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Report of the individual review of the greenhouse gas inventory of Sweden submitted in 2006*

* In the symbol for this document, 2006 refers to the year in which the inventory was submitted, and not to the year of publication.

CONTENTS

I. Overview

A. Introduction

1. This report covers the in-country review of the 2006 greenhouse gas (GHG) inventory submission of Sweden, coordinated by the United Nations Framework Convention on Climate Change (UNFCCC) secretariat, in accordance with decision 19/CP.8. The review took place from 23–28 April 2007 in Stockholm, Sweden, and was conducted by the following team of nominated experts from the roster of experts: generalist – Mr. Jim Penman (United Kingdom); energy – Mr. Amit Garg (India); industrial processes and solvent and other product use – Mr. Koen Smekens (Belgium); agriculture – Mr. Vitor Gois Ferreira (Portugal); land use, land-use change and forestry (LULUCF) – Mr. Leandro Buendia (Philippines); waste – Ms. Sirintornthep Twoprayoon (Thailand). Mr. Amit Garg and Mr. Jim Penman were the lead reviewers. The review was coordinated by Mr. Harald Diaz-Bone (UNFCCC secretariat).

2. In accordance with the "Guidelines for the technical review of greenhouse gas inventories from Parties included in Annex I to the Convention", (hereinafter referred to as UNFCCC review guidelines), a draft version of this report was communicated to the Government of Sweden, which provided comments that were considered and incorporated, as appropriate, in this final version of the report.

B. Inventory submission and other sources of information

3. In its 2006 submission, Sweden submitted a complete set of common reporting format (CRF) tables for the years 1990−2004 and a national inventory report (NIR). On 19 December 2006 Sweden also submitted a GHG inventory that had been revised since its original 2006 GHG inventory submission made in April 2006. This review also takes account of further revisions made by Sweden provided on 11 July 2007. Where necessary the ERT also used the previous year's submission, additional information provided during the review and other information. The full list of materials used during the review is provided in the annex to this report.

C. Emission profiles and trends

4. In 2004, the most important GHG in Sweden was carbon dioxide (CO_2) contributing 79.2 per cent to total[1] national GHG emissions expressed in CO_2 eq., followed by nitrous oxide (N_2O), 11.0 per cent and methane (CH_4), 8.2 per cent. Hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), and sulphur hexafluoride (SF_6) taken together contributed 1.5 per cent of the overall GHG emissions in the country. The energy sector accounted for 75.1 per cent of the total GHG emissions followed by agriculture (12.4 per cent), industrial processes (8.7 per cent) and waste (3.4 per cent). Total GHG emissions (excluding LULUCF) amounted to 69,703.7 Gg CO_2 eq. in 2004, having decreased by 3.2 per cent from the 1990 base year to 2004. The trends for the different gases and sectors are reasonable and reflect significant policies introduced by Sweden to mitigate its GHG emissions.

5. Tables 1 and 2 show the GHG emissions by gas and by sector, respectively.

[1] In this report, the term total emissions refers to the aggregated national GHG emissions expressed in terms of CO_2 eq. excluding LULUCF, unless otherwise specified.

Table 1. Greenhouse gas emissions by gas, 1990–2004

GHG emissions	Gg CO_2 eq.								Change
	Base year Convention[a]	1990	1995	2000	2001	2002	2003	2004[a]	BY–2004 (%)
CO_2 (with LULUCF)	34 012.77	34 012.77	40 830.86	35 068.35	37 772.08	38 581.23	39 822.47	38 588.60	13.5
CO_2 (without LULUCF)	56 301.08	56 301.08	58 043.03	53 358.42	54 102.36	55 260.02	56 333.59	55 239.35	–1.9
CH_4	6 731.02	6 731.02	6 688.68	6 092.68	6 071.49	5 898.25	5 738.95	5 752.91	–14.5
N_2O	8 693.93	8 693.93	8 506.46	8 053.55	7 928.34	7 871.40	7 810.92	7 803.31	–10.2
HFCs	3.85	3.85	126.44	550.26	594.91	644.03	685.71	743.28	19.231.0
PFCs	376.82	376.82	343.43	240.52	235.61	260.91	258.30	253.98	–32.6
SF_6	107.47	107.47	126.74	93.51	111.46	103.94	69.07	82.71	–23.0

Note: The base year (BY) for Sweden under the Convention is 1990 for all gases; LULUCF = land use, land-use change and forestry.

[a] Sweden submitted revised estimates for the years 1990–2004 in the course of the initial review on 11 June 2007. These estimates differ from the Party's GHG inventory submitted in 2006

Table 2. Greenhouse gas emissions by sector, 1990–2004

Sectors	Gg CO_2 eq.								Change
	Base year Convention[a]	1990	1995	2000	2001	2002	2003	2004[a]	BY–2004 (%)
Energy	53 398.14	53 398.14	55 237.56	50 735.21	51 263.16	52 567.30	53 509.20	52 365.62	–1.9
Industrial processes	5 792.52	5 792.52	5 906.04	5 832.05	5 991.79	5 900.15	6 007.42	6 071.70	4.8
Solvent and other product use	332.49	332.49	308.62	277.59	268.58	265.50	273.89	283.68	–14.7
Agriculture	9 406.54	9 406.54	9 321.94	8 762.79	8 785.15	8 720.63	8 585.86	8 636.39	–8.2
LULUCF	–22 117.31	–22 117.31	–17 077.14	–18 113.78	–16 157.88	–16 508.26	–16 339.30	–16 478.92	–25.5
Waste	3 113.48	3 113.48	2 925.59	2 605.01	2 563.08	2 414.43	2 348.36	2 346.32	–24.6
Other	NO	NO	NO	NO	NA NO	NA NO	NA NO	NA NO	NA
Total (with LULUCF)	49 925.86	49 925.86	56 622.61	50 098.87	52 713.89	53 359.75	54 385.43	53 224.80	6.6
Total (without LULUCF)	72 043.17	72 043.17	73 699.75	68 212.65	68 871.76	69 868.01	70 724.73	69 703.72	–3.2

Note: The base year (BY) for Sweden under the Convention is 1990 for all gases; LULUCF = land use, land-use change and forestry; NA = Not applicable; NO = Not occurring.

