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REPORT OF THE INDIVIDUAL REVIEW OF THE GREENHOUSE GAS INVENTORY OF SWEDEN SUBMITTED IN THE YEAR 2001[1]

(Desk review)

EXECUTIVE SUMMARY

1. This report contains the findings of the desk review of the greenhouse gas (GHG) inventory submitted by Sweden for the year 2001. For this review, the expert review team (ERT) examined Sweden's common reporting format (CRF) for 1990–1999, as well as Sweden's national inventory report (NIR). Material prepared by the UNFCCC secretariat, including the draft synthesis and assessment (S&A) report, status report and preliminary key source analysis,[2] were also used.

2. Overall, the ERT found that Sweden's review is of high quality and is quite transparent and complete. The NIR provides very useful information regarding the methods and data sources used in preparing estimates, although there are some areas where expanded discussion would be helpful. There are also some relatively minor sources for which emission estimates should be prepared. From a general perspective, the inventory would benefit from expanded quality assurance/quality control (QA/QC) activities (which Sweden indicates it plans to undertake), as well as preparation of a key source analysis and quantitative uncertainty estimates following the IPCC good practice guidance.

I. OVERVIEW

A. Introduction

3. The Conference of the Parties (COP), at its fifth session, by its decision 6/CP.5, requested the secretariat to conduct, during the trial period, individual reviews of greenhouse gas (GHG) inventories for a limited number of Parties included in Annex I to the Convention (Annex I Parties) on a voluntary basis, according to the UNFCCC guidelines for the technical review of

[1] In the symbol for this document, 2001 refers to the year in which the inventory was submitted, and not to the year of publication. The number (1) indicates that for Sweden this is a desk review report.

[2] The UNFCCC secretariat had identified, for each individual Party, those source categories which are *key sources* in terms of their absolute level of emissions, applying the tier 1 level assessment as described in the IPCC Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories (hereinafter referred to as the IPCC good practice guidance). Key sources according to the tier 1 trend assessment were also identified for those Parties which provided a full CRF for the year 1990. The key sources presented in this report are based on the secretariat's preliminary key sources assessment. They might differ from the key sources identified by the Party itself.

GHG inventories from Annex I Parties, hereinafter referred to as the review guidelines.[3] The secretariat was requested to coordinate the technical reviews and to use different approaches to individual reviews, including desk reviews, centralized reviews and in-country reviews.

4. The review of Sweden took place from 14 November 2001 to 8 March 2002. The desk review was carried out by a team of nominated experts from the roster of experts. Experts participating in the review were Ms. Dina Kruger (Generalist, United States), Mr. Javier Hanna Figueroa (Energy, Bolivia), Dr. Hugh Saddler (Energy, Australia), Ms. Irina B. Yesserkepova (Industrial Processes, Kazakhstan), Mr. William Kojo Ageymang Bonsu (Industrial Processes, Ghana), Mr. Luis Gerardo Ruiz Suarez (Agriculture, Mexico), Ms. Pascale Collas (Land-Use Change and Forestry, Canada), Mr. Francois Wencelius (Land-Use Change and Forestry, France), Ms. Maria Paz Cigaran (Waste, Peru), and Mr. Charles Russell (Waste, New Zealand). The review was coordinated by Ms. Astrid Olsson (UNFCCC secretariat). Ms. Dina Kruger and Ms. Irina B. Yesserkepova were lead-authors of this report.

5. In accordance with the 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

1. National inventory report

6. Sweden submitted a comprehensive NIR in 2001. The NIR is complete and describes methodologies, assumptions and other key aspects of the emission inventory.

2. Common reporting format

7. In its 2001 submission, Sweden submitted CRF tables for the time series 1990–1999.

3. Other sources of information

8. Sweden did not submit any other sources of inventory for the purposes of review. The ERT used the draft S&A report 2001, the preliminary key source analysis and the status report prepared by the secretariat. The ERT also referred to Sweden's response to the draft S&A report.

9. Other sources of information used during the review guidance for experts participating in the individual review of GHG inventories were the UNFCCC reporting guidelines[4] and the review guidelines.

[3] For the UNFCCC review guidelines and decision 6/CP.5, see document FCCC/CP/1999/7, pages 109 to 114 and 121 to 122, respectively.

[4] The 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/CP/1999/7), are referred to in this report as the UNFCCC reporting guidelines.

4. Emission profile, trends and key sources

Emissions profile

10. Sweden has an emission profile which is fairly typical of an Annex I Party. The most important GHG is CO_2 (carbon dioxide), which in 1999 accounted for 79.9% of total emissions,[5] followed by N_2O (nitrous oxide) at 10.3%, and CH_4 (methane) at 8.7%. While Sweden's proportion of CO_2 emissions is typical, it is one of the few Annex I Parties in which N_2O emissions exceed CH_4 emissions. By sector, energy accounted for 77.4% of total emissions in 1999, agriculture 10.8%, industrial processes 8.6% and waste 3.0%.

Emissions trends

11. Sweden's emission trends are summarized by sector and GHG in tables 1 and 2. Sweden's emissions increased by 1.6% between 1990 and 1999. The emission trend over this period was variable; at the peak emission level, in 1996, emissions were 11.2% above 1990 levels. By gas, CO_2 emissions increased by 2.5% over the period, and N_2O emissions increased by 1.5%. Emissions of CH_4 fell by 9.4% over the period. By sector, energy emissions increased by 1.2%. Industrial sector emissions also increased steadily and were 27% higher in 1999 than in 1990. Agriculture emissions fell by 4.9% over the period, and waste emissions fell by 15.9%.

