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Review of the National Greenhouse Gas Inventory
Categories Energy and Industrial Processes

Final Report

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Abstract

As part of the quality assurance measures concerning the Swiss Greenhouse Gas Inventory, a national review has been carried out. The review covers the sectors 1 Energy and 2 Industrial Processes of the submission of 2005 (time series 1990 - 2003). The topics addressed are completeness, methods, correctness, consistency and transparency.

Regarding the topics, influencing GHG emissions, only minor issues have been identified. Most of them have been known before or have already been corrected for the most recent submission of 2006.

The main issue of the Swiss inventory is the problem of transparency. The inventory consists of a set of interconnected Excel files. Many of these files were created as part of an internal (Swiss) GHG inventory and later adapted to meet the IPCC demands. There is no comprehensive documentation of the methods and assumptions applied. Some information is included in the Excel files which comprise several dozens of spreadsheets. Some information can be found in the National Inventory Report. Also references to other documents are very often missing or not precise enough.

FOEN is working on a new data management system for their GHG inventory. This new data bank system will also include a comprehensive documentation of every stated emission, including the involved data sources and models applied to calculate the final numbers reported on the CRF. The documentation will only be available in German.

Zusammenfassung

Einführung

Die Schweiz hat die UN Rahmenkonvention zum Klimawandel und das Kyoto-Protokoll unterzeichnet und ratifiziert. Die Schweiz ist dadurch verpflichtet, ein Treibhausgasinventar zu führen, welches den Richtlinien des IPCC (Intergovernmental Panel on Climate Change) entspricht. Diese Richtlinien verlangen auch qualitätssichernde Elemente. Ein solches Element ist ein Review des Inventars durch einen nationalen Experten. Das Bundesamt für Umwelt (BAFU), welches das schweizerische Treibhausgasinventar führt, beauftragte die Dr. Eicher+Pauli AG mit dem Review der Kategorien *1 Energy* und *2 Industrial Processes* der Submission 2005 (1990 - 2003). Die zu prüfenden Gegenstände waren: Vollständigkeit der Emissionsquellen, Methodik und deren Umsetzung, Konsistenz der Zeitreihen und Transparenz/Dokumentation.

Ergebnisse

Transparenz/Dokumentation

Das untersuchte Inventar besteht aus mehreren Dutzend verknüpften Excel-Tabellen, die bedingt durch ihre Entstehungsgeschichte, ein nicht leicht zu durchschauendes Konglomerat bilden. Es existiert dazu keine umfassende Dokumentation der Datenquellen, Umrechnungen und Annahmen. Dieses Manko ist gravierend und stellt den wichtigsten Kritikpunkt am Inventar dar.

Zur Zeit arbeitet das BAFU an einer neuen Lösung, welche die hier untersuchten Excel-Tabellen vollständig ersetzen wird. Wichtigster Teil dieser Lösung ist eine Emissionsdatenbank, aber auch eine umfassende Dokumentation.

Für den Review bedeutete die fehlende Dokumentation, dass ein Verständnis der Berechnungen nur mittels zeitintensiver Analyse der Excel-Formeln und -Verknüpfungen möglich war. Bei dieser Analyse wurden auch ein paar wenige Excel-Verknüpfungsfehler gefunden, die aber keinen Einfluss auf die Emissionsberechnungen hatten.

Kategorie 1 Energy

Diese Kategorie deckt 80% der schweizerischen Treibhausgasemissionen ab, davon 99% als CO_2. Datenquelle ist hier primär die schweizerische Gesamtenergiestatistik (GES), welche nicht Gegenstand des Reviews ist.

Im sogenannten *Reference Approach* des IPCC wird eine vereinfachte Berechnung der CO_2-Emissionen aus fossilen Energieträgern auf Basis von Import/Export- und Lagerverschiebungsdaten durchgeführt. Ein Vergleich dieses Ergebnisses mit der entsprechenden Grösse aus dem *Sectoral Approach* (IPCC-Feingliederung) zeigt nur geringe Differenzen im Bereich von etwa 1%. Diese Differenz kann teilweise auf unterschiedliche Datenquellen zurückgeführt werden. Insgesamt zeigt die sehr gute Übereinstimmung der beiden Ansätze, dass der Sectoral Approach kaum Lücken oder relevante Berechnungsfehler aufweist.