[a] Sweden submitted revised estimates for the years 1990–2004 in the course of the initial review on 11 June 2007. These estimates differ from the Party's GHG inventory submitted in 2006.

D. Key categories

6. Sweden has reported a key category tier 1 analysis, both level and trend assessment, as part of its initial report submission. Key category analyses are provided with and without the LULUCF sector. The key category analysis is used in choosing methodologies. The ERT noted that the key category analysis is more disaggregated in the energy sector than in other sectors, and that this is intended to facilitate communication of the results to stakeholders. The ERT noted that this approach is an acceptable variation of good practice reflecting national circumstances.

7. The key category analyses performed by Sweden and the secretariat[2] produced similar results, although the comparison is not completely straightforward because of the greater level of disaggregation used by Sweden in the energy sector. Sweden has used key category analysis for the development of the inventory and the results in terms of choice of methodologies are consistent with what would be expected on the basis of the secretariat's analysis.

E. Main findings

8. Sweden's GHG inventory is largely complete and is mostly compiled in accordance with the Revised 1996 IPCC Guidelines and the IPCC good practice guidance. In general, Sweden's inventory submission adheres to the revised UNFCCC reporting guidelines. A full set of CRF tables for the years 1990–2004 is provided.

9. Sweden has in place institutional arrangements, including a national system in accordance with the guidelines for national systems. This includes a single national entity, associated institutional arrangements and procedures for official approval, a quality analysis/quality control (QA/QC) plan, a working archive system, processes for collecting data and developing estimates, and the identification of key categories and processes for making recalculations to improve the inventory. The ERT commends Sweden on its inventory and its implementation of a full QA/QC system, and on improving the uncertainty estimates with the elaboration of methods used to determine the uncertainties.

10. It is clear to the ERT that Sweden has focused on providing adequate documentation on improvements in reporting emissions from key sources, as time and resources permit. The NIR is well laid out: it follows the structure of the revised UNFCCC reporting guidelines and contains most of the prescribed annexes. Although the information in the NIR is clear and accessible, the ERT noted that greater use of tabular and graphic material and technical annexes could improve transparency at the level of individual source categories.

F. Cross-cutting topics

1. Completeness

11. The inventory is complete in terms of geographical coverage, years, sectors and gases. Potential emissions as well as actual emissions are reported for fluorinated compounds. CRF table 9(a) identifies categories that are not estimated. These include fugitive emissions from oil and natural gas activities, CH_4 from industrial and commercial wastewater as well as CH_4 from some industrial processes

[2] The secretariat identified, for each Party, those source categories that are key categories in terms of their absolute level of emissions, applying the tier 1 level assessment as described in the IPCC *Good Practice Guidance for Land Use, Land-use Change and Forestry* (hereinafter referred to as the IPCC good practice guidance for LULUCF) for the base year or base year period as well as the latest inventory year. Key categories according to the tier 1 trend assessment were also identified. Where the Party performed a key category analysis, the key categories presented in this report follow the Party's analysis. However, they are presented at the level of aggregation corresponding to a tier 1 key category assessment conducted by the secretariat.

emissions. The ERT understands that Sweden believes these emissions to be small, but recommends that the availability of data be reviewed, for possible future inclusion.

2. Transparency

12. The NIR provides a good overview of the methods used to estimate emissions and extensive references are provided as background material. The ERT's task would have been easier had the NIR provided more methodological detail so that the relationship between activity data (AD), emission factors (EFs) and equivalent parameters and emission estimates was clear, and if the reasons for apparent outliers or anomalies in implied emission factors (IEFs) had been easier to understand. This would have reduced the number of questions and requests for background material during the review. The ERT recommends that the accessible style of the NIR be retained, but that more use be made of tabular and graphic material, and annexes to convey the methodological detail.

3. Recalculations and time-series consistency

13. The ERT noted that Sweden's well-developed review system and systematic approach to recording suggestions for improvement are well adapted to identifying the need for recalculations on the basis of revised AD or new scientific information. The system applies to recalculated estimates as well as other estimates, and will in the same way ensure that they are prepared in accordance with the IPCC good practice guidance. Recalculations are identified in the NIR and the CRF.

14. The ERT noted that recalculations reported by the Party of the time series from the base year to 2004 had been undertaken in the energy, industrial processes, agriculture and waste sectors to take into account revisions to AD and methods. The major recalculation was in the land-use change and forestry sector, where adoption of the *IPCC Good Practice Guidance for Land use, Land-use change and Forestry* has resulted in more comprehensive coverage and improvements in data quality. The recalculations are explained in the NIR and the overall effect on estimated emissions in the 2006 inventory submission (made in December 2006) compared with the 2005 submission is small – a decrease in estimated 1990 base year emissions by 0.0274 per cent, and an increase in estimated emissions in 2003 by 0.304 per cent. With the revisions that were made as a consequence of this in-depth review, these percentages became a decrease of 0.231 per cent in the figures for base year emissions and an increase of 0.242 per cent in estimated emissions in 2003 (both compared with the estimates made in the 2005 submission).

4. Uncertainties

15. Sweden has provided an uncertainty analysis for each source category and for the inventory as a whole, following the tier 1 method in the IPCC good practice guidance. The uncertainty analysis uses information on the probability distributions from sectoral experts and is cross-referenced to source categories in the CRF. This information is documented using expert protocols designed to comply with the advice in the IPCC good practice guidance. The ERT acknowledged that this is a systematic approach. The NIR presents results without adjustment for correlation between categories; the ERT noted that this may result in underestimation of the overall uncertainty. The ERT encourages Sweden to undertake an analysis with correlated categories aggregated. The ERT also encourages the Party to undertake an analysis of the uncertainty in the emission trend. Both these activities are in accordance with the IPCC good practice guidance.

16. The estimated uncertainty in total emissions falls from 6.93 per cent for 2003 emissions estimated in 2005 to 5.84 per cent for 2004 emissions estimated in 2006.