Table 1. GHG emissions by gas, 1990–1999 (Gg CO_2 equivalent)

GHGs	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
	CO_2 equivalent (Gg)									
Net CO_2 emissions/ removals	34,782	27,153	31,506	25,547	32,927	37,229	40,732	29,800	33,811	32,153
CO_2 emissions without LUCF[(a)]	55,074	56,481	54,859	54,879	59,233	58,521	63,001	57,088	58,142	56,458
CH_4	6,810	6,745	6,878	6,829	6,724	6,644	6,633	6,527	6,375	6,173
N_2O	7,156	6,941	6,785	6,953	7,118	6,892	7,103	7,075	7,335	7,260
HFCs	1	3	4	17	47	94	141	239	303	375
PFCs	440	427	414	402	390	389	343	316	306	329
SF_6	81	82	82	88	97	115	103	146	92	96
Total (with net CO_2 emissions/ removals)	49,270	41,352	45,669	39,836	47,303	51,363	55,055	44,102	48,223	46,387
Total (without CO_2 from LUCF[(a)]	69,562	70,679	69,022	69,168	73,608	72,656	77,324	71,390	72,554	70,692

[(a)] LUCF = land-use change and forestry

[5] In this report, the term "total emissions" refers to the aggregate national emissions based on CO_2 equivalents excluding land-use change and forestry unless otherwise specified. Sweden includes CO_2 emissions from agricultural soils in the agriculture sector, and for purposes of comparison with other countries, these emissions are also excluded in these percentages.

Table 2. GHG emissions by sector, 1990–1990 (Gg CO_2 equivalent)

GHG SOURCE AND SINK CATEGORIES	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
	CO_2 equivalent (Gg)									
1. Energy	54,098	54,998	53,120	53,042	57,409	56,308	60,910	54,958	56,359	54,727
2. Industrial processes	4,808	5,259	5,436	5,581	5,684	6,050	6,114	6,043	5,949	6,107
3. Solvent and other product use	111	111	111	111	111	111	111	111	111	111
4. Agriculture	7,992	7,713	7,748	7,919	7,998	7,788	7,820	7,943	7,851	7,600
5. LUCF[(a)]	-20,292	-29,328	-23,353	-29,332	-26,305	-21,293	-22,269	-27,288	-24,331	-24,305
6. Waste	2,554	2,598	2,607	2,515	2,406	2,399	2,369	2,335	2,284	2,147
7. Other	0	0	0	0	0	0	0	0	0	0

[(a)] LUCF = land-use change and forestry

C. Key sources

12. Sweden conducted a key source analysis for the energy sector as part of its 2001 submission. It did not identify key sources in other sectors. Sweden notes that it intends to provide a comprehensive key source analysis with documentation in its 2002 submission. The secretariat preliminary analysis identified key sources (level assessment) listed in table 3.

Table 3. Key sources Sweden: Level and trend assessment (UNFCCC secretariat)[(a)]

Key source	Gas	Level assessment %	Cumulative Total %	Contribution to trend %
Stationary combustion – oil	CO_2	31.5	32	1.8
Mobile combustion - road vehicles	CO_2	25.6	57	12.7
Stationary combustion – coal	CO_2	9.7	67	18.8
Enteric fermentation in domestic livestock	CH_4	4.4	71	2.5
Agricultural soils	N_2O	3.2	74	4.5
Solid waste disposal sites	CH_4	3.0	77	6.1
Iron and steel industry	CO_2	2.9	80	12.2
Stationary combustion – gas	CO_2	2.4	83	6.0
Cement production	CO_2	1.7	84	2.1
Stationary combustion – other fuels	CO_2	1.5	86	1.9
Stationary combustion – oil	N_2O	1.2	87	2.3
Mobile combustion – aircraft	CO_2	1.1	88	
Other (agricultural soils)	NO_2	1.1	89	
Nitric acid production	N_2O	1.1	90	1.0
Mobile combustion – waterborne navigation	CO_2	0.9	91	
Manure management	N_2O	0.9	92	1.9
Mobile combustion – road vehicles	N_2O	0.7	93	2.4
Animal production	N_2O	0.7	93	1.7
Non-CO_2 stationary combustion – coal	N_2O	0.5	94	1.3
Ferro-alloys production	CO_2	0.5	95	1.9
PFCs from aluminium production	CF_4+C_2F_6			1.7
Non CO_2 stationary combustion – biomass	N_2O			1.1
Mobile combustion – road vehicles	CH_4			2.4
Other (industrial processes)	N_2O			2.1
Other (transportation)	N_2O			1.1

[(a)] See footnote 2 of this report

D. General assessment of the inventory

1. Completeness of reporting

CRF

13. In its 2001 submission, Sweden provided a complete CRF for the period 1990–1999, with almost all required tables included. Key tables not provided for the period included:

(a) Industrial processes: table 2(II).F;

(b) LUCF: tables 5.A, 5.B and 5.C;

(c) Waste: table 6.B.

14. Sweden in its response to the draft desk review report, explained that data covering most of the information in table 2(II).F were submitted in annex to the NIR for the years 1990–2000 in Sweden's 2002 submission.

NIR

15. Sweden submitted a detailed NIR as part of its 2001 submission. Overall, the ERT noted that the NIR was complete and of high quality.

2. Conformity with the UNFCCC reporting guidelines and the IPCC Guidelines

16. The national inventory submitted by Sweden is in conformity with the UNFCCC reporting guidelines.

17. Sweden's submission is in conformity with the IPCC Guidelines. For many sources, the extent to which Sweden has begun to implement the IPCC good practice guidance is not explicitly discussed. In the NIR, Sweden noted that it has implemented good practice for some parts of the inventory. The ERT suggests that more explanation regarding the implementation of the IPCC good practice guidance would be helpful.

3. Cross-cutting issues

Verification and QA/QC approaches

18. Sweden indicated that its QA/QC procedures are under development. According to the NIR, some QC is performed, but independent inventory review (QA) has not yet been performed. Sweden indicated that it will improve QA/QC activities for its inventory in future years. The ERT notes that Sweden's detailed documentation and careful references form a good basis for developing an archive of inventory-related materials.

Recalculations

19. Recalculation information was provided in table 8, and a discussion of the underlying changes was provided in the NIR. Expanded discussion of large recalculations would be useful.

Uncertainties

20. In its NIR, Sweden provided a general discussion of sources of uncertainty in its inventory. The implementation of quantitative uncertainty analysis following the IPCC good practice guidance was not discussed. Sweden did not indicate its future plans with respect to

uncertainty assessment. The ERT suggests that Sweden consider undertaking quantitative uncertainty assessment following the IPCC good practice guidance and provide an expanded discussion of this topic in its future NIRs.

