in the NIR or the Carbotech Report. Unfortunately, there are no details on the sources of these statements or on possible usage in nuclear plants.

The introduction and use of devices and systems containing HFC, PFC and $SF_{6,}$ along with the introduction and use of these extinguishing agents has been prohibited since 1.1.1996. According to StoV [6] the regulated extinguishing gents could be used until 31.12.2002 to refill existing stationary units. For this reason, the quantity of HFC, PFC and SF_6 consumed before 1996 and the refill level up to 2002 are to be determined and storage levels estimated for existing systems. Further information and data sources are referenced in the “Mitteilung zur Stoffverordnung, Löschmittel” of BUWAL [15].

10.4 Aerosols/metered dose inhalers (2F4)

10.4.1 General observations

According to the 2006 IPCC Guidelines, this area of application includes aerosol packages (sprays), which contain HFCs and PFCs as a propellant or solvent. The emissions percentage for this area of application was, in 2009 and according to the greenhouse gas inventory, around 2% of the total SGG emissions in the industrial processes sector and is only of slight significance.

Aerosols may be broken down into the following categories [5]:

Technical sprays

The terms technical sprays is used to describe cold and compressed air sprays, lubricant sprays and pipe freezers. In individual cases HFC134a was used and, more rarely HFC152a.

Medical sprays

As part of medical applications HFCs are mainly used in metered aerosols (asthma sprays and MDIs). In most other medicinal sprays (foot sprays, skin sprays etc.) HFC are not used. The afore-mentioned technical cold sprays are used in the medical area, for example in dentistry for checking the condition of teeth.

Manufacturers are no longer trying to replace all HFC in metered aerosols with halogen-free propellant gases. It is currently not possible to change the treatment of all medical patients to powder inhalers (DPIs). A remaining quantity of HFC will still be used in the future.

Other sprays

Other sprays or non-technical sprays are any sprays that cannot be assigned to either of the above product groups. This product group mainly includes domestic and cosmetics sprays such as so-called “novelties“, mostly party articles such as streamer sprays, as well as fake snow in cans. SGG are no longer used in Switzerland for these domestic applications.

10.4.2 Completeness

The aerosol area of application in Switzerland is represented by both nationally-produced products and imported products.

The data on the level of usage of SGG is based on the FOEN import statistics. Therefore, it may be assumed that the amount of SGG used in manufacturing products is recorded quantitatively. Unfortunately, thereby the types of application and the manufacturers can not be broken down for this area of application.

The relevant synthetic gases HFC134a, HFC227ea and HFC152a used in aerosols in accordance with the 2006 IPCC Guidelines were taken into consideration.

Remarks:

The description of the area of application in the NIR and the Carbotech Report [2] is extremely brief and does not provide an overview. In addition, it does not, in the case of the Carbotech Report, give the relevant categories of the area of application.

No data are provided for the export and import of aerosol products containing SGG. The assumption that the amounts of exports and imports are equal is not based on statements made by experts. The small quantities used however mean that assumptions are to be recommended.

10.4.3 Methodology and assumptions

The NIR, the Carbotech Report [2] and the Carbotech Excel table [3] all confirm that a tier 2 approach was selected. In fact, the modelling is based on the FOEN import statistics. According to the 1996/2006 IPCC Guidelines, however, a tier 1 approach was used, since there is currently no detailed information from manufacturers on the consumption figures from the various sub-applications.

The method of calculating the AD using import statistics appears to be reasonable, since there are no other consumption figures available. The top-down approach chosen to determine the AD, under these preconditions, also corresponds to the 2006 IPCC Guidelines.

The values for the EF in the first and second years seem to be plausible and they correspond to the default EF in the 2006 IPCC Guidelines, Chapter 7.3.2.2.

Remarks:

It should be able to work towards obtaining reliable production and import and export figures from aerosol manufacturers. It is recommended therefore that negotiations are held with the Swiss Aerosol Industry Association (ASA).

The default EF for product life (50%) was used together with a manufacturing EF of 1% for emission modelling. It is unclear why this was the case, since the default value according to the 2006 IPCC Guidelines also takes manufacturing emissions into consideration.

10.4.4 Verification of calculations

The AD for aerosols come from the FOEN import statistics and were correctly adopted and well-documented.

The EF in the Carbotech Excel tables [3] are in line with the data in the NIR and Carbotech Report [2].

The AD and EF in the CRF tables 2(II).F v1.6 for the years 1990 and 2008-2010 tally with the values in the Carbotech Excel table [3] (exceptions, see Remarks). The calculations of the emissions from manufacturing and stocks are correct for the years in question.

A Monte Carlo analysis was carried out in order to determine the uncertainties of the model calculations. The results from the aerosols area of application are defined in the Carbotech Report, chapter 4 (total emissions), indicating a total level of uncertainty of 40.8%. The NIR confirms this value.

Remarks:

Worthy of note is a difference between the AD and EF for manufacturing and product life for HFC152a in CRF table 2(II).F v1.6 for the years 2008, 2009 and 2010 and the values in the Carbotech Excel table [3]. This should be verified.

In the Carbotech Excel table, it is not clear how the amount of aerosols was added from the solvent area of application from 2009 (conflicting comments).

Since the model calculations are effectively based on a tier 1 approach, it is not clear if the Monte Carlo analysis is appropriate. The 2006 IPCC Guidelines, Chapter 7.3.3 refer to experts defining the parameter uncertainties as being good practice.

The uncertainties of the significant modelling parameters such as emission factors or import quantities are not included in the Carbotech Report [2], the NIR or the Carbotech Excel table [3].

10.4.5 Consistency

The AD and EF were compiled in the same way for the entire time series from 1990 to 2010 and included in the Carbotech Excel table [3]. There are no gaps in and no changes to the data source observed in the Carbotech Excel table.

10.4.6 Transparency

The aerosols area of application is summarised in the NIR under the heading 2F4 Aerosols/metered dose inhalers. In the NIR, no details are given as to which products are covered by this heading. Technical aerosols are not mentioned.

The method used for the aerosols area of application is given in the NIR.

The bases for the AD (FOEN import statistics) and EF are defined in the NIR and documented together with the AD in the Carbotech Excel table [3]. The AD and EF are comprehensible and well-documented in CRF tables 2(II).F v1.6 for the years 1990 and 2008-2010.

The calculations of emissions are documented in the Carbotech Excel table [3] and reproducible.

Remarks:

With regard to the aerosol area of application, the Carbotech Report [2] consequently does not include cross-references to sources (e.g. import statistics). There is no documentation about the source of the EF. The Carbotech Excel table [3] does not contain the source data for the EF.