5. Verification and quality assurance/quality control approaches

17. Sweden has developed an impressive quality assurance/quality control (QA/QC) system based on a database system (TPS) developed by the Swedish Meteorological and Hydrological Institute as an assignment job for the Swedish Environmental Protection Agency (SwEPA). This is in accordance with the Intergovernmental Panel on Climate Change (IPCC) *Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories* (hereinafter referred to as the IPCC good practice guidance) and includes general (tier 1) QC procedures, source/sink category-specific (tier 2) procedures, identification of QC coordinators and procedures for internal review. There is a clearly defined progression as the annual inventory passes steps in the quality control process and an internal review by Swedish Methodology for Environmental Data (SMED), prior to the national and international stages of peer review by staff who have not been involved with the preparation process. These latter stages are organized by SwEPA.

6. Follow-up to previous reviews

18. Since the previous submission, Sweden has implemented a full QA/QC system. The uncertainty estimates have also been improved with elaboration of methods used to determine the uncertainties. However, the NIR requires improvements which are detailed in the various sections below.

G. Areas for further improvement

1. Identified by the Party

19. The NIR identifies planned improvements, including in the energy sector (revised EFs) and for LULUCF (inclusion of below-ground dead wood and improvements to the estimation of other pools).

2. Identified by the ERT

20. The ERT identified the following cross-cutting issues for improvement. The Party should:

(a) Consider whether estimates could, in fact, be made of sources that are currently not estimated (see paragraph 23);

(b) Make greater use of graphic and tabular material, possibly in annexes, to improve the transparency of the NIR (see paragraph 10);

(c) Increase the use of interpolation to represent actual conditions and remove apparent outliers (see paragraph 12);

(d) Extend the uncertainty analysis to take account of correlations between data and to estimate trend uncertainties (see paragraph 15).

21. Recommended improvements relating to specific source categories are presented in the relevant sector sections of this report.

II. Energy

A. Sector overview

22. In 2004, the energy sector accounted for 75.1 per cent of Sweden's total GHG emissions (excluding LULUCF). Fuel consumption accounted for 98.3 per cent of emissions from the sector, and fugitive CH_4 emissions for 1.7 per cent. CO_2 accounted for 96.5 per cent of GHG emissions in the sector in 2004. The largest source of such emissions was transport, followed by energy industries, manufacturing industries and construction, and energy use in other sectors (1.A.4), contributing

38.3, 24.4, 23.0 and 12.1 per cent to the energy sector's total GHG emissions, respectively, in 2004. Between 1990 and 2004, GHG emissions from the energy sector decreased by 1.9 per cent.

23. The coverage of source categories and gases is almost complete for 2004 emissions, although Sweden has not reported emissions from fugitive emissions (coke ovens), and coal, oil and natural gas systems (1.B.1a, 1.B.1b, 1.B.2aiii, 1.B.2av, 1.B.2c venting, 1.B.2c flaring ii), indicating that they are insignificant. The ERT recommends that Sweden provide in its next NIR a short calculation to support this assumption.

24. The ERT recommends that Sweden institutionalize system-level checks to minimize the risk of missing plants or data in its future submissions. These QC checks could include an independent sectoral expert review of AD, and cross-checking by SMED sectoral experts to check the CRF tables and the NIR to explain the reasons for the large inter-annual variations in emissions from key sources (in both the level assessment and the trend assessment). QA could be improved by including specific questions in the annual energy surveys of the industry on additional data/information, for example, on the quantity of plastics being burned for energy purposes, and any other relevant background data.

25. The ERT was informed during the review that the Swedish Energy Agency has now been given responsibility for assessing the net calorific values and EFs for all fuels. The ERT appreciates this as it will improve the transparency, consistency and accuracy of the emission estimates.

26. The ERT noted that the recalculations carried out have been useful, and have increased the accuracy and transparency of the inventory. The NIR explains the recalculations well. However, the ERT noted that there is scope for better explanation to provide greater transparency on the rationale and the method used for the recalculations, for example, by providing details of revised AD and EFs, plants not included earlier, and reasons for the omission of other sources in the past.

27. Sweden collects energy data from postal sample surveys sent to all working units. Quarterly fuel statistics are based on the sample for the annual industrial energy statistics, except for electricity and heat production, for which there are quarterly fuel statistics based on a comprehensive survey. Data are collected from all companies involved in electricity and heat production, all companies in the pulp and paper industry, and all companies in the manufacturing industry with more than nine employees, and annual fuel combustion rates of more than 325 tonnes of oil equivalent (toe). Sweden informed the ERT that these data are of high quality. Some data, for example, biogas statistics, are collected over the telephone. The ERT suggests that this practice be reviewed since it may make it more difficult to achieve good practice in documenting the collection and archiving of AD.

28. Data from the European Union emissions trading scheme (EU ETS) have been used to reallocate AD in several subsectors of energy use in manufacturing industries and construction (including iron and steel, chemicals, pulp, paper and print) for some years following the results of a SMED study. The ERT encourages the Party to cross-check these reallocations with sectoral experts in future, according to good practice for quality control.

B. Reference and sectoral approaches

1. Comparison of the reference approach with the sectoral approach and international statistics

29. CO_2 emissions from fuel combustion have been calculated using the reference approach and the sectoral approach. For 1990, the CO_2 emission estimates calculated using the reference approach are 1.43 per cent higher than those calculated by the sectoral approach. For 2004, the reference approach estimate is 11.4 per cent higher. Explanations are provided in the documentation box of CRF table 1.A(c) in terms of fugitive and industrial processes emissions. In addition, the NIR provides explanations for the fluctuations in the differences between the two approaches over the years.

30. The apparent consumption reported to the UNFCCC corresponds to that reported to the International Energy Agency (IEA) for Sweden, within about 4 per cent for most years. The growth of total apparent consumption is 3 per cent according to the CRF and 5 per cent according to the IEA. The apparent consumption of liquid fuels is usually higher in the CRFs than in the IEA data. This difference is mostly due to differences in stock changes and (to a lesser extent) to differences in international bunkers. Moreover, lubricants and ethane which are reported to the IEA, are not reported in the CRF. Sweden indicated to the ERT that lubricants are reported in non-energy use of fuels in CRF, while the data on ethane are not used. The ERT recommends that Sweden reconcile its reporting to the IEA with its reporting in the CRF.