E. Areas for further improvement

1. Issues identified by the Party

21. In its NIR and its response to the draft S&A report, Sweden identified several areas for future improvement. In the NIR, for example, Sweden noted that it intends to expand its QA/QC activities in future years in order to implement the IPCC good practice guidance more fully. Sweden also noted that for some source categories (for example CH_4 emissions from enteric fermentation), specific activities are under way to improve the quality of the inventory.

2. Issues identified by the ERT

22. The ERT found Sweden's emission inventory submission to be of high quality. The ERT identified several areas for future improvement, however, which would increase the transparency, completeness and quality of the inventory. General areas for improvement include expanding the discussion of methodologies and data sources in the NIR, particularly for key sources. Further, the ERT suggests that Sweden should perform a key source analysis (both level and trend) for all sectors, and notes that Sweden indicated in its response to the draft S&A report that it intends to do so in future. Additional QA/QC activities should be undertaken in accordance with the IPCC good practice guidance, and again the ERT notes that Sweden has already indicated its intention to expand its efforts in this area. Finally, the ERT suggests that Sweden should initiate quantitative uncertainty analysis in accordance with the IPCC good practice guidance.

Energy

23. The ERT recommends that Sweden address some completeness issues identified in the energy sector. In particular, emissions of CO_2 in the transport sector from certain fuels appear to be missing, and the treatment of fugitive emissions from natural gas does not appear to be consistent throughout the time series and would not seem to be not occurring ("NO") in 1999. The ERT also notes that Sweden's inventory includes a complex allocation of CO_2 emissions from the combustion of coal, coke and by-products (coke oven gas, blast furnace gas) in coke ovens and iron and steel production among: 1.A.1.c (manufacture of solid fuels and other energy industries), 1.A.2.a (iron and steel), 1.B.1.b (solid fuel transformation), and 2.C.1 (iron and steel production). The ERT recommends that Sweden provide in the NIR a detailed account of the method used in this allocation. Sweden should also explain why CH_4 emissions in 2.C.1 are estimated to be zero, as this is not consistent with the IPCC Guidelines. Additional explanation of differences in emission factors, particularly for N_2O (where most emission factors are much higher) and CH_4 (where most emission factors are significantly lower) should also be provided in the NIR.

Industrial processes

24. The ERT suggests that Sweden should pay particular attention to improving its estimates and documentation for key sources in this sector. Several gaps need to be filled with respect to emissions of halocarbons and SF_6. Sweden's N_2O emissions from nitric acid production should also be improved and better documented. In its response to the draft desk review report Sweden

explained that in the 2002 submission care was taken to fill in notation keys in the relevant tables and that activity data for nitric acid production will be improved in future submissions**.**

Agriculture

25. The ERT recommends expanding the discussion in the NIR for some areas, particularly key sources. For several key sources (for example CH_4 from enteric fermentation and N_2O from direct soil application) a clear presentation of summary tables with the time series and expanded discussion of the reasons for observed changes would aid the review process. The ERT notes that Sweden is reviewing its emission factors for CH_4 from enteric fermentation and agrees that this is an important priority given the differences between Sweden's emission factors and those of other Parties.

LUCF

26. The ERT recommends that Sweden document the rationale for excluding tables 5.A, 5.B and 5.C from reporting, and suggests that notation keys be used as appropriate in tables 5.A to 5.D. The ERT notes that non-CO_2 emissions are not estimated for this sector and recommends that a rationale for this be provided in the NIR. The NIR could also be improved by including more detailed discussion of methods and references to key data sources. Finally, the ERT recommends that future NIRs provide more information on recalculations.

Waste

27. Sweden reported only emission estimates for CH_4 from solid waste disposal sites in this sector. Emissions from waste incineration were reported in the energy sector, and emissions from wastewater handling were not estimated. The ERT recommends that Sweden estimate emissions for domestic and industrial wastewater, following the IPCC Guidelines and the IPCC good practice guidance. The ERT also recommends the use of notation keys to improve the clarity of the inventory.

3. Good practice

28. In its NIR, Sweden indicated that it had begun to implement the IPCC good practice guidance. The ERT encourages Sweden to continue incorporating good practice, and to provide in future submissions more detailed information about its progress in this area.

Verification and QA/QC

29. The ERT recognizes that Sweden is developing QA/QC procedures. The ERT urges it to continue to emphasize this area and to provide an update on its progress in its next submission.

Uncertainty

30. The ERT encourages Sweden to perform quantitative uncertainty assessments, following the IPCC good practice guidance.

Recalculations

31. The ERT recognizes that Sweden provides useful documentation on recalculations. It would be helpful if Sweden were to provide more detailed information for some source categories, as discussed in more detail in the following sectoral sections.

Key source analysis

32. The ERT notes that Sweden has conducted a key source analysis for the energy sector. The ERT recommends that Sweden conduct a key source analysis for the entire inventory and report on its findings in future submissions.

II. ENERGY

A. Sector overview

33. The energy sector accounted for 77.4% of total gross emissions in 1999 and 118% of total net emissions, reflecting the very large CO_2 removals from its LUCF sector. Emissions of CO_2 from the energy sector, totaling 52,022.4 Gg, represent 92% of total CO_2 emissions. The energy sector includes ten key source categories.

34. During the period 1990–1999, total CO_2 equivalent emissions from energy increased by 1.2%. Over the period, CO_2 emissions increased by 0.9%, CH_4 decreased by 18.6% and N_2O increased by 17.2%. The emission growth was attributable to 10% emission growth in 1.A.1 (energy industries), 4% growth in 1.A.2 (manufacturing industries and construction) and 6% emissions growth in 1.A.3 (transport), offset by a decrease of 18% in 1.A.4 (other sectors). Fugitive emissions from fuels are low, but grew by 19% during this period.