In the Carbotech Report, there is no description of the aerosol area of application, including complete detailed information on AD, EF and assumptions and must be completed. Although the NIR mentions aerosol manufacturers under “Activity data”, no references are provided for these sources in the Carbotech Report.

The area of application is defined as “Aerosols” in the 2006 IPCC Guidelines. It is recommended that this heading is used for the NIR.

Details of the method selected (tier 1 or 2) is missing from Annex A6 of the Carbotech Report [2].

There are gaps in the details of the bases for the EF in the Carbotech Report.

10.5 Solvents (2F5)

10.5.1 General observations

This category, in accordance with the 2006 IPCC Guidelines, covers HFC and PFC, which are used for precision cleaning, electronics cleaning, metal cleaning and the separation of fluoride substances. The emissions percentage of this area of application, in 2009 and according to the greenhouse gas inventory, represented around 1% of all SGG emissions in the industrial processes sector and is of little significance.

The significant industrial applications in particular include the surface cleaning of metals, glass or precious stones. Cleaning surfaces usually means removing grease and drying and is often found between individual production or treatment phases (before coating a surface, before gluing materials etc.) as well as at the end of production processes. Typical significant industrial users of solvents in surface cleaning systems include the metal-processing industry, the optical, precision tool and aerospace and medical technology [5].

10.5.2 Completeness

The afore-mentioned industrial applications are to be found in Switzerland.

Individual processing companies have not previously been included. The processing quantity of solvents is based on FOEN import statistics, which fully encompasses the use of the materials in Switzerland.

The relevant synthetic gases, HFC134a, HFC43-10-mee, C_2F_6, C_3F_8, C_4F_{10}, C_6F_{14}, c-C_4F_8, CF_4 and SF_6 were taken into consideration.

Remarks:

The area of application is described very briefly in the NIR and the Carbotech Report [2] with the relevant applications not being described. The information in the work log of the Carbotech Excel table (solvents) [3] are sometimes not well-documented.

According to the Carbotech Report, import companies involved in the HFC or PFC solvents areas of applications were questioned. Unfortunately, no more details were made available about these import companies.

Information about the export of solvents cannot be found in the NIR or the Carbotech Report.

The assignment of the various categories of substances with trivial names in the Carbotech Excel table [3] to the materials published in the greenhouse gas inventory is unclear and should be verified

10.5.3 Methodology and assumptions

The SGG emissions are calculated using a tier 1 approach. This currently corresponds with the 2006 IPCC Guidelines.

A default EF value of 50% is used for the first year of use, which is expressed in the 2006 IPCC Guidelines and is in line with good practice. Other quantities of SGG are fully emitted in the second year of use.

The method used to calculate the AD using import statistics appears to be reasonable due to the lack of detailed user data. Further enquiries to the processing industries allowed the materials to be broken down into sub-applications. This procedure is in line with the 2006 IPCC Guidelines on good practice. In addition, this showed that imported PFC are predominantly used to manufacture semiconductors. The AD of the solvent area of application were adjusted accordingly.

The top-down approach selected to define the emissions is in line with 2000 IPCC Good Practice Guidance.

Remarks:

Neither in the Carbotech Excel table, nor the Carbotech Report [2] nor the NIR contain data on the quantities of HFC and PFC destroyed.

It is unclear why the Carbotech Excel table includes a tier 2 approach, although the emissions were calculated using a tier 1 approach.

10.5.4 Verification of calculations

The AD were taken from the import statistics, with the external applications taken into consideration, and correctly assigned to the various areas of applications.

Default EF in the Carbotech Excel table [3] are in line with the data in the NIR. No information is given in the Carbotech Report.

The AD and EF in the CRF tables 2(II).F v1.6 for the years 1990 and 2008-2010 tally with the values in the Carbotech Excel table [3] (for exceptions, see Remarks). The calculations of the emissions are correct for the years in question.

In accordance with IPCC Good Practice Guidance a Monte Carlo analysis was used to determine the uncertainties of the model calculations. Therefore, the uncertainties of the import figures listed in the Carbotech Report [2] and NIR were taken into consideration. These seem to be plausible. Chapter 4 of the Carbotech Report provides information on the Monte Carlo analysis calculated values for the Solvents area of application, with total uncertainty defined as 1.8%. The NIR confirms this value.

Remarks:

It is unclear why CRF tables 2(II).F v1.6 for years 1990 and 2008 in the Solvents area of application under HFC134a place “IE” in category “Emissions from stocks and from disposal”.

It is also unclear why CRF tables 2(II).F v1.6 for the years 2008, 2009 and 2010 in the Solvents area of application record AD under “Filled into new manufactures products” instead of under “In operating systems” and EF under “Product manufacturing” instead of “Product life factor”, since the Carbotech Excel table states otherwise. In addition, EF are defined as 100%. The reasons for this should be given.

Although the Carbotech Excel table provides AD for HFC134a in 2008, an EF of 0 % is given in Product life. In addition, CRF table 2(II).F v1.6 for 2008 in terms of HFC134a does not give AD, EF or emissions.

The AD for HFC134a in CRF table 2(II).F v1.6 of 2009 do not tally with the AD in the Carbotech Excel table. In the latter, also the EF, at 41%, deviates from the default (50% in the first year and 50% in the second).

The AD and emissions of C_6F_{14} in CRF table 2(II).F v1.6 for 2008, 2009 and 2010 correspond to the values for C_4-C_{14}Fx in the Carbotech Excel table. This information is unclear, since C_4-C_{14}Fx is a class of substance.

There is no explanation about whether the EF uncertainty was taken into consideration in the Monte Carlo analysis, since there are no data.

10.5.5 Consistency

The AD and EF were compiled in the same way for the entire time series from 1990 to 2010 and included in the Carbotech Excel table [3].

There are no gaps in and no changes to the data sources in the Carbotech Excel table.

10.5.6 Transparency

The solvents area of application is briefly summarised in the NIR under the heading 2F5.

The method is clearly described in the NIR.

The AD (import figures) and EF are included in the NIR and the Carbotech Report [2] and documented in the Carbotech Excel table [3].

The emissions calculations are included in the Carbotech Excel table [3] and well-documented.

Remarks:

The basic data (EF, lifespan, etc.) are not transparently expressed in the Carbotech Excel table, the Carbotech Report [2] or the NIR.

The AD and EF in the CRF tables 2(II).F v1.6 for the years 1990 and 2008-2010 are partly assigned to the wrong heading (Manufacturing instead of Product life).

The method used to calculate the SGG emissions in the solvents area of application is not mentioned in the Carbotech Report.

There is no description of the solvents applications neither in the NIR or the Carbotech Report. This should be remedied.