2. International bunker fuels

31. In the CRF tables, the ERT noted discrepancies between table 1.C and table 1.A(b) for jet kerosene (international aviation) in 1990, and for gas/diesel oil and residual fuel oil (international marine bunkers) for all years. A brief comparison between the IEA and CRF datasets indicates that the discrepancies are a result of differences in units, definitions and routines for data revision. For example, jet gasoline consumption reported as domestic aviation in the IEA data is reported as military aviation in the CRF tables. The ERT recommends that Sweden reconcile its reporting to the IEA with its reporting in the CRF.

3. Feedstocks and non-energy use of fuels

32. For energy use in iron and steel (1.A.2.a), Sweden provided the ERT with carbon flow accounting for one of the two major steel plants in Sweden, and with the carbon flows (a) as reported by the plant and (b) as estimated using the CRF. The difference between the two was less than 5 per cent. Sweden also provided detailed energy flows for this source category, indicating that all emissions from energy use are indeed accounted for. However, the ERT noted that some of the emissions due to energy use are accounted for in the industrial processes source category iron and steel production (2.C.1) (approximately 49 per cent for 1990 and 40 per cent for 2004). The ERT recommends that Sweden follow the IPCC good practice guidance in allocating all energy use emissions to the energy sector.

C. Key categories

1. Road transport – all GHGs

33. A new model, ARTEMIS, has been set up for emissions from road transport. Detailed surveys are conducted annually on parameters such as the number of vehicles registered, energy consumption, age profile, driving cycles and cold starts. The time-series information available from these detailed surveys has been used in the ARTEMIS model, thus improving the accuracy of the road transport emission estimates.

2. Petroleum refining: refinery gas – CO_2

34. The CO_2 emission estimates fluctuate widely. The Swedish experts explained during the in-country visit that some refinery gas produced is used internally by the refineries, and the energy balance is also reflected in the estimation of these emissions. The ERT recommends that Sweden provide clear and detailed explanations for the fluctuations in these emissions in its next NIR.

3. Other manufacturing industries and construction: liquid fuels – CO_2

35. According to the NIR (page 87), "AD for several fuels, especially for solid and liquid fuels, and several plants has been revised by adding or exchanging data in 1990–2003, due to new information from the plant". Estimated CO_2 emissions in 1990 are higher than in 1991 by 371 Gg CO_2 for liquid fuels

alone and by 285 Gg CO_2 for all fuels combined. The explanations for this in the NIR are not clear. After examining a detailed analysis of industry-level and fuel-level data provided after the in-country review by Sweden, the ERT concluded that there is no possible misallocation among the various fuels and industries, and no double counting. The decrease in emissions between 1990, 1991 and 1992 is reflected in the underlying AD and is probably due to the temporary decrease in economic activity in the early 1990s. Sweden has also re-checked the fuel reallocation for the period 1990–2003 and found no discrepancies.

4. Civil aviation (liquid fuels) and aviation bunkers – CO_2

36. The allocation of fuel between civil aviation and aviation bunkers is not transparently described in the NIR, especially for the period 1990–1994. On the basis of additional material provided following the in-country visit, the ERT concluded that the estimates of total CO_2 emissions from aviation for the period 1990–1994 are based on high-quality data on the supply and delivery of petroleum products, and are consistent with the estimates for subsequent years. Total CO_2 emissions are then split between domestic and international traffic, based on estimates of domestic CO_2 emissions provided by the Swedish Civil Aviation Authority (SCAA). The estimate of domestic emissions for 1990 has been calculated based on the share of domestic emissions for 1998, which is approximately 29 per cent. To adjust for the relative development of domestic and international traffic since 1990, this is multiplied by a factor of 1.16 to reflect the larger share of domestic traffic in 1990. (This factor is the share of domestic landing/take offs (LTO) in 1990 divided by the share of domestic LTO in 1998. Based on LTO data from the SCAA, this is 0.724/0.626 = 1.156, or 1.16 to two decimal places.) The share of domestic CO_2 emissions in 1990 is consequently estimated to be 1.16 x 29 or 34 per cent. International emissions are estimated as total emissions minus domestic emissions. Finally, emissions from domestic and international aviation are split between LTO and cruise on the basis of the mean value for LTO cycles for domestic and international flights in the years 1995–2000. The ERT recommends that Sweden aim for greater transparency in reporting how fuel consumption is split between domestic and international aviation.

D. Non-key categories

37. Sweden has not reported emissions from fugitive emissions (coke ovens), and coal, oil and natural gas systems (1.B.1 (a), 1.B.1 (b), 1.B.2 (a) iii, 1.B.2 (a) v, 1.B.2 (c) venting, 1.B.2 (c) flaring ii) indicating these to be insignificant. However, the NIR does not provide a quick estimation to indicate that these are indeed insignificant. The ERT recommends that Sweden conduct this quick estimation and report back in its next submission.

III. Industrial processes and solvent and other product use

A. Sector overview

38. In 2004, emissions from industrial processes and solvent and other product use accounted for about 6,355.4 Gg CO_2 eq., or 9.1 per cent of total national GHG emissions, of which the industrial processes sector accounted for 8.7 per cent. CO_2 accounted for about 72.2 per cent, HFCs for 11.7 per cent, N_2O for 10.6 per cent, PFCs for 4.0 per cent, SF_6 for 1.3 per cent, and CH_4 for 0.1 per cent of the sectors' GHG emissions in 2004.

39. Between 1990 and 2004 the GHG emissions of these sectors increased by 3.8 per cent, from 6,233.5 to 6,355.4 Gg CO_2 eq. The major increase occurred within industrial processes, for which emissions rose by 4.8 per cent, mainly due to an increase in HFC emissions, partially offset by reductions in N_2O and PFC emissions. Emissions from solvents decreased by 14.7 per cent, due to a decrease in CO_2 emissions, partly offset by an increase in N_2O emissions.