1. Completeness

35. With some exceptions, the CRF included estimates of most gases and sources of emissions from the energy sector, as recommended by the IPCC Guidelines. The exceptions were as follows:

(a) There were no emission factors, and hence no estimated emissions, for CH_4 and N_2O emissions arising from the following transport fuel uses: aviation fuel in 1.A.3.a (aviation); natural gas in 1.A.3.b (road transportation); liquid fuels (presumably diesel) in 1.A.3.c (railways); and diesel in 1.A.3.d (navigation). Sweden in its response to the draft desk review report explained that emissions from the transport sector will be further improved in future submissions as was described in the NIR;

(b) Sector 1.A.5 (other) reported emissions from military activities, as described in the NIR. Emissions from the combustion and other oxidation of engine oil and other lubricants, which can be reported here, were estimated to be zero, by virtue of the assumption that 100% of fossil carbon in these products was stored (see table 1.A(d)). This is not consistent with the IPCC Guidelines, which use a default storage factor of 0.5. No explanation for the departure from IPPCC Guidelines was provided;

(c) In the fugitive emissions sector, emissions from leakage in the natural gas supply system were reported as “NO” and the documentation box did not report the gas throughput or length of pipelines. However, the NIR implied (p. 14) that emissions were reported from this activity, and also that some flaring occurred and was reported. Moreover, the revised CRFs for all years from 1990 to 1998 inclusive showed some emissions from this source (in table 8(a)s1 in each case), and table 10s1 for 1999 showed a steady pattern of emissions up to 1999, when it was suddenly reported as “NO”. The reason for this change in trend needs to be explained. It is understood that production of coal, oil and gas do not occur in Sweden; so there are no fugitive emissions from these activities;

(d) Most cells where either "NO" or, in the cases identified above, not estimated ("NE") should appear, have been left blank. This includes the cells in 1.A.3 where CH_4 and N_2O emission factor values were not available, as described above;

(e) Note that estimates of N_2O in 1.A.4 were reported as incomplete in table 7s1, but were complete in table 1.A(a)s4; that is, all relevant cells contained data.

2. Methodologies

36. Both the reference approach and the sectoral approach were used. IPCC tier 2 methods were used for most sectors. For road transportation (1.A.3b), the tier 3 method was used.

3. Emission factors

37. According to the NIR, emission factors were compiled by the Swedish Environmental Protection Agency (EPA) using national measurements and other data. All emission factors were reported in the NIR. Compared with IPCC tier 1 default values,

(a) CO_2 emission factors were mostly slightly higher;

(b) CH_4 emission factors were mostly significantly lower;

(c) N_2O emission factors were much higher for natural gas (mostly about twenty times) and liquid fuels (mostly about three times) and somewhat higher for coal (mostly about one third higher).

38. As noted above, CH_4 and N_2O emission factor values were not available for some parts of 1.A.3 (transport).

4. Activity data

39. According to the NIR, all activity values were obtained from official national energy statistics, compiled by a comprehensive survey of energy users, and were considered to be of very good quality.

5. Recalculations

40. A major recalculation exercise was undertaken for every year from 1990 to 1998. However, the net effect on energy sector emissions was relatively small – increases in each year of between roughly 0.5% and 2.0%. These recalculations were attributed to improved emission factors and activity data. Much larger changes occurred within the energy sector, for example in the form of reallocation of emissions, in particular from 1.A.2 to 1.A.1 for many of the years. All the recalculated data showed consistent trends and were presumed to be internally consistent and reliable.

6. Comparison between reference and sectoral approaches

41. Both reference and sectoral (national) approaches were used. The reference approach appeared to follow the IPCC Guidelines, except that an oxidation factor value of 1.0 was used for all fuels. Reference approach estimates of CO_2 emissions, compared with sectoral approach estimates, were:

(a) higher by 1.2% for liquid fuels;

(b) higher by 37.2% for solid fuels;

(c) higher by 0.1% for natural gas;

(d) lower by 15.6% for other fuels (which are not defined).

42. Discrepancies were significantly greater between the two estimates of energy consumption, but this was explained by the need to adjust for fuel used as feedstocks from which fossil carbon is stored in products. Table 1.A(d) contained detailed information on feedstocks, and the reconciliation was shown in appendix 11 to the NIR.

43. The wide discrepancy in estimates of CO_2 emissions from solid fuels can be explained by the fact that much of the CO_2 emitted from coal and coke is reported under 1.B (fugitive emissions) and 2.C (industrial processes: metal production, specifically including production of iron and steel, ferro-alloys, aluminium and copper). When these adjustments were made, as in appendix 11 of the NIR, it was found that estimated CO_2 emissions from the reference approach are 2.3% lower than those from the sectoral approach. This is considered to be an acceptable variation, given uncertainties relating to emission factors for solid fuels.

44. For liquid fuels, the discrepancy was even less than reported, because of misreporting in table 1.A(a)s1. In row 13 of that table, "other fuels" can include petroleum fuels used in transportation, other than those specifically identified by name. In this case, 2,568 TJ of petrol used in navigation was reported in the summary under "other fuels" rather than under "liquid fuels". This means that inventory totals for the various types of fuel may be incorrect, as in this case, though the overall total emissions will not be affected.

B. Key sources

1. Stationary combustion: oil – CO_2

45. All sub-sources are estimated.

Methodologies, emission factors and activity data

46. Tier 1 methods (for both sectoral and reference approaches) were used for all sub-sources with country-specific emission factors. The emission factors for the various petroleum products as reported in table 1.A(b) were close to IPCC default values (slightly lower than the IPCC default for residual fuel oil, slightly higher for liquefied petroleum gas (LPG) and diesel). According to the NIR, all activity data used were obtained from official national energy statistics.

2. Mobile combustion: road vehicles – CO_2

47. All sub-sources, comprising CO_2 from combustion of gasoline, diesel and natural gas were estimated.

Methodologies, emission factors and activity data

48. The tier 3 method was used for this key source, based on estimation of consumption of fuels by the Swedish National Road Administration, applied to a model which accounts for traffic data, descriptions of different vehicle categories, engine technology and different modes of driving (rural/urban/highway).