Die wichtigsten Feststellungen:

- Beim totalen Rohölimport besteht eine Differenz zwischen GES und der Statistik der Schweizerischen Erdölvereinigung von 0.3%. Der Grund für diese (kleine) Abweichung ist unklar.
- In der Kategorie *Combined Heat/Electricity* (1A1 aii) werden anstelle der totalen Emissionen aus der Abfallverbrennung nur 32% davon ausgewiesen (elektr. Wirkungsgrad). Das BAFU hat diesen Fehler für die Submission 2006 bereits korrigiert.
- Es hat sich gezeigt, dass die Annahmen der GES bezüglich Lagerhaltung von Kohle und Schweröl wahrscheinlich von der Realität abweichen.
- Die Emissionen der *Civil Aviation* (1A3 a) müssen mittels Modell berechnet werden, da die Absatzzahlen für Kerosin den Verbrauch für internationale Flüge beinhalten. Deren Emissionen sind gemäss IPCC nicht auszuweisen. Das bis zur Submission 2005 verwendete Berechnungsmodell basierte auf vielen groben Annahmen. Das neue, ab 2006 eingesetzte Modell zeigt, dass bis anhin die Emissionen leicht unterschätzt wurden.
- Der Erdgasverbrauch der Kategorie *Road Transportation* (1A3 b) wurde bis zur Submission 2005 nicht separat ausgewiesen. Eine Änderung dieser Praxis ist geplant.
- In den Kategorien *Energy Industries* (1A1) *& Manufacturing Industries and Construction* (1A2) wurden keine separaten Emissionsfaktoren für die motorische Nutzung (WKK) von Energieträgern angewendet. Für 2007 ist eine entsprechende Differenzierung geplant.
- Die Emissionsfaktoren in der Kategorie *Road Transportation* (1A3 b) werden mittels komplexer Modellrechung ermittelt. Diese gelten nur für die Schweiz. Heute werden diese Faktoren aber auch auf den Verbrauch im Ausland (Tanktourismus) angewendet. Es ist zu klären, wieweit diese Annahme gültig ist.
- Bei den Leckagen der Erdgasleitungen (CH_4), Kategorie *Transmission/Distribution Gas* (1B 2bii), besteht eine Diskrepanz zwischen Inventar und einer Publikation des SVGW (Schweizerischer Verein des Gas- und Wasserfaches). Das BAFU plant, das Problem im Rahmen der laufenden Überarbeitung der Emissionsdatenbank zu lösen.

Kategorie 2 Industrial Processes

Industrielle Prozesse trugen 2003 5.1% zu den schweizerischen Treibhausgasemissionen bei, wobei die mineralischen Produkte, i.b. der Zement, dominieren. Die Emissionen aus diesem Sektor nehmen ab, hingegen steigt die Bedeutung der synthetischen Gase (halogenierte Kohlenwasserstoffe und SF6). Diese sind seit 1990 um 270% angestiegen und machten 2003 1.5% der Treibhausgasemissionen aus. Insbesondere im Bereich der Lösungs- und Kältemittelemissionen sind unzählige Prozesse involviert. Es konnte deshalb nicht mit Sicherheit festgestellt werden, ob das Inventar hier komplett ist.

Die wichtigsten Feststellungen:

- Das Aluminiumrecycling (Schmelzen) soll gemäss IPCC nicht wie heute in der Kategorie *Other - Non-Ferrous Metals* (2C5), sondern unter *Fuel Combustion Activities*, *Non-Ferrous Metals* (1A2 b) ausgewiesen werden. Diese Änderung ist gemäss BAFU für die Submission 2006 geplant.
- Der CO_2-Emissionsfaktor für die Klinkerproduktion in der *Cement Production* (2A1) ist heute ein konstanter Wert für alle rapportierten Jahre. Es wird empfohlen, diesen Wert wissenschaftlich zu überprüfen.
- Die Kältemittelemissionen (nur R134a) der Prozesse *Refrigeration* und *Air Conditioning Equipment* (2F1) basieren auf einer fixen Lebensdauer der Geräte von zwölf Jahren. Da angenommen wird, dass vor 1990 keine Geräte in Betrieb waren, entsteht durch den Entsorgungsprozess 2002 eine künstliche Emissionsspitze.
- Die SF6 Emissionen in *Electric Equipment* (2F7) basieren auf wenigen Industriedaten. Ein beträchtlicher Teil der Emissionen stammt aus dem Produktionsprozess. Hier ist deshalb nicht klar, weshalb die Emissionen viel weniger stark variieren (25%), als der Materialumsatz (280%).