40. Sweden's inventory of emissions by these sectors is functionally complete, and the missing sources reported (for CH_4 and N_2O) are estimated to be small. Completeness is ensured by reviews of the annual industrial environmental reports which are presented annually by the local authority boards and other competent authorities. In addition, SwEPA undertook a national review for the 2006 submission. Sweden has the necessary QA/QC procedures and institutional arrangements in place. For the fluorinated gases, both potential and actual, Sweden has introduced in its 2006 inventory submission a new calculation method based on product registries and product allocation. This approach resulted in these emissions being recalculated for the whole time period but has considerably improved the quality of the reporting for these gases.

41. Some of the methods used for calculating emissions by subcategory are not reported in a transparent or consistent manner, including for some key categories, as noted below. The time series for most categories, including for some key categories, contains some inconsistencies, partly because different basic data sources are available or have been used. Gaps in the underlying data time series are often filled by interpolation using data from known years, since the data cannot be retrieved from companies which no longer exist. The national peer review performed before the 2006 submission has improved the quality of the reporting and the coverage of this sector. The use of a country-specific allocation rule for some CO_2 emissions within the industrial processes sector reduces comparability with other Parties' IEFs.

42. Sweden has identified the following CRF level 2 key categories: mineral products – CO_2, chemical industry – N_2O, metal production – CO_2 and PFCs and consumption and production of halocarbons – HFCs. It also has performed a tier 1 uncertainty analysis.

B. Key categories

1. Iron and steel production – CO_2

43. CO_2 emissions from iron and steel production are identified as a key category in both the level assessment and the trend assessment. Sweden uses a country-specific method to estimate and allocate the CO_2 emissions from primary (pig) iron production. Sweden calculates these CO_2 emissions based on the total amount of blast furnace gas consumed. In addition it accounts for these emissions in the (sub)sectors where the blast furnace gas is combusted, including in some (sub)categories in the energy sector. This results in lower emissions, and hence a lower IEF, compared to other Parties for this category's CO_2 emissions since not all blast furnace gas is combusted in the iron and steel sector; and the emissions of the sectors where blast furnace gas is combusted are consequently higher, since the CO_2 from blast furnace gas combusted is included there. This country-specific method does not change the total amount of CO_2 emitted; it only changes the distribution of emissions between the relevant subcategories. The ERT suggests that Sweden adopt the approach set out in the IPCC good practice guidance, which would facilitate future reviews and comparison between Parties.

2. Cement production – CO_2

44. CO_2 emissions from cement production are identified as a key category in both the level assessment and the trend assessment. The tier 2 methodology from the IPCC good practice guidance is used to estimate CO_2 emissions from this sector. Although the IEF is among the highest of reporting Parties, Sweden has provided sufficient justification, including information on the use of organic carbon and cement kiln dust, which increases the IEF. Following the recommendation of the ERT, Sweden has agreed to collect or estimate data on the lime (CaO) content of clinker, and to provide this information in its future submissions.

3. Lime production – CO_2

45. For 2004, CO_2 emissions from lime production were identified as a key category in both the level assessment and the trend assessment. Three industries produce emissions from lime – conventional lime production, the sugar industry and the pulp and paper industry.

46. Emissions from conventional lime production are estimated in accordance with the IPCC good practice guidance, but those from the sugar and the pulp and paper industries are not because the AD used are not amounts of lime produced. This leads to an inconsistent and non-transparent emission calculation, especially since removal of CO_2 is also reported for the latter two categories. This CO_2 removal leads to a lower IEF compared to those of other Parties for CO_2 emissions in these two categories. The ERT recommends that Sweden follow the IPCC good practice guidance and also provide transparent information on the estimation of the CO_2 removals. Following the recommendation of the ERT, Sweden will take action to improve transparency in its future submissions.

4. Aluminium production – PFCs

47. The ERT noted that the methodology used to estimate emissions of PFCs from aluminium production deviates from the IPCC good practice guidance in that different slope coefficients for the anode effects are used. The ERT recommends that Sweden revise the estimation method, based on IPCC good practice guidance methodology, and describe it in its next NIR.

C. Non-key categories

1. Limestone and dolomite use – CO_2

48. Some limestone use and associated GHG emissions are included in other source categories, for example, the iron and steel industry, where the CO_2 from the limestone used in blast furnaces is added to the CO_2 content of the blast furnace gas. This reallocation of emissions does not change the level of total emissions; it reduces the comparability of the IEFs for the other categories. The ERT recommends that Sweden follow the Revised 1996 IPCC Guidelines and account for all CO_2 emissions from limestone use in the category limestone and dolomite use. The ERT recognises that the proposed 2006 IPCC Guidelines for National Greenhouse Gas Inventories (hereinafter referred to as the 2006 IPCC Guidelines) would allow inclusion of these emissions in the sector where the limestone is used, but the 2006 guidelines have not yet been adopted.

2. Other (industrial processes) – CH_4, N_2O

49. The ERT noted that CH_4 and N_2O emissions originating from the combustion of cooking liquor in the pulp and paper industries are accounted for in the category other (2.G), whereas they should be included in energy use in pulp, paper and print, as well as the biogenic CO_2 emissions associated with this cooking liquor combustion. The ERT recommended that the Party reallocate these emissions accordingly.

IV. Agriculture

A. Sector overview

50. In 2004, total emissions from the agriculture sector amounted to 8,636.4 Gg CO_2 eq. and accounted for 12.4 per cent of total national emissions. CH_4 accounted for 38.0 per cent of sectoral emissions and N_2O contributed the remainder (62.0 per cent). Emissions in 2004 were 8.2 per cent lower than in 1990. All relevant source categories and GHGs are reported. CH_4 and N_2O emissions from field burning of agricultural residues are reported as not occurring ("NO"), although in the NIR Sweden

reports that this activity is not very common, rather than completely absent. The ERT encourages Sweden to clarify its use of the notation key "NO" for this source category.

51. The inventory relies on several country-specific methodologies, which are well referenced in the NIR and supported by extensive background documentation. In particular, Sweden is using country-specific methodologies or EFs to estimate emissions of CH_4 from enteric fermentation from dairy cattle and non-dairy cattle; CH_4 and N_2O emissions from manure management from dairy cattle, non-dairy cattle and swine; direct N_2O emissions from the application of synthetic fertilizers and animal manure, nitrogen (N)-fixing crops, crop residues and grazing; and indirect N_2O emissions from leaching and run-off. The ERT welcomes these developments but, following previous review reports, recommends that Sweden further increase the transparency of the NIR by providing underlying background information about supporting studies, and clarifying whether the country-specific methods and EFs reflect field data, expert judgement, or compilations from scientific literature.