The transfer of the AD from the Solvents area of application to the Semi-conductors and Other areas in the Carbotech Excel table [3] is not very transparent and not well-documented for external readers.

No references are provided to the companies questioned (industrial applications of solvents).

10.6 Other applications using ODS substitutes (2F6)

In accordance with 2006 IPCC Guidelines, this area of application includes niches, which define HFC and/or PFC as ODS replacements and are not taken into consideration in other areas of application. According to the guidelines, these include sterilisation, tobacco processing and solvents used in the manufacture of adhesives, surface coatings and inks.

No such applications are known in Switzerland. There is, correctly, no entry in the inventory of greenhouse gases. The NIR mentions this content, but the Carbotech Report [2] does not contain any details of this area of application.

10.7 Semiconductor manufacturing (2F7)

10.7.1 General observations

Fluorinated gases (HFC, PFC and SF_6) are suitable in etching processes (plasma etching, plasma procedures) as a supplier of fluorine. In the main, PFC are used as etching gases. Etching processes can be found in the semiconductor industry, circuit board production and the photovoltaic industry. The semiconductor plays the dominant role in terms of application quantities and emissions. Unlike most of the afore-mentioned applications, fluorinated gases are used as etching gases until they are changed or they decay. Therefore, the quantities used inevitably do not constitute a mass of emissions. However, several factors, such as process control, waste gas cleansing, process type and the gases used etc. are relevant [5].

The emission percentage for this area of application, for 2009 and in accordance with the greenhouse gas inventory, lies at around 1% of the total SGG emissions in the Industrial processes sector and is of little significance.

The most significant user of fluorinated gases in this area of application in Switzerland is ABB AG, which is the leading producer in the semiconductor sector.

10.7.2 Completeness

This area of application exists in Switzerland, in the form of semiconductor production, circuit board production and photovoltaics.

The relevant quantities are determined by using the FOEN import statistics and industry data to assign PFC to industrial applications and there are no detectable gaps. In particular, statements made by the largest consumer, ABB AG, are taken into consideration.

The gases included are based on FOEN import statistics and are in line with the relevant materials mentioned in the 2006 IPCC Guidelines (CF_4, C_2F_6, C_3F_8, C_4F_{10}, C_4F_6, C_5F_8, CHF_3, CH_2F_2, C_6F_{14}, c-C_4F_8, c-C_4F_8O and SF_6).

10.7.3 Methodology and assumptions

According to the NIR, the SGG emissions were calculated, up to the 2010 Inventory Report using a tier 1 approach, based on FOEN import data. After that date, the method changed to a tier 2 approach in accordance with industry data. The 2006 IPCC Guidelines confirm that both tier 1 and tier 2 approaches are good practice, depending on the availability of reliable data. The tier 2c approach actually used based on 2000 IPCC Good Practice Guidance.

The method used to calculate AD using import statistics and assignment to industrial applications according to processors' data appears to be sensible.

The EF values for operation and emission control technology are default values from 2000 IPCC Good Practice Guidance and appear to be plausible.

Remarks:

Exact data regarding AD and EF of the area of application are not included in the Carbotech Report [2] or the NIR.

Although the 2006 IPCC Guidelines, chapter 6.2, are based on a process gas-specific tier 2a approach based on company data regarding gas consumption and waste gas cleansing, the approach selected in the 2000 IPCC Good Practice Guidance, using inventory data and the breaking down of gases according to industrial data appears to be sensible and more target-oriented than a tier 1 approach.

As soon as more exact data on the various manufacturing processes are available, it is recommended that the detailed and itemised EF for semiconductors from the 2006 IPCC Guidelines are used instead of EF of the 2000 IPCC Good Practice Guidance.

10.7.4 Verification of calculations

The AD for industrial applications are correct and well-documented. They are taken from the FOEN import statistics and included in the Carbotech Excel table [3].

The AD and EF in the CRF tables 2(II).F v1.6 for the years 1990 and 2008-2010 are in line with the values in the Carbotech Excel table [3]. The calculations of the emissions are correct for the years in question.

A Monte Carlo analysis was used to determine the uncertainties of the model calculations using a tier 2 approach, in accordance with 2000 IPCC Good Practice Guidance. Therefore, the uncertainty of the import figures was taken into consideration in accordance with the data in the NIR. This appears to be plausible. Chapter 4 of the Carbotech report provides information of the values calculated using the Monte Carlo analysis, for the semiconductor manufacturing area of application and indicates total uncertainty of 40.2%. The NIR confirms this value.

Remarks:

It is unclear why the CRF tables 2(II).F v1.6 for the years 2008, 2009 and 2010 in the semiconductor manufacturing area of application place AD under “Filled into new manufactured products” instead of “In operating systems” and the EF under “Product manufacturing” instead of “Product life factor”, as the Carbotech Excel table states otherwise. In order to avoid confusion the allocation of EF and AD should be done consistently in the CRF tables and the Carbotech Excel table.

It is unclear how the uncertainties for the EF are taken into consideration when calculating the overall uncertainty using Monte Carlo. Neither the NIR nor the Carbotech Report contain information about this.

10.7.5 Consistency

The AD and EF were included in the same way for the entire time series from 1990 to 2010 and in the Carbotech Excel table [3].

For the first time, for the 2011 Inventory Report, SGG emissions were calculated according to a tier 2 approach. Therefore, industry data were taken into consideration and significant quantities of PFC transferred from the Solvents (2F7) and Other (2F9) areas of application to Semiconductor manufacturing and assigned to the different industrial applications.

No gaps have been found in the data source in the Carbotech Excel table.

Remarks:

Neither the Carbotech Report nor the NIR included a retrospective recalculation of modelling based on the PFC transfer from the Solvents (2F7) and Other (2F9) areas of application.

Whether or not the EF are changed through the change from a tier 1 to a tier 2 approach is not obvious from the documents available in the NIR, Carbotech Report [2] or Carbotech Excel table [3]. A comment in the documents would be helpful.

10.7.6 Transparency

The Semiconductor manufacturing area of application are summarised in the NIR under the 2F7 heading.

The method is clearly defined in the NIR.

How the emissions are calculated are described in the Carbotech Excel table [3] and are well-documented.

Remarks:

Since the area of application includes applications in the semiconductor industry as well as in photovoltaic production and circuit board manufacture, the designation “Semiconductors” is incomplete. The 2006 IPCC Guidelines also describe this area of application as “Electronics industry emissions”. It is recommended that this description is adopted.

There is no more exact description of the material applications in the Semiconductor manufacturing area of application both in the NIR and the Carbotech Report. This should be remedied.