Fazit

Das Total der in der Submission 2005 ausgewiesenen Emissionen der Kategorien *1 Energy* und *2 Industrial Processes* ist mit keinen relevanten Fehlern behaftet und wird als von sehr guter Qualität beurteilt. Die Berechnungen für die einzelnen Kategorien sind weitestgehend korrekt umgesetzt und die hinterlegten Annahmen wurden als den schweizerischen Verhältnissen angepasst beurteilt. Einziges gravierendes Manko ist die Transparenz/Dokumentation des Inventars. Im Rahmen der laufenden Entwicklung einer neuen Treibhausgasinventar-Datenbanklösung werden gemäss BAFU die wenigen beanstandeten Punkte, aber auch das Dokumentationsproblem angegangen. Die Dokumentation wird nur in Deutsch verfügbar sein.

Content

1. Introduction & Objectives

Switzerland has signed and ratified the UN Framework Convention on Climate Change as well as the Kyoto-Protocol. The Federal Office for the Environment (FOEN) is in charge of compiling the emission data and bears overall responsibility for Switzerland's national greenhouse gas inventory.

To fulfil the two agreements, every year a Greenhouse Gas (GHG) Inventory has to be produced. The preparation is based on the comprehensive guidelines of the Intergovernmental Panel on Climate Change IPCC [1 - 5].

The reporting consists of two elements:

- a set of tables of all years since 1990 in the Common Reporting Format (CRF)
- a National Inventory Report (NIR) as documentation of the inventory

The IPCC guidelines request quality assurance measures. A quality assurance element is a review of the inventory by international experts, the so called In-Country Review (ICR). Objective of an ICR is to check the compliance of national inventories with the IPCC guidelines. Such a review was carried out on the Swiss inventory in 2004 [9].

Another quality assurance element is a domestic review of the inventory. FOEN contracted Dr. Eicher+Pauli AG to review sectors 1 Energy and 2 Industrial Processes of the submission of 2005 (time series 1990 - 2003), by addressing the following subjects:

- Completeness: Are all sources of emissions included?
- Methods: Are the applied methods adequate to the national circumstances?
- Correctness: Are the emission calculations correct?
- Consistency: Are the time series consistent?
- Transparency: Is the documentation sufficient?

2. Data management

2.1 Software tools

The reviewed version (submission 2005) of the Swiss GHG Inventory consists of a set of interconnected Excel files. Many of these files were created as part of an internal (Swiss) GHG inventory and later adapted to meet the IPCC demands. This explains the quite “organic” structure of the files.

The files can be subdivided into four categories:

- Files delivered by third parties (TPF), i.e. not produced directly by FOEN. They contain data (activity and emissions) which are in a raw state or already very close to the demands of the IPCC CRF. Normally these files contain time series of the whole reporting period (1990 - 2003). An exception is the data on category 2F where there are three files for each year.
- Data conversion files (DCF). These files produce the allocation of raw activity data to the sectors and categories corresponding to the CRF. These files also contain the emission factors (EF) in different forms. EF can be present as a table (e.g. fuel type vs. EF) or be part of an Excel equation. The same EF can appear several times on different sheets.
- Emission calculation files (ECF). These files do contain almost all information needed for the CRF files. In most cases the emission calculations are done in these files. The layout of the sheets is mostly identical with the CRF. For every year there is one file.
- Common Reporting Format files (CRF). They import data directly from the ECF, but there are quite view exceptions in which the data source of AD or EF is a DCF.

FOEN is working on a new data management system for their GHG inventory. It is planned to use the new system for the submission in 2007. The new system consists of a data bank (new EMIS) and one Excel file. The latter covers the functions of the above mentioned TPF and DCF. The resulting AD is transferred to the data bank where the emissions are calculated and the CRF tables produced. The new Excel file was created by FOEN but independent of the old files. FOEN is currently comparing the result of the two tools. So far no differences were detected which is good evidence that calculation errors may not be a relevant issue. The old EMIS, only updated till 1995, does provide emissions and EF for different processes. In the new EMIS these processes will be revised.

According to FOEN the new GHG data management system will also include a comprehensive documentation of every stated emission, including the involved data sources and models applied to calculate the final numbers, reported in the CRF tables. This documentation will also resolve the problem that at FOEN only one person has in-depth knowledge of the whole Excel spreadsheet system. The documentation will only be available in German which is not in accordance with the IPCC guidelines.