52. There remain some inconsistencies in the time series. In general Sweden updates values in the time series only when new studies are available for a given year. As a consequence, the time series in underlying data, IEFs and emissions show significant inter-annual variations which apparently do not correspond to actual variations in practices or activity, but only reflect data availability. The change in statistical definition for the swine subclasses is particularly important. Changes in the definition of subclasses (sows and young females) have led to an unrealistic increase in the number of sows in the period 1994–1996 which does not represent real changes in animal numbers and produces inconsistencies in the time series for AD, IEFs and emissions. The ERT recommends that Sweden use the IPCC good practice guidance to try to improve time trends in order to better represent the real evolution of the activity.

B. Key categories

1. Enteric fermentation: cattle – CH_4

53. Sweden uses country-specific tier 2 EFs for non-dairy cattle – beef cows and growing animals (12–24 months and calves) – which are set individually for each cattle subclass. The EFs for the subclasses are not well documented with the necessary underlying assumptions that could allow comparison with the results from other Parties. The EF used for beef cows (98 kg CH_4/head/year) is high when compared with the underlying data in the Revised 1996 IPCC Guidelines and is not consistent with the milk yield that Sweden, during the in-country visit, reported as representative of the national herd (1,300 kg milk/head/year). Sweden acknowledged that this EF and the associated emission estimates are overestimated for the whole time series and, following the in-country review, as a result of a reassessment of its country-specific data, has revised the EF for beef cows downwards to 78.0 kg CH_4/head/year, providing appropriate documentation and justification of the underlying assumptions.

54. Sweden reports a comparatively high tier 2 IEF for dairy cattle, ranging from 118.3 to 129.3 kg/head/year, which is the highest of reporting Parties but nevertheless consistent with the milk yields reported in Swedish statistical sources. However, the related information (average gross energy intake (GE) and average CH_4 conversion rate (Y_m) provided in CRF table 4.A is not consistent with the EF model that Sweden is using or with the trend in the IEF. During the in-country visit, Sweden provided clarification that these values were not actually used in calculations, and the ERT recommends that Sweden revise its CRF reporting to provide only information that is consistent with the estimates.

55. Sweden uses a country-specific tier 2 EF for reindeer (7.7 kg CH_4/head/year) which is based on studies carried out in Finland and was chosen on the assumption that reindeer are kept under similar conditions in all the Nordic countries. However, the IEFs in the submissions of Norway and Finland are now substantially higher – 11 kg CH_4/head/year and 19.9 kg CH_4/head/year, respectively. Following the

recommendation of the ERT, Sweden has assessed the Norwegian and Finnish approaches and provided revised estimates on the basis of the latter.

2. Manure management: cattle and swine – CH_4

56. Sweden is using a methane correction factor (MCF) for liquid systems (10 per cent) that is lower than the default value in the IPCC good practice guidance (39 per cent). The value is based on documentation that was provided to the ERT during the in-country visit. However, the recommendations in the documentation provided shows that the MCF values for both liquid systems and solid storage should be revised for swine and cattle. The ERT encourages Sweden to clarify its reasons for not using both recommendations from the underlying study.

57. The fraction of animal waste treatment systems that are liquid systems is based on information from the national statistics office, Statistics Sweden, but inconsistencies were detected in the time series. The resultant time series shows unexpected trends for certain animal types in relation to changes in the origin of the statistical information. For non-dairy cattle there is an increase from 1990 (when it was 30 per cent) to 1996 (41 per cent), and then a sudden decrease in 1997 (28 per cent). For swine there is an increase from 1990 (44 per cent) to 1996 (63 per cent), and then a sudden decrease in 1997 (24 per cent) and an increase again in 2004 to 38 per cent. The ERT encourages Sweden to improve the consistency of the time series or provide explanations for the apparent increases and decreases.

3. Agricultural soils: direct soil emissions – N_2O

58. The NIR is not fully transparent for this source category. Sweden uses a set of country-specific methodologies including different volatilization fractions for N input from manure applied to soils and N excretion on pasture range and paddock, and country-specific EFs for N input from the application of synthetic fertilizers, N input from manure applied to soils and N excretion on pasture range and paddock. However, there is no reporting of the values of these parameters for all years. Moreover, Sweden considers two types of situation under N excretion on pasture range and paddock – permanent pastures and grassland – although the NIR does not define these clearly. The ERT acknowledges the use of a higher-level methodology but encourages Sweden to improve the transparency of its reporting.

59. Sweden uses fertilizer sales as AD to estimate N_2O emissions from synthetic fertilizers. The ERT noted that data on fertilizer use would be more appropriate as the AD for this source category.

60. Sweden does not report in CRF table 4.D the quantity of N in sewage sludge used as fertilizer, which makes it impossible to calculate the IEF and compare it with those of other Parties. The ERT encourages Sweden to improve transparency by reporting the appropriate data.

4. Agricultural soils: indirect soil emissions – N_2O

61. Sweden does not provide sufficient information in the NIR about the volatilization ratios of ammonia (NH_3) and nitrogen oxide (NO_X) from the use of synthetic fertilizers and the application of animal manure. The methodology and parameters referenced are included in the Swedish Informative Report submitted under the United Nations Economic Commission for Europe (ECE) Convention on Long-Range Transboundary Air Pollution (LRTAP). In the interests of transparency, the ERT recommends that Sweden include the relevant information concerning the determination of these volatilization ratios in its future NIRs.