The Carbotech Report [2] does not include any information on the selected method (tier 1, tier 2) for calculating SGG emissions or for any recalculations in this area of application.

The NIR and the Carbotech Report do not contain exact data on AD and EF. It is recommended that the data is expressed in tabular format.

There is no information in Chapter 3.3.6 of the Carbotech Report (Semiconductor manufacturing) on the sources of the breakdown of gases into individual industrial applications. Annex A5 also does not include all these sources.

The AD and EF in the CRF tables 2(II).F v1.6 for the years 2008-2010 are sometimes assigned to the incorrect heading (manufacturing instead of product life).

10.8 Electrical equipment (2F8)

10.8.1 General observations

This area of application, in accordance with the 2006 IPCC Guidelines, include SF_6 and PFC, which are used in the manufacture and operation of electrical equipment. In 2009 and in accordance with the greenhouse gas inventory, the emissions percentage of this area of application is around 8 % of the total SGG emissions for the Industrial processes sector.

Electrical operating equipment (switch units, switch systems and transformers) are used in Switzerland in power networks for distributing and transforming electricity and for interconnecting and separating utilities and industrial operations. Electrical equipment is found in all voltage ranges from low voltage (voltages lower than 1 kV) to the highest voltage. The voltage range above 1 kV is subdivided into medium voltage (MV: 1 kV to smaller 52 kV), high voltage (HV: from 52 kV) and highest voltage (greater than 110 kV).

Sulphur hexafluoride (SF_6) is used worldwide as an extinguishing and/or insulation medium in electrical operating high voltage devices (>52 to 380 kV) since the sixties and, in terms of middle voltage (1-52 kV), only 10 years later. SF_6 replaced either oil or air. When manufacturing components for gas-insulated internal switch systems (converters and bushings) and high voltage open-air converters, SF_6 is also used [5].

The sector is sensitive to economic changes. Changed plant construction therefore has a direct effect on the use of SF_6.

10.8.2 Completeness

The electrical equipment area of application is widespread in Switzerland. This includes installed, gas-filled and partly imported units in the medium, high and highest voltage sector as well as the manufacture of the same by Swiss companies.

The greenhouse gas inventory is based, with regard to this area of application, to a sector agreement with the Swissmem association. Every year, the association compiles the amount of SF_6 consumed by member companies. These include all companies in Switzerland, which use SF_6 in the various industrial applications. Therefore, all relevant companies and consumption/storage quantities are included.

SF_6 was quantitatively included as the most significant gas in the Electrical equipment area of application.

Remarks:

When reading the Carbotech Excel table [3], the NIR and the Carbotech Report [2], it is not obvious how the SF_6 emissions of Swissmem were assigned to the various sources. The Swissmem material flow balance must therefore contain information on electricity production (EVU), high and medium voltage systems production and particle accelerators. Only with indicated data from the corresponding balance figures it can be estimated if the figures are complete and are correctly assigned. They should therefore be described.

It is not clear, from the NIR and the Carbotech Report, whether or not PFC is also used in the Electrical equipment area of application in Switzerland. Possible areas of use in accordance with 2006 IPCC Guidelines are dielectrics, heat transfer fluids in power transformers and cooled transformers (retrofitting CFC113).

10.8.3 Methodology and assumptions

An overall balance of SGG emissions is calculated using a tier 3 approach. This corresponds to good practice according to the 2006 IPCC Guidelines. Calculated EF are used, based on the overall mass balance.

The method used to calculate AD and EF using the overall mass balance appears to be reasonable, since there are no detailed data on leakage rates or losses at system level.

The values for the EF used in production, operation and disposal of electrical equipment seem to be plausible. A direct comparison of the calculated EF from the overall balance with the default EF of the 2006 IPCC Guidelines, Chapter 8.2.2.1 cannot be achieved, since these are system-specific in the guidelines. The amounts however appear to be correct.

The basic data used to calculate the emissions include an equipment lifespan of 35 years. This is at the lower threshold of the default values as defined by the 2006 IPCC Guidelines. According to the statements made by experts, 35years correspond to the actual value.

10.8.4 Verification of calculations

The AD for the total area of application were taken from the total Swissmem balance in the Carbotech Excel table [3] and are well-documented.

The EF and device lifespan in the Carbotech Excel tables [3] tally with the data in the NIR.

The AD and EF in the CRF tables 2(II).F v1.6 for the years 1990 and 2008-2010 are in line with the values in the Carbotech Excel table [3]. The calculations of the emissions from manufacturing, stocks and disposal are correct for the years in question.

In order to define the uncertainties for model calculations in accordance with tier 3 a Monte Carlo analysis was used in accordance with 2000 IPCC Good Practice Guidance. Chapter 4 of the Carbotech Report provides information on the calculated values of the Monte Carlo analysis of the Electrical equipment area of application, with a total uncertainty for emissions of ±5.1 %. The NIR confirms this value. The 2006 IPCC Guidelines indicate an uncertainty of resulting emissions of ±10%

Remarks:

It is unclear how the uncertainties of the EF were used to calculate the total uncertainty of emissions using the Monte Carlo analysis. Neither the NIR nor the Carbotech Report include any relevant data.

The origin of the emissions factors should be explained in the Carbotech Excel table [3] and the Carbotech Report [2].

10.8.5 Consistency

The AD and EF were modelled, from 1999 to 2010, on the basis of the material flow analysis provided by Swissmem. Due to a lack of available data, AD and EF from 1990 to 1998 were modelled on the average values from 1999-2004. This procedure appears to be reasonable, since 5 years is a representative phase in terms of economic changes. The breakdown according to export, domestic production and maintenance were calculated using the information provided by Plüss&Stauffer. The Swissmem data relating to AD for SF_6 procurement on production purposes was corrected in 2000 using the current import statistics from Omya, since there was an obvious calculation error in the Swissmem balance.

There are no gaps in and no changes to the data sources identified in the Carbotech Excel table [3].

10.8.6 Transparency

The area of application is summarised briefly in the NIR in the section 2F8 Electrical Equipment.

The method is clearly described in the NIR.

The origin of the AD (Swissmem) is mentioned in the NIR and Carbotech Report [2], although the calculation of the EF is only included in the NIR. AD and EF are documented in the Carbotech Excel table [3]. The AD and EF in the CRF tables 2(II).F v1.6 for the years 1990 and 2008-2010 are comprehensible and well-documented.

The calculations of the emissions are expressed in the Carbotech Excel table [3] and are well-documented.

Remarks:

The Carbotech Report [2], chapter 3.3.7 Electrical equipment makes reference to the tier 3 method. Annex A6 however refers to a tier 2 approach in the Electrical equipment area of application. in addition, in Chapter 3.3.7 there is no cross-reference to the method in Annex 6.