49. The implied emission factors (IEFs) for gasoline and diesel (75.52 and 71.75 Gg/PJ respectively) were not consistent with the carbon emission factors used in the reference approach (table 1.A(b)), which were 19.80 and 20.54 Gg C/PJ respectively, equivalent to 72.6 and 75.3 Gg CO_2/PJ. The latter are similar to, but somewhat higher than, IPCC default values. The ERT recommends that Sweden provide an explanation for the apparent discrepancy in these values.

50. According to the NIR, activity data were estimated by the Swedish National Road Administration, as described above, and included adjustments for apparent private storage of diesel and also for allocation to off-road vehicles and other transport modes (rail, navigation, military).

3. Stationary combustion: coal – CO_2

51. All sub-sources are estimated.

Methodologies, emission factors and activity data

52. The tier 1 method (for both sectoral and reference approaches) was used for all sub-sources, with country-specific emission factors. The IEFs for solid fuels varied widely between individual sectors in energy industries and manufacturing. Presumably this reflects variations in the mix of the different types of solid fuel in the various sectors. According to the NIR, all activity data were obtained from official national energy statistics.

4. Stationary combustion: gas – CO_2

Completeness

53. All sub-sources were estimated.

Methodologies, emission factors and activity data

54. The tier 1 method (for both sectoral and reference approaches) was used for all sub-sources, with country-specific emission factors. The IEFs for gaseous fuels in most subsectors were identical, were the same as the emission factor for natural gas in the reference approach, and were close to the IPCC default value. The IEF for gaseous fuels in sector 1.A.4.a was just under 2% higher. According to the NIR, all activity data were obtained from official national energy statistics, which were compiled by means of a comprehensive survey of energy users for sectors 1.A.1 and 1.A.2, and were considered to be of very good quality for these sectors. For the other sectors, statistics on fuel deliveries were used with various modeling approaches.

5. Stationary combustion: other fuels – CO_2

55. Consumption of other fuels was reported to occur in sectors 1.A.1.c and 1.A.2.c, d, e and f. It can be deduced from the NIR that the category other fuels consisted mainly of municipal solid waste (MSW).

Methodologies, emission factors and activity data

56. The tier 1 method was used for all sub-sources. Other fuels were not reported in the reference approach; that is, the table design makes no allowance for this fuel type. The IEFs for other fuels varied between subsectors, as would be expected, given that the NIR reported a value of 32.78 g/MJ for sector 1.A.1.a and 28.4 g/MJ for sector 1.A.2. There is no IPCC default

emission factor. According to the NIR, all activity data were obtained from official national energy statistics, derived largely from plant by plant surveys.

6. Stationary combustion: oil – non-CO_2

57. All sub-sources were estimated.

Methodologies, emission factors and activity data

58. The tier 1 method (for both sectoral and reference approaches) was used for all sub-sources, with country-specific emission factors. According to the NIR, all emission factors were compiled by the Swedish EPA using national measurements, together with other data. All emission factors were reported in the NIR. Compared with IPCC tier 1 default values, CH_4 emission factors were mostly significantly lower and N_2O emission factors were about three times higher. According to the NIR, all activity data were obtained from official national energy statistics, largely derived from company by company surveys for sectors 1.A.1 and 1.A. 2, and from a variety of less reliable modeling and other methods for sector 1.A.4.

7. Mobile combustion: aircraft – CO_2

59. Emissions from consumption of both aviation fuel and jet fuel were reported.

Methodologies, emission factors and activity data

60. According to the NIR, the division between domestic and international flights was based on calculations made by the Swedish EPA for CORINAIR. These calculations were in turn based on calculations from the Swedish Civil Aviation Administration. LTO-cycles were considered according to the IPCC good practice guidance. The IEFs for aviation gasoline and jet fuel were consistent with the emission factor values used in the reference approach. The value for jet fuel was about 2% higher than the IPCC default value. According to the NIR, data on fuel use was collected by surveys of fuel wholesalers, and was allocated between domestic and international flights in line with data compiled for CORINAIR, as described above.

8. Mobile combustion: waterborne navigation – CO_2

61. Emissions were reported from the consumption of diesel oil, residual oil and gasoline. Significant emissions were also reported under the category other fuels, but these were not defined.

Methodologies, emission factors and activity data

62. According to the NIR, emission estimates from shipping were determined by a model developed in 1991 for the National Administration of Shipping and Navigation. In this model, emissions from shipping in Sweden were calculated for an area covering the Baltic, the Skagerrak and the Kattegatt. Emission estimates were based on registration of ship movements between ports and fuel consumption. The IEFs for diesel oil and residual oil were consistent with the emission factor values used in the reference approach. The value for diesel oil was about 1% lower than the IPCC default value, and the value for residual oil was about 1% higher than the IPCC default. According to the NIR, consumption data for diesel oil and residual fuel oil for domestic and bunker navigation was obtained by a survey of fuel wholesalers. In addition, 1.5% of delivered gasoline in Sweden was assumed to be used by small boats, on the basis of an investigation in 1992.

9. Mobile combustion: road vehicles – N_2O

63. Emissions were reported from the use of gasoline and diesel in road transport. However, emissions from natural gas were not estimated, although CO_2 emissions from natural gas in road transport were estimated.

Methodologies, emission factors and activity data

64. The methods and activity data used were described above, under CO_2 from mobile combustion – road vehicles. The IEFs for gasoline and diesel in road transport were respectively 15 and three times higher than the IPCC default values.

10. Stationary combustion: coal – non-CO_2

65. All sub-sources were estimated.

Methodologies, emission factors and activity data

66. The tier 1 method (both sectoral and reference approaches) was used for all sub-sources, with country-specific emission factors. According to the NIR, all emission factors were compiled by the Swedish EPA using national measurements, together with other data. All emission factors were reported in the NIR. Compared with IPCC tier 1 default values, CH_4 emission factors were mostly significantly lower and N_2O emission factors were about one third higher. Activity data were obtained as described for CO_2 from stationary combustion of coal.

III. INDUSTRIAL PROCESSES

A. Sector overview

67. All CRF tables were completed in accordance with the UNFCCC reporting guidelines. IPCC summary tables were also included.