2.2 Documentation & transparency

There is no comprehensive documentation of the methods and assumptions applied to calculate AD and EF. This problem does seriously affect the transparency of the inventory. The most severe deficit was found in the methods of calculating AD. What would be needed is a documentation of every model applied, including precise references to data sources and descriptions of every assumption made.

Currently some general information can be found in the National Inventory Report [6] and more detailed information is included in the Excel files which comprise several dozens of spreadsheets. These two information sources are not comprehensive and very often insufficient to understand the calculations. In addition, references to other documents are often missing or not precise enough.

As mentioned before EF are not stored in a specific table, they are spread over different tables or are even only part of Excel equations.

To understand what assumptions and models have been applied, it is in most cases necessary to analyse the Excel equations.

What has been done therefore is to take a closer look at the central files of the inventory, especially on the one called Fuels_3.xls. Additionally, for key sources (level and trend) the whole path between input data of the inventory and the resulting emissions on CRF tables was checked.

2.3 File connection issues

The following errors concerning file connections were found:

- The file “Fuels_3.xls” had a connection to the file “Kontrolle BFE-BUWAL (Verbräuche Inventare)_2a.xls”, this is an old version of “Kontrolle BFE-BUWAL (Verbräuche Inventare)_3.xls”. Since the source figure is the same in both files, no error occurred.
- The file “Gest-CO2-Berechnung 1990-200x (korr).xls” had a connection to the file “Fuels.xls”, this is an old version of “Fuels_3.xls”. Since the source figure is the same in both files, no error occurred.

3. Energy

2003 the sector 1 Energy accounted for a quite constant share of 80% of total GHG emissions. The two major sources are 1A3 b Road Transportation (29%, increasing) and 1A4 b Residential (23%, decreasing).

3.1 Completeness

To assess the completeness of the inventory one has to look at the completeness of the used sources of AD.

3.1.1 Fuel Combustion Activities

For 1A Fuel Combustion Activities the Swiss Energy Statistics (SES) of the Swiss Federal Office of Energy (SFOE) [7] complemented with the yearly report of the Swiss Petroleum Association (Erdöl-Vereinigung: EV) [8] do cover 100% of the raw AD, corrected by international bunkers. Since these sources are not subject of this review 1A can be assumed to be complete.

As also mentioned in [9], Switzerland did not calculate international marine bunker fuels. As described in the NIR [6], although there may be some bunker fuel uses, especially on the River Rhine. Since the amount of bunker fuels is rather small and there exists a discrepancy between different data sources, all fuels are reported as domestic.

3.1.2 Fugitive Emissions from Fuels

No remarks

3.2 Methodology and correctness

3.2.1 Fuel Combustion Activities (1A)

General findings

Emissions are calculated by the multiplication of AD and EF where AD is the amount of energy used. As mentioned in chapter 3.1.1 AD is derived from SES less international bunkers. This means all AD is a disaggregation of SES information, except 1A3 Civil Aviation which is a completely modelled (bottom-up approach) figure.

Concerning AD the review focused therefore on the methods of how the disaggregation of SES data was done.

Activity data

In general the assumptions and models used have been found as appropriate and implemented correctly in the Excel files.

The figure of the overall crude oil import according SES in 2003 (4'567 Gg) differs by 0.3% from what is stated by Swiss Petroleum Association (4'552 Gg). The reason of this (small) difference is not clear.

The SES data are converted from weight to energy. The used heating values stem from Swiss measurements of the Swiss Federal Laboratories for Materials Testing and Research done in 1995/98 [7] and are kept constant over the whole reporting period. As confirmed by the Swiss expert for this topic (Mr Jäckle, Intertek, pers. com.) the values are still correct. One uncertainty lies in the value for hard coal, where the cement industry uses a lower value (25.8 TJ/t) than SES (28.1 TJ/t). It is planned to reduce the SES value close to the one which is used by the cement industry.

Combined Heat/Electricity (1A1 aii)

In category Other (waste incineration) the AD used is the amount of waste multiplied by the energetic efficiency factor of 32%. The remaining 78% of the emissions are reported in category Waste Incineration (6C). This is not correct, 100% should be reported under Combined Heat/Electricity (1A1 aii). This correction has already been implemented by FOE for the submission of 2006.