The calculation of the AD and EF for the years 1990-1998 based on the average values of the overall Swissmem balance for 1999-2004 is only mentioned in the Carbotech Excel table. This should also be included in the Carbotech Report.

Neither the Carbotech Report [2], the NIR nor the Carbotech Excel table [3] describe the industrial applications (electricity production, high and medium voltage system production, part accelerators), which are within the Swissmem sector agreement. This should be added.

The Electrical equipment definition is not expressed anywhere.

The annex to the Carbotech Report does not include any source data (Swissmem).

It is recommended that the quality assurance of the overall balance is assessed with Swissmem. In particular the ways of avoiding the double counting or omission of emissions in accordance with the 2006 IPCC Guidelines, Chapter 8.2.2 should be taken into consideration.

10.9 Other (2F9)

10.9.1 General observations

In accordance with the 2006 IPCC Guidelines, this section includes the following applications, which cannot be assigned to any other source category:

- SF_6 and PFC used in military applications (radar, heat transfer fluids)
- SF_6 used in equipment in university, research, industrial and medical particle accelerators
- SF_6 and PFC in rubber (tires, shoes)
- SF_6 used in sound-proof windows
- PFC as heat transfer fluids in commercial and consumer applications
- PFC used in cosmetics and in medical applications

– Other uses of SF_6 and PFC in gas-air tracer in research and leak detectors

According to the 2009 greenhouse gas inventory, the emissions percentage for this area of application is equal to around 6% of all SGG emissions from the Industrial processes sector.

It is accepted that the emissions relating to this heading will increase in the next few years and will then stabilise due to the significant storage quantity, which, for example, is partly released by decommissioning gas-filled windows.

10.9.2 Completeness

The NIR and Carbotech Report [2] both confirm that the SF_6 and PFC emissions are assigned to the 2F9 heading by differentiating between the relevant areas of application and the import statistics. This heading, in particular, includes electrical equipment, research, windows, and cables. The applications were, inter alia, defined by industry and therefore apply to Switzerland.

The documentation does not expressly indicate whether or not all relevant companies are included. However, it is certain that by differentiation between the SGG levels according to the import statistics and relevant areas of application there are no gaps.

Remarks:

Neither the NIR nor the Carbotech Report indicate whether or not the residual SGG in heading 2F9 are assigned according to the 2006 IPCC Guidelines. It is recommended that some clarification is provided as to whether or not the afore-mentioned sources (Chapter 10.9.1) are significant in Switzerland.

It is not clear if the particle accelerators are included by the Swissmem association and, therefore, was included in the 2F8 Electrical equipment area of application or in 2F9. This should be checked to avoid any double counting.

It is unclear why applications are included in Electrical equipment under 2F9 and not in 2F8.

With regard to the gases SF_6 and PFC, the 2006 IPCC Guidelines concluded that both HFC134a and HFC23 are to be included in the inventory as well. If they are not assigned to other areas of application (e.g. aerosols), they are correctly taken into consideration in 2F9.

10.9.3 Methodology and assumptions

SGG emissions are calculated using a tier 2 approach, which corresponds to the 2006 IPCC Guidelines. EF are used which, in the case of sound-proof windows, correspond to the default values of the 2006 IPCC Guidelines. Particle accelerator EF are taken from the Swissmem mass balances. EF for the analysis/laboratory/research applications are estimated at an average of 50%. The EF calculation method appears to be reasonable and the values appear plausible.

The method for calculating AD by means of differentiating between import statistics and the Swissmem mass balance appears to be reasonable. This method and the further assignment to applications according to experts' statements are in accordance with 2006 IPCC Guidelines good practice.

The basic data used to calculate emissions included a lifespan for sound-proof windows of 25 years and 40 years for cables/controls. This is in line with the default values according to the 2006 IPCC Guidelines.

Remarks:

The EF for the production, operation and disposal of the cables and controls applications are based on statements taken from experts (unfortunately no source information available). However, the same EF is used for both applications, which is improbable.Comparative figures from the IPCC guidelines and foreign sources could not be found. It is recommended that the correctness of these EF is checked with cable manufacturers (e.g. Brugg Kabel AG).

10.9.4 Verification of calculations

The AD are correct and the calculations well-documented.

The AD and EF in CRF tables 2(II).F v1.6 for 1990 are in line with the values in the Carbotech Excel table [3] (for exceptions, see Remarks). The calculations of the emissions from stocks and disposals are correct for 1990.

When determining the uncertainties of a model calculation using a tier 2 approach a Monte Carlo analysis was implemented in accordance with 2000 IPCC Good Practice Guidance. Chapter 4 of the Carbotech Report provides information on the calculated values of the Monte Carlo analysis in the “Other” area of application and determines a total emissions uncertainty of 80.6 %. The NIR confirms this value.

Remarks:

The AD, EF and lifespan for the products in the Carbotech Excel tables [3] are only partially included in the NIR and never in the Carbotech Report [2].

The AD and EF in the CRF tables 2(II).F v1.6 for the years 2008, 2009 and 2010 are not in line with the values in the Carbotech Excel table [3]. The calculations of emissions from manufacturing and stocks are not correct for the years under consideration. The transfer of data between the Carbotech Excel table [3] and the CRF table should be checked.

It is unclear how the uncertainties of the EF and AD are taken into consideration when calculating the overall uncertainty of the emissions using the Monte Carlo analysis. Neither the NIR nor the Carbotech Report contain relevant information.

10.9.5 Consistency

The AD and EF were calculated in the same way for the entire time series from 1990 to 2010 and included in the Carbotech Excel table [3]. Adjustments were made to the 2010 inventory when assigning SF_6 to the various applications and recalculated for the entire time series. In particular, no SF_6 was used for windows in 2009 and 2010. This mirrors the calculations in the Carbotech Excel table.

It is not obvious in the Carbotech Excel table how large the quantities of PFC are, which were transferred from the Other (2F9) area of applications to Semiconductor manufacturing.

No gaps were found in the data sources in the Carbotech Excel table.

Remarks:

Neither the Carbotech Report nor the NIR mention the retrospective recalculation of the modelling due to the PFC transfer from the Other (2F9) area of application.

10.9.6 Transparency

The area of application is briefly summarised in the NIR under heading 2F9 Other.

The tier 2 method is described in the NIR.

The derivation of the AD is mentioned in the NIR and the Carbotech Report [2], but the EF values are only partially expressed in the NIR. AD and EF are documented in the Carbotech Excel table [3]. The AD and EF in the CRF tables 2(II).F v1.6 for the years 1990 and 2008-2010 are comprehensible and well-documented.