5. Agricultural soils: other (agricultural soils) – N_2O

62. Sweden estimates emissions of N_2O from mineral soils using a country-specific EF and methodology which, although not explicitly recommended in the Revised 1996 IPCC Guidelines or the

IPCC good practice guidance, do not conflict with the underlying considerations in the Revised 1996 IPCC Guidelines. During the review Sweden provided explanations and documentation clarifying that there is no double counting of these emissions with the emission estimates for the other sources of direct N_2O emissions from N added to soil, and that these emissions are anthropogenic in nature because they result from N mineralization from sources of N such as dead roots and soil organic matter. The method takes account of the estimated fraction of emissions at a zero application rate of N fertilizer that is due to anthropogenic activities on the land, combined with country-specific EFs linked to the rate of application of N fertilizer. The ERT suggests that more transparent documentation be included in the NIR.

V. Land use, land-use change and forestry

A. Sector overview

63. In 1990, the LULUCF sector in Sweden was a net sink of carbon of 22,117.3 Gg CO_2 eq. This carbon sink occurs mainly in forest land with some contributions from grassland and settlements. Cropland was a source of CO_2 emissions. In 2004, the sector was a net sink of 16,478.9 Gg CO_2 eq. with most of the carbon stored in forest land and grassland. Settlements and cropland were sources of CO_2 emissions.

64. Sweden represents its total land area in a way that is consistent with the land-use categories provided in the IPCC good practice guidance. The six land-use categories forest land, cropland, grassland, wetlands, settlements and other land form the basis on which GHG emissions and removals from land use and land-use conversion are estimated and reported. All forest land, cropland, grassland and settlements are assumed to be managed, while all wetlands and other land are assumed to be unmanaged. The reported land-use categories are linked to the 17 national land-use categories monitored by the Swedish National Inventory of Forests.

B. Key categories

Forest land, cropland, grassland and settlements – CO_2

65. In the level assessment, four categories were identified as key categories in the base year: CO_2 from forest land remaining forest land; CO_2 from land converted to forest land; CO_2 from cropland remaining cropland; and CO_2 from grassland remaining grassland. For the inventory year 2004, in both the level assessment and the trend assessment, two additional categories were identified as key: CO_2 from land converted to grassland; and CO_2 from settlements. CO_2 emissions from settlements mostly come from conversion of forest land and grassland to settlements.

66. Sweden now uses the stock change method in estimating changes in carbon (C) stocks in biomass, which the ERT considered an improvement in methodology. The ERT noted, however, that the NIR needs to be more transparent on how this method and related parameters relate to the CRF tables and how C stock changes in biomass are estimated.

67. The ERT appreciated Sweden's effort to improve the estimates of C stock changes in dead organic matter and soils by using a sampling approach, and acknowledged that significant changes are difficult to detect. The ERT supported the Party's approach that a combination of modelling and sample data is the best way forward, combined with continuation of the sampling approach as a means of verification. The ERT encourages the Party to use a Monte Carlo analysis to estimate uncertainties where models are used.

68. Outliers were observed in the trend of CO_2 emissions/removals, C stock changes, and areas. In most cases these outliers coincide with the transition years for data collection (such as 1993 and 2002)

indicating a problem of time-series consistency. The ERT recommends that the Party validate these inconsistencies in the time series and report the findings/revisions in its next NIR.

69. The ERT compared the IEFs for the increase in C stocks in biomass in forest land remaining forest land for Finland, Norway and Sweden. Sweden's value was the lowest (the average is 0.31) as compared to Finland (1.31) and Norway (0.51). The ERT noted that Sweden may be underestimating the C stock increase in living biomass and recommends that Sweden verify these differences and make revisions if necessary.

C. Non-key categories

Wetlands – CO_2

70. Sweden indicates in the NIR that, as part of forthcoming improvements, N_2O emissions from peat extraction will be considered in future submissions, although estimating these emissions is optional. The IPCC good practice guidance, however, does require the estimation of CO_2 emissions from land converted to wetland. These CO_2 emissions are associated with either peat extraction or flooding. The ERT recommends that Sweden provide a full estimate in its next submission.

VI. Waste

A. Sector overview

71. In 2004, the waste sector contributed 3.4 per cent of total national emissions. Emissions from solid waste disposal sites (SWDS) accounted for by far the largest share (88.1 per cent) of sectoral emissions, followed by emissions from waste incineration (6.0 per cent) and wastewater handling (5.9 per cent). Between the base year and 2004, emissions from waste decreased by 24.6 per cent. Emissions of N_2O from wastewater fell by 28.8 per cent over the same period. Emissions of CO_2 from incineration increased by 219.9 per cent between the base year and 2004.

72. Sweden has improved and changed some parameters such as degradable organic carbon (DOC) and the degradable organic carbon fraction (DOC_F) to take account of current statistical data and to be consistent with the IPCC good practice guidance. Recalculation to take account of these revisions increased estimated sectoral emissions by 11.5 per cent in 1990 and by 17.4 per cent in 2003 compared with the 2005 submission. Sweden has a QA/QC system in place and the uncertainties have been estimated. Although the NIR provides a clear overview of the sector, the ERT noted that transparency would be increased by the addition of more methodological detail, including justification of the parameter values and information on the utilization of gas recovery.

B. Key categories

1. Solid waste disposal on land – CH_4

73. Sweden uses a tier 2 methodology to estimate CH_4 emissions from SWDS, with country-specific parameter values. The NIR provides a comparison of the tier 1 and tier 2 methods. Historical data on type and quantity of waste treated at landfill sites are reported. Sweden has developed policies and regulations on waste management according to the EU directive as well as promoting waste recycling, which results in declining amounts of waste going to landfill sites.

74. Sweden has used a decay half-life (7.5 years) for waste in landfill that is shorter than the IPCC default value (14 years), although close to the value (7 years) recommended in the 2006 IPCC Guidelines for moderately degrading waste in wet boreal and temperate areas. Sweden indicates that 95 per cent of its landfills are situated in areas where mean annual precipitation is greater than potential evapotranspiration (MAP/PET>1).

75. The amount of gas recovered from landfills increased by 300 per cent between 1990 and 2003, but has now started to decrease because of the dramatic reduction of landfilling of organic waste. The ERT recommends that Sweden provide further information on the utilization of gas recovery in its next NIR. Recovered gas is used for heating, road transportation and electricity production.