Manufacturing Industries and Construction (1A2) & Commercial / Institutional (1A4 a)

SES does not use the same allocation of processes as IPCC, furthermore the allocation used in SES changed in 1998. For that reason, a model for the two categories is used to break down the sum of the consumptions of 1A2 and 1A4 a (source: SES) into the needed sub-categories. This disaggregation model produces absolute numbers of the consumption of the different energy sources. In the case of coal and heavy fuel oil, it became evident that SES probably does not consider stock changes correctly. In certain years this leads to the problem of not having enough of those sources in SES to cover needs of the modelled use of 1A2, resulting in negative numbers in the 1A2 f Other which is a buffer. FOEN decided to do these "stock changes" and in the case of coal "stock reductions" in the SES figures to solve the mentioned problem of negative numbers in the buffer. The author of the National Inventory Report talked to the most important coal importer which confirmed a constant reduction of the Swiss coal stocks. No changes were made in the reference year (1990) and the changes are < 0.1% compared to 1A.

The modelled figure do also show a growing difference in light fuel oil consumption compared to what is stated in SES. This is not subject of this review but should be mentioned as an area for further investigations.

Civil Aviation (1A3 a)

SES does only state the whole consumption of jet kerosene. Due to this fact, the figure for civil aviation had to be modelled. The model used up to submission 2005 is based on different rough expert estimations. In the meantime SFOE, in collaboration with the Federal Office of Civil Aviation (FOCA), developed a new model which is based on very precise data on airplanes (consumption and emission data) and passenger destination information. Compared to the new model, the old figures underestimated this category.

Road Transportation (1A3 b)

Up to 2003, the use of natural gas is not reported. FOEN explained that the amount of gas was very small and therefore subsumed under gasoline. FOEN plans to report natural gas in future submissions separately, as it will be done in category Off-road (1A3 eii) in submission of 2006.

Oxidation factor

The oxidation factor applied for all processes is 1.00. This value differs from the IPCC defaults:

- Coal 0.98 (global average, but varies for different types of coal, and can be as low as 0.91)
- Oil and Oil products: 0.99
- Gas: 0.995

Coal is mainly (80%) used for the cement production. The high temperatures and long residence time in cement kilns do lead to a very high rate of oxidation of the fuel. In EC 2004 [10] a rate of 1.00 is suggested for cement kilns. For other coal combustion activities a factor of 99% is given. The Swiss value of 1.00 can therefore be considered as high but justified.

For oil, oil products and gas EC 2004 recommends an oxidation factor of 0.995. This seems to be appropriate for the Swiss processes, especially for gas. In the case of oil and oil products a value between 0.990 and 0.995 should be considered.

Emission factor for CO_2

CO_2 emissions account for 99% of the GHG emissions (CO_2 equivalents) of this category. The used CO_2 EF are based on measurements of the Swiss Federal Laboratories for Materials Testing and Research done in 1995/98 [7]. As confirmed by the Swiss expert (Mr Jäckle, Intertek, pers. com.) the carbon content of the fuels did not change during the reporting period.

Emission factor for other gases

Energy Industries (1A1) & Manufacturing Industries and Construction (1A2)

SFOE does not distinguish between different technologies of energy transformation, i.e. furnace, gas turbine or piston engine. The used EF are only valid for furnaces. This affects the emissions of CH_4 and also the non-greenhouse gases NOx and CO from these sources. For the submission 2007 SFOE plans to differentiate as described. On the basis of the already done disaggregation of the energy transformation technologies it can be calculated that the CH_4 emissions will rise constantly between 1990 (+ 0.02 Gg) to 2003 (+ 0.10 Gg).

Road Transportation (1A3 b)

The EF are calculated with a complex model valid only for Switzerland [12]. As gasoline prices are lower in Switzerland than in the surrounding countries there is so called fuel tourism occurring. This fuel is to a very high portion not used on Swiss roads and therefore not covered by the EF-model. The emission calculation of this amount of fuel uses the same EF as for the fuel burned in Switzerland which implies the same composition of vehicles and the same characteristics of vehicle use. It is recommended to reconsider these assumptions.

When reconsidering emissions from fuel tourism, it has also to be taken into account that there is evidence from two studies [13, 14] that fuel tourism is overestimated by the mentioned model [12]. This means that the effect of applying different EF for the tank tourism fuel would be lower.