1. Completeness and transparency

68. Sweden reported activity data and emissions at a disaggregated level. Where data were not provided, appropriate notation keys were used. There are, however, instances where activity data were reported in the NIR but not in CRF tables. In some other cases - for example, nitric acid production - activity data were not provided at all. In its response to the draft S&A report, Sweden indicated that these lacks would be addressed in the third national communication and in the 2002 submission.

2. Methodologies

69. For CO_2 emissions from subcategories 2.A, 2.B, 2.C, 2.D and 2.G, country-specific methods were used. The CORINAIR methodology was used for CH_4 and N_2O.

70. The tier 2 method was used to estimate emissions of PFCs and SF_6 under subcategory 2.C (metal production). In sub-category 2.F, tier 2 and tier 1b methods were used for estimating HFCs, PFCs and SF_6 emissions, for actual and potential emissions respectively.

3. Emission factors

71. Country-specific emission factors were used to estimate CO_2, CH_4 and N_2O emissions in subcategories 2.A, 2.B, 2.C, 2.D and 2.G. However, under subcategory 2.C, plant-specific

emission factors were used to estimate PFC emissions. For SF_6 emissions, country-specific emission factors were used. A hybrid of default and country-specific emission factors were used for HFC emission estimates under 2.F. In the case of PFCs and SF_6 in category 2.F, country-specific emission factors were used.

4. Activity data

72. Activity data for pulp and paper were reported for the year 1997 only. In its response to the draft desk review report Sweden informed that activity data for pulp and paper were reported in the 2002 submission.

B. Key sources

73. A key source analysis was not performed by Sweden for this sector. The secretariat's preliminary analysis identified three key sources.

1. Iron and steel production – CO_2

74. CO_2 emissions from iron and steel production is a key source, contributing about 2.9% and 12.2% to national total emissions in absolute level and trend in emissions respectively. The pig iron activity data reported in the CRF for 1999 (102.7 kt) is far lower than United Nations statistical data (381.6 kt) for the same year. The ERT recommends that Sweden explain this discrepancy in the NIR.

2. 2.B.2 Nitric acid production – N_2O

75. N_2O emissions from nitric acid production contribute about 1%, both in terms of absolute level and trend in emissions. Activity data for nitric acid production were reported in neither the CRF tables nor the NIR. Sweden did, however, provide some data covering 1997 to 1999 in response to the query raised in the draft S&A report 2001. However, no data were provided for the period 1990 to 1996 and no explanation was provided for this gap in the response. The ERT suggests that Sweden better document the data underlying its emission estimate for this source. Sweden responded to the draft desk review that in the 2002 submission activity data for nitric acid production were included for the years 1997–2000 and that data for the years 1990–1996 will be provided in the 2003 submission.

3. Consumption of halocarbons: PFCs, HFCs and SF_6

76. This is a very important key source contributing 5.1% in trend emissions, but no data were provided. The draft S&A report identifies several gaps in reporting. Sweden has indicated that it intends to address these data gaps in its next submission. The ERT supports Sweden's intention and suggests that this source should be a priority for future improvement. In its response to the draft desk review report Sweden explained that the reporting was improved in the 2002 submission, in that relevant background data were submitted in an annex to the NIR and the use of notation keys in relevant tables was improved.

IV. AGRICULTURE

A. Sector overview

77. Emissions from the agriculture sector were 7,991.9 Gg CO_2 equivalent in 1990, and fell to 7,599.9 Gg in 1999. This represents a 5.2% decrease in emissions. In the 1990 inventory, the agriculture sector was responsible for 16.2% of total emissions in CO_2 equivalent. In 1999, the sector was responsible for four key sources, representing 16.4% of total emissions. The key sources in the sector are: CH_4 from enteric fermentation in domestic livestock, direct N_2O emissions from agricultural soils, other N_2O emissions from agricultural soils, and N_2O from manure management.

1. Completeness and transparency

78. The inventory was complete in terms of spatial coverage, GHG and most sources. Rice cultivation, savanna burning and field burning of agricultural residues were reported as "NO". In general, the inventory for the sector was supported by references to country-specific research, or sources such as trade associations and expert opinion. The NIR provided a comprehensive description of the methods and raw data, properly documented in tables which are easy to use.

Methodologies, emission factors and activity data

79. In most cases, the IPCC Guidelines were followed. A combination of tier 1, CORINAIR and country-specific methods were used. Emission factors were obtained using default and country-specific values, some of which are under revision. Activity data were obtained from national statistics, surveys and trade associations.

80. In general, the livestock population characterization was consistent for the sources which share the same basic activity data (for example CH_4 from enteric fermentation and manure management and N_2O from manure management and from manure applied to agricultural soils). Some livestock species show different levels of disaggregation from one source to another, as discussed further below. Correspondence among categories is clearly stated.

B. Key sources

1. 4.A Enteric fermentation – CH_4

81. In 1990, methane emissions from this source were 3,219.3 Gg CO_2 equivalent, of which 89.6% came from cattle. Estimates were prepared using country-specific values, which are currently under review. For other livestock species, the tier 1 method with default values was used. By 1999, emissions from this source were 3,083.2 Gg CO_2 equivalent, of which 89.4% came from cattle.

Trends and completeness

82. A consistent time series was provided for the period 1990 to 1999, but it needed to be extracted from table 10s2 in the CRF for 1999. Emissions in 1999 were 4% lower than in 1990 but no trend was observed in table 10s2 in the 1999 CRF. No summary tables were presented in the NIR. The ERT suggests that the review process would be considerably improved if summary tables were provided in the NIR.

Methodologies, emission factors and activity data

83. The methods in the IPCC Guidelines were the basis of the calculations for this source. National statistics, which are obtained in June of each year, were used for this source; they were assumed to be equivalent to one-year averages. The age distribution of calves was made by assigning 60% of calves to the category "less than 6 months of age". These national statistics were complemented by surveys and information supplied by trade associations.

84. Sweden's IEFs were the highest among the reporting Parties and more than 50% higher than default values for Western Europe. This was also noticed in the S&A report 2000 and draft S&A report 2001. These values were based on national research which is not currently fully documented in the NIR. These values are under revision and Sweden states that updated values will be used in the 2003 submission. For non-dairy cattle and swine, IEFs show changes during the period due to changes in the age structure of the herd.