The calculations of the emissions are included in the Carbotech Excel table [3] and are well-documented.

Remarks:

Neither the Carbotech Report [2], the NIR nor the Carbotech Excel table [3] describe the industrial applications with a sufficient amount of detail.

The Carbotech Report does not include the sources for industrial and importer statements in relation to AD in the annex.

The Carbotech Report [2] places the description under heading “Other” Category G. The correct designation for these SGG applications is, however, 2F9. The report should be corrected accordingly.

The EF for the production, use and disposal of the cable and controls are based on experts’ statements and are mentioned in the NIR, but are nowhere to be found in the Carbotech Report. There are no source data for these EF.

The method regarding tier 2 in the Carbotech Report [2] is not fully described in annex A6. In addition, in Chapter 3.3.8 there is no cross-referencing of the method in annex 6.

11. Conclusion and recommendations

11.1 General

The review of the Swiss GHG inventory, NIR, EMIS-comments, Carbotech-report and Carbotech-Excel-tables and the related industrial process GHG emissions CO_2, CH_4, N_2O, HFC, PFC and SF_6 basically revealed a good data gathering approach.

Overall, for most source categories in the sector industrial processes the GHG emissions in the GHG inventory are reported correctly and need no or mid-term improvements only.

Nevertheless, the applied evaluation criteria completeness, methodology, correctness, consistency and transparency disclosed some deviations from the requirements according to 2006 IPCC Guidelines, inventory quality of several source categories. Potential improvements are mainly related to optimized documentation and traceability and have a minor effect on the total amount of GHG emissions. The identified inadequateness does not make necessary fundamental adaptations of the GHG inventory of the industrial processes setor.

Since the review encompassed numerous source categories and the findings related to the different evaluation criteria are divers the specific deviations are listed in the respective GHG source category chapters of this review report for better understanding. The source categories show potential for improvement regarding all evaluation criteria.

11.2 Deviations

The following Table 1 summarizes the findings of the review for each source category (as-is state). This qualitative evaluation illustrates the compliance with the evaluation criteria (details see chapter 3.1). In order to have an overview of the magnitude of deviations the source categories are qualitatively evaluated using traffic light logic.

- Red colour: significant deviations from requirements or decisive omissions
- Yellow colour: deviations obvious but less critical for source category inventory
- Green colour: no/not relevant deviations identified

	Source category	Complete-ness	Method	AD	EF	Calcu-lation	Consistency	Transparency
2A1	Cement							
2A2	Lime							

	Source category	Complete-ness	Method	AD	EF	Calcu-lation	Consistency	Transparency
2A3	Limestone/ dolomite							
2A4	Soda ash	N.O.	N.O.	N. O.	N. O.	N.O.	N.O.	N.O.
2A5	Asphalt roofing	N.A.	N.A.	N. A.	N. A.	N.A.	N.A.	N.A.
2A6	Road paving	N.A.	N.A.	N. A.	N. A.	N.A.	N.A.	N.A.
2A7a	Plaster							
2A7b	Glass							
2A7c	Glass wool							
2B1	Ammonia							
2B2	Nitric acid							
2B3	Adipic acid	N.O.	N.O.	N. O.	N. O.	N.O.	N.O.	N.O.
2B4	Carbide							
2B5a	Acetic acid							
2B5b	Ethylene							
2B5c	Caprolactam	N.O.	N.O.	N. O.	N. O.	N.O.	N.O.	N.O.
2B5d	Carbon black		N.A.		N. A.	N.A.	N.A.	N.A.
2B5e	Dichloroethylene	N.O.	N.O.	N. O.	N. O.	N.O.	N.O.	N.O.
2B5f	Styrene	N.O.	N.O.	N. O.	N. O.	N.O.	N.O.	N.O.
2B5g	Methanol	N.O.	N.O.	N. O.	N. O.	N.O.	N.O.	N.O.
2B5h	Coke		N.A.		N. A.	N.A.	N.A.	N.A.
2B5i	New categories		N.A.		N. A.	N.A.	N.A.	N.A.
2C1	Iron&steel							
2C2	Ferroalloys							
2C3	Aluminium							
2C4	SF_6 Al&Mg							

	Source category	Complete-ness	Method	AD	EF	Calcu-lation	Consistency	Transparency
2C5a	Batteries							
2C5b	Non-ferrous		N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
2D1	Pulp&Paper		N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
2D2	Food&Drink							
2G1	Blasting& Shooting							
2E	Halocarbons&SF_6	N.O.	N.O.	N.O.	N.O.	N.O.	N.O.	N.O.
2F1a	Domestic ref.							
2F1b	Commercial/ industrial ref.							
2F1c	Transport ref.							
2F1d	Stationary AC							
2F1e	Mobile AC							
2F2	Foam blowing							
2F3	Fire extinguishers		N.A.		N.A.	N.A.	N.A.	N.A.
2F4	Aerosols							
2F5	Solvents							
2F6	Other ODS substitutes		N.A.	N.A.	N.A.	N.A.	N.A.	
2F7	Semiconductor							
2F8	Electrical equipment							
2F9	Other PFC, SF_6							

Table 1 Summarized qualitative review findings in traffic light logic. N.A.: Not applicable; N.O. Not occurring

11.3 Relevance of GHG emissions

Based on the emission data of the inventory 2010 the contribution of the different GHG to the overall emissions was calculated and visualized in the following Figure 1 GHG emissions of industrial processes in 2010 (see also Appendix A for data). It is obvious that CO_2 emissions are by far the most important portion of the emissions generated by industrial processes along with HFCs and should be the main focus for improvements. Despite of their high GWP SF_6, PFC and CH_4 contribute less to the overall GHG emissions.