The two mentioned studies were carried out specifically to quantify fuel tourism in Switzerland. Both are based on the same field data of gasoline sales in the Swiss border area (5 km from the border to Italy, Germany and France).

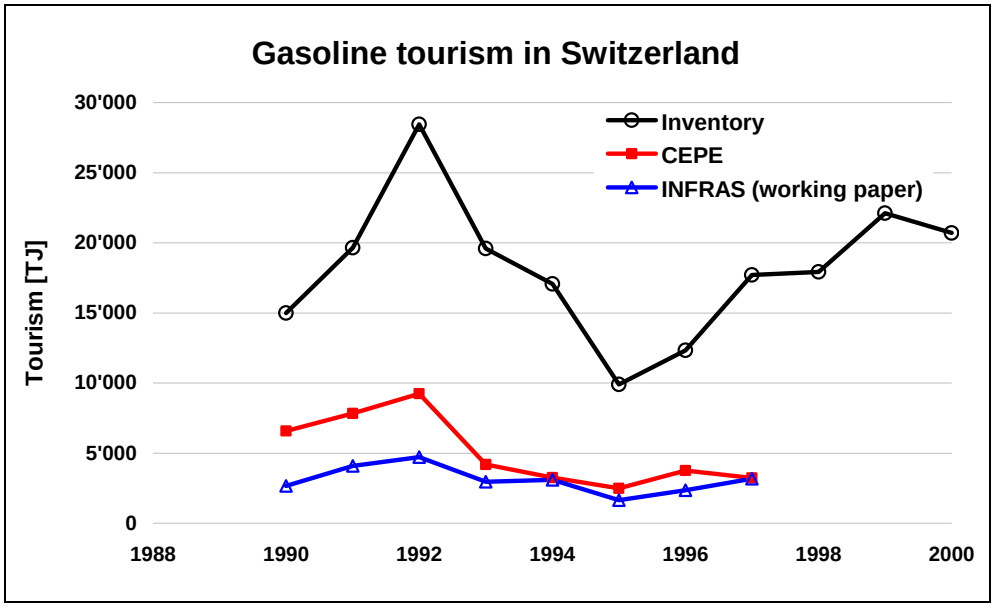

Figure 1: Gasoline tourism in Switzerland according to the data used for the Swiss GHG inventory [12] and two studies, looking exclusively at the issue [13, 14]. The latter is an unpublished working paper with provisional results.

The authors of [13] assume fuel tourism in regions more than 5 kilometres away from the border to be negligible. In [14] it is mentioned that the region between 5 and 20 kilometres away from the border may have some fuel tourism. Figures for this more distant area do not exist.

Figure 1 shows that fuel tourism is likely to be over estimated in the Swiss inventory, especially when price differences between Switzerland and the surrounding countries are high. The mean difference between the inventory and the two studies is about 13'000 TJ. As mentioned, the two studies did only look at the 5 km border area, so fuel tourism occurring in more distant areas may lower this number to about 10'000 TJ.

3.2.2 Fugitive Emissions from Fuels (1B)

General findings

Transmission/Distribution Gas (1B 2bii)

Pipeline data (length of different types and pressure) and corresponding EF for CH_4 have been worked out by the Swiss natural gas industry (SVGW) for 1990-93 and 1996. The other years are inter-, or extrapolated respectively. Contrary to what is written in the NIR, the emissions from a high-pressure natural gas transfer pipeline crossing Switzerland from France to Italy are already included, but are of minor importance (2%). The used extrapolation is not totally in correspondence with a newer internet publication of SVGW. This publication implies a constant or slightly rising emission and not a decrease as it is assumed in the inventory. For 1996, the difference is about 4% compared to the total CH_4 emission of 12.7 Gg. FOEN plans to resolve this issue when updating EMIS.

3.3 Time-series consistency

As mentioned earlier some AD (consumption of different fuels) and emissions are not delivered by the disaggregation model for *Manufacturing Industries and Construction (1A2) & Commercial / Institutional (1A4 a)* but by the old EMIS data bank. For instance in Iron and Steel (1A2 a), the overall AD for fuel combustion emissions (fuel consumption) is provided by the model. The old EMIS provides only information on some production sites. For the process emissions (2C1) all data comes from EMIS. The two information sources seem not to be fully in accordance, why trends in emissions from 1A2 a (increasing) and 2C1 (no trend) are not corresponding. This issue is also mentioned in [9] and should be addressed by FOEN when updating EMIS.