2. 4.D Agricultural soils – direct N_2O

85. In 1990, N_2O emissions from this source were 2,545.1 Gg CO_2 equivalent. By 1999 emissions from this source were 2,253.7 Gg CO_2 equivalent. Sweden answered the questions raised in the draft S&A report. Most of them related to country-specific conditions and unit errors in the report tables which do not affect final calculations.

Trends and completeness

86. The time series could not be reviewed from 1990 to 1999 because the trend table in the CRF (table 10s3) is too aggregated to be of use. The provision of source-level trend information in the NIR would aid the review process.

Methodologies, emission factors and activity data

87. Emissions were estimated using point studies and CORINAIR methods, with other years interpolated. Activity data for N_2O emissions were calculated from national statistics on sales of mineral fertilizers, technical reports and CORINAIR. National emission factors were used, taken from a technical report based on a literature survey that had not yet been published.

3. Nitrogen used in agriculture – other N_2O emissions

88. In 1990, N_2O emissions from this source were 784.3 Gg CO_2 equivalent. By 1999, emissions from this source were 765.7 Gg CO_2 equivalent, representing 1.1% of total emissions. This source includes cultivation of mineral soils and hayfields.

Trends and completeness

89. The time series for 1990 to 1999 could not be reviewed because the trend table in 1999 CRF (table 10s3) is too aggregated to be useful for this source. The provision of source-level trend information in the NIR would aid the review process.

Methodologies, emission factors and activity data

90. For hayfields, Sweden used a national methodology based on national research and the IPCC default emission factor. The N-fixing factor was calculated using a national computer model. For mineral soils, a national method was used, which considered background emissions from mineral soils as well as organic soils. For hayfields, the national method allows input of

county activity data. Activity data for mineral soils were based on national statistics. For hayfields, default IPCC emission factors were used. For mineral soils, the emission factors were national, based on a literature survey.

4. 4.B Manure management – N_2O

91. In 1990, N_2O emissions from this source were 727.3 Gg CO_2 equivalent. They included emissions from pasture range, and solid storage. By 1999, emissions from this source were 601.9 Gg CO_2 equivalent. Most of the reduction was from solid storage systems. Sweden answered the questions raised in the draft S&A report, relating to country-specific conditions.

Trends and completeness

92. A consistent time series was provided from 1990 to 1999. This time series rests heavily on extrapolated data.

Methodologies, emission factors and activity data

93. The methods in the IPCC Guidelines were used. Activity data were consistent with those for other source categories sharing the same population characterization, as suggested by the IPCC good practice guidance. N-production by different livestock categories was developed using extensive national research at particular locations. No estimates of uncertainty were provided for extrapolation to national level. Default emission factors from the IPCC Guidelines were used.

C. Non-key sources

1. 4.B Manure management – CH_4

94. In 1990, emissions were 253.8 Gg of CO_2 equivalent. In 1999, emissions were 299.4 Gg. Sweden responded to questions raised in the draft S&A report relating to changes in production methods that in turn led to changes in subcategories population and ultimately to changes in manure management systems. All of these changes are reflected in the IEF.

Trends and completeness

95. A consistent time series was provided for 1990 to 1999, but it needed to be extracted from table 10s2 in the CRF tables for 1999. There was no apparent trend in the emissions from this source.

Methodologies, emission factors and activity data

96. For cattle and swine, the tier 2 method from the IPCC Guidelines was used to estimate emissions. Other species were estimated using a tier 1 method. Activity data were consistent with those for other source categories sharing the same population distribution. Information on manure management systems was from national statistics. Default emission factors from the IPCC Guidelines were used. Manure production was estimated from extensive national research, but no estimate of uncertainty was provided for extrapolation to national level. Changes in IEF were noted in the draft S&A report; according to Sweden these are due to changes in the distribution of manure management systems.

V. LAND-USE CHANGE AND FORESTRY

A. Sector overview

1. Completeness

97. A complete time series was provided for the sources and sinks reported. Only tables 5 and 5.D were completed. Useful explanatory data and information on methods for changes in forest and woody biomass stocks were provided in the NIR.

98. As a minimum, the ERT suggests providing in the relevant documentation boxes the rationale for excluding tables 5.A, 5.B and 5.C from reporting. The aggregated growth and emission data could be provided in table 5.A under the "boreal" category along with the area of forest lands covered. Also, data on commercial harvest and fuel wood consumed could be provided in table 5.A. Instead it is assumed that both are implicitly included under the category "fellings", provided in the NIR.

99. In table 5, estimates provided in the CO_2 removals column were growth estimates already net of fellings and natural loss. Therefore, they should have been reported only in the "net" column. An alternative would be to distinguish between emissions from fellings and natural loss (reported in the emissions column) and gross removals (in the removals column).

100. No estimate was provided for forest and grassland conversion and abandonment of managed lands. The NIR indicated that abandonment of managed land is of very limited occurrence (20 kha since 1990). As for forest conversion, it was indicated that there are no statistics. This could mean that no conversion is occurring, although this is not explicitly stated. Explanatory comments, provided on CO_2 and the other two gases (CH_4 and N_2O) to that effect in table 9 of the CRF, do not seem internally consistent.

101. No estimates for forest soils and mineral soils were provided.

102. The ERT notes that the empty boxes in CRF tables 5.A to 5.D should be filled in with relevant notation keys: not applicable ("NA") or "NE".

103. The ERT assumed that since no estimates of non-CO_2 emissions were provided, there were no forest fires or prescribed burning in managed forest. In Sweden's next submission, the NIR should give a rationale for excluding non-CO_2 emissions.

2. Transparency

104. While the NIR ensured a good degree of transparency, the description of methods and reporting could be more detailed in both the CRF and the NIR. In particular, it would be useful if Sweden provided more discussion with respect to land-use changes (for example the statement that they are insignificant could be backed by evidence or information), changes in biomass for land types other than managed forests, and harvested wood products. In addition, key data sources quoted in the NIR on forest biomass, soils and wood products were not referenced.