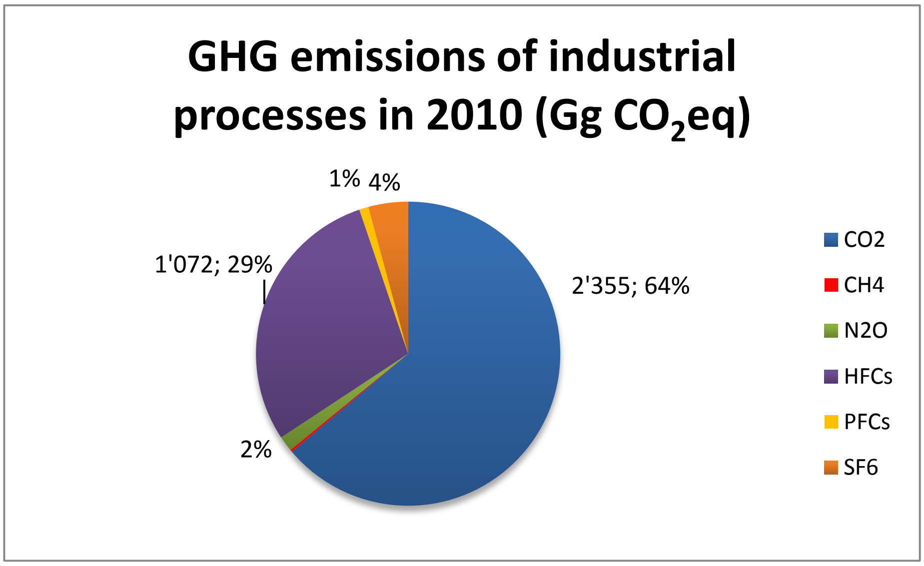

Figure 1 GHG emissions of industrial processes in 2010

The influences of different source categories on the overall GHG emissions were calculated and illustrated in following Figure 2 GHG emissions of source categories in 2010

Source categories with considerable GHG contributions (>50'000 t CO_{2eq}/a in 2010) and particular relevance are listed in the following. Cement production (2A1) and Refrigeration and Air conditioning equipment (2F1) are the main emission source categories.

- 2A1 Cement production
- 2A2 Lime production
- 2A3 Limestone and dolomite use
- 2B2 Nitric acid production
- 2B5b Ethylene production
- 2C1 Iron and Steel production
- 2F1 Refrigeration and Air conditioning equipment
- 2F8 Electrical equipment
- 2F9 Other

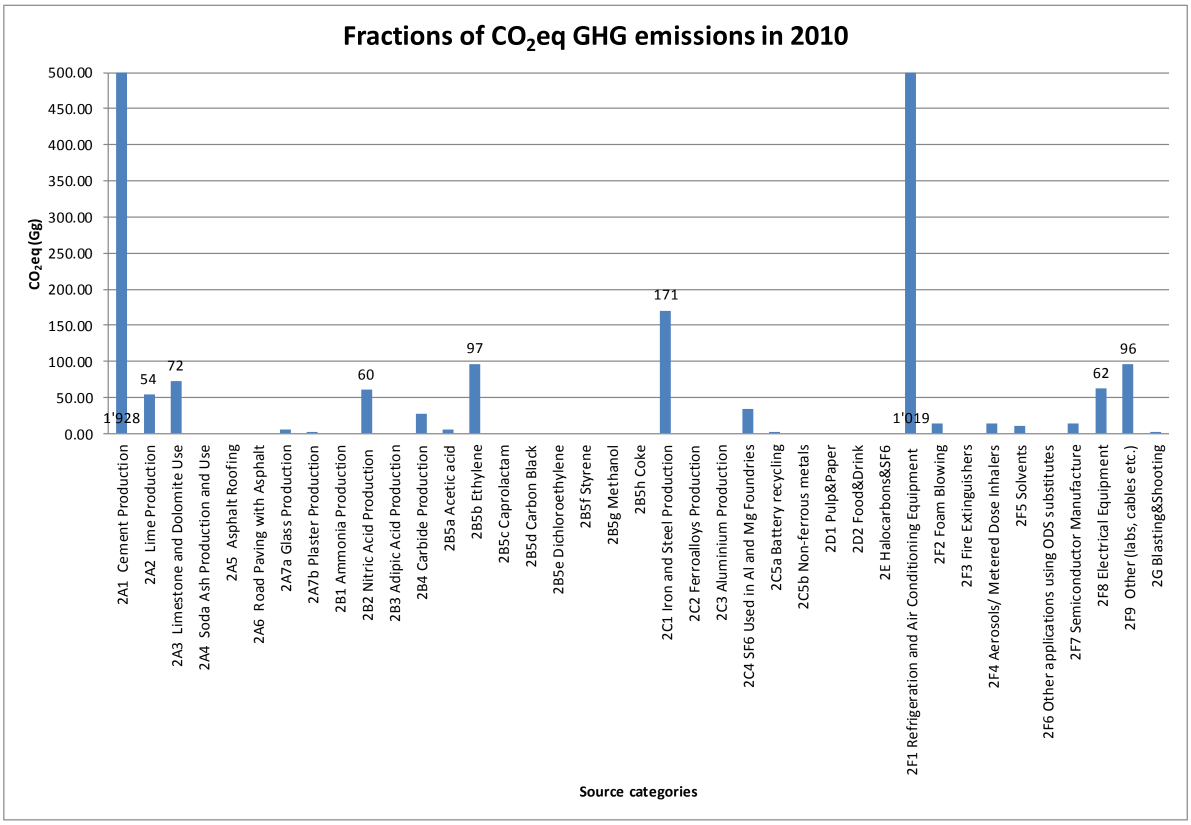

Figure 2 GHG emissions of source categories in 2010

11.4 Improvements and effects

In order to prioritize the need for improvements and corrections in the inventory of industrial processes emission data of the source categories are assessed according to the as-is state and relevance for the overall GHG emissions based on 2010 data (source categories with >50'000 t CO_{2eq}/a in 2010).

The priorities for improvements are considered as follows:

1. Actions recommended due to deviations with high influence on GHG emissions in the review period
2. Mid-term improvements recommended due to obvious deviations with minor influences on GHG emissions in the review period
3. No actions recommended due to correct data and/or irrelevant process in the review period

Deviations from criteria with potential influence on GHG emissions are listed in Table 1. The criterion transparency is not directly relevant for GHG emission quantification and therefore considered as an issue for mid-term improvement only.

The following Table 2 summarizes the numeric contribution of the source categories to the overall GHG emissions and the priorities for improvements. The percentage of emissions and the priority for improvement indicate the effects on the overall GHG emissions.

Source categories with priority 1 for improvements and their quantitative influence on GHG emissions are as follows:

- 2A1 Cement production:
  GHG emissions are possibly overestimated by 4% (+77.12 Gg CO_{2eq}). The influence on total GHG emission of industrial processes sector is 2% (Gg CO_{2eq}),
- 2F1 Refrigeration and Air conditioning equipment:
  this source category consists of five sub-categories. All of them show deviations from the criteria listed in Table 1, however, the sub-categories Commercial/industrial refrigeration (2F1b), Stationary AC (2F1d) and Mobile AC (2F1e) are particularly important due to their contribution to GHG emissions. An estimation of the various influencing parameters revealed a possible underestimation of this source category by 16% (-165.63 Gg CO_{2eq}). The influence on total GHG emission of industrial processes sector is 5% (Gg CO_{2eq}),
- 2F9 Other: this source category might include up to 50% (48.15 Gg CO_{2eq}) GHG emissions that have to be declared in other source categories of the industrial processes sector (overestimation). However, the overall amount of GHG emissions for the industrial processes sector would remain the same as the allocation concerns source categories of the same sector.