3.4 Reference and Sectoral Approaches

The differences between sectoral and reference approach are very small, with the latter being on average 0.5% in CO_2 and 1.5% in energy consumption higher. These differences are rather constant through the whole time series. They are to a certain portion due to the partially different data sources used for the two approaches. FOEN mentions that differences between data from the Swiss Petroleum Association [8] and SES [7] concerning the production of refineries (especially residual fuel oil) gives some variations of the calculated difference of CO_2, in the range of approximately 0.2 to 1.8%.

In the reference approach the carbon emission factor for Gas / Diesel Oil is the one of LFO (21.0 t C/TJ). In the submission of 2006 this value was changed according to the mix of fuels subsumed under this category.

The oxidation factor used for all fuels is 1.00. This issue was discussed in chapter 3.2.1.

4. Industrial Processes

2003 2 Industry Processes accounted for a share of 5.1% of total GHG emissions. The dominant source is 2A Mineral Products. Its emissions have decreased by almost -20% in the period 1990-2003 and reached an actual share on overall GHG emissions of 3.3%. 98% of these emissions are coming from category 2A1 Cement.

The second most important category of GHG emissions is 2F Consumption of Halocarbons and SF6. These emissions have grown by 270% in the reported period and reached a level of 1.5% on overall GHG emissions. The increase is driven by the substitution of ozone depleting substances CFC (covered by the Montreal Protocol) by HFC (reported here) in a lot of technical applications.

4.1 Completeness

Concerning AD of categories 2A to 2E the reviewer could not determine any missing processes occurring in Switzerland. The fast growing category 2F is very diverse and it is difficult to conclude that all relevant emission sources have been considered. The growth in the import of the gases in this category is caused by the above mentioned substitution process of CFC by HFC. The chronology of this process corresponds well with the reported emissions. For that reason it can be concluded that there are no relevant sources missing.

4.2 Methodology, transparency and correctness

Other - Non-Ferrous Metals (2C5)

Aluminium second smelting has to be reported under Fuel Combustion Activities, category 1A2 b. According to FOEN this change will be done for the submission of 2006.

Cement Production (2A1)

The CO_2-EF of clinker is defined in the Swiss inventory as an annual value. But this value is kept constant for all reported years (0.525 t/t). As also stated in [9] it is recommended to do more research on this value. An Excel error was found in the internal inventory files which, from 2001 onwards, are all linked with the value of 2001. Since, as mentioned earlier, all annual values are the same, no error occurred in the emission calculation.

Consumption of Halocarbons and Hexafluoride (2F)

Refrigeration and Air Conditioning Equipment (2F1)

Only the refrigerant R134a is considered with imports starting in 1990. The emission model assumes a service life of twelve years for every unit (domestic refrigeration, mobile airconditioning and commercial refrigeration). Since it is assumed that there were no systems in operation before 1990. This causes that decommissioning emissions only start in 2002, causing an artificial peak in the time series. It is recommended to use a probability distribution for the service life length.

For domestic refrigeration the amount of product remaining in the appliance when decommissioned is assumed to be 90%. This number does not correspond with the annual leakage rate of 0.5% of the original amount of refrigerant in the appliance.

The emission calculations of all here subsumed appliances base on different assumptions which all have medium to high uncertainties. For that reason a Monte Carlo analysis was made [12]. The parameters (minimum, maximum and most likely) used to do these analyses have been reviewed and found adequate.

Solvent (2F5)

The considered PFC imports start only in 1997. It is possible that already in previous years a certain use has occurred. Since the emissions of this category are of minor importance further investigations on this point are not indicated.

Electric Equipment (2F7)

In this category SF6 emissions are reported. As explained in the NIR [6] the industry association SWISSMEM is reporting actual emissions on basis of a mass balance approach (Tier 3a), including data for production of electrical equipment, installation, operation and disposal. Only industry data for the period of 1999 to 2002 are included in the inventory. For the remaining years, basically mean values of the documented period are used. The reported emissions in the period of 1999 to 2002 show fluctuations of about 25%. A major part of the emissions come from production processes. The here reported AD data do show very high fluctuations of 280%. It is not clear why emissions and AD do not correlate.

4.3 Time-series consistency

See remarks in chapter above on service life length in category 2F1 and AD vs. emissions in category 2F7.

5. References

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