2. Waste incineration – CO_2

76. Sweden has one hazardous waste incineration plant. Only non-biogenic CO_2 emissions are reported. During the in-country visit, the ERT was informed that the amount of CH_4 and N_2O emissions was negligible due to the high efficiency of incineration (at temperatures of 1,200–1,400°C). This is confirmed by periodic measurements. The ERT recommends that Sweden measure these emissions periodically on-site.

77. CO_2 emissions in 2003 and 2004 are extremely high as compared to the previous years and base year due to capacity expansion of the plant and, as a result, waste incineration is a key category by trend. Emissions in 2003 and 2004 cover both biogenic and non-biogenic wastes because a mixture of municipal solid waste (MSW), industrial waste and hazardous waste is treated together in the incinerator and hence leads to overestimations for these years. The ERT recommends that Sweden account for CO_2 emission only from non-biogenic sources according to the IPCC Good Practice Guidelines.

C. Non-key categories

Wastewater handling – N_2O

78. Emissions from wastewater handling have been estimated only for N_2O from industrial and domestic sources using country-specific EFs. Emissions in 2004 were lower than in the base year due to the improvement of N removal facilities.

79. CH_4 emissions from wastewater treatment have not been estimated. Sweden reports in its NIR that 95 per cent of wastewater is treated mechanically, chemically and biologically. During the in-country visit, the ERT was provided with the environmental report Miljorapport 2006 which indicated the high efficiency of water treatment technology. According to the NIR, sludge from both domestic and industrial organic wastewater treatment plants is landfilled, and associated CH_4 emissions are therefore accounted for under SWDS. The ERT recommends that Sweden use the notation key "not estimated" ("NE") for CH_4 emissions from wastewater treatment, instead of "included elsewhere" ("IE"), in CRF table 6.B.

VII. Recommendations

80. In the course of the review, the ERT formulated a number of recommendations relating to the completeness and transparency of Sweden's information presented in the initial report. The key recommendations[3] are that Sweden:

(a) Increase the transparency of the inventory by providing more detailed descriptions in the NIR in relation to the CRF;

(b) Review the availability of data for sources of emissions that are currently not estimated;

(c) Improve time-series consistency and avoid apparent outliers and anomalies, e.g. by means of interpolation;

(d) Provide further explanations or revised data in the next inventory submission.

[3] For a complete list of recommendations, the relevant sections of this report should be consulted.

81. Future reviews of the institutional arrangements should focus on:

(a) Whether the structure of the NIR and the transparency of the methodological descriptions have been improved;

(b) Progress with the other specific items identified in paragraph 20 above;

(c) The effective transfer of data between the data providers and the TPS database, and the use of this information to produce the emission estimates.

Annex

Documents and information used during the review

A. Reference documents

IPCC. Good practice guidance and uncertainty management in national greenhouse gas inventories, 2000. Available at: <http://www.ipcc-nggip.iges.or.jp/public/gp/english/>.

IPCC. Good practice guidance for land use, land-use change and forestry, 2003. Available at: <http://www.ipcc-nggip.iges.or.jp/public/gpglulucf/gpglulucf.htm>.

IPCC/OECD/IEA. Revised 1996 IPCC Guidelines for national greenhouse gas inventories, volumes 1–3, 1997. Available at: <http://www.ipcc-nggip.iges.or.jp/public/gl/invs1.htm>.

UNFCCC. Guidelines for the preparation of national communications by Parties included in Annex I to the Convention, Part I: UNFCCC reporting guidelines on annual inventories. FCCC/SBSTA/2004/8. Available at: <http://unfccc.int/resource/docs/2004/sbsta/08.pdf>.

UNFCCC. Guidelines for the technical review of greenhouse gas inventories from Parties included in Annex I to the Convention. FCCC/CP/2002/8. Available at: <http://unfccc.int/resource/docs/cop8/08.pdf>.

UNFCCC. Guidelines for national systems under Article 5, paragraph 1, of the Kyoto Protocol. FCCC/KP/CMP/2005/8/Add.3. Available at: <http://unfccc.int/resource/docs/2005/cmp1/eng/08a03.pdf#page=14>.

UNFCCC. Guidelines for the preparation of the information required under Article 7 of the Kyoto Protocol. FCCC/KP/CMP/2005/8/Add.2. Available at: <http://unfccc.int/resource/docs/2005/cmp1/eng/08a02.pdf#page=54>.

UNFCCC. Guidelines for review under Article 8 of the Kyoto Protocol. FCCC/KP/CMP/2005/8/Add.3. Available at: <http://unfccc.int/resource/docs/2005/cmp1/eng/08a03.pdf#page=51>.

UNFCCC secretariat. Status report for Sweden. 2006. Available at: <http://unfccc.int/resource/docs/2006/asr/swe.pdf>.

UNFCCC secretariat. Synthesis and assessment report on the greenhouse gas inventories submitted in 2006. FCCC/WEB/SAI/2006. Available at: <http://unfccc.int/resource/webdocs/sai/2006.pdf>.

UNFCCC secretariat. Sweden: Report of the individual review of the greenhouse gas inventory submitted in the year 2005. FCCC/WEB/ARR/2005/SWE. Available at: <http://unfccc.int/resource/docs/2006/arr/swe.pdf>.

B. Additional information provided by the Party

Responses to questions during the review were received from Mr. Hans Wrådhe (Swedish Environmental Protection Agency) including additional material on the methodology and assumptions used.

Avfallsanlaggningar med deponering. Statistik 2002. RVF (Svenska Renhållningsverksföreningen) Rapport 2003:08. ISSN 1103-4092 (information on utilization of gas recovery).

Manual for SMED's Quality System in the Swedish Air Emission Inventories. SMED on behalf of the SwEPA, March 2005.

Miljorapport 2006. M-real Sverige AB, Husum-Wifsta fabriker, Husum (environmental report).

Naturvårdsverket. Deponigasgenerering. Underlag for riktlinjer. Vattenfall Energisystem AB. Rapport 4158. Underlagsrapport-90-talets avfallshantering 1993. SwEPA, 1993.

Sakab. – Norrtorp Behandling avfall, Askab Miljorapport 2006 (document on incineration).

Sweden's National System for Inventory and Reporting in Accordance with the Kyoto Protocol and Decisions within the EU. SwEPA 2005.

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