3. Methodology, emission factors and activity data

105. A combination of IPCC default method and country-specific methods and factors was used. The main source of information for category 5.A was National Forest Statistics.

4. Recalculations

106. The NIR indicated that recalculations in the 2001 submission were due to revised conversion factors and expansion factors in the forest biomass calculations. A study permitted the revision of country-specific conversion factors for stump and coarse root biomass. The ERT recommends that future NIRs provide more details and usefully document how the conversion factors have changed over the years. The biggest difference between net removals previously reported and those reported in 2001 due to such recalculations occur for the year 1990 (now 24,100 Gg CO_2 as opposed to 34,368 Gg CO_2 in the previous submission, or an approximately 30% decrease) and for 1996 (an approximately 18% decrease).

B. Specific sources and sinks

1. Forest biomass

107. Net removals by forest biomass were 24,100 Gg CO_2 per year in 1990 and 28,100 Gg CO_2 in 1999. Annual fluctuations ranged from -18% and +37% during the 1990s. No trend analysis was provided in the NIR, but in its response to the draft S&A report, Sweden explained that harvesting rate fluctuations are actually the key factor influencing net removals in managed forests. Growth for deciduous and coniferous forests were averaged over five-year periods. Natural losses in the forest varied between 733 and 5133 Gg CO_2/yr (0.2 and 1.4 Tg C/yr).

108. The method used by Sweden to estimate change in forest C stocks was country-specific and described in the NIR. The ERT notes that it would be useful to explain the methodology used in greater detail, possibly in an annex.

109. Changes made to the conversion and expansion factors were addressed in the recalculations section.

110. It would be useful to define the term “fellings” and what they include other than informal fuel wood gathering.

111. Some 0.3 Mha of forest areas were reclassified as reserved lands between the last two forest inventories and therefore are not accounted for under the LUCF inventory. An adjustment of 4.8 Tg C was made to take this shift into account. Some explanation was provided, but the NIR does not document the data source.

112. Changes of stocks from tree growth on land types other than managed forest and preserved areas were not known. However, an estimate of 6 Tg C of change during 1990–2000 is included in the LUCF totals. There is a lack of transparency regarding how the 6Tg C estimate was derived and to what land types it refers. It is assumed that these comprise agricultural woodlots or urban forestry.

2. Forest soils

113. Ranges of increase in C stocks from soils and CO_2 emission estimates from drained forest peat soils were provided but they were not included in the total for the LUCF sector. The methodology used to derive such ranges was not detailed, nor was it specified whether plans exist for including forest soils in LUCF estimates in the future.

3. Harvested wood products

114. Sweden reported an annual average net removal of 100 Gg CO_2 corresponding to averaged increases in housing stocks between 1983 and 1994. Estimates are extrapolated since there have been no new data since 1994. There is an error in the conversion between the NIR (0.1 Tg C/yr) and table 5 (100.00 Gg CO_2).

115. The ERT notes that the NIR would greatly benefit from an explanation of the methodology used for estimating the changes in housing stocks over the country as well the source and reliability of the statistics used in this exercise. Moreover, it would be interesting to know how an estimate of changes in stocks of houses compares with a methodology which takes into account round wood production and trade statistics, as well as decay rates of woody construction materials.

4. Cultivation of organic soils

116. CO_2 emissions from organic soils were estimated to have remained constant during the period 1990 to 1999 at 992,250 MgC/yr or 3,638 Gg CO_2. Country-specific factors were used (for example subsidence rates, depending on the crop type, and a constant carbon loss factor). The resulting emission factors by crop type were within the IPCC default ranges for organic soils for cool temperate and warm temperate climates. The breakdown of lands in table 5.D (upland crops and pasture/forests) was different from the one in the NIR (pasture, lay, cereals and row crops) and it was not possible to make a straightforward comparison between the two breakdowns of the related annual loss rates values.

5. Liming – CO_2

117. The IPCC method was followed. CO_2 emissions from liming (limestone and dolomite) were estimated to be 170 Gg CO_2 in 1990 and 156 Gg CO_2 in 1999, with small annual variations due to fluctuations in the amount of lime used.

VI. WASTE

A. Sector overview

118. The waste sector represented approximately 3% of Sweden's emissions in 1999, and there has been a 16% decline since 1990. Emissions increased slightly up to 1992 and reduced by an average of 57 Gg annually after that. The only source categories reported were solid waste disposal on land, which was reported in the waste sector, and waste incineration, which was reported in the energy sector.

1. Completeness and transparency

119. An NIR was submitted which detailed the methodology used for the SWDS. The documentation box was used and gave a brief description of the First Order Decay (FOD) model. It also explained why some additional information was not included.

2. Methodology, emission factors and activity data

120. The IPCC tier 2 FODM was used with default emission factors and a country-specific time series. Activity data came from several sources (the Swedish EPA, Statistics Sweden and the Swedish Association of Waste Management).

3. Recalculations

121. The recalculation tables were completed for all years. There were substantial differences in the 1998 data after recalculation with the tier 2 method (78% in 1998). The ERT recommends that Sweden provide more detailed information on recalculations in its future submissions.

B. Key sources

1. Solid waste disposal on land

122. This was the only source category reported in the waste sector and it was explained in detail in the NIR. All of the comments in the general discussion above thus apply here. The draft S&A report commented upon the lack of data for population numbers and waste generation, the fraction of municipal solid waste (MSW) disposed of, and the fractions of wastes incinerated. These data could have been included, although the Swedish reply that this information was not relevant to the methodology used is noted.

C. Non-key sources

123. No emissions were reported from wastewater handling or for other sources in the waste sector, and this was reported in the completeness tables, as “data not at present available”. Domestic and industrial waste streams were discussed in the NIR although there was very little in the CRF to indicate this discussion or cross-reference. The ERT recommends that Sweden include these source categories in its future emission estimates and that it use correct notation keys to improve the clarity of the inventory.

124. Emissions from waste incineration were reported in the energy sector, because all waste (including toxic waste) incinerated in Sweden is used for electricity and heat production.

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