Source category	**CO_2eq (Gg)**	**% Emissions**	**Priority**
2A1 Cement Production	1928.12	52	1
2A2 Lime Production	54.23	1	2
2A3 Limestone and Dolomite Use	72.39	2	2
2A4 Soda Ash Production and Use	0	0	3
2A5 Asphalt Roofing	0	0	3
2A6 Road Paving with Asphalt	0	0	3
2A7a Glass Production	5.88	0.2	3
2A7b Plaster Production	0.05	0.0	3
2B1 Ammonia Production	0	0	2
2B2 Nitric Acid Production	60.26	2	3
2B3 Adipic Acid Production	0	0	3
2B4 Carbide Production	26.74	1	2
2B5a Acetic acid	6.30	0.2	2
2B5b Ethylene	96.75	3	2
2B5c Caprolactam	0	0	3
2B5d Carbon Black	0	0	2
2B5e Dichloroethylene	0	0	3
2B5f Styrene	0	0	3
2B5g Methanol	0	0	3
2B5h Coke	0	0	2
2C1 Iron and Steel Production	170.57	5	2
2C2 Ferroalloys Production	0	0	3
2C3 Aluminium Production	0	0	3
2C4 SF_6 Used in Al and Mg Foundries	34.54	1	3
2C5a Battery recycling	1.85	0.1	3
2C5b Non-ferrous metals	0	0	3
2D1 Pulp&Paper	0	0	3
2D2 Food&Drink	0	0	2

Source category	CO_2eq (Gg)	% Emissions	Priority
2E Halocarbons&SF_6	0	0	3
2F1 Refrigeration and Air Conditioning Equipment	1019.13	28	1
2F2 Foam Blowing	13.59	0.4	2
2F3 Fire Extinguishers	0	0	2
2F4 Aerosols/ Metered Dose Inhalers	14.71	0.4	2
2F5 Solvents	10.25	0.3	2
2F6 Other applications using ODS substitutes	0	0	3
2F7 Semiconductor Manufacture	13.62	0.4	2
2F8 Electrical Equipment	62.47	2	2
2F9 Other (labs, cables etc.)	96.30	3	1
2G Blasting&Shooting	0.96	0.0	3
Total	3688.70	100	

Table 2 GHG emissions of source categories and priorities for improvement

The largest fractions of GHG emissions in the source categories Cement production (2A1), Refrigeration and air conditioning equipment (2F1) and the category Other (2F9) need revision as relevant deviations from the quality criteria applied by the 2006 IPCC Guidelines exist. However, improvements in these source categories will have a limited effect on the overall GHG inventory of the industrial processes sector of -2% to +5%.

The greenhouse gases from the industrial processes sector are equal to around 7% of all Swiss emissions (2010 inventory). The reviewers' recommendations for improving the determination of emissions with first priority include net 0.2% of all Swiss greenhouse gas emissions. Most of the GHG emissions of the industrial processes sector are sufficiently estimated and substantial recalculations are not necessary.

It is recommended to verify inappropriate methodology, EF, AD, calculations and consistency of the source categories first as they have generally greater influence on the results. Afterwards completeness and transparency would be subject for improvements if insufficient.

For the effective improvement of the inventory it is recommended to consider all claims and recomendations listed in the respective chapters of the source categories in this review report under the heading "Remarks".

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APPENDIX A SOURCE CATEGORIES AND GHG EMISSIONS 2010

GREENHOUSE GAS SOURCE AND	CO_2	CH_4	N_2O	HFCs	PFCs	SF_6
SINK CATEGORIES	1	21	310	A	A	23'900
Inventory 2010, Submission 2012 v1.6	CO2 equivalent (Gg)			CO_2 equivalent (Gg)		CO_2 equivalent (Gg)
Total Industrial Processes	2'355.46	8.39	60.26	1'072.97	36.51	155.12
A. Mineral Products	2'060.66	NA,NO	NA,NO			
1. Cement Production	1'928.12					
2. Lime Production	54.23					
3. Limestone and Dolomite Use	72.39					
4. Soda Ash Production and Use	IE,NO					
5. Asphalt Roofing	NA					
6. Road Paving with Asphalt	NA					
7. Other	5.93	NA,NO	NA,NO			
Glass Production	5.88	NA	NA			
Plaster Production	0.05	NA	NA			
B. Chemical Industry	121.41	8.39	60.26	NO	NO	NO
1. Ammonia Production	IE	NA	NA			
2. Nitric Acid Production			60.26			
3. Adipic Acid Production	NO		NO			
4. Carbide Production	24.66	2.09				
5. Other	96.75	6.30	NA,NO	NA,NO	NA,NO	NO
Carbon Black		NO				
Ethylene	96.75	NA	NA			
Dichloroethylene		NO				
Styrene		NO				
Methanol		NO				
Cracking process	NO	NO	NO	NO	NO	NO
Organic chemicals production	NA	6.30	NA	NO	NO	NO
C. Metal Production	172.43	NA,NO	NA,NO	NA,NO	NA,NO	34.54
1. Iron and Steel Production	170.57	NA,NO				
2. Ferroalloys Production	IE	NO				
3. Aluminium Production	NO	NO			NO	
4. SF_6 Used in Aluminium and Magnesium Foundries						34.54
5. Other	1.85	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO
Aluminium second smelting	NO	NO	NO	NO	NO	NO
Battery recycling	1.85	NA	NA	NO	NO	NO
Non-ferrous metals	NA	NA	NA	NA	NA	NA
D. Other Production	NA					
1. Pulp and Paper						
2. Food and Drink	NA					
E. Production of Halocarbons and SF_6				NA,NO	NA	NA
F. Consumption of Halocarbons and SF_6				1'072.97	36.51	120.59
1. Refrigeration and Air Conditioning Equipment				1'011.69	7.43	NO
2. Foam Blowing				13.59	NO	NO
3. Fire Extinguishers				NO	NO	NO
4. Aerosols/ Metered Dose Inhalers				14.71	NO	NO
5. Solvents				2.37	7.88	NO
6. Other applications using ODS[3] substitutes				NO	NO	NO
7. Semiconductor Manufacture				NO	6.63	6.99
8. Electrical Equipment				NO	NO	62.47
9. Other				30.62	14.56	51.12
Analysis, syntheses, laboratories				29.97	14.56	NO
Windows, cables, electric equipment				0.64	NO	51.12
G. Other	0.96	NA	NA	NA,NO	NA,NO	NO
Blasting&Shooting	0.96	NA	NA	NO	NO